# UNITED REPUBLIC OF TANZANIA

## MINISTRY OF INDUSTRY AND TRADE

## NATIONAL DEVELOPMENT CORPORATION

**Tender Number: TR185/2024/2025/INV/01**

**FOR**

**ESTABLISHMENT OF SODA ASH PROCESSING PLANT AT ENGARUKA BASIN**

**December, 2024**

## 1.0. Background:

The National Development Corporation (NDC) was established as a statutory body by an Act of Parliament in 1962 and it is wholly owned by the Government of the United Republic of Tanzania. NDC has responsibility for promoting economic development in Tanzania in partnership with the private sector. NDC has several mineral concessions in the country, among which is the Engaruka Basin’s Soda Ash concession. Engaruka Basin is an internally drained Basin which is fed with water from streams, rivers and underground springs flowing from the surrounding volcanic cones and up thrown blocks. Parallel to the inflowing water, is a high rate of evaporation and deposition of clastic sediments which include sand and gravel in the marginal parts of the Basin and fines (clay and silt) in the remaining parts of the Basin. Various studies have been carried out in Engaruka basin in order to be able to fulfill the responsibility of establishing basic chemical industry in the country. In 2008, NDC in collaboration with Geological Survey of Tanzania (GST) conducted preliminary research (Reconnaissance Survey) to determine the presence of Soda ash in the basin. This was followed by drilling exploration study, brine simulation study and water study. Techno-economic (feasibility) and Environmental and Social Impact Assessment studies has been completed in 2021 in which it shows the project is technically and financially feasible. Also, the Environmental Impact Assessment (EIA) certificate has been obtained. The total area of the Engaruka Soda Ash project is 244.82 square kilometres.

## 2.0. Project Location and accessibility

Engaruka Basin is located at Monduli District, Arusha Region. It is 50km northeast of Mto wa Mbu Town and 58km south-east of Lake Natron. The area can be accessed through the Arusha - Kiteto Road, then through Mto wa Mbu to Loliondo road. Arusha to Engaruka basin is about 190km. The bidding blocks are divided into two with the following coordinates shown in tables below:

Table 1: Coordinates of Block North

| Corner | Easting | Northing |
|---|---|---|
| 1. | 179424 | 9664417 |
| 2. | 193324 | 9664417 |
| 3. | 179471 | 9657811 |
| 4. | 193339 | 9657826 |

The area size of block North is 82.08km$^2$.

Table 2: Coordinates of block South:

| Corner | Easting | Northing |
|---|---|---|
| 1. | 184018 | 9657831 |
| 2. | 193339 | 9657826 |
| 3. | 193313 | 9644532 |
| 4. | 185438 | 9650070 |
| 5 | 185413 | 9644685 |
| 6 | 184012 | 9650053 |

The size of South block area is 94.02 km$^2$.

## 3.0. Soda Ash Reserve and Characteristics

Appraisal of the Brine Resources conducted during techno-economic study estimated to be 3,813,320,000m$^3$ of brine with 68.30 and 768.80 million tons of sodium bicarbonate and sodium carbonate, respectively. The brine is replenished at a rate of 17,693,640m$^3$ per year. Also, the samples were laboratory tested locally and abroad. The result shown that the quality of brine is suitable for production of Soda Ash for all usage as shown in **appendix 1**;

## 4.0. Objective

The primary objective is to secure a qualified strategic local or foreign investor to partner with the National Development Corporation (NDC) through Joint Venture Agreement in establishing the Engaruka Soda Ash Extraction and Processing Plant.

## 5.0. Scope of Work

The scope of work includes:

1. Performing a confirmatory study of brine resources using methods such as Electrical Resistivity Tomography (ERT) and Transient Electromagnetics (TEM) or equivalent techniques to design brine extraction boreholes effectively.
2. Conducting brine solution extraction and soda ash processing operations within the mining license owned by NDC.
3. Ensuring adherence to environmental and social protection guidelines in compliance with national laws during all extraction and processing activities.

## 6.0. Eligibility

Eligible bidders must be companies, joint ventures, consortia, or associations with proven experience in the soda ash or related mineral business, equipped with sufficient capital, advanced technology, and established market access. Detailed qualification criteria are outlined in Section 13.0.

## 7.0 Site Survey and Pre-Bid Meeting

1. **Site Visit**:
   - Interested bidders are encouraged to visit and assess the project site and its surroundings.
   - The NDC will organize the site visit to provide bidders with essential information for proposal preparation.
   - The site visit is scheduled for **27-29 January**, 2025 at the Engaruka Basin. Bidders will bear their own costs.

2. **Pre-Bid Meeting**:
    - A pre-bid meeting will be held on **January 29, 2025,** in Arusha, Tanzania, to address bidder queries and provide additional information.

**8.0 Plant Construction**

The successful bidder is expected to complete the construction of the soda ash processing plant within 36 months of contract signing.

**9.0 Clarification of Request for Proposals**

1. Prospective bidders may seek clarifications in writing by contacting the NDC at the below provided address.
2. Enquiries can also be raised during the site visit or pre-bid meeting.
3. The deadline for clarification requests is **7th February**, 2025.

**10.0 Regulatory Compliance**

Successful bidders must comply with the Mining Act, Cap 123, and the Mining (State Participation) Regulations of 2022.

**11.0 Correction of Arithmetical Errors**

1. Errors in totals corresponding to addition or subtraction of subtotals will be corrected, with subtotals prevailing.
2. Discrepancies between words and figures will favor the words unless they result in an arithmetic error, in which case the figures will prevail.

**12.0 Documents Comprising Bid Proposal**

Bidders must submit all documents listed in qualification criteria tables A, B, and C (Section 15.0).

**13.0 Evaluation Scores**

1. Evaluation will aggregate technical and financial scores.
2. The bidder with the highest combined score will be recommended for contract negotiation and signing.

3. As a matter of allocation, the best evaluated bidder will get North block and the second-best evaluated bidder will be allocated South block. However, both blocks have enough soda ash deposits with approved quality.

## 14.0 Commitment Fee

The successful bidder must pay a non-refundable commitment fee of USD 300,000 (or its equivalent in Tanzanian Shillings) before signing the Joint Venture Agreement.

## 15.0 Qualification Criteria

### A. Preliminary Evaluation

| **APPLICANTS MUST SUBMIT CERTIFIED COPIES OF THE FOLLOWING:** |
|---|
| Proof of application fee payment (USD 250 or equivalent in TZS). |
| Valid business license |
| Company profile and physical address |
| Special power of attorney |
| Information on JV members (if applicable) |
| Historical contract performance, including pending and litigation history |
| Declaration of any conflict of interest |

**B: Technical Evaluation (proposed 70% to be distributed in the criteria)**

| CRITERIA | MAXIMUM SCORE (%) |
|---|---|
| **Firm's Experience in similar projects/assignments** | **25** |
| Implementing industrial project | 5 |
| Operating soda ash, related industrial mineral processing plant(s) or a factory that uses soda ash as a raw material | 20 |
| **Market accessibility** | **20** |
| Indicate potential market, support with evidence like consumption level (if a bidder is a consumer) / MoU with potential buyers / forward sales agreement | 20 |
| **Technical approach and methodology to implement the project** | **30** |
| Proposed mining and processing technologies, includes quantity of water and electric power requirements | 15 |
| Understanding of scope of work and project description | 5 |
| Project organization chart and staffing schedule for achieving compulsory obligations | 5 |
| Consideration for establishing of downstream soda ash processing plants in Tanzania | 5 |
| **Proposed project implementation schedule** | **25** |
| Key milestones and activities/tasks | 10 |
| Proposed measure to minimise lead time to project commissioning | 10 |
| Proposed timeframe up to the commissioning stage | 5 |
| **TOTAL** | **100** |

**The Investors who will score above 70% will be considered for nest stage of Financial Evaluation**

**C. Financial Evaluation (proposed 30% to be distributed in the criteria)**

| CRITERIA | MAXIMUM SCORE (%) |
| --- | --- |
| **Proposed custodian fee (%) to be paid to NDC** | 20% |
| Interested bidders will propose the percentage (%) of gross sales (revenue) to be paid to NDC as custodian fee | |
| **Proposed shares (%) to be allotted to NDC** | 20% |
| Interested bidders will propose the percentage (%) of shares to be allotted to NDC in Joint Venture | |
| **Availability and Planned capital for project implementation** | |
| Interested bidders will submit the proposed investment capital and financing plan of the project which will enable production of at least 500,000 tons per annum. | 40% |
| Interested bidders will submit recent three (3) years audited financial statements which will be used to ascertain bidder's liquidity and profitability ratios | 20% |
| **TOTAL** | **100%** |

**17.0 Address for Submission**

The proposal should be submitted to:

National Development Corporation (NDC),

Development House,

6th Floor, Room No. 605,

Kivukoni Front/ Ohio Street,

P.O. Box 2669,

**DAR ES SALAAM**.

E-mail: pmu@ndc.go.tz

# APPENDIX I

# LABORATORY TEST REPORT

# 1 INTRODUCTION

JSC Global Services, based in Tanga, Tanzania, have been involved in brine simulation test at Engaruka basin, sent us this sample on behalf of the National Development Corporation, for laboratory tests. The brine (2 x 10 litre container samples) was sampled from about 90m from a 120m borehole. As the brine was taken from only one sample, it is not clear whether how representative it is with respect to other boreholes, which are known to be as far as 5-7km apart.

The analyses were carried out by Modderfontein Laboratory Services (MLS) for the carbonate, bicarbonate, chloride, sulphate and other items, including metals. Rare earth analysis was carried out by Mintek.

A summary description of the results and methodologies is provided below.

# 2 MODDERFONTEIN LABORATORY SERVICES RESULTS

## 2.1 Analyses Required

Total Dissolved Solids (TDS)
pH
Carbonate
Bicarbonate
Sulphate
Fluoride
Chloride
Nitrate

Total Organic Carbon (TOC)
Sodium
Lithium
Magnesium
Potassium
Calcium

After discussion with MLS, it was agreed that as the use of XRF / ICP would indentify a number of elements, these would be reported as well and are reflected in the table of results.

## 2.2 Sample Description

Ardeer Engineering delivered 2 x 5L samples of brine solution to Modderfontein laboratories.

### *2.2.1 Important features of the sample*

- Condition of the sample
- The Colour of sample and the sample container.
- Anion and cation balance
- Total dissolved solids
- The Carbonate/ bicarbonate result vs. alkalinity.
- Total dissolved carbon
- The density of the sample

#### 2.2.1.1 Sample condition

On opening the container in which the samples were delivered it was noted that the samples had developed a small leak during transit. We can assume about 50 ml of sample was lost.

#### 2.2.1.2 Colour of sample and the sample container

The sample bottles were plastic and it was noted that the bottles were seemingly being attacked by the contents of the bottle, causing a discoloration of the container. It was very evident that as sample was removed from the bottle for analysis a new black line would appear where the meniscus was and darkening of the bottle would occur. Whilst some solids were present in the solution, that could have been the cause of the discoloration, this was not removed by wiping the internal surface of the bottle and hence the conclusion that some attack may have occurred.

[It was subsequently noted from JSC Global that: "The brine was darkish in colour at the time of sampling. It wasn't clear." This may require additional work in the future.]

When the bottle was opened for the first time it was noted that hydrogen sulphide gas was released. A Dräger tube was used to sample the head space and the tube was completely saturated with $H_2S$. The maximum calibration of the tube used is 10 ppm $H_2S$.

The sample was then analysed and the analysis report is included in Table 1.

#### 2.2.1.3 Anion and cation balance

There is a concern on the interpretation of the result due to the fact that there was an excess of around 900me on anions. The major cation that is present is sodium. The sample was re-analyzed by a different method viz. atomic absorption instead of ICP and produced a similar sodium result. The slight variation could be due to the very large dilution that was done to put the sodium in the correct analytical range.

#### 2.2.1.4 Total dissolved solids

The total dissolved solids were initially done by evaporation at 50 C. It was noted that a 50ml sample would not release all the water due to a crust forming on the surface of the sample. A much smaller sample was used and the free water was then easily removed.

It was then decided to carry on drying both the samples to 110°C and 180°C. It was noted that all the water was removed from the larger aliquot at 180°C.

The residue was then pressed into a disk and an XRF scan was done. The TDS results for the 50ml sample at different temperatures are shown below.

| | Brine 50ml sample |
|---|---|
| TDS @ 50 °C | 40.0 % (m/m) |
| TDS @110 °C | 40.5 % (m/m) |
| TDS @ 180 °C | 24.0 % (m/m) |

The sodium does compare well with the previous analysis when taking into account that the sample was concentrated up by a factor of 4.8077.

This confirmed the cations and also confirmed the chloride and sulphur result which only left the carbonate and bicarbonate to be confirmed.

So the dried cake on which the XRF analysis was performed was milled and a sample was taken to analyse for total carbonate.

The final result as sodium carbonate was 71.6% m/m. No bicarbonate was present.

Using the above value for calculation yields a composition using the ratio of $Na_2CO_3/NaHCO_3$ of 7.43/3.17=2.34 from Table 1. Accepting the Chloride number and working back to the original solution obtains the following composition:

| | |
|---|---|
| $Na_2CO_3$ | 11.7% wt/wt |
| $NaHCO_3$ | 5 % m/m |
| NaCl | 2.8% m/m |
| $Na_2SO_4$ | 0.4% m/m |
| KCl | 0.07% m/m |

With this composition the ion balance closes to near 100%.

#### 2.2.1.5 TOC

Initial results showed a high TOC result that could be due to the plastic bottle being attacked by the sample. However, carbonate could also contribute to the total organics carbon if it was not removed with excess sulphuric acid and warmed to remove the $CO_2$. So the COD would be a more reliable result for organics present. The TOC method has revised and the excess carbonate was neutralized with dilute sulphuric acid excess and the $CO_2$ was removed by gentle heating. The result was < 200ppm C.

#### 2.2.1.6 Density

The density was determined by using the Anton Paar density meter. This gives an extremely accurate result.

#### 2.2.1.7 Crystallisation Study

Although it was envisaged that a crystallisation study would be carried out, the difficulties observed with evaporating / drying the samples lead to a re-evaluation of this in terms of timing and difficulty of obtaining meaningful results. It was therefore decided that this should be placed on hold for the time being and incorporated into the main study, if this proceeds.

Table 1

| | Brine 20130939 |
|---|---|
| pH | 9.9 |
| Nitrate (as N) | < 1 ppm (m/m) |
| Density | 1.2098 g/cm³ @20 °C |
| Sulphate (as SO4) | 3030 ppm (m/m) |
| Chloride (as Cl) | 16360 ppm (m/m) |
| Silver (as Ag) | 0.2 ppm (m/m) |
| Aluminium (as Al) | 0.7 ppm (m/m) |
| Arsenic (as As) | 0.6 ppm (m/m) |
| Boron (as B) | 28 ppm (m/m) |
| Barium (as Ba) | 0.9 ppm (m/m) |
| Beryllium as Be | <0.01 ppm (m/m) |
| Bismuth (as Bi) | 5.1 ppm (m/m) |
| Calcium (as Ca) | 2.6 ppm (m/m) |
| Cadmium (as Cd) | <0.04 ppm (m/m) |
| Cobalt (as Co) | <0.04 ppm (m/m) |
| Chromium (as Cr) | <0.03 ppm (m/m) |
| Copper (as Cu) | 0.2 ppm (m/m) |
| Iron (as Fe) | 0.8 ppm (m/m) |
| Mercury (as Hg) | 2.1 ppm (m/m) |
| Potassium (as K) | 357 ppm (m/m) |
| Lithium (as Li) | <0.005 ppm (m/m) |
| Magnesium (as Mg) | 2.6 ppm (m/m) |
| Manganese (as Mn) | 0.5 ppm (m/m) |
| Molybdenum (as Mo) | 0.2 ppm (m/m) |
| Sodium (as Na) | 75984 ppm (m/m) |
| Nickel (as Ni) | <0.5 ppm (m/m) |
| Phosphorus as P | 118 ppm (m/m) |
| Lead (as Pb) | 0.4 ppm (m/m) |
| Antimony (as Sb) | <1 ppm (m/m) |
| Selenium (as Se) | 2.9 ppm (m/m) |
| Tin (as Sn) | 2.7 ppm (m/m) |
| Strontium (as Sr) | <0.4 ppm (m/m) |
| Titanium (as Ti) | 9.1 ppm (m/m) |
| Vanadium (as V) | 0.6 ppm (m/m) |
| Tungsten (as W) | 1.2 ppm (m/m) |
| Zinc (as Zn) | 0.1 ppm (m/m) |
| Zirconium (as Zr) | 3.5 ppm (m/m) |
| Fluoride (as F) | 496 ppm (m/m) |
| Ammonia (as N) | 41 ppm (m/m) |
| Sodium Carbonate | 13.3 % (m/m) |
| Sodium Bicarbonate | 5.7 % (m/m) |
| Sodium (as Na) | 81440 ppm (m/m) |
| TDS @ 50 °C | 26.4 % (m/m) |
| TDS @110 °C | 22.1 % (m/m) |
| TDS @ 180 °C | 20.8 % (m/m) |

# 3 MINTEK RARE EARTH ANALYSIS

Both the liquid and solids in the sample were analysed.  The results are shown in the tables below.

MINTEK
Specialists in mineral and metallurgical technology

200 Malibongwe Drive
Randburg
2125

**ANALYTICAL SERVICES TEST REPORT**

**Mass Spec Section**

Sheet No. / ID: INT13731A
Project No: ASC-00000040-10
Date Received: 30/10/2013
Date Authorized: 14/11/2013
Samp. Type: LIQUID
Method: MS
Customer: Mr. David Hill
Address: Ardeer Engineering (Pty) Ltd
P.O. Box 14, Modderfontein, 1645
E-Mail: hilld@ardeer.co.za; russelld@ardeer.co.za

MS_RARE_EARTH_SLN

| Sample Name | nls DESCRIPTION | Rep | | Ce | Dy | Er | Eu | Gd | Ho | La | Lu | Nd | Pr | Sm | Tb | Tm | Y | Yb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm |
| INT13731A/1 | NaHCO3/NaCO3/NaCl brine sample1 | | | 23.0136 | **0.77** | <1 | 0.27 | 0.97 | 0.15 | 12.4873 | <0.1 | 7.87 | 2.17 | 1.29 | 0.18 | <0.1 | 3.27 | 0.31 |
| INT13731A/1 | NaHCO3/NaCO3/NaCl brine sample2 | | | 24.2522 | **0.86** | <1 | 0.29 | 1.10 | 0.17 | 10.4777 | <0.1 | 8.97 | 2.26 | 1.45 | 0.21 | <0.1 | 3.70 | 0.39 |
| BLANK | | 1 | | 0 | **0.32** | <1 | 0.12 | 0.36 | <0.1 | 2.0 | <0.1 | 2.3 | 0.60 | 0.51 | <0.1 | <0.1 | 1.2 | 0.16 |

xxx

COMMENTS

Authorized by:
FRANSMA
The...

The results relate only to the items tested

Accredited : ASD-MET-OES-SP005;ASD-MET-AAS-SP001;ASD-MET-C16/26;ASD-MET-C06/37;ASD-MET-SPT006;ASD-MET-SPT007;
ASD-MET-SPT008;ASD-MET-FA002;ASD-MET-XRF002;ASD-MET-XRF004;ASD-MET-XRF019

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**ANALYTICAL SERVICES TEST REPORT**

**Mass Spec Section**

Sheet No. / ID: INT13731AA
Project No: ASC-00000040-10
Date Received: 30/10/2013
Date Authorized: 14/11/2013
Samp. Type: SOLID
Method: MS
Customer: Mr. David Hill
Address: Ardeer Engineering (Pty) Ltd
P.O. Box 14, Modderfontein, 1645
E-Mail: hilld@ardeer.co.za; russelld@ardeer.co.za

MS_RARE_EARTH

| Sample Name | nls DESCRIPTION | Rep | | Ce | Dy | Er | Eu | Gd | Ho | La | Lu | Nd | Pr | Sm | Tb | Tm | Y | Yb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm |
| INT13731AA/1 | NaHCO3/NaCO3/NaCl brine sample1 | | | >120 | **7.5** | 4.0 | 3.9 | 11.3 | 1.5 | >120 | <1 | 110 | 35.1 | 16.4 | 1.5 | <1 | 34.0 | 3.2 |
| INT13731AA/1 | NaHCO3/NaCO3/NaCl brine sample2 | | | >120 | **7.6** | 4.0 | 3.9 | 11.4 | 1.5 | >120 | <1 | 116 | 36.2 | 16.5 | 1.6 | <1 | 33.5 | 3.5 |
| BLANK | | 1 | | <1 | **<1** | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| ACC.VALUE | | 1 | | <1 | **<1** | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |

xxx

COMMENTS

Authorized by:
FRANSMA
The...

The results relate only to the items tested

Accredited : ASD-MET-OES-SP005;ASD-MET-AAS-SP001;ASD-MET-C16/26;ASD-MET-C06/37;ASD-MET-SPT006;ASD-MET-SPT007;
ASD-MET-SPT008;ASD-MET-FA002;ASD-MET-XRF002;ASD-MET-XRF004;ASD-MET-XRF019

# APPENDIX II

# FEASIBILITY STUDY

**NATIONAL DEVELOPMENT CORPORATION**

# "TECHNO-ECONOMIC STUDY FOR SODA ASH PROJECT AT ENGARUKA IN MONDULI DISTRICT, ARUSHA REGION"

## PROJECT REPORT SUMMARY

**Submitted by:**
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P. O BOX 23235, Dar es Salaam, Tanzania,
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**May 2021**

# ACKNOWLEDGEMENT

On behalf of the Tanzania Industrial Research and Development Organisation (TIRDO), I'm grateful to the Government of the United Republic of Tanzania through National Development Corporation (NDC) for trusting and financing TIRDO to undertake the Techno-Economic Study for Engaruka Soda Ash Project in Monduli District, Arusha Region.

TIRDO would also like to thank the following Government Institutions for their valuable contributions to this study: Tanzania Mining Commission, Geological Survey of Tanzania (GST), The University of Dar es Salaam (UDSM), Mbeya University of Science and Technology (MUST), Internal Drained Water Basin (IDWB), and Chartered Institute of Logistics and Transport (CILT).

Special thanks to lead experts: Prof. Abdulkarim Mruma from Tanzania Mining Commission, Prof. Wineaster Anderson, Prof. Beatus Kundi and Prof. Abraham Temu all from the University of Dar es Salaam, Dr George Makuke from Chartered Institute of Logistics and Transport, Eng. Crowdrick Ruvunduka from Mbeya University of Science and Technology, and Mr. Salim Lyimo from the Internal Drained Water Basin, and many others who worked with these experts in undertaking the study.

In addition, we thank the NDC Management led by the Ag. Managing Director Ms. Rhobi Sattima, the Late Managing Director Prof. Damian Gabagambi, the project leader Dr. Yohana Mtoni and the Monitoring and Evaluation (M&E) team led by Prof. Hudson Nkotagu for their valuable expert contributions to this study. With his strong leadership, the Late Prof. Damian Gabambi, ensured that this task received the required support, the fruits of it, he could not live to witness. May the Almighty God Rest His Soul in Eternal Peace, Amen.

Furthermore, we thank the Arusha Regional Commissioner, Arusha Regional Administrative Secretary, Monduli District Commissioner, Monduli District Executive Director, Engaruka Ward Secretary, Village Chairpersons for Engaruka Juu, Irerendeni, Engaruka Chini, and Donanyoo and without forgetting the Project site guide Mr. William Martin.

I thank the Ministry of Industry and Trade and the Office of the Treasury Registrar for their guidance, trust, support and encouragement throughout the execution of this task. With their support, TIRDO was entrusted to undertake this unique exercise.

Finally, we would like to thank the entire TIRDO technical team lead by Eng. Dr. Raphael Isingo, Eng. Dr. Lugano Wilson, Dr. Julius Elias, Eng. Liberatus Chizuzu, Eng. Athanas Ntawanga, Mr. Jacobson Kisiwa, Eng. Baraka Manyama, Ms. Kunda Sikazwe, Ms. Jacquilene Mwenda, Ms. Latifah Musa and Mr. Ally Massawe for their inputs to this study

**Prof. Madundo M. A. Mtambo**
Director General – TIRDO
20th May 2021

# CONTENTS

# 1 INTRODUCTION

## 1.1 Background to the Project

The Government is currently implementing a strategic industrialisation programme as the main catalyst to transform the economy, generate sustainable growth and reduce poverty. The strategy is targeting to have industries based on local resources. One of the areas that have been given a priority is the establishment of soda ash plant, through utilising the abundant natural soda ash deposits available at Engaruka Basin.

The National Development Corporation (NDC) is a Government institution, which has a broad mandate in stimulating industrialization in partnership with private sector. NDC holds three (3) prospecting licences (PLs) within Engaruka Basin located in Monduli District covering a total area of $132km^2$. In the year 2008 through 2013, NDC has conducted soda ash exploration within the basin, which involved borehole drilling and preliminary simulation studies on soda ash recovery. The results of the studies were very promising with brine resource estimation, indicating the presence of about 4,680,000,000 $m^3$ of brine equivalent to 1.4 billion tonnes of salts of which 982 million tonnes is soda ash.

The Government has entrusted NDC to fast track the recovery of soda ash for the development of chemical industries in the country. NDC, in partnership with strategic investor(s), intends to establish a soda ash recovery plant with the initial capacity of 500,000t/y, eventually expanding to 1,000,000t/y of soda ash and other by-products.

In that regard, NDC appointed Tanzania Industrial Research and Development Organization (TIRDO), a Government institution mandated to assist the Tanzania industrial sector by conducting applied research, providing technical expertise and support services, to conduct a comprehensive techno-economic study for establishment of economically, environmentally and socially sound soda ash recovery plant at Engaruka, including associated infrastructures.

## 1.2 About Soda Ash

Soda ash is a common name for sodium carbonate, an inorganic compound with a chemical formula $Na_2CO_3$ and its various hydrates. It is an important ingredient in manufacturing of: all kinds of glasses, detergents, and industrial chemicals. It is used in water treatment, textiles processing, flue gas desulphurisation and mineral processing among other several uses.

Soda ash can be produced by synthetic method or from natural deposits. Synthetic soda ash is mostly manufactured by the Solvay process, whereas natural soda ash is mainly recovered from natural deposits such as trona or from sodium carbonate-bearing brines. The recovery process from natural soda ash is less energy-intensive and emits less green-house-gases (GHGs), however it is limited to the availability of such deposits worldwide and the presence of impurities, which require extra processing to obtain 99.5% and above soda ash purity. Beside Tanzania's deposit, the world's largest natural soda ash deposits are found in the Green River Basin, Wyoming in USA. Other natural deposits are found in China, Kenya, Botswana, Mexico, Peru, India, Egypt, and Turkey.

# 2 OBJECTIVE AND SCOPE OF THE TECHNO-ECONOMIC STUDY

## 2.1 Objectives

The main objective is to carry out a techno-economic study for the establishment of economically, environmentally and socially sound soda ash plant at Engaruka including associated/related infrastructures. The techno-economic study will inform the Government on the quantity and quality of the resource, the appropriate and the most economical technologies to be used for the recovery. The report will also be used for mobilization and soliciting of required resources (human capacities, technology and capital) for the project in a form of PPP.

## 2.2 Scope

The Techno-Economic Study was divided into several multi components as detailed in the given Terms of Reference (ToR) in **Appendix I**.

# 3 APPROACH AND METHODOLOGY

Activities involved the following:

a) Literature review, field works (geological investigations, geophysical survey, topographical survey, and pumping tests), sampling and analysis of rock, soil and water samples, data processing, map preparation, resource modelling and estimation of the brine resources.
b) Literature reviews, Consultations, Site visits, desk works reviews, online survey, and field visits to get information related to the demand and supply of soda ash products.
c) Desk study, literature review, and characterisation of brine samples to assess and determine the best effective method for extraction. Conduction of materials and energy balances for the determination of the values and composition of process streams and the energy requirements.
d) Site visits, analysis of information, and desk studies to develop project engineering design and detailed investment cost estimates of plant and machinery.
e) Site visits, site works, analysis of information obtained from various areas, to develop relevant site maps, architectural designs of buildings, and performing detailed investment costs.
f) Desk study, field research, rapid appraisal methods, data analysis for the determination of the optimum transportation modes for soda ash and raw materials.
g) Desk study, field work, interviews, mobilizing and review of inputs from other teams, and financial modelling in appraisal of the project.
h) Desk study, field work, interviews and consultations with MDA for the ESIA study.

# 4 REPORT PRESENTATION AND LAYOUT

This study report is presented in nine volumes (Volume I to Volume IX) of individual reports. Each volume is an independent study component which is part of the Techno-Economic Study. The layout of the report is presented as follows:

| No. | Volume | Study Component |
|---|---|---|
| 1. | Volume I | Appraisal of the Brine Resources |
| 2. | Volume II | Market Study |
| 3. | Volume III | Soda Ash Technological Assessment |
| 4. | Volume IV | Soda Ash Project Engineering Design |
| 5. | Volume V | Assessment of Availability of Plant Utilities |
| 6. | Volume VI | Plant and Township Sites Selection and Infrastructures Design |
| 7. | Volume VII | Soda Ash Transport Logistics |
| 8. | Volume VIII | Project ESIA Study |
| 9. | Volume IX | Soda Ash Project Appraisal |

# 5 PROJECT RESULTS

## 5.1 Appraisal of the Brine Resource

Engaruka Basin is covered mostly by superficial deposits of recent volcanic origin consisting of tuffaceous beds, alluvial, outwash materials and alluvium including mbuga. The basin is surrounded by volcanic mountains such as Kerimasi, Essimingor and Burko. Kerimasi Mountain has volcanic rocks mainly composed of carbonatitic composition while Essimingor and Burko mountains have rocks with nepheline syenite and ijollite composition. Rivers and streams, most of them seasonal, flow into the Engaruka Basin from all directions bringing in additional salts (originating from the volcanic rocks) into the brines hosted in the aquifers.

Through logging of core and reverse circulation rock chips from Engaruka Basin conducted from year 2011 through 2013, and the current appraisal study, the Basin is composed of the four stratigraphic units of various thicknesses. These layers are dominated by clay, fine sand, course sand and salt layers and thick layer of crystalline salts (mostly sodium carbonate and sodium bicarbonate) from the surface up to 200 meters deep.

Logging of exploratory boreholes and interpretation of VES measurements reported the presence of two types of aquifers. Sampling and analysis of brines hosted in the sediments of the Engaruka Basin during appraisal revealed that the brines are rich in sodium bicarbonate and sodium carbonate ranging from 12.0g/l to 25.49g/l and from 125.93g/l to 245.92g/l, respectively.

Rock and soil samples representing lithological units contained in and around Engaruka Basin were sampled and analysed (mineralogical and chemical analysis). It was realized that the rocks and soils are dominated by $Na^+$ and $Ca^{2+}$ rich volcanic minerals including aegirine-augite, plagioclase, hedenbergite, carbonates and salts (mostly trona).

VES interpretation reveals zones with low resistivity located at depths not exceeding 35 meters below the surface. Resource modelling of VES results using Leapfrog Geo Software identified six (6) stratigraphic units: clay, upper sand clay, sand with brine, low sand clay – sand with brine, alluvial sediments and undefined sediments. The low resistivity wireframe (sand with brine wireframe) was used to estimate the brine resource block model.

Pumping test of boreholes was done in order to determine aquifer characteristics that are necessary for resources estimations. Six (6) boreholes (BH5, BH6, BH12, BH13, BH-U1 and BH-U2) were subjected to pumping test. Pumping test for borehole BH5 drilled to 110m depth yielded a discharge capacity of 61.5m$^3$/hr of brine and 62.94m$^3$/hr for the previous tests conducted in 2013 and during this appraisal, respectively.

Airborne and ground geophysical data revealed the presence of NW-SE trending magnetic low anomalies. These are interpreted to represent deep-seated faults which could be conduits for recharging the acquirers in the basin. However, some of these fractures could also be conduits for draining the basin aquifers.

Brine resource estimates conducted in 2013 covering the study area of 234km$^2$ at Engaruka Basin indicated the presence of about 4,680,000,000m$^3$ of brines equivalent to 1.4 billion tonnes of salts of which 982 million tonnes is soda ash. The rate of brine replenishment was estimated to be 1,875,000$m^3$/yr. Re-evaluation of resources in this appraisal exercise was able to cover only 153.146$km^2$ of the Basin. The total volumes of brines in the licensed areas of NDC that fall in the Engaruka Basin is estimated to be 3,294,704,894$m^3$ of brine with 59.00 and 664.24 million tonnes of sodium bicarbonate and sodium carbonate, respectively.

**Challenges:**

a. Despite of promising results of presence of abundant brine resource, it has to be noted that in most of the covered areas the 3D resource model are poorly supported. There were insufficiently close spaced boreholes, insufficient number of boreholes; distantly closely spaced VES data that corresponds with the big size of the basin and good quality pumping test results. In addition, the boreholes and VES measurements penetrated the sediments only up to 200 meters deep while Engaruka Basin is much deeper. These 200 meters depth were extrapolated over the entire area to obtain Inferred Resources.
b. Five (5) exploratory boreholes were missing at their respective positions as reported during the study conducted in 2011 – 2013. In addition, one (1) borehole was covered under the lake hence was not accessible. Furthermore, six (6) boreholes were vandalised and were not tested. Some of the reported boreholes had less depth than the actual drilled depths. Some of the boreholes were located outside NDC PLs, Thus, their resource data were not used and has affected the appraisal exercise.

Apart from the afore-mentioned challenges, the combined discharge of all pumped boreholes at a tested capacity of 171.805$m^3$/hr yielded normal drawdown thus indicating presence of good productive aquifers.

**Recommendations:**
From the above mentioned shortfalls encountered during the brine resource appraisal, it is recommended that:

a. Drilling of additional exploratory cum production boreholes to depths of not less than 300m should be undertaken in order to facilitate accurate assessment of aquifer properties before, during and after drilling. Representative water samples for each aquifer should be collected in this exercise to allow determination of proper composition of brine in each aquifer. The same boreholes can later be used as production boreholes.
b. Establishing meteorological weather station and conducting proper estimation of recharge rate using available standard techniques.

### 5.2 Market Analysis

The main objective of carrying out the market study analysis is to establish the market trends for soda ash demand and supply in Tanzania, East Africa and globally. Critically, the market analysis identified key market areas in the soda ash value chain while focusing on the drivers that impact supply and demand for soda ash in the future; and identified market for soda ash by quantifying the demand for each segment currently and in the future.

Since Soda ash is an important ingredient in manufacturing of all kinds of glasses, production of detergents, industrial chemicals, water treatment, textile industries, flue gas desulphurization and mineral process the market analysis also looked at how the chain value may be economically viable. Globally, at least 50% of the main users of soda ash constituted glass industries during the past two years. According to the International Glass, the glassmaking industry used 53% out of the 60 million tonnes of soda ash which was produced in the year 2019.

Globally, the Market trend shows that China in 2018 represented the largest consumer of soda ash globally, accounting for 41.6% of the total soda ash market. China was followed by Asia- Pacific (Excluding China) (21.7%), Europe (13.0%), North-America (12.1%), Middle East and Africa (6.9%) and Latin America (4.7%). Prices of Soda ash are increasing in the World due to increased demand which does not match with the supply. The price of soda ash has been increasing at a CAGR of 0.84% during 2011-2018, reaching a value of around US$ 301 per ton in 2018.

Exports of soda ash in the EAC reached 342,780 tonnes in 2017 and declined to 289,350 tonnes in 2018. Kenya is the main exporter of Soda Ash in the region. Kenya export soda ash dense and main destination is in India following investment of Soda Ash plant by an Indian investors, TATA Chemicals. Based on the 2018 data of imports trend for EAC, the importation of Soda Ash is below 60,000 tonnes per year. The largest importer of Soda Ash is Tanzania with about 40,000 tonnes per year, followed by Uganda which imports about 15,000 tonnes per year. Based on the 2014-2018 trade indicators, average price per ton for imported soda ash was US$ 302.

In market estimation the Engaruka soda ash production of 500,000 tonnes per year has been considered and design is reasonable to meet the demands for local, regional and the international markets. It is estimated that the exports of soda ash is likely to be 87% of the total produce. The local market is expected to absorb 13% to 30% at the end of the year 2030 given a sound promotion of local industrial uses of the soda ash as suggested in this market plan analysis. The main consumers in the local market will be glass as well as soap and detergent industries, which absorb more than 60% of the current soda ash, as it is the trend in the global soda ash market.

Tanzania soda ash project in Engaruka has several competitive advantages for soda ash as compared to other competing producers such as Kenya and Botswana, especially when we take into account a number of variable factors such as location, access to markets, logistics and supporting infrastructure for the industrial establishment.

Sales of the Engaruka soda ash are expected to be of direct sales from the manufacturing or area of production to the export market and large scale Project Company owned by the investors of the plant who will use soda ash in feed stock. Also, sales will be realised through distributors where by local companies other than investors companies will need to buy from a distributor.

In general Soda ash has high demand both in the local and international markets. Its market is majorly driven by the growing demand for end-user industries. The government efforts staging strategically to promote the Tanzanian Industrial Development Era popularly known as *Tanzania ya Viwanda*, need to be re-aligned with the industries that consume locally available inputs to promote local content) thus, the need to prioritize the proposed areas (industries and geographical wise).

## 5.3 Soda Ash Technological Assessment

This study on soda ash technological assessment was to establish the appropriate and most economical methods for extraction and processing of soda ash from brine. Initial target is to produce 500,000tonnes/yr of high quality (above 99.6%w/w) soda ash and sodium bicarbonate.

The raw material is natural soda ash deposit which occurs naturally as brine or solid crust under Engaruka Basin. The solar salt pond technology among others was evaluated in respect to its application for processing of brine to recover soda ash and table salt. Product from solar method requires further purification by re-dissolving of the salt to obtain brine. Since Engaruka brine is in a saturated state and in contact with the solid crystals, re-slurring of the salt from the solar ponds for further purification of the obtained crude salts is a repetition process raising the capital investment.

This study has evaluated and selected the carbonation process as the suitable process for production of soda ash from Engaruka Basin. The process involves treatment of filtered brine with carbon dioxide gas in carbonation towers to convert the sodium carbonate ($Na_2CO_3$) in solution to less soluble sodium bicarbonate ($NaHCO_3$) which precipitates out. The precipitated sodium bicarbonate salt is separated from the mother liquor by hydro-cyclone and filtration. The recovered salt is washed, dried and a fraction of this product is marketed as sodium bicarbonate. The major faction is calcined to convert the sodium bicarbonate to light soda ash. Finally, the light soda ash is compacted in roller mills to convert it into dense soda ash pellets or it is steamed to produce fine dense soda ash.

Wastes generated in the carbonation process in large quantities are the mother liquor, used process water, and mud sludge. Additionally, 49,500tonnes of carbon dioxide will be generated annually from the calcination process, which will be recycled back to the carbonation unit. Low concentration of table salt in the brine, entails evaporation of large quantity of water to recover it with other salts as well. This makes the recovery process of table salt uneconomical when compared with recovery process of table salt from sea water.
Other raw materials required for the production of soda ash are: fresh water, liquid carbon dioxide, flocculating agents, coal for steam generation, hot air for drying, water treatment chemicals and product packaging materials.

## 5.4 Soda Ash Project Engineering Design

Project Engineering Design was carried out to assess and carry out preliminary design of plant and machinery for production of soda ash. This included selection and sizing of process equipment, designing brine pumping system and settling/storage ponds, as well as specifying steam and power generation systems. It also provided estimates for purchasing and installing major pieces of equipment involved.

The plant with a rated/operating capacity of 500,000 tonnes per year of soda ash and sodium bicarbonate was designed. However, in order to cater for wear, flow variances, and calculation errors and other safety reasons, the plant is designed for the capacity of 550,000 tonnes per year (10% in excess of the rated capacity). The plant has been designed to produce three products in the proportions in brackets, namely sodium bicarbonate (10%), light soda ash (20%) and dense soda ash (70%). In addition, steam will be generated using a coal fired boiler and subsequently generating 15 MW of electricity.

The purity of the sodium bicarbonate produced is 99.6%, while light soda ash has a purity of 99.6% and the dense soda ash has a purity of 99.4%. Specifications for all the major equipment and machinery required for the soda ash plant have been given. In addition, a list of potential equipment suppliers as well as complete soda ash plant vendors has been prepared.

The estimated cost for the plant including fixed plant cost, steam and power generation, brine pumping and a dedicated power line from TANESCO is about USD 3.1m. These estimates do not cover design and construction of factory buildings and other plant associated infrastructure. The design presented a preliminary one; it is a front-end engineering design (FEED). The actual plant will require a detailed design of the plant and machinery, fabrication of the major units, design and construction of foundations for the major units, installation of all units and accessories, testing and commissioning of the plant. It is recommended to implement these activities as a turnkey project.

### 5.5 Assessment of Plant Utilities

Assessment of plant utilities was carried out to investigate supply options for water, power and fuel for the proposed Engaruka soda-ash plant project.

Estimation of water required for the project was done by calculating water required by each section/unit in the plant. The sections/units are the soda-ash plant (for processing the soda-ash and sanitation requirements within the plant premises), community and landscaping uses. Water required by the plant was estimated based on the recommended soda-ash production process, installed plant capacity and/or production rate. The water requirement was estimated at 903m$^3$/day. The investigation of water sources was carried for surface, groundwater sources and rain harvesting option at the vicinity of the project area.

Sample collection and water quality analysis was carried by Ngurdoto Research Water Laboratory and it was recommended to use two water sources, the Engaruka River and Lositete springs to supply the Engaruka project. As the sources are located at different sides of the project area, each source shall have its own route and facilities to reach the project area. Therefore, the engineering design was made from the two water sources to the project site. The designs include intakes (at each source), pressure break tanks and topographical survey for pipeline and storage tanks. The survey carried out under the proposed project is sufficient for detailed design and prepare investment cost. The cost for supply of water is estimated at about USD 1.86m.

The project power supply is recommended to be from the TANESCO National Grid and self-generation from coal fuel. Coal will be transported from Southern Tanzania coal mines to the generating station (Engaruka). Unlike gas and oil, coal is abundantly available and easily transportable to Engaruka site.

### 5.6 Plant Site Selection and Infrastructures Design

The study on Plant Site Selection was to make assessment of most suitable areas for the development of plant buildings and township buildings for the soda ash project. The study analysis included selecting the most scoring criteria among the three selected options for plant site and township.

The criteria for selecting the most suitable township and plant site included but not limited to ecological factors, assessment of physical outlook of soil degradation; flooding history for project area, geological situation of the area and reports from other studies such as; Plant and machinery design, Technology assessment, ESIA, Transport logistics and Brine resource assessment..

Township buildings were designed based on arts of township layout and historical background of project area. Project area is located in the seismic area of the Rift Valley on which the most preferable buildings are single storey. Residential buildings were designed based on the staff cadre hierarchy.

In the proposed area, different social services and amenities have been considered. The estimated bill of quantities (BOQ) for the plant buildings and township is about USD. 15.3m.

### 5.7 Soda Ash Transport Logistics

Soda ash transport logistics study was undertaken to assesses, evaluate and come up with an optimal modal mix in terms of cost effectiveness for movement of soda ash products and raw materials. The project is envisaged to transport initially 500,000 tonnes per year of soda ash for marketing and raw materials such as coal and liquid carbon dioxide for production operations.

The project site is located in a very remote area with neither road nor rail connectivity making transport logistics one of the big challenges facing the project in as far as movement of construction and raw materials as well as finished goods. Thus, transport logistics requires critical assessment and in this regard it has been done and identified as one of the major component for the project viability and making it success.

The study has revealed that, for smooth movement of the project cargo during the initial period and thereafter, the transport logistics analysis has been recommended the following:

a. An 18km tarmac road to sustain effective movement of heavy vehicles be constructed from ECVC to the plant site because at the moment there is no accessible road at all. This would cost about USD 8.22m
b. Upgrading to tarmac phase of the road from Mto wa Mbu to Loliondo and be completed at least to Engaruka Junction to allow flexibility of using either Mto wa Mbu or Longido to reach the plant site. Since currently the work is so far in progress, therefore the cost is already provided for by the government.
c. Upgrading to tarmac phase of 95 km road from Moshi to Longido as an alternative route in case of any emergency. The estimated cost would be USD 43.4m and
d. Construction of a railway line from Arusha to the plant site based on the American Railway Engineering and Maintenance of Way Association (AREMA) standards should be done as already planned. The “all rail” option is the most cost effective mode of transport and would make Soda Ash which is produced at Engaruka more commercial competitive in both local and foreign markets. According to the available estimates the 54 km stretch from the main line to Engaruka plant site would cost USD 278.0m.

### 5.8 ESIA Study

The Government of United Republic of Tanzania through National Development Corporation (NDC) is undertaking Techno-Economic Study (TES) for the establishment of Engaruka Soda Ash Project (ESAP) with a capacity of producing 500,000 million tonnes per year at start. The proposed project is strategically located in an area of about 25,000 hectares at Engaruka basin in Monduli District, Arusha region, Tanzania. However, only 100 ha (i.e. only 0.4%) will be covered by the soda ash project facilities.

The project design covers brine extraction and soda ash processing plant and associated project components. The associated project components include: brine’s extraction wells, pipelines (to transfer extracted brine from boreholes to the plant’s storage ponds), administrative offices, brine holding ponds, power substation, boiler and generator shed, solid waste collection facilities, water storage tanks, wash rooms, car packing area, fence and living accommodations for staff.

This ESIA study was done in compliance with Tanzania’s environmental laws and regulations as well as the World Bank Policies and International Finance Corporation (IFC) Performance Standards on Environmental and Social sustainability. During the study environmental, socio-economic and cultural impacts associated with the proposed project were identified, assessed and predicted and their respective mitigation measures were proposed. These include impacts on land use (i.e., blocking of footpaths, wildlife corridors, hunting blocks, grazing areas, loss of pasture land); accidents due to increased road traffic; impact on water resources, flora and fauna, air and water quality and natural habitat. Therefore, the management of the identified negative impacts will require implementation of the necessary mitigation measures together with the possible remedial options as detailed in the Environmental and Social Management Plan (ESMP)

## 5.9 Project Appraisal

The main objective of the appraisal component of the study was to assess the overall financial and economic viability of the Engaruka Soda Ash Project (ESAP). The component has addressed the aspects of: human resources requirements and costs; projected project revenues and costs; financial appraisal in terms of profitability, internal rate of return (IRR), net present value (NPV) and payback; project financing; economic analysis; and risks & mitigation measures.

This report has analysed and proposed the relevant business functions and organisational structure, manning levels, skills requirements, and HR cost estimates. Best practices require three different levels of functions for delivering business results - high-level demarcation of functional roles in the business. These are the Plan and Govern Level; Produce and Deliver Level and Service and Support Level. Proposed organization structure consists of 5 departments: Production and Technical Services; Sales, Marketing and Logistics; Resource Supply, Monitoring & Evaluation; Health, Safety and Environment; and, Corporate Services. A total of 223 staff will gradually be employed by ESAP.

ESAP is a mega project which will require a total US$ 367.1 million to operationalise, over and above the strategic value of the brine resources. It is proposed to be a joint venture involving the Government of Tanzania (GoT) and a Strategic Investor (SI) owning the project in 49:51 ratio. The GoT contribution to the project will be in the form of the huge and strategic soda ash deposits, land and other natural resources surrounding the project area. The SI investment will be in the form of equity investment to facilitate the acquisition of relevant project equipment and infrastructures as well as arrangement of debt financing to ensure that ESAP takes off in 2025. A debt to equity ratio of 67:33 to fund the project is recommended.

The project will be financially viable and bankable as follows:

- ESAP Net Present Value (NPV) will be US$ 335.1 million.
- ESAP Internal Rate of Return (IRR) is 19.7%.
- ESAP Payback Period is 5 years.

The economic analysis has dwelt on Value added generated; Foreign exchange effect; Employment creation; Balance of payment; Social opportunity costs; Externalities; Cost Benefit analysis and Ratios. The findings have established that the project has substantial socio-economic benefits including employment generation, contribution to value added, generation of foreign exchange and other community level impacts including improvement in social services. Though there are as well, social opportunity costs and externalities associated with the project, but the benefits outweigh costs.

The cost-Benefit analysis has revealed that this project is economically viable. At a discounting rate of 10%, the project generates the ENPV of US$ 1,763 million. At a social-discounting rate of 5%, the ENPV is even higher at US$ 3,226 million. In addition, the Benefit-Cost Ratios are high (greater than 1), ranging from 3.8 to 4.9 when the discounting rate is varied from 10% to 5%. This is a clear indication that the project benefits outweigh costs. On the other hand, the Economic Rate of Return (ERR) is 0.6% which is lower than the discount rate but this was expected since this analysis involves social aspects with limited returns as compared with commercial ones.

The Comparison of two cases (*With the Project* and *Without the Project*) tells that by having the project, the community and country as a whole will benefit more than if the project is not implemented. The project is both financial and economically viable and is recommended for implementation.

# 6 APPENDICES

## 6.1 Terms of Reference for Techno-Economic Study

**NATIONAL DEVELOPMENT CORPORATION**

**PROPOSED TERMS OF REFERENCE (TOR) FOR TECHNO-ECONOMIC STUDY FOR ESTABLISHMENT OF SODA ASH PLANT AT ENGARUKA IN MONDULI DISTRICT, ARUSHA REGION**

### 1.0 BACKGROUND

The National Development Corporation (**NDC**) was established as a statutory body by an Act of Parliament in 1962, wholly owned by the Government of the United Republic of Tanzania, charged with responsibility of promoting economic development in Tanzania in partnership with the private sector.

Tanzania is endowed with huge deposit of soda ash at Engaruka Basin in northern part of Tanzania about 190 km north-west of Arusha town. The Engaruka Basin is located about 58 km south-east of Lake Natron in the East Africa Rift Valley System. The basin is very flat area extending for about 18 km in a north-south and 13 km in an east-west direction. It is an internally drained basin which is fed by water from streams, rivers and ion-rich underground springs flowing from the surrounding volcanic cones and up thrown blocks.

NDC has conducted a drilling exploration and preliminary brine simulation at the Engaruka Basin. Based on the size of the basin and the thickness of the aquifer, it is estimated that there is a total of 4,680,000,000 $m^3$ of brines in the basin. This brine is being replenished at a rate of 1,875,000 $m^3$/year. Pursuant to the outcome of the above studies, the Government of United Republic of Tanzania (URT) has entrusted NDC to fast track utilization of this resource for creation of formidable base for the development of chemical industry in the country. In the light of the foregoing, NDC has conceived a grand project, which will involve setting up of extraction of soda ash plant at Engaruka and construction of associated infrastructure for the project. The construction of the soda ash extraction plant will devolve on the outcome of the techno-economic study. In this regard, NDC applies for funds to carry out a techno--economic study for the establishment of the proposed soda ash plant at Engaruka.

### 2.0 OBJECTIVE

The main objective is to carry out a techno-economic study for establishment of economically, environmentally and socially sound soda ash plant at Engaruka including associated/related infrastructure. The techno-economic study will inform the Government on the appropriate and most economical technology for the same. The techno-economic study will also inform the bankable feasibility study for mobilization of required resources (human capacities, technology, and capital) for the project.

## 3.0 SCOPE OF WORK

### 3.1 Market Analysis

The study will cover description ad analysis of the market information including:

- Availability of local and regional market (EAC, SADC, etc.) including price structure and Regional soda ash production,
- Global past industry trends for the past 5 -10 years (production, consumption, pricing),
- Globally existing industry structure (installed capacities, production & consumption levels, pricing),
- Global future scenario for the next 5 years (demand growth, production, pricing) and global demand supply gap,
- Synthetic versus natural soda ash,
- Potential market share for the project (local, regional, worldwide),
- Envisaged market segments (and size of each segment),
- Product quality requirement for each market segment,
- Assessment of potential market barriers,
- Marketing strategies, promotion methods and distribution channels to achieve projected sales, and
- Any other relevant marketing information

### 3.2 Appraisal of the Brine Resource

The study will capture description of the information on the brine resource including

- Description of regional geology and geological settings of the Mineral Property area and geographical co-ordinates of the Mineral Property plotted on relevant maps;
- Review of previous exploration programs and other studies conducted including geophysical surveys, drilling programs, pump tests, sampling, simulation of brine evaporation, etc.;
- Full description of the Quality and Quantity of Engaruka Brine Resource and its potential commercial use (possible commercial products);
- Full description of level of Total Organic Carbon (ToC), rare earth elements such as Lithium, etc. if they do exist;
- Determination of hydrogen sulphide and fluorides content in the brine;
- Amount of brine required for the envisaged plant capacity and projected life span of the project.
- Resource estimation to Joint Ore Resource Commission Certification (JORC) complaint status.

### 3.3 Technological Assessment

The study will cover appropriate mining and processing technologies including:

- Assessment of available brine mining/extraction technologies (merits and demerits);
- Assessment of available soda processing technologies (merits and demerits) and justification for selecting particular technology;
- Assessment of inclusion of solar ponds system in the processing technology;
- Establish flow diagram for processing soda ash, edible salt, etc.;
- Mathematical modeling of boreholes which will enable maximum brine collection to Solar Pans;
- Complete description of the selected processing technology for soda ash, edible salt, industrial salts, etc. (including Piping and Instrumentation Diagram - P&ID);
- Quantity and Quality of wastes (solids/liquids/gases) to be generated;
- Selection of plant capacity for economies of scale;
- Consideration for commercial exploitation of edible salt and other products in order to maximize resource utilization;
- Quality requirements of end products for different users/applications;
- Other raw material requirements (quality and quantity) for the envisaged product use and plant capacity;

### 3.4 Assessment of Availability of Plant Utilities

The study will assess availability of the following utilities in the vicinity of the project site:

#### 3.4.1 Power Supply

- Power requirements estimates (plant, township, etc.);
- Evaluate/analyze power sources options (captive power using coal/gas or grid connection) and recommend the most cost-effective source;
- If the supply is from the grid, provide the nearest point for connection from the power utility including appropriate voltage level.

#### 3.4.2 Water Supply

- Water requirement estimate for Plant and Community;
- Water sources options;
- Establish water quality and recommend the most effective method for water treatment (if necessary), storage, distribution, etc.;

#### 3.4.3 Fuel Supply

- Evaluate/analyze fuel sources options (coal, gas, HFO, etc.) for steam generation including its cost;
- Determine the most effective way on how the fuel will be transported and distributed to the plant site.
-

### 3.5 Plant Site

The study will focus on the following issues:

- Propose relevant criteria for selecting the most suitable plant site including but not limited to proximity to raw material (cost implication of delivering brine to plant site), water sources (cost implication of delivering water to plant site), market centre, environmental issues (cost of environmental protection), site preparation work (cost of earthworks), etc.;

- Select various suitable plant sites and come up with at least three (3) options for detailed evaluation;
- Based on the proposed criteria, select the most suitable plant site.
-

### 3.6 Transport Logistics

The study will come up with analysis of optimum mode of transporting fuel and finished products to and from the plant site including the following elements:

- Review the existing studies on transport logistics and recommend accordingly to suit the proposed project site;
- Analysis of the condition of available modes of transport to major centres, e.g. Arusha and gateway port of Tanga;
- Identification of constraints and assessment of adequacy of each mode and the broad areas of up-gradation and new construction required on the existing railway and road sector for smooth flow of the project traffic;
- On the basis of constraints and inadequacy identified assessment of an optimal modal mix (rail-rail, road-rail, road-road) in terms of cost-effectiveness;
- Identification of suitable wagons/trucks to optimize the rolling stock utilization and minimize empty movement.
- Assessment of the requirement of warehousing facility if any;

### 3.7 Project Engineering Design

The study will assess the following issues:

#### 3.7.1 Plant and Machinery

- Soda ash processing plant facilities;
- Flue Gas Desulphurization (FGD) unit;
- Carbonation unit;
- Crystallization unit;
- Filtration and Centrifuge;
- Packaging unit;
- Salt Plant Unit and auxiliaries;
- Coal handling and storage system;
- Any other relevant system for supporting the plant;
- Detailed investment cost estimates.

#### 3.7.2 Electrical Power Distribution and Control System

- Transformers and Circuit breakers;
- Motor Control Centres and switchgears;
- Plant Control System;
- Main distribution boards;
- Capacitor banks;
- Any other relevant system/facility for effectively distribution and control;
- Detailed investment cost estimates.

#### 3.7.3 Brine Pumping System and Storage

- Location of extraction wells/boreholes as per mathematical model;
- Extraction wells/boreholes network design;

- Construction of extraction wells;
- Solar ponds system design if required;
- Solar ponds construction/establishment;
- Piping and pumping systems design;
- Any other relevant pumping system and storage;
- Detailed investment cost estimates.

**3.7.4 Power supply System**

- Design of power supply system;
- Construction of power supply system including power supply auxiliaries;
- Any other relevant system for supporting power supply;
- Investment Cost estimates.

**3.7.5 Steam Plant**

- Steam plant and auxiliaries (water treatment plant, ash handling system, water storage tanks, bag filter, main fans);
- Power plant and auxiliaries (turbine system, substation, condenser, control system);
- Emergency power supply system;
- Any other relevant system for supporting the steam plant;
- Detailed investment cost estimates.

**3.7.6 Water Supply System**

- Boreholes construction;
- Piping system to plant and township;
- Water treatment facilities;
- Water storage tanks;
- Any other relevant system for water supply support;
- Detailed investment cost estimates.

**3.7.7 Mobile equipment**

- Salt harvesting, stockpiling and feeding equipment;
- Solar pond maintenance equipment;
- Material handling equipment;
- Plant vehicles;
- Any other relevant mobile equipment;
- Detailed Capital Cost estimates.

**3.7.8 Plant Buildings and covered sheds**

- Plant buildings and covers sheds;
- Offices;
- Workshops;
- Stores (spare and finished product);
- Operator rooms (e.g. changing rooms etc.);
- Other service buildings (canteen, training, administrative block, etc.);
- Detailed investment cost estimates.

**3.7.9 Township and Infrastructure**

- Propose relevant criteria for selecting most suitable area for establishment of township within vicinity of the plant area.

- Select various suitable township sites and come up with at least three (3) options for detailed evaluation and recommend the most suitable;
- Prepare a layout plan of the township facilities and infrastructure (housing, roads, health centre, schools, police post, shopping centre, playgrounds, local authority offices, recreation areas, etc.);
- Investment Cost Estimates.

## 3.8 Human Resources Requirements

The study will address all human capacities including:

- Establish plant organization structure and manning;
- Identify relevant key skills to operate the plant;
- Recommend training requirements for key skills;
- Cost estimates.

## 3.9 Project Cost Estimates

The study will estimate the following costs:

### 3.9.1 Investment Cost

- Land (including land development costs);
- Process Equipment (delivery, duties and taxes, installation and commissioning);
- Utilities (water, steam and electricity);
- Construction of Evaporation Ponds;
- Well fields construction, piping, and pumping system;
- Instrumentation and Control System;
- Electrical reticulation;
- Construction (including plant buildings and services);
- Auxiliary services;
- Pre-operation expenses;
- Interest during construction;

### 3.9.2 Operational Cost (Working Capital)

- Raw materials;
- Utilities;
- Fuel;
- Production consumables;
- Spare parts inventory;
- Capital expenditure;
- Personnel cost;
- Administrative cost;
- Financial cost.
- Maintenance cost (predictive equipment and Computerized Maintenance Management System)

## 3.10 Project Financing

To realize the establishment of soda ash plant a well-structured project financing is paramount. The study will analyze different financing model/structure options and propose the best option for Tanzania environment for the project while pointing out reasons from best practice. All related ratios, indicators and players should be calculated or pointed out to justification to attract strategic investors.

## 3.11 Project Appraisal

The study will focus on an integrated project analysis which allows reconciliation between economic performance, financial performance and the distributional impacts of a project. This will enable other factors related to the project such as stakeholder's analysis and political-economic dimensions to be easily analyzed. The analysis will be done along with the following issues:

### 3.11.1 Financial Analysis

As a means to determining indicative indicators of net project worthiness, the preferred methodology is the discounted cash flow analysis (Discounted Cash Flow Rate of Return (DCFRR)). The study will develop a high-level economic and financial spreadsheet model for financial analysis based on DCFRR:

- Investment;
- Discounted Cash flow Rate of Return (DCFRR);
- Internal Rate of Return (IRR);
- NPV;
- Payback period;
- Break-even point;
- Return on equity;
- Various taxes/royalties to be paid;
- Sensitivity Analysis of key project parameters.

### 3.11.2 Economic Analysis

- Value added generated;
- Foreign exchange effect;
- Employment creation;
- Balance of payment;
- Social opportunity costs;
- Externalities;
- Linkages (Forward and backward);
- Cost Benefit analysis and Ratios.

### 3.11.3 Risk Analysis

The study will assess risks and uncertainties that threaten during project implementation and operations and recommend necessary measures to be taken to mitigate the expected risks.

## 3.12 ESIA Study

The study shall follow guidelines of National Environmental Management Council (NEMC) of Tanzania and incorporate all environmental concerns in the design of the brine pumping system and soda ash processing plant in order to ensure environmental sustainability during construction, operation and decommissioning stages. The study will have the following scope:

- Description of the project
- Policy, Legal and Administration Framework
- Description of the Environmental Setting (Baseline Environmental Data and Information)
- Consultation and Community Involvement
- Project Alternatives
- Cost Benefit Analysis
- Identification, Analysis and Assessment of Potential Impacts
- Mitigation Measures and Detailed Environmental Management Plan
- Detailed Monitoring Plan
- EIA Certification

### 3.13 Implementation Scheduling

The proposed implementation time frame will include.

- Planned start date of implementation schedule;
- Implementation Responsibility Matrix;
- Project Implementation time schedule (Gantt chart);
- Critical milestones.

## 4.0 DURATION OF THE ASSIGNMENT

The proposed time frame for the assignment is nine (9) months.

## 5.0 KEY PERSONNEL

The study ought to be conducted by qualified and experienced personnel registered locally or internationally with relevant professional bodies capable of providing NDC with necessary technical advice. The specific personnel and their minimum qualifications and experience are as follows.

### 5.1 Project Team

(i) **Process/Chemical Engineer** – University Degree with proven expertise in the research, development and implementation of chemical/process technologies (production/processing, packaging and branding technologies) in the global context with minimum experience of 10 years;

(ii) **Electro Mechanical/Industrial Engineer** – Minimum of University Degree with wide knowledge in project analysis, plant and power system design specifically using modern computer software acceptable internationally with minimum of 5 years working experience;

(iii) **Mining Engineer** – Minimum of University Degree with wide knowledge in mining and establishment of mine with minimum experience of 5 years of working experience;

(iv) **Financial/Project Appraisal Specialist** – Minimum of University Degree in Finance, Economics or related field with wide knowledge in financial modelling, familiarity and experience in the application of methodologies for measuring the net worth of projects such as those under consideration on this assignment having minimum working experience of 5 years in the field;

(v) **Economist** – Minimum of University Degree in Economics/Finance and having experience in industrial development or fresh project startup with minimum experience is 5 years;

(vi) **Market Assessment Specialist** – Minimum of University Degree in Marketing, Economics, Business Administration/Finance with skills and experience in preparing detailed market assessments covering a range of sectors and geographies;

(vii) **Infrastructure Development Specialist** - Minimum qualification is University Degree in Transport Economics/Transport engineering/civil engineering with previous experience in the evaluation and appraisal of infrastructure development projects elsewhere; knowledge of the local Tanzanian policy, legislative and institutional environment in so far as it pertains to the surface transport sectors having a minimum of 5 years working experience.

(viii) **Geologist** - Minimum of University Degree with wide knowledge in individual rock formations, mining and establishment of mine with minimum experience of 5 years of working experience;

(ix) **Environmental Engineer** - Minimum of University Degree in Environment and having experience in use of principles of engineering, soil science, biology, and chemistry to develop solutions to environmental problems with minimum experience is 5 years;

(x) **Hydrologist/Water Engineer** - Minimum of University Degree with wide knowledge in research the distribution, circulation, and physical properties of earth's underground and surface waters as well as designing water infrastructure with minimum experience is 5 years of working experience.

### 5.2 Team Leadership

An organogram of proposed team indicating the project team and coordination arrangements should also be covered in the study. It is envisaged that the project team should be led by a strong Team Leader and assisted by Project Manager who are among the members of the project team as stated above. The proposed Team Leader must have a minimum qualification of Post Graduate University Degree or PhD in chemical/process engineering with demonstrable ability to integrate a multi-sectoral team of specialists/ experts. The Team Leader/ Project Manager with experience in similar projects (Soda Ash Industry) will have added advantage. The team should be ready to deliver the study results timely and within the budget constraint.

## 6.0 EVALUATION CRITERIA

The procurement of any consultancy service should be evaluated and awarded according to National Competitive Procedures specified in Public Procurement (Consultancy Works), Regulations 2005 as indicated in Section C – PDS of this RFP.

## 7.0 PROJECT COST

Project study cost to undertake the above assignment should be worked out by the consultant, including budget for monitoring and supervision of feasibility study by Client.

## 8.0 DELIVERABLES AND SCHEDULE

### 8.1 Deliverables

The following reports shall be submitted to NDC chronologically as detailed in the Table below including schedule of payment.

| S/N | Report | Remarks | Number/Type of Copies |
|---|---|---|---|
| 1. | Inception Report | One (1) month after signing of the Consultancy Agreement | One Original + two (2) hard copies and soft copy |
| 2. | Interim Report | Three (4) months after signing of the Consultancy Agreement | One original + three (3) hard copies and soft copy. |
| 3. | Draft Final Report | Seven (7) months after signing of the Consultancy Agreement | One original + three (3) hard copies and soft copy. and |
| 4. | Final Report | Nine (9) months after signing of the Consultancy Agreement | One original + three (3) hard copies and soft copy. |

### 8.2 Proposed Payment Schedule

The proposed payment schedule for the assignment should base upon successful submission and approval by NDC of the deliverables as indicated in the table below:

| S/N | Report | Payment |
|---|---|---|
| 1. | Submission & Approval of Inception Report | 25% of Contract Sum |
| 2. | Submission & Approval of Interim Report | 30% of Contract Sum |
| 3. | Submission & Approval of Draft Final Report | 25% of Contract Sum |
| 4. | Final Report | 20% of Contract Sum |

## 9.0 REPORTING

For the purpose of this assignment the reporting regarding the execution of the study should be effected through contact persons anointed by NDC and the financier. The Contact Person with address all matters pertaining to coordination of research activities, report submission, contract management and administration in accordance with the pre-approve milestones and associated payments, prior to submission for final approval to the NDC and the Government.

## 6.2 Terms of Reference for Environmental Impact Assessment

**NATIONAL DEVELOPMENT CORPORATION**

NDC

**PROPOSED TERMS OF REFERENCE (TOR) TERMS OF REFERENCE FOR ENVIRONMENTAL IMPACT ASSESSMENT FOR ENGARUKA SODA ASH EXTRACTION PLANT**

### 1.0 BACKGROUND

The national Development Corporation is in the process of establishing Soda Ash Extraction Plant with a capacity of about 1,000,000 Tonnes Metric Tonnes Per Annum (TMPA) at Engaruka, Monduli District, Arusha Region. The soda ash will be transported to gateway port to the external market at Tanga by Arusha – Moshi – Tanga railway line. The major components of the project would be brine piping system, soda ash processing equipment, power supply system, fuel distribution system, water supply system, workshop, township, administrative buildings, haul roads, approach roads, drainage systems, etc.

### 2.0 LOCATION

The project area is situated at Engaruka Basin, Monduli District, Arusha Region. The area is located some 190 km from Arusha Town.

### 3.0 OBJECTIVE

The objective of commissioning the consultancy is to carry out a detailed EIA, including detailed Environmental Management Plan and Monitoring Plan of the proposed Soda Ash Plant. The ultimate aim is to incorporate all environmental concerns in the design of the brine pumping system and soda ash processing plant in order to ensure environmental sustainability during construction, operation and decommissioning stages.

### 4.0 EIA REQUIREMENT

In carrying out the EIA, the consultant shall follow guidelines of the National Environment Management Council (NEMC) of Tanzania.

### 5.0 SCOPE OF WORK

### 5.1 Description of the Project

The consultant shall specify the area of influence of the study and provide a brief description of the project, using maps at appropriate scale and including the following information: technical description of the soda ash plant, types and quantity and quality of wastes (solids/liquids/gases) to be generated; disposal of waste, indication of need of any resettlement and/or compensation, pre-construction, construction and operation activities; work schedule; staffing facilities and services; life span, local STD and HIV/AIDS facilities and capacity, National HIV/AIDS programme, and any other relevant information.

**5.2 Policy, Legal and Administrative Framework**

The consultant shall include the provisions in the pertinent policies, laws, regulations, and standards relevant to the proposed project.

**5.3 Description of the Environmental Setting (Baseline Environmental Data and Information)**

The consultant shall review existing baseline data and information and shall assess adequacy of the existing data and information and collect more data to fill the gap, if any, on the Physical, Biological, Socio-economic Elements and Cultural Elements

**5.4 Consultation and Community Involvement**

The consultant shall, identify different groups of stakeholders, including: relevant Government Ministry such as Ministry of Energy and Minerals, Regional Office, District Office, Village Governments, NGOs, disadvantaged groups (eg. elderly, children, women, disabled, etc.) and use the most appropriate method to establish their views regarding the proposed project. Minutes of the meetings, with names and signatures, should be recorded for submission as part of the project report. The result of this excise shall assist in preparing final ToR for the EIA.

**5.5 Project Alternatives**

The consultant shall carry out an analysis as regards to “with the project” and “without the project” scenarios.

**5.6 Cost Benefit Analysis**

The consultant shall carry out a cost benefit analysis of the project. Where possible the benefit should be quantified on monetary basis.

**5.7 Identification, Analysis and Assessment of Potential Impacts**

The consultant shall identify, analyse and assess environmental impacts of the proposed soda ash plant on the Physical Environment, Biological Environment, Socio-economic Environment and Cultural Environment.

**5.8 Mitigation Measures and Detailed Environmental Management Plan**

The consultant shall recommend feasible and cost-effective mitigation measures to prevent or reduce all identified negative impacts and enhance the positives. The consultant shall also prepare a Resettlement Action Plan (RAP), if applicable. In preparing the RAP, the consultant should make reference to the existing Resettlement Policy Framework within the Guidelines for Environmental Management.

5.9 **Detailed Monitoring Plan**

The consultant shall prepare a detailed monitoring plan to monitor the implementation of mitigation measures during construction and operation phases. Include in the plan an estimate of capital and operating costs and any other required input to effectively implement the monitoring plan. In the monitoring programme, the consultant shall include what factors need to be monitored during the construction and operation phases, parameters, frequency of checks, duration of monitoring, costs involved and assign responsibility to various stakeholders.

### 5.10 EIA Certification

Upon approval of the Final EIA Report by NDC, the consultant shall submit the required number of copies to NEMC for review by the Technical Advisory Committee of NEMC. During review of the EIA Report by NEMC, the consultant shall, in consultation with NDC, provide technical clarifications regarding the EIA process in order to facilitate approval of the EIA Report. Upon approval of the EIA Report by NEMC, the consultant shall liaise with NEMC and Vice President's Office, Division of Environment, for getting EIA Certificate.

## 6.0 COMPOSITION OF THE CONSULTING TEAM

The consulting team shall include highly experienced experts in the field relevant to the proposed project. The team shall consist but not limited to Process/Chemical Engineer, Mining Engineer, Environmentalist, Ecologist (flora and fauna), Socio-economist, etc.

## 7.0 DURATION OF THE STUDY

The duration of the study is five (5) calendar months from the date of signing the contract.

## 8.0 SELECTION PROCESS

The consultant will be selected and awarded a consultancy contract according to National Competitive Procedures specified in Public Procurement (Consultancy Works), Regulations 2005.

## 9.0 DELIVERABLES AND SCHEDULE

The following Reports shall be submitted to NDC in the following chronology as detailed in the Table below.

**Table on project reports**

| S/N | Report | Remarks | Number/Type of Copies |
|---|---|---|---|
| 1. | Scoping Report | One (1) month after signing of the Consultancy Contract | Three (3) hard copies and soft copy |
| 2. | Progress Report | Two (2) months after signing of the Consultancy Contract | Three (3) hard copies and soft copy |
| 3. | Draft Final Report | Four (4) months after signing of the Consultancy Contract | Five (5) hard copies and soft copy |
| 4. | Final Report | Five (5) months after signing of the Consultancy Contract | Fifteen (15) hard copies and soft copy |

## 10.0 REPORTING

For the purposes of this assignment the Consultant will submit reports or interface with Client through Project Manager for Soda Ash for all matters pertaining to report submission, contract management and administration that will pre-approve milestones and associated payments, prior to submission for final approval to the Accounting Officer.

**NATIONAL DEVELOPMENT CORPORATION**

# "TECHNO-ECONOMIC STUDY FOR SODA ASH PROJECT AT ENGARUKA IN MONDULI DISTRICT, ARUSHA REGION, TANZANIA"

**VOLUME I**

**APPRAISAL OF THE BRINE RESOURCE**

**Prepared by:**
**Tanzania Industrial Research and Development Organization**

**May, 2021**

## STUDY TEAM

### Leader of the Team

| Name | Title | Address | Signature |
|---|---|---|---|
| Prof. Abdulkarim. H. Mruma | Team leader | Mining Commission of Tanzania<br>P.O. Box -2292<br>Dodoma | |

### Members of the team

| SN | Name | Institution |
|---|---|---|
| 1. | Godfrey Mallya | Geological Survey of Tanzania (GST) |
| 2. | Yusto Joseph | Geological Survey of Tanzania (GST) |
| 3. | Eng. Liberatus Chizuzu | Tanzania Industrial Research and Development Organization (TIRDO) |
| 4. | Eng. Athanas C. Ntawanga | Tanzania Industrial Research and Development Organization (TIRDO) |
| 5. | Latifa Mussa | Tanzania Industrial Research and Development Organization (TIRDO) |
| 3. | Efraim Herman | STAMIGOLD Gold Company Limited |
| 4. | Herzron Philipo | Pangani Basin Water Board |
| 5. | Salim Lymo | Internal Drainage Basin Water Board |
| 6. | Yokbeth Myumbilwa | Geological Survey of Tanzania (GST) |
| 7. | Onesphorius Balambirwa | Geological Survey of Tanzania (GST) |
| 8. | Haji Komba | Mineral Resources Institute (MRI) |
| 9. | Majid Omary | Mineral Resources Institute (MRI) |

# EXECUTIVE SUMMARY


**Geological Setting and Drainage:**
Engaruka Basin is covered mostly by superficial deposits of recent volcanic origin consisting of tuffaceous beds, alluvial, outwash materials and alluvium including mbuga. The basin is surrounded by volcanic mountains such as Kerimasi, Essimingor and Burko. Rocks from these mountains have different minerals composition. Kerimasi Mountain has volcanic rocks mainly composed of carbonatitic composition while Essimingor and Burko mountains have rocks with Nepheline Syenite and Ijollite composition.

Rivers and streams, most of them seasonal, flow into the Engaruka Basin from all directions thus forming an internal drainage system. During the rainy season, a shallow lake is formed at the basin centre which becomes an expense of alkaline dust with occasional thin crust of sodium bicarbonate and other salts in the dry season. Because of this geological setting rivers draining into the basin as well as groundwater re-charging systems are continuously re-charging the basin aquifers and thus bringing in additional salts (originating from the volcanic rocks) into the brines hosted in the aquifers.

**Stratigraphy and rock composition:**
Through logging of Core and Reverse Circulation rock chips from Engaruka Basin conducted from 2011 through 2013, the basin is composed of the following stratigraphic units from the surface up to 200 meters deep:

- Upper Zone which is clay dominated horizon (Zone A).
- Second Zone which is dominated by fine sand (Zone B).
- Third Zone which is composed of coarse sand and salt layers (Zone C).
- Fourth zone (Zone D) dominated by thick horizontal layers of solid crystalline salts (mostly Sodium Carbonate and Sodium Bicarbonate).

Zone A with 2 meters thick, occurs at the depth from 80 to 82meters, Zone B with 5 meters thick occurs at the depth from 87 to 92 meters, Zone C with 15 meters thick occurs at the depth from 141 to 156 meters, and Zone D with thickness over 38 meters occurs at the depth from 162 meters extending to below 200 meters depth. Zone D is reported to have high content of Sodium Carbonate and Bicarbonate crystals sometimes of up to 100% in volume.

In the current Appraisal study, drill cores (BH9 and BH11) were re-logged and all the afore-mentioned strata with high content of solid crystals of Sodium Carbonate and Bicarbonate were verified. However, during verification of positions of these two core boreholes in the field, position of BH9 was not seen. Therefore, only cores from BH11 were involved for further resource appraisal.

**Aquifer in Engaruka Basin:**
Through logging of exploratory boreholes and interpretation of VES measurements conducted in 2013, reported the presence of two types of aquifers. Sand and gravel aquifers hosted in layers B, C, and upper part of layer D and in the porous to cavernous salty layer in the lower part of layer D. These aquifers are hosting brines with high concentrations of

Sodium Bicarbonate and sodium Carbonate ranging from 20.23g/l to 121.66g/l and from 86.84g/l to 210.65g/l respectively.

Sampling and analysis of brines hosted in the sediments of the Engaruka Basin during appraisal revealed that the brines are rich in sodium bicarbonate and sodium carbonate ranging from 12.0g/l to 25.49g/l and from 125.93g/l to 245.92g/l respectively.

**Mineralogical and Chemical Composition:**
Rock and soil samples representing lithological units contained in and around Engaruka Basin were sampled and analysed (mineralogical and chemical analysis). It was realized that the rocks and soils are dominated by Na+ and Ca+ rich volcanic minerals including Aegirine-Augite, Plagioclase, Hedenbergite, Carbonates and Salts (mostly Trona).

Apart from the common rock-forming major elements (Al, Si, Fe, Mg and Ca) some rocks in the area were seen to have elevated values of Bismuth (up to 637 ppm), Manganese (up to 385.5 ppm), Strontium (greater than 350 ppm) and Uranium (up to 290.7 ppm). However, values of these elements were not seen to be elevated in the brines most probably because of low solubility of the minerals that are hosting them.

Results of these analysis show that rock samples with high Total Carbon content (higher than 1%) are the one with carbonate mineral (Calcite) contents higher than 50%.

**Borehole and Topographical Surveys:**
Topographical survey of the study area was done using Differential Global Positioning System (DGPS) mainly for the purpose of establishing topographical data to be used in resource modelling. The survey was done after establishing six (6) Control Points (reference points) from National Control Point (T124). A total of 16 positions of existing exploratory borehole reported in 2013 and other 59 spot heights of randomly selected topographic features were surveyed and the obtained data was used to develop the topographical model of the basin.

**Vertical Electrical Sounding:**
A total of nine (9) Vertical Electrical Soundings (VES) were measured in the study area. Among the nine (9) VES positions measured, seven (7) were executed at the positions of exploratory boreholes. VES results were correlated with the stratigraphy established from borehole logging as well as low resistivity positions with positions of aquifers.

VES interpretation reveals zones with low resistivity located at depths not exceeding 35 meters below the surface. Resource modelling of VES results using Leapfrog Geo Software identified six (6) stratigraphic units: clay, upper sand clay, sand with brine, low sand clay – sand with brine, alluvial sediments and undefined sediments. The low resistivity wireframe (sand with brine wireframe) was used to estimate the brine resource block model.

**Pumping Test:**
Pumping test of boreholes was done in order to determine aquifer characteristics that are necessary for resources estimations. Six (6) boreholes (BH5, BH6, BH12, BH13, BH-U1 and BH-U2) were subjected to pumping test.

Previous pumping test conducted in 2013 for borehole BH5 drilled to 110m depth yielded a discharge capacity of 61.5m$^3$/hr of brine. The same borehole was tested during appraisal for 43 hours and its discharge capacity was 62.94m$^3$/hr. Measurements of in-situ parameters of the brines from the identified boreholes showed that all of them are alkaline and vey saline ground waters.

**Sub-surface geological features:**

Airborne and ground geophysical data revealed the presence of NW-SE trending magnetic low anomalies. These are interpreted to represent deep-seated faults which could be conduits for recharging the acquirers in the basin. However, some of these fractures could also be conduits for draining the basin aquifers. Therefore, there is a need for further studies to establish the influence of these fractures in recharging or draining of the aquifers.

**Resource Modelling:**

Brine resource estimates conducted in 2013 covering the study area of 234km$^2$ at Engaruka Basin indicated the presence of about 4,680,000,000 m$^3$ of brines equivalent to 1.4 billion tons of salts of which 982 million tons is soda ash. The rate of brine replenishment was estimated to be 1,875,000m$^3$/yr.

Re-evaluation of resources in this appraisal exercise was able to cover only 153.146km$^2$ of the basin since some of the exploratory boreholes were not in the position to allow verification (BH1, BH2, BH3, BH4, BH8 and BH9 were missing; BH14, BH15 were filled with rocks and sand, BH11 was a diamond drill core and BH16 was totally dry).

By using limited data (as most of the studies boreholes were located far apart and not evenly distributed in the entire area) the studied block was estimated to host a total of 3,813,320,000m$^3$ as brines. Taking an average composition of these brines to be 17.9g/l for sodium bicarbonate and 201.61g/l for sodium carbonate, the brines in Engaruka Basin is estimated to host 68.30 and 768.80 million tons of sodium bicarbonate and sodium carbonate, respectively. These estimates were calculated using computer based modelling and statistical software (Leapfrog Geo).

It was realized that licensed areas for NDC covers only a portion of the basin (132.318km$^2$) and much of NDC's licences lies on the mountainous areas to the east of the Engaruka Basin. These mountainous areas are covered by massive, lithified and un-fractured volcanic rocks which are not expected to host significant number of brines that can allow economic recovery. Therefore, total volumes of brines in the licensed areas of NDC that fall in the Engaruka Basin area is estimated to be 3,294,704,894m$^3$ of brine with 59.00 and 664.24 million tons of sodium bicarbonate and sodium carbonate, respectively.

An area of about 20.828km$^2$ lies within the surveyed part of Engaruka Basin but it is outside the licensed areas of NDC. This part is estimated to host 518,611,520 cubic meters of brine containing 104.55 and 9.28 million tons of sodium carbonate and sodium bicarbonate, respectively. NDC is therefore advice to relinquish all of its licenses which fall on the highlands (east of the Engaruka Basin) that are covered by massive volcanic rocks and relocate them to cover this area that contains significant number of resources.

**Challenges:**

- Despite of promising results of presence of abundant brine resource, it has to be noted that in most of the covered areas the 3D resource model is poorly supported. There were insufficiently close spaced boreholes, insufficient number of boreholes; distantly closely spaced VES data that corresponds with the big size of the basin and good quality pump test results (most of the boreholes were too small in diameter to allow insertion of big pumps with appropriate powers). In addition, the boreholes and VES measurements penetrated the sediments only up to 200 meters deep while Engaruka Basin is much deeper. These 200 meters depths were extrapolated over the entire area to obtain Inferred Resources.

- Three submersible pumps of different capacity were made available to ensure proper pumping tests. However, the step drawdown test was not carried out using the three pumps because boreholes BH6, BH12, BH13, BH7 and BH-U1 have smaller diameters that two of the most efficient pumps could not be inserted. The only boreholes that could allow the use of both pumps for step drawdown test are boreholes BH5 and BH-U2.

- Five (5) exploratory boreholes were missing at their respective positions as reported during the study conducted in 2011 – 2013. In addition, one (1) borehole was covered under the lake hence was not accessible. Furthermore, six (6) boreholes were vandalised and were not tested. Some of the reported boreholes had less depth than the actual drilled depths. Some of the boreholes were located outside NDC PLs, Thus, their resource data were not used and has affected the appraisal exercise.

Apart from the afore-mentioned challenges, the combined discharge of all pumped boreholes at a tested capacity of 171.805$m^3$/hr yielded normal drawdown thus indicating presence of good productive aquifers.

**Recommendations:**

From the above-mentioned shortfalls encountered during the brine resource appraisal, it is recommended that:

- Further geophysical surveys using Electrical Resistivity Tomography (ERT) and Transient Electromagnetics (TEM) should be used to explore the depth beyond 200 meters. These geophysical methods have capability to penetrate to a greater depth of not less than 500m. This will help in establishing fully the lithological units and spatial extent of aquifers within the basin.

- Drilling of additional exploratory cum production boreholes to depths of not less than 300m should be undertaken in order to facilitate accurate assessment of aquifer properties before, during and after drilling. The boreholes final casing diameter should not be less than 10 inches to allow usage of big and efficient pumps. It is recommended that:

- Two (2) bore holes should be diamond drill cores for bringing better clarity of stratigraphic sequences of the sediments, understanding mineralogical composition of the sediments and computation of accurate porosity of the sediments.
- Four (4) Reverse Circulation boreholes – “Open Hole Diameter of 406.4mm and Casing Inside Diameter of 304.8mm and Outside Diameter of 330.2mm” - be drilled and while drilling identification of layers of aquifer and their respective aquifer characteristics be established. Representative water samples for each aquifer should be collected in this exercise to allow determination of proper composition of brine in each aquifer. The same boreholes can later be used as production boreholes.

- Establishing meteorological weather station and conducting proper estimation of recharge rate using available standard techniques.

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| BH | Borehole |
| BHU | Borehole Unidentified |
| CBR | Control Brine Samples |
| Cm | Centimetre |
| DD | Diamond Drilling |
| EC | Electric Conductivity |
| ERT | Electrical Resistivity Tomography |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| HP | Horsepower |
| MRI | Mineral Resources Institute |
| NDC | National Development Corporation |
| pH | potential of Hydrogen |
| PL | Prospecting License |
| RTK | Real-Time Kinematics |
| RC | Reverse Circulation |
| TEM | Transient Electro- Magnetic Survey |
| TDS | Total Dissolved Salts |
| TIRDO | Tanzania Industrial Research and Development Organization |
| USGS | United States Geological Survey |
| UTM | Universal Transverse Mercator |
| VES | Vertical Electrical Soundings |
| WH | Water Hole |
| µS/cm | micro-siemens/centimeter |
| ohm-m | Ohm-Metre |

# CHAPTER ONE

# INTRODUCTION

## 1.1. Background

The Techno–Economic Study for Establishment of Soda Ash Plant which is being executed by Tanzania Industrial Research and Development Organization (TIRDO) is a preparatory undertaking for the development of a Soda Ash Producing Plant at Engaruka, a village that is located in Monduli District, Arusha Region. The Soda Ash Producing Project is 100% owned by the National Development Corporation (NDC) which is an organization owned by the Government of the United Republic of Tanzania. NDC appointed TIRDO to conduct a study for the establishment of economically, environmentally and socially sound soda ash plant.

This report provides a full report on Appraisal of the Brine Resources at Engaruka Basin which is a part of the entire "Techno – Economic Study for Establishment of Soda Ash Plant at Engaruka Basin". Field research for this component commenced on 2$^{nd}$ October 2019 and ended on 30$^{th}$ November 2019. Laboratory analyses of water, drill-core and chips, rock and soil samples were conducted from 1$^{st}$ December 2019 to 10$^{th}$ of January 2020 and this was immediately followed by data interpretation and compilation of this report. Main activities conducted in this component were executed by combination of scientists from the Geological Survey of Tanzania, Pangani and Internal Drainage Basin Water Boards and Mineral Resources Institute under the coordination and supervision of Prof. Abdulkarim H. Mruma (Geologist and Commissioner - Mining Commission).

## 1. History of Development of Soda Ash around Lake Natron

In the late 1990s NDC was holding a mining license (a license that was inherited from the State Mining Corporation (STAMICO) to conduct commercial extraction of soda ash at Lake Natron. Despite of having this legal license issued by the Government of Tanzania, NDC could not conduct such mining because on 13$^{th}$ August 2000 Tanzania joined the RAMSAR International Convention and thereafter Lake Natron was declared as one of the Wetlands of International Importance (RAMSAR site); a declaration that was made because of the fact that Lake Natron is having an excellent environment for flamingo breeding.

In an attempt to search for other areas that might have good quality soda ash of enough quantity, in 2008 NDC engaged Geological Survey of Tanzania (GST), to conduct research at Engaruka Basin to assess the possibility of having soda ash deposit in the basin. Thereafter, in 2011 through 2013 NDC engaged C.Z. Kaaya of O.C. Industrial Holdings (LTD) to carry out detailed investigations in the basin. The study aimed to establish the quality and quantity of soda ash hosted in brines within the aquifers but also solid salts hosted in the sediments within the basin.

Selection of the Engaruka Basin for searching possible existence of commercially viable soda ash was based on the fact that the basin is only 58 km south-east of Lake Natron, and has been exposed to similar geological, tectonic and climatic conditions as those found in Lake Natron for many years. In addition, the two basins are surrounded by similar volcanic formations whose sands and dissolved salts are continuously being fed by surface river waters and ground channels. These basins have similar geological, hydrological, hydro-geological and climatic environment. In addition, these basins have been considered to have some horizons beneath the superficial mbuga/lake clays which contain crystalline salts including soda ash. Furthermore, there are large quantities of brines hosted in aquifers which are made up of sandy and/or conglomeratic horizons in the sedimentary sequences or fractured and weathered volcanic substrate in fault zones beneath the sedimentary piles.

# CHAPTER TWO

# OBJECTIVES AND METHODOLOGY

## 2.1. Objectives of the Component

### 2.1.1. Main Objective

The appraisal of the brine resources for Engaruka Basin was conducted to determine its quantity and quality.

### 2.1.2. Specific Objectives

- Description of regional geology and geological settings of the Mineral Property of the area and geographical co-ordinates of the Mineral Property plotted on relevant maps;
- Review of previous exploration programs and other studies conducted including geophysical surveys, drilling programs, pump tests, sampling, simulation of brine evaporation, etc.;
- Full description of the Quality and Quantity of Engaruka Brine Resource and its potential commercial use (possible commercial products);
- Full description of level of Total Organic Carbon (ToC), rare earth elements such as Lithium, etc. if they do exist;
- Determination of hydrogen sulphide and fluorides content in the brine;
- Amount of brine required for the envisaged plant capacity and projected life span of the project.
- Resource estimation to Joint Ore Resource Commission Certification (JORC) complaint status

## 2.2. Methodology

The Appraisal of brine resources in Engaruka was accomplished by performing the following:

a) Literature review on regional geology to establish the general geological setting of the area.
b) Detailed review of the previous resource evaluation report of soda ash exploration conducted in 2011 – 2013.
c) Detailed geological ground physical investigation for identification of main rock units in the area and mapping their spatial distribution (in correlation with position of the basin and the drainage patterns which feed into the basin).
d) Geophysical survey for identification of subsurface structures that may relate to sources of brine water in the basin.
e) Collecting rock and soil samples around the basin for the purpose of establishing their mineralogical and chemical compositions (through laboratory analysis) for the purpose of establishing their possible impact to the chemistry of the brines.
f) Sampling of the surface waters (rivers, springs and ponds) and establishing their chemical compositions (through laboratory analysis) for the purpose of establishing their possible impact to the chemistry of the underground brines.

g) Sampling of the underground brines and performing laboratory analysis for the purpose of establishing their chemical compositions (constituents of dissolved useful salts, possible existence of other useful materials, possible existence of toxic/harmful materials e.g., fluoride, radioactive elements etc.)
h) Surveying of positions of boreholes and special selected topographical features by Differential Global Positioning System instrument (DGPS) for generating proper topographic pattern of the area.
i) Flushing of the bore-holes and thereafter performing ‘Pump Tests” to establish yields of the aquifers (safe yields of the boreholes for aquifer management).
j) Data processing, analysis, map preparation, resource modelling & estimation and report writing.

# CHAPTER THREE

## 3. GEOGRAPHICAL LOCATION OF THE ENGARUKA BASIN

### 3.1. Location

Engaruka Basin is located in Monduli District, Arusha Region north-eastern Tanzania. It is about 50 km northeast of Mto wa Mbu Town and 58 km south-east of Lake Natron. The Engaruka Basin can be accessed through a tarmac road covering a distance of 112km from Arusha to Mto wa Mbu Town, then branching off to Engaruka Basin through a gravel road covering a distance of about 58km.

### 3.2. Prospecting Area

The prospect covers three (3) prospecting licences (PLs) (Table 3.1) forming a total area of 132.318km$^2$ within the prospecting area. The soda ash exploration which involved borehole drilling conducted in 2013 covered a total area of 234km$^2$ (Table 3.2). However, soda ash appraisal covered a total area of 196.136km$^2$ within the Engaruka Basin. An area of about 21,036.78km$^2$ within the studied area which contain exploratory boreholes is located outside the licensed area.

Table 3.1 Coordinates of the Engaruka NDC PL Project area (Arc 1960).

| No | Easting's | Northing's | Latitude | Longitude | Bound Code |
|---|---|---|---|---|---|
| | UTM Units | | Latitude – Longitude Units | | |
| 1 | 179463 | 9664330 | 3.033° | 36.117° | NW Corner |
| 2 | 179463 | 9649630 | 3.167° | 36.117° | SW Corner |
| 4 | 201713 | 9649630 | 3.167° | 36.317° | SE Corner |
| 4 | 201713 | 9664330 | 3.033° | 36.317° | NE Corner |

Table 3.2. Coordinates of the Engaruka Basin that was surveyed by C.Z. Kaaya (2011) on behalf of NDC (Arc 1960)

| No | Easting's | Northing's | Latitude | Longitude | Bound Code |
|---|---|---|---|---|---|
| | UTM Units | | Latitude – Longitude Units | | |
| 1 | 179778 | 9663540 | 3.04° | 36.12° | NW Corner |
| 2 | 179778 | 9663540 | 3.19° | 36.12° | SW Corner |
| 3 | 189246 | 9663560 | 3.19° | 36.21° | SE Corner |
| 4 | 179778 | 9663540 | 3.04° | 36.12° | NE Corner |

### 3.3. Climate

Engaruka area being on the leeward side of Monduli Mountain has little rainfall and a long dry and sunny period. The short rains season fall in November /December and the long rains fall in March to May. The total annual rainfall from the Magugu Weather Station located 120km south-west of Engaruka basin in Magugu Village, Babati District of Manyara region is in the order of 300mm.

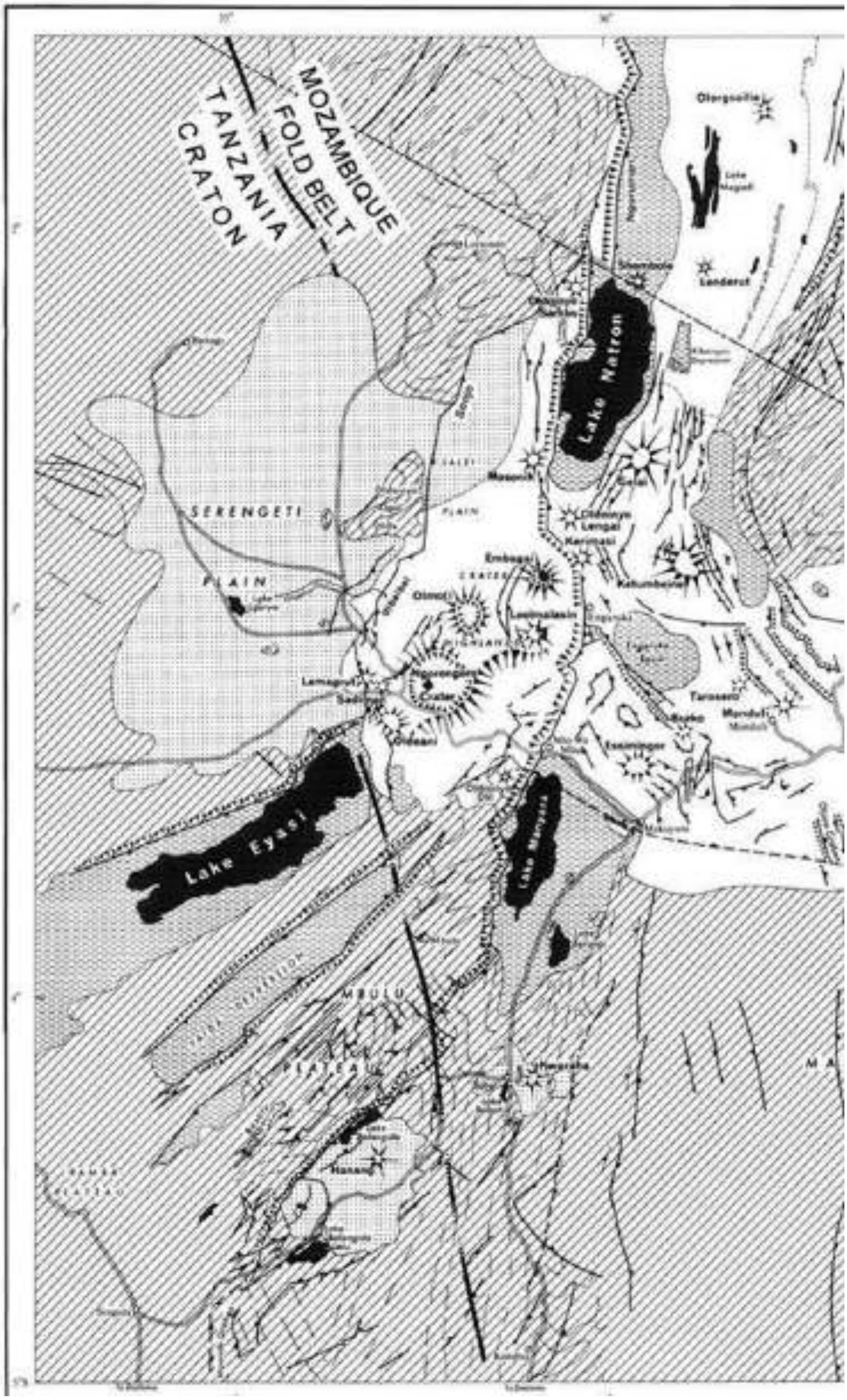
In the month of October, temperatures are considerably high, in the range of 25-35$^{o}$C during day time and 10-20$^{o}$C during the night. The humidity ranges from 30% to 40% in the day time rising to 60% at night.

### 3.4. Topography and Drainage:

Engaruka basin lies within the East Africa Rift Valley System (Figure 3.1). It is bounded by two main faults trending in a NW-SE direction (Figure 3.2). Surrounding the basin is a typical lava plateaus broken into gently tilted or horizontal fault blocks bounded by fault scarps and occasional volcanic cones like Kerimasi, Ketumbaine, Essimingor, Monduli and Burko Hills (Figure 3.3). The basin itself is very flat, (average elevation 710m above sea level) an indication that it was once covered by an extensive lake. Its surface is now covered by soils of alluvium including mbuga clays, alluvial and outwash materials including boulders, pebbles, sand and pumice derived from the surrounding volcanic rocks. In some places, particular near the edges of the basin (far from the lake) these loose sediments have been re-worked by wind to from thin layers of Aeolian Deposits.

Rivers and streams, most of them seasonal, flow into the Engaruka Basin from all directions thus forming an internal drainage system. During the rainy season, a shallow lake is formed at the basin centre which becomes an expense of alkaline dust with occasional thin crust of sodium bicarbonate and other salts in the dry season (**Error! Reference source not found.**). T he largest water flows are that of Engaruka River from the NW, Ngurumo ya Komani River from the SE and Emugut Belek from the NE (Figure 3.4).

Figure 3.1. Position of Engaruka Basin in the East Africa Rift System (Source: Dawson, 2008).



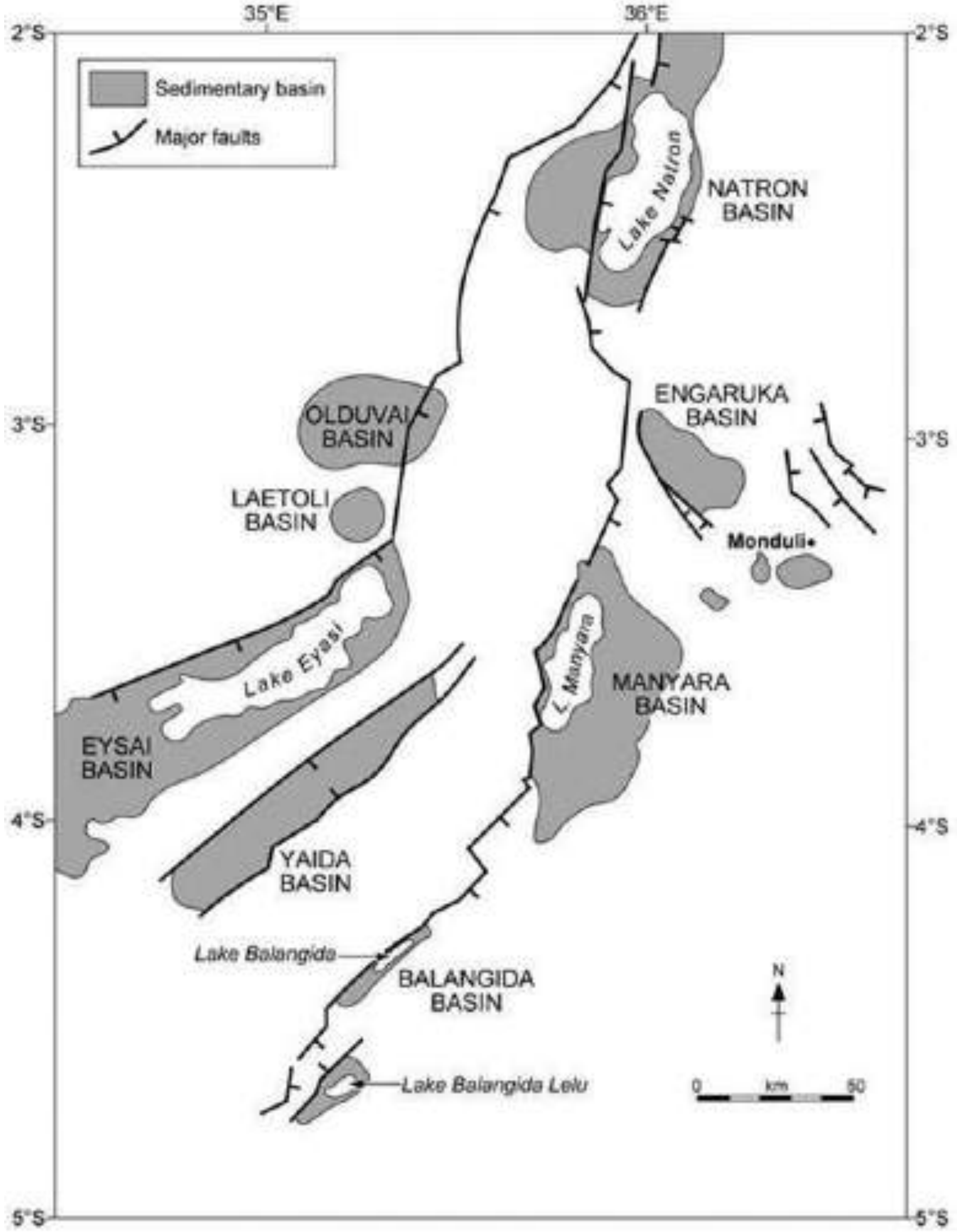



Figure 3.2: Engaruka Basin bounded by two major faults trending NE-SW (Source: Dawson, 2008).

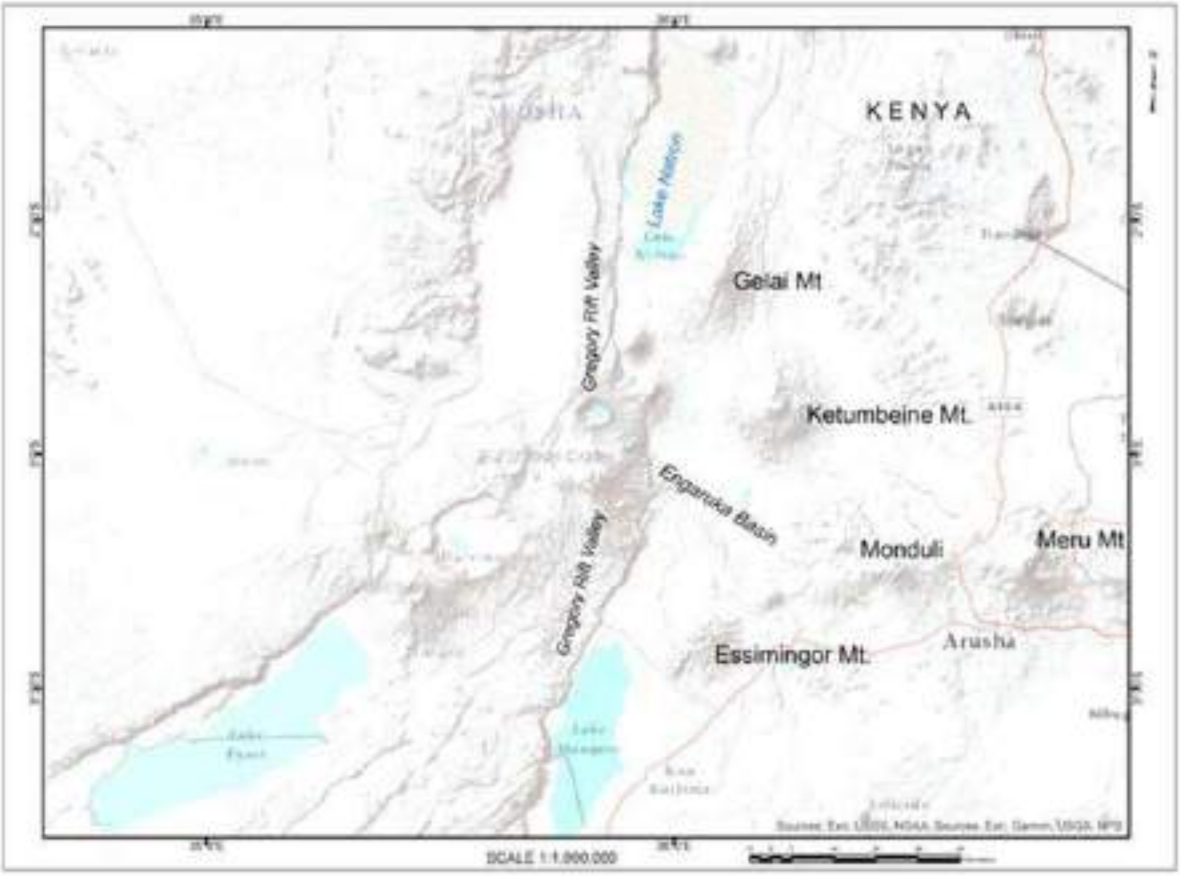



Figure 3.3. Volcanic Mountains around the Engaruka Basin within the East African Rift System (Source: USGS 2015).

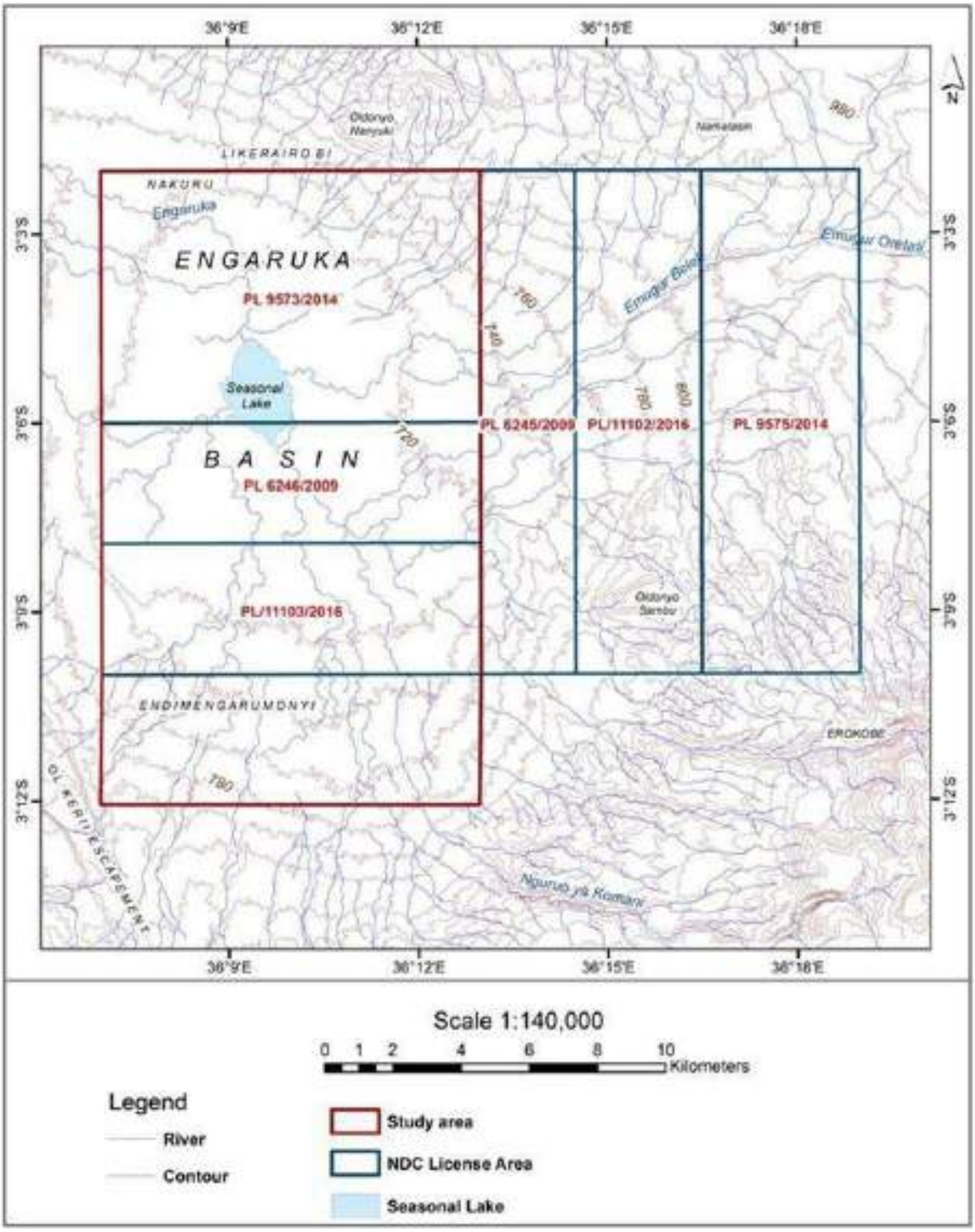



Figure 3.4: Engaruka basin drainage systems (Source; USGS 2015)

# CHAPTER FOUR

## 4. GEOLOGICAL SETTING OF THE ENGARUKA BASIN

Engaruka Basin is located in the Geological Map QDS 54 Monduli. According to Dawson, (1961) and Pickering, (1963) Engaruka Basin, is a playa lake, covered mostly by superficial deposits of recent volcanic origin consisting of tuffaceous beds, alluvial, outwash materials and alluvium including mbuga. The slopes of the hills on the north-northeast are dominated by rounded gravels and boulders consisting of pumice, magnesite and basalt, which are floating on top of the volcanic soils derived from surrounding hills and from the adjacent Gregory Rift escarpment. Remnants of the conglomerates are also found on small rounded hills north of Essimingor hill. Much of the fault block area west of Engaruka Basin is covered with grey calcareous soil. On the southern slopes of Essimingor and Burko are black soils with high phosphorous content (Dawson 1961).

Younger extrusive rocks are associated with, or post-date, the main phase of faulting. The largest centres are Kerimasi dominated by carbonatitic materials, Essimingor and Burko. For the case of Essimingor its earliest activity was highly explosive giving rise to central cores of nephelinitic and ijolitic pyroclastic with a thin covering of later lavas. In the pyroclastics, which grade from tuff to agglomerates, the commonest minerals are soda pyroxene, nepheline, magnetite and various carbonate minerals. On Burko the nephelinitic and phonolitic lava are the most prominent eject blocks.

The older extrusive rocks comprise the Tarosero and Kitumbaine volcanoes and the faulted terrain of lava-plateau of Monduli hills. The faulted terrains and the lower slopes of the volcanoes consist mainly of feldspar-phyric-olivine basalt overlain by olivine and augite-phyric-basalts and trachybasalts associated with trachyandesites.

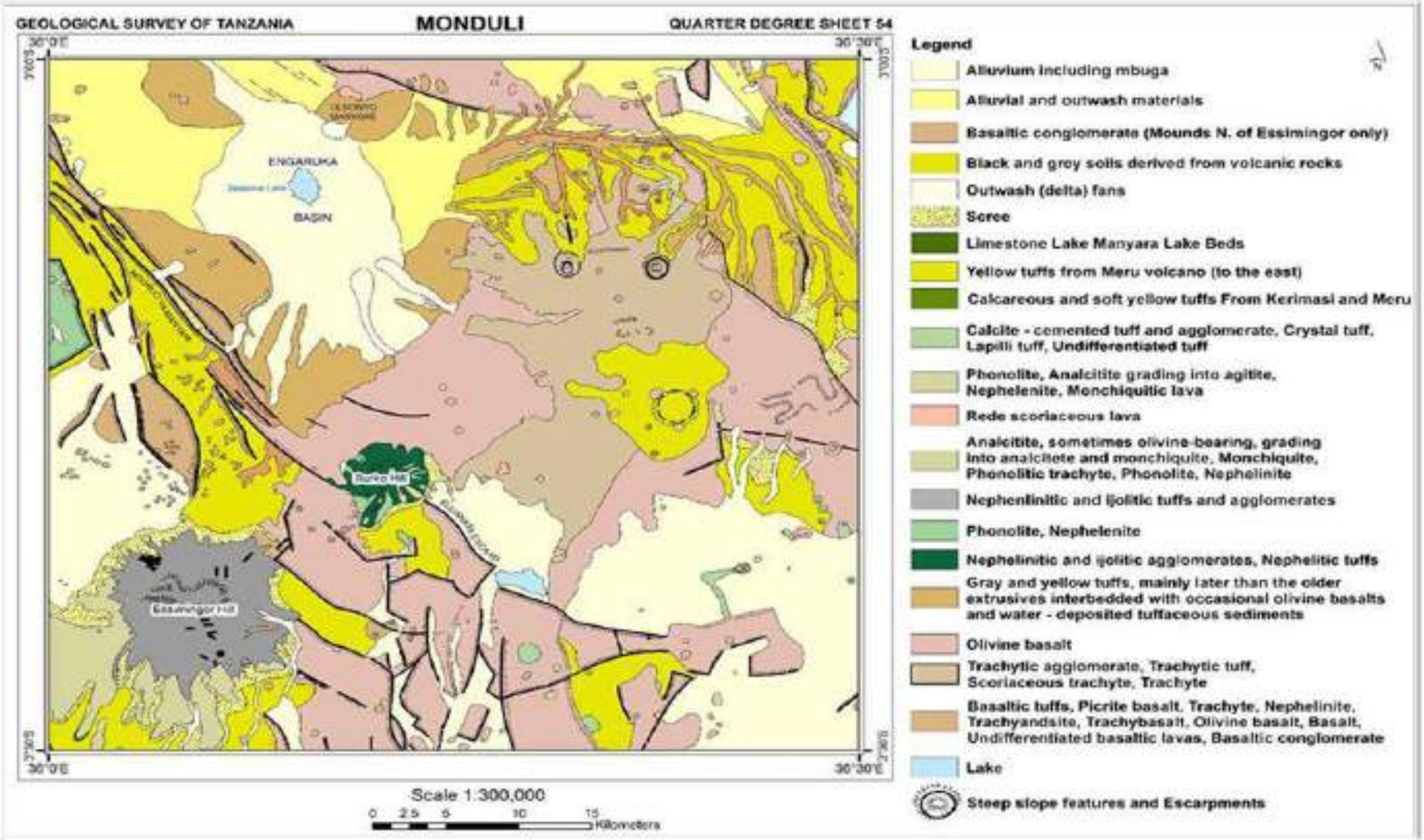



Figure 4.1. Geological Map of Monduli area where Engaruka Basin is located (Modified after GST 2011).

## CHAPTER FIVE

# 5. REVIEW OF BRINE RESOURCES IN ENGARUKA BASIN

## 5.1. Introduction

This part presents the review of previous soda ash exploratory reports conducted at Engaruka Basin between 2008 and 2013, where most of the data is based from 16 reported exploratory boreholes (14 RC holes and 2 Diamond holes) (Kaaya, 2008; 2012; 2013). The main works reported were:

- Logging of the drill-core/chips to establish the stratigraphy of the area.
- Pumping test for identification of characteristics of aquifers within the basin.
- Ground and surface water sampling and analysis to establish the composition of the brines.
- VES to verify existence of aquifers with brines.

## 5.2. Status of Boreholes

Most of the drilled boreholes reported in the study conducted in 2011 – 2013 were of depth between 120 to 200m deep and their spacing on the surface (immediate neighbourhood) was ranging from 1.8 to 5 km. All the boreholes were reported to have intersected two to three aquifers with brine. Cores from BH9 and BH11 were reported to be drilled to a depth of 200m and 170m respectively.

## 5.3. Logging of the Cores and Chips and Establishment of Aquifers

- Geological logging for diamond drilled holes (BH9 and BH11) indicated the presence of solid crystalline trona in the basin within the drilled depth and established that total thickness of sediments in Engaruka Basin exceeds 200 m.
- Most of the identified crystalline solid salts during logging of drill-cores/chips were reported to be transparent (clear salts) to dull (salts with mud intercalations), granular to prismatic in form, fine to very coarse in size forming massive pure salt sequence or embedded in clay/matrix (Figure 5.1)

## 5.4. Pumping Test, Laboratory analysis and Resource Estimation of the Brine

- Pumping test conducted in borehole number 5 drilled to 110m depth yielded a discharge capacity of 61.5 $m^3$/hr. Laboratory analysis of water samples from the boreholes identified the presence of Na, Ca, K, Mg, Fe, Cl, $HCO_3$, $SO_4$ and F in the brines. The total dissolve salts (TDS) were ranging from 287.18 to 343.785g/l.

- Salts precipitate from the brine were reported to be sodium carbonates $Na_2CO_3$ (192 - 229 g/*l*.), sodium bicarbonate $NaHCO_3$ (11.36 - 15.12 g/*l*), sodium chloride NaCl (79.4 - 83.3 g/*l*), calcium carbonate $CaCO_3$ (0.28 g/*l*), potassium chloride KCl (2.4 – 4.5) g/*l*), and calcium sulphate CaSO4 (<0.277 g/*l*).

- Mineral Resource estimate reported for Engaruka Basin indicated the presence of about 4,680,000,000 $m^3$ of brines equivalent of 1.4 billion tons of salts of which 982 million ton is soda ash. The rate of brine replenishment was estimated to be 1,875,000$m^3$/year. REPEATETION


Figure 5.1. Different form of salt crystals: a) Fine to medium grains of salt crystals embedded in in sand/clay matrix at 42 m depth b) Very coarse prismatic crystals from 9m thick unit at 184 m depth.

CHAPTER SIX

# 6. MAIN FINDINGS

## 6.1. Geological Mapping

Geological mapping involved identifying lithology and geological structures in the study area. It was conducted within the project area and the surrounding highland as indicated in Figure 6.1. Verification of the actual area licensed to NDC (also shown in Figure 6.1 by green rectangular blocks) shows that a big part of the area falls partly in the Engaruka Basin with sedimentary piles and partly in the hillside to the east of the Basin. From the general geological knowledge, and after making visual observation of the textures and structures of volcanic rocks on the highlands, it is unlikely to have aquifers of significant size as most of these rocks are massive, well-crystalline and do not have fractures. Based on these observations, licensed blocks to NDC in the hillside to the East of the appraised area are not expected to host brines of significant size to allow economic extraction.

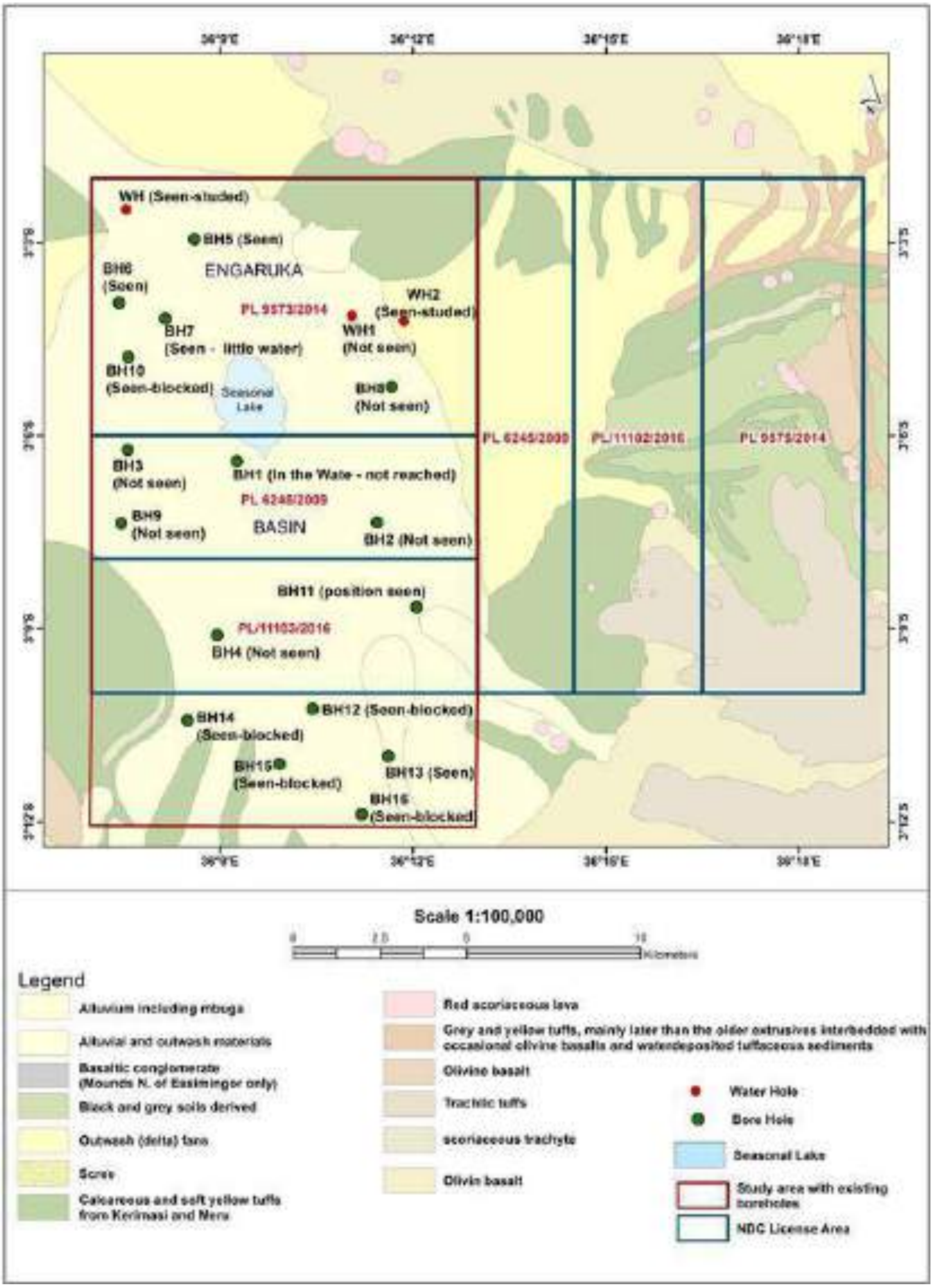



Figure 6.1. Distribution of the major volcanic rocks surrounding Engaruka Basin (Dawson, 1963)

***Surficial Deposits***

Main surficial deposits identified in the area following their order of formation from top to bottom are as follows:

i. **Aeolian Deposits.**

These are loose silts and clays that are currently being transported by wind during dry season and deposited on almost all over the surface of the basin; some are deposited on the existing water-lake causing yellowish coloration to the lake water.

ii. **Chemically Precipitated Salts.**

These are mainly carbonates and crystals of soda-ash. These salts are mostly deposited on the surface of the underlying sand and silty lake deposits.

iii. **Conglomeratic Deposits.**

Channel conglomeratic deposits with well-rounded volcanic pebbles in sandy to silty matrix. They are normally deposited on top of the sandy-silty lake deposits forming elongated bodies oriented in the flow direction of their depositing channels. Most of the observed conglomeratic channel deposits are seen to extend towards SWS into the basin from the eastern highlands basin and some are elongated towards east into the basin from the western highlands.

iv. **Sandy and Silty Lake Deposits**

These are flat-lying to gently dipping sandy and silty lake deposits partly cemented (mainly by carbonates). These deposits normally outcrop in the form of up to ½ meter stepping ridges within the basin particularly in the western part of the basin.

A B

Figure 6.2. Major sandy to silty lake bed ridges overlain by elongated conglomeratic channel deposits in the Engaruka Basin (A – Conglomerate/Lake Bed Deposits, B – Stratified Lake Beds).

***Volcanic Formations***

The main volcanic rocks that are exposed in the ridges surrounding the basin arranged in their order of abundancy (from the highest to the least) are:

**i. Calcareous and Soft yellow Tuff from Kerimasi**

They are grey to yellow in colour, calcareous, mostly sandy in size sometimes interbedded with lenses of gravel and agglomerates of basaltic composition. They are thought to be correlated with Kerimasi Carbonatite volcano. These are the main lithology that form the immediate ridges that bound the basin.

ii. **Olivine Basalt**

The olivine basalts border the basin in the south eastern and north-western ridges and partly in the northern part.

iii. **Red Scorious lava**

These occur as isolated hills in the east, north and north-western part of the basin. They mostly occur as interlayers in the calcareous yellow tuff from Kerimasi.

Other rocks in the vicinity that may have influence in the composition of the brines in Engaruka include:

iv. **Nepheline and Ijolite Tuff and Aglomerate of Burko and Essimingor Hills**

The central core of the Essimingor has Nephelinitic and Ijolitic pyroclastics containing soda pyroxene, nepheline, magnetite and carbonate. On the Burko hill the lava are nepheline and phonolite. The presence of sodium and carbonate in these hills, during rainfall Season River may erode the minerals to the basin and increase the concentration of the brine this may be proved by the result of the analysis of the water samples from the boreholes.

Geographical locations of all these volcanic rocks in relationship with the position of Engaruka Basin and the drainage patters are presented in **Error! Reference source not f ound..**

## 6.2. Sampling and Analysis of Rocks and Soils

***Sampling Site and Laboratory Analysis***

A total of 36 observation points has been studied in the field of which 33 points (with E number) their solid rock and soil samples have been collected (XRD result (Table 6.2) of rock and soil samples collected within and around Engaruka Basin indicate that anorthoclase, albite, labradorite, oligoclase, nepheline, calcite, phillipsite, augite analcime, and andesine are minerals containing a high percentage of sodium and carbonate. During rainy season, rivers and streams may transport weathered minerals to the basin and contribute to the concentration of brine.

Table 6.1) from the field; special distribution of these points is shown in **Error! Reference source not found.**. Thin sections for micro-petrographic analysis have been prepared for 5 of these samples and their micro-petrographically analysis done at the Geological Survey of Tanzania are presented in section 6.2.2 of this report. XRD analysis for 33 samples were done at the Department of Geology, University of Dar es Salaam and their results are described in section 6.10.3 and presented in Table 6.2. Graphic presentation of X-Ray Diffraction Analysis for the analysed samples is presented in Appendix **Error! Reference source not found.** . In addition, all the 33 samples were crushed, pulverized and geochemically analysed at Mintec laboratory in Mwanza using LM 01C- ICP for malt-element, LM-14/01 for Total Carbon and UV/VIS for Carbonate, Chloride, Nitrate and Sulphate. General results of geochemical analysis of rock samples are described in section 6.2.3 and presented in Table 6.3.

XRD result (Table 6.2) of rock and soil samples collected within and around Engaruka Basin indicate that anorthoclase, albite, labradorite, oligoclase, nepheline, calcite, phillipsite, augite analcime, and andesine are minerals containing a high percentage of sodium and carbonate. During rainy season, rivers and streams may transport weathered minerals to the basin and contribute to the concentration of brine.

Table 6.1. Rock and soil samples collected on the surface in Engaruka Basin (Arc 1960 UTM zone 37)

| **Sample No** | **Description** | **Eastings** | **Northings** | **Elevation above sea level (m)** |
|---|---|---|---|---|
| OB1 | Basaltic Conglomerate | 181523 | 9663122 | 724 |
| OB2 | Basaltic Conglomerate | 181113 | 9663134 | 726 |
| OB3 | Basaltic Conglomerate | 178513 | 9663275 | 744 |

| | | | | |
|---|---|---|---|---|
| E01 | Mudstone | 182496 | 9662603 | 697 |
| E02 | Mudstone | 183111 | 9662646 | 712 |
| E03 | Mudstone bottom layer | 188051 | 9661583 | 731 |
| E04 | Mudstone upper layer | 188056 | 9661587 | 733 |
| E05 | Basalt | 196402 | 9664058 | 869 |
| E06 | Mudstone | 196338 | 9663740 | 858 |
| E07 | Mudstone | 186301 | 9664306 | 764 |
| E08 | Scorious Lava | 186594 | 9665318 | 815 |
| E09 | Basalt | 186607 | 9665315 | 818 |
| E10A | Calcareous Tuff | 179086 | 9663505 | 737 |
| E10B | Calcareous Tuff | 179086 | 9663505 | 737 |
| E11 | Calcareous Tuff | 178489 | 9663238 | 744 |
| E12 | Scorius Tuff | 175010 | 9664880 | 754 |
| OB4 | Mudstone | 186303 | 9664273 | 763 |
| E13 | Tuff | 176167 | 9659486 | 762 |
| E14 | Calcrete | 176171 | 9654403 | 771 |
| E17 | Basaltic Conglomerate | 168266 | 9657374 | 927 |
| E18 | Red Lava | 167619 | 9663278 | 828 |
| OB5 | Basalt | 181287 | 9639919 | 953 |
| TUFF | Calcareous Tuff | 176050 | 9654027 | 776 |
| E19 | Tuff | 190155 | 9660049 | 739 |
| E20 | Tuff | 192647 | 9658300 | 757 |
| E21 | Olivine Basalt | 195623 | 9654973 | 807 |
| E22 | Red Tuff | 195670 | 9654924 | 827 |
| E23 | Tuff | 191103 | 9653653 | 740 |
| E24 | Conglomerate tuff | 193725 | 9651001 | 823 |
| E25 | Nephline pophyritic basalt | 193947 | 9651502 | 822 |
| E26 | Conglomerate tuff | 188649 | 9645648 | 790 |
| E27 | Calcrete tuff | 189462 | 9643673 | 849 |
| E28 | Basalt | 190127 | 9643024 | 932 |
| E29 | Basalt | 190610 | 9642803 | 979 |
| E30 | Consolidated Soil | 181615 | 9660255 | 726 |
| E31 | Consolidated Soil | 181940 | 9660044 | 725 |

Table 6.2. X-Ray Diffraction (XRD) analytical results of 33 rock samples from Engaruka Basin.

| Sample ID | Mineral Phases | Mineral Formula | 0/o Proportion (Semi - Quantitative) |
|---|---|---|---|
| E01 | Analcime | $NaAlSi_20_6\cdot H_20$ | 20.4 |
| | Sanidine | $KAlSi_30_8$ | 10.3 |
| | Magnetite | $Fe_30_4$ | 2.7 |
| | Hornblende | $(Ca, Na)_2(Mg, Fe, Al)_5(Al, Si)_8(OH, F)_2$. | 15.2 |
| | Augite | $(Ca, Na) (Mg, Fe, Al, Ti) (Si, Al)_20_6$ | 20.6 |
| | Quartz | $Si0_2$ | 5.76 |
| | Enstatite | $MgSi0_3$ | 25.1 |
| E02 | Arrojadite | $BaNa_3(Na, Ca) Fe^{2+}13Al (PO_4)_{11}(PO_3OH) (OH)_2$ | 11.8 |
| | Analcime | $NaA1Si_20_6\cdot H_20$ | 29.4 |
| | Anorthoclase | $(Na, K) AlSi_30s$ | 42.1 |
| | Hematite | $Fe_20_3$ | 2.84 |
| | Diopside | $MgCaSi_20_6$ | 13.9 |
| E03 | Analcime | $NaA1Si_20_6\cdot H_20$ | 18.9 |
| | Albite | $NaA1Si_30_5$ | 40.8 |
| | Aegirine | $NaFeSi_20_6$ | 22.3 |
| | Fluoro-edenite | $NaCa_2Mgs (Si_7Al)0_{22}(0H, F)_2$ | 17.9 |
| E04 | Analcime | $NaA1Si_20_6\cdot H_20$ | 25.7 |
| | Albite | $NaA1Si_30_5$ | 41.9 |
| | Fluoro-edenite | $NaCa_2Mgs (Si1Al)0_{22}(0H, F)_2$ | 17.6 |
| | Diopside | $MgCaSi_20_6$ | 14.77 |
| E05 | Diopside | $MgCaSi_20_6$ | 15.11 |
| | Labradorite | $(Ca, Na) (Al, Si)_4O_8$ | 80.89 |
| | Kutnohorite | $CaMn^{2+(}C0_3)_2$ | 4 |
| E06 | Hedenbergite | $CaFeSi_20_6$ | 9.69 |
| | Chromio-pargasite | $\{Na\}\{Ca^2\} \{Mg_4Cr^{3+}\} (Al_2Si_60_{22}) (0H)_2$ | 12.09 |
| | Analcime | $NaA1Si_20_6\cdot H_20$ | 13.69 |
| | Anorthoclase | $(Na, K) A1Si_30_8$ | 43.77 |
| | Magnetite | $Fe_30_4$ | 1.73 |
| | Wairakite | $Ca (Al_{16}Si_{32}0_{96})$ •l $6H_20$ | 19.03 |
| E07 | Analcime | $NaA1Si_20_6\cdot H_20$ | 24.65 |
| | Calcite | $CaC0_3$ | 6.93 |
| | Augite | $(Ca, Na) (Mg, Fe, Al, Ti) (Si, Al)_20_6$ | 18.23 |
| | Labradorite | (Ca, Na) (Al,)4 | 29.38 |
| | Enstatite | $MgSi0_3$ | 20.81 |

| | | | |
|---|---|---|---|
| E8 | Oligoclase | Na0.8Ca0.2Al1.2$Si_2$.8$O_8$ | 74.88 |
| | Hematite | $Fe_20_3$ | 2.29 |
| | Augite | (Ca, Na) (Mg, Fe, Al, Ti) (Si, Al)$_20_6$ | 22.22 |
| E8b | Pseudo brookite | $Fe_2Ti0_5$ or $(Fe^{3+},Fe^{2+})_2(Ti,Fe^{2+})0_5$. | 3.12 |
| | Oligoclase | Na0.8Ca0.2Al1.2$Si_2$.8$O_8$ | 74.75 |
| | Augite | (Ca, Na) (Mg, Fe, Al, Ti) (Si, Al)$_20_6$ | 19.66 |
| | Apatite | $Ca_5(PO_4)_3$(OH, F, Cl) | 2.47 |
| E9 | Nepheline | $Na_3KA_{14}Si_40_{16}$ | 42.31 |
| | Diopside | $MgCaSi_20_6$ | 57.69 |
| ElOA | Hedenbergite | $CaFeSi_20_6$ | 9.68 |
| | Oligoclase | Na0.8Ca0.2Al1.2Si2.8$O_8$ | 90.32 |
| ElOB | Analcime | $NaAlSi_20_6{\cdot}H_20$ | 9.67 |
| | Natrolite | $Na_2Al_2Si_30_{10}$ •$2H_20$ | 14.99 |
| | Calcite | $CaC0_3$ | 8.87 |
| | Oligoclase | Na0.8Ca0.2Al1.2$Si_2$.8$O_8$ | 25.52 |
| | Sanidine | $KAlSi_30_5$ | 9.92 |
| | Enstatite | $MgSi0_3$ | 19.33 |
| | Augite | (Ca, Na) (Mg, Fe, Al, Ti) (Si, Al)$_20_6$ | 11.69 |
| E11 | Oligoclase | Na0.8Ca0.2Al1.2Si2.8$O_8$ | 78.27 |
| | Diopside | $MgCaSi_20_6$ | 13.33 |
| | Calcite | $CaC0_3$ | 8.4 |
| E12 | Calcite | $CaC0_3$ | 100 |
| E13 | Analcime | $NaA1Si_20_6{\cdot}H_20$ | 11.99 |
| | Oligoclase | Na0.8Ca0.2Al1.2Si2.8$O_8$ | 47.09 |
| | Augite | (Ca, Na) (Mg, Fe, Al, Ti) (Si, Al)$_20_6$ | 17.2 |
| | Calcite | $CaC0_3$ | 13.98 |
| | Natrolite | $Na_2AlSi_30_{10}$•$2H_20$ | 9.73 |
| El4 | Natrolite | $Na_2Al_2Si_30_{10}$•$2H_20$ | 6.98 |
| | Augite | (Ca, Na) (Mg, Fe, Al, Ti) (Si, Al)$_20_6$ | 20.17 |
| | Titanite | $CaTiSi0_5$ | 11.81 |
| | Oligoclase | Na0.8Ca0.2Al1.2Si2.8$O_8$ | 26 |
| | Analcime | $NaA1Si_20_6.H_20$ | 7.54 |
| | Calcite | $CaC0_3$ | 27.5 |
| E15 | Analcime | $NaA1Si_20_6$. $H_20$ | 11.56 |
| | Diopside | $MgCaSi_20_6$ | 13.07 |
| | Pyrargyrite | $Ag_3SbS_3$ | 1.33 |
| | Natrolite | $Na_2Al_2Si_30_{10}$ •$2H_20$ | 13.29 |
| | Calcite | $CaC0_3$ | 13.9 |
| | Nepheline | Na $_3KA_{14}Si_40_{16}$ | 23.18 |
| | Oligoclase | Na0.8Ca0.2Al1.2Si2.8$O_8$ | 23.68 |

| | | | |
|---|---|---|---|
| E16 | Aegirine | $NaFeSi_20_6$ | 23.12 |
| | Analcime | $NaA1Si_20_6.H_20$ | 33.17 |
| | Augite | $(Ca, Na) (Mg, Fe, Al, Ti) (Si, Al)_20_6$ | 25.52 |
| | Oligoclase | $Na0.8Ca0.2Al1.2Si2.8O_8$ | 18.18 |
| E17 | Analcime | $NaA1Si_20_6$·. $H_20$ | 7.14 |
| | Ankerite | $Ca (Fe, Mg, Mn)(C0_3)_2$ | 7.17 |
| | Augite | $(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_20_6$ | 15.39 |
| | Anorthoclase | $(Na,K)A1Si_30_8$ | 32.62 |
| | Phillipsite | $(Ca, Na_2,K2)_3Al_6Si10032$·. $l2H_20$. | 37.69 |
| E18 | Alarsite | $A1As_{04}$ | 1.08 |
| | Hematite | $Fe_20_3$ | 1.97 |
| | Sanidine | $KA1Si_30_8$ | 23.24 |
| | Enstatite | $MgSi0_3$ | 20.15 |
| | Augite | $(Ca,Na)(Mg,Fe,Al, Ti)(Si,Al)_20_6$ | 30.04 |
| | Oligoclase | $Na0.8Ca0.2Al1.2Si2.8O_8$ | 23.52 |
| E19 | Analcime | $NaA1Si_20_6$ $H_20$ | 8.09 |
| | Calcite | $CaC0_3$ | 11.34 |
| | Augite | $(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_20_6$ | 19 |
| | Oligoclase | $Na0.8Ca0.2Al1.2Si2.8O_8$ | 36.2 |
| | Enstatite | $MgSi0_3$ | 25.37 |
| E20 | Tridymite | $Si0_2$ | 6.65 |
| | Analcime | $NaA1Si_20_6$· $H_20$ | 3.52 |
| | Hedenbergite | $CaFeSi_20_6$ | 2.05 |
| | Phillipsite | $(Ca, Na_2,K_2)_3Al_6Si10032$·$l2H_20$. | 84.32 |
| | Diopside | $MgCaSi_20_6$ | 3.47 |
| E21 | Albite | $NaA1Si_30s$ | 34.64 |
| | Ferro-hornblende | $(Ca,Na)2\text{-}lMg,Fe,Al)_5(Al,Si)80_{22}(0H,F)_2$. | 1.45 |
| | Enstatite | $MgSi0_3$ | 20.56 |
| | Oligoclase | $Na0.8Ca0.2Al1.2Si2.8O_8$ | 34.69 |
| | Sanidine | $KA1Si_30_8$ | 8.66 |
| E22 | Oligoclase | $Na0.8Ca0.2Al1.2Si2.8O_8$ | 77.4 |
| | Aegirine | $NaFeSi_20_6$ | 7.32 |
| | Hematite | $Fe_20_3$ | 1.42 |
| | Pargasite | $NaCa_2(Mg4Al)(Si_6Al_2)O_{22}(OH)_2$. | 13.86 |
| E23 | Calcite | $CaC0_3$ | 50.28 |
| | Analcime | $NaA1Si_20_6$·$H_20$ | 43.3 |
| | Quartz | $Si0_2$ | 6.42 |
| E24 | Calcite | CaC03 | 33.51 |
| | Quartz | $Si0_2$ | 6.06 |
| | Sylvite | KCl | 6.88 |
| | Anorthoclase | $(Na,K)A1Si_30_8$ | 36.69 |
| | Diopside | $MgCaSi_20_6$ | 16.86 |

| | | | |
|---|---|---|---|
| E25 | Albite | $NaA1Si_{3}0s$ | 74.59 |
| | Ingersonite | $(CaMn)_{2}SiO_{4}$ | 0.56 |
| | Witherite | $K_{2}CO_{3}$ | 1.67 |
| | Augite | $(Ca,Na)(Mg,Fe,Al,Ti)(Si,Al)_{2}0_{6}$ | 4.72 |
| | Enstatite | $MgSi0_{3}$ | 6.18 |
| | Sanidine | $KA1Si_{3}0_{8}$ | 12.28 |
| E26 | Analcime | $NaA1Si_{2}0_{6}\ H_{2}0$ | 12.59 |
| | Halite | NaCl | 10.38 |
| | Natrolite | $Na_{2}Al_{2}Si_{3}0_{10}\ \bullet 2H_{2}0$ | 11.13 |
| | Enstatite | $MgSi0_{3}$ | 32.66 |
| | Sanidine | $KA1Si30_{8}$ | 23.54 |
| | Diopside | $MgCaSi_{2}0_{6}$ | 9.71 |
| E27 | Pargasite | $NaCa_{2}(Mg_{4}Al)(Si_{6}Al_{2})O_{22}(OH)_{2}$. | 20.56 |
| | Sylvite | KCl | 4.46 |
| | Al bite | $NaA1Si_{3}0s$ | 29.15 |
| | Phillipsite | $(Ca,Na_{2},K_{2})_{3}Al_{6}Si10032 \cdot l2H_{2}0$. | 45.84 |
| E28 | Andesine | $(Ca, Na)(Al, Si)_{4}O_{8}$ | 78.87 |
| | Diopside | $MgCaSi_{2}0_{6}$ | 10.49 |
| | Enstatite | $MgSi0_{3}$ | 10.65 |
| E29 | Andesine | $(Ca, Na)(Al, Si)_{4}O_{8}$ | 87.09 |
| | Diopside | $MgCaSi_{2}0_{6}$ | 6.72 |
| | Enstatite | $MgSi0_{3}$ | 6.18 |
| E30 | Chabazite | $(Ca,Na_{2},K_{2},Mg)AlSi_{4}0_{12} \cdot 6H_{2}0$ | 9.84 |
| | Enstatite | $MgSi0_{3}$ | 29.33 |
| | Aegirine | $NaFeSi0_{6}$ | 7.96 |
| | Ingersonite | $(CaMn)_{2}SiO_{4}$ | 1.47 |
| | Anorthoclase | $(Na,K)A1Si_{3}0s$ | 51.4 |
| E31 | Enstatite | $MgSi0_{3}$ | 18.7 |
| | Pollucite | $(Cs,Na)_{2}AhSi_{4}0_{12} \cdot 2H_{2}0$ | 7.89 |
| | Analcime | $NaA1Si_{2}0_{6} \cdot\ H_{2}0$ | 30.95 |
| | Hematite | $Fe_{2}0_{3}$ | 1.38 |
| | Augite | $(Ca,Na)(Mg,Fe,Al, Ti)(Si,Al)_{2}0_{6}$ | 8.52 |
| | Anorthoclase | $(Na,K)A1Si_{3}0s$ | 30.31 |
| | Ingersonite | $(CaMn)_{2}SiO_{4}$ | 2.21 |

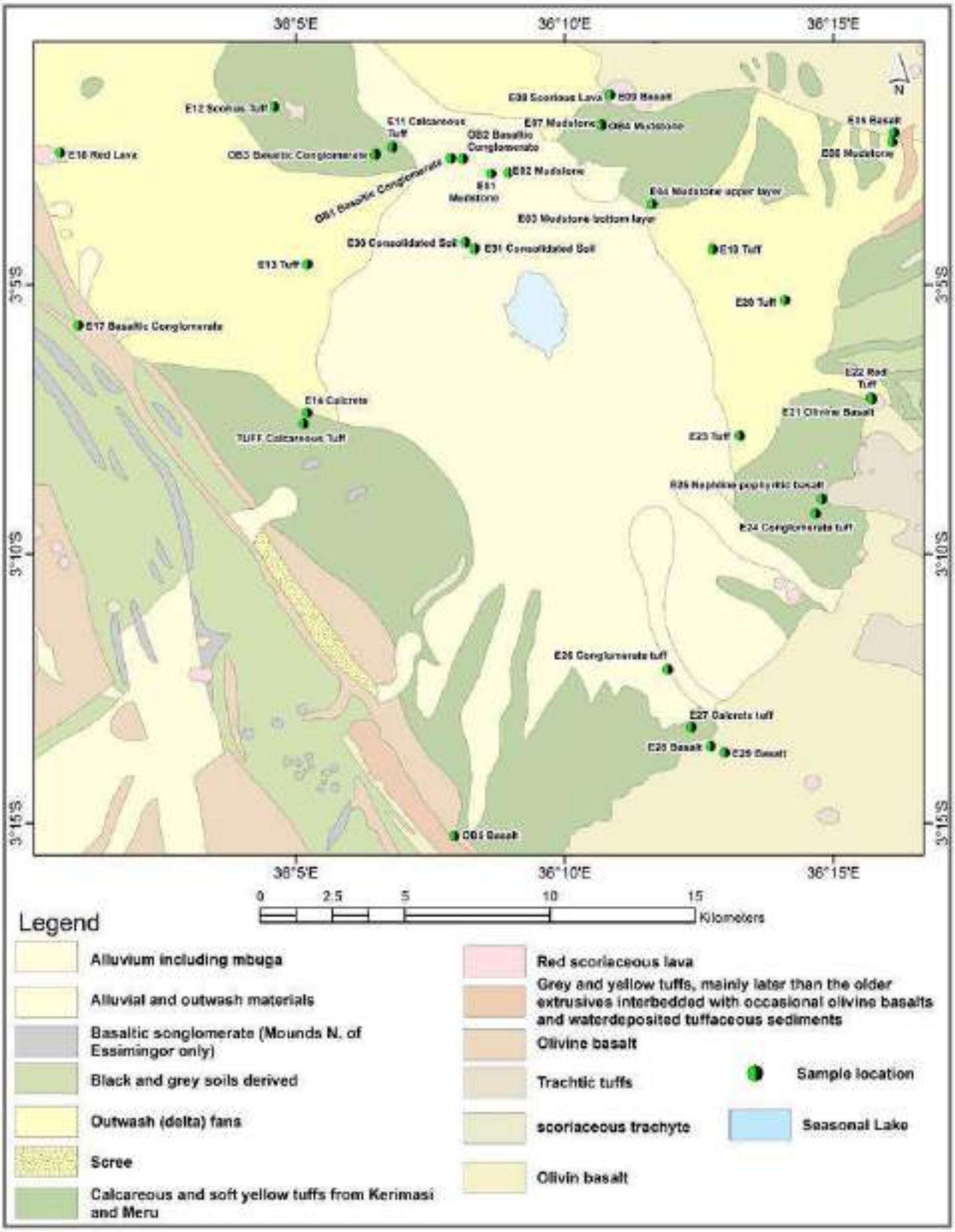



Figure 6.3. Sampling locations of rocks and soils at the Engaruka Basin

*Micro-petrography*

Petrography study indicates the presence of trachyte rock unit (Sample E25) dominated by alkali-feldspar (sanidine). Disintegration of sanidine {(K,Na)(Si,Al)4O8} by weathering releases sodium that contributes to the brine chemistry of the Engaruka Basin.

i. **Sample ID**: E05

**Rock Name**: Basalt

**Mineralogical Composition**

**Plagioclase** (65% in volume) - Colourless in thin section, anhedral to euhedral in shapes and shows low interference colours (first order colour). Lath like and tabular shape, medium grained and simple twinning is observed to be common in these minerals.

**Pyroxene** (18% in volume) -fine to medium grained and anhedral to euhedral in outline mostly occur as finely grained groundmass. Very few phenocrysts that show two sets of cleavage meeting at right angles.

**Olivine** (10% in volume) -They occur as fine-grained matrix (groundmass) and a very few phenocrysts in the sample.

**Amphibole** (hornblende) (4% in volume)-are fine grained and prismatic in shape.

Iron oxide (opaque) (3% in volume)-are fine grained and distributed throughout the sample, they occur as alteration minerals and a few magnetite grains as a primary origin.

**Secondary mineral (alteration product)** –Iron oxide.

**Summary Description.**

The sample is volcanic-igneous rock dominated by coarse phenocrysts of plagioclase in a groundmass composed of fine crystals of several other minerals including pyroxene, olivine hornblende and iron oxides mineral assemblages. As such, from textural point of view the rock is generally fine grained with some feldspar porphyry, holocrystalline with anhedral to euhedral crystal outline (Figure 6.4).

Figure 6.4. Microphotograph showing euhedral plagioclase feldspar porphyry in fine groundmass (Image under Cross Polar and 5X magnification).

ii. **Sample ID**: E09

**Rock Name**: Olivine-basalt

**Mineralogical Composition**

**Plagioclase** (55% in volume) – Colourless in thin section, generally fine to medium grained, anhedral to euhedral in outline, they occur in the form of both coarse phenocrysts and as fine groundmass, the shape is prismatic and lath like. Simple twinning and multiple twinning have been observed in most grains.

**Olivine** (25% in volume) - Colourless in thin section, subhedral to euhedral in outline and medium grained, it has high relief and high interference colours of 3$^{rd}$ and upper 2$^{nd}$ order. The minerals are fractured and alter to iron oxide. They occur as coarse phenocrysts (in some cases) as well as fine groundmass in other cases.

**Pyroxene** (10 -15% in volume) – greenish in thin section, medium grained and anhedral to euhedral in outline, few grains show two sets of cleavage intersecting at almost at right angles.

**Iron oxide (opaque)** (3% in volume)-are fine grained and distributed evenly throughout the sample

**Secondary mineral (alteration product)** –iron oxide and iddingsite

**Summary Description**

The sample is volcanic- igneous rock consisting of plagioclase, olivine, pyroxene and iron oxide mineral assemblages. Due to the presence of sufficient olivine minerals the rock is qualified to be olivine basalt. Generally, the sample is porphyritic in texture (Olivine and plagioclase making the phenocrysts), holocrystalline, anhedral to euhedral in outline.

Most of olivine crystals occur as phenocrysts in a fine groundmass of plagioclase, pyroxene and iron oxides. They contain irregular cracks and slight alteration along cracks producing the brownish substance called iddingsite (Figure 6.5).

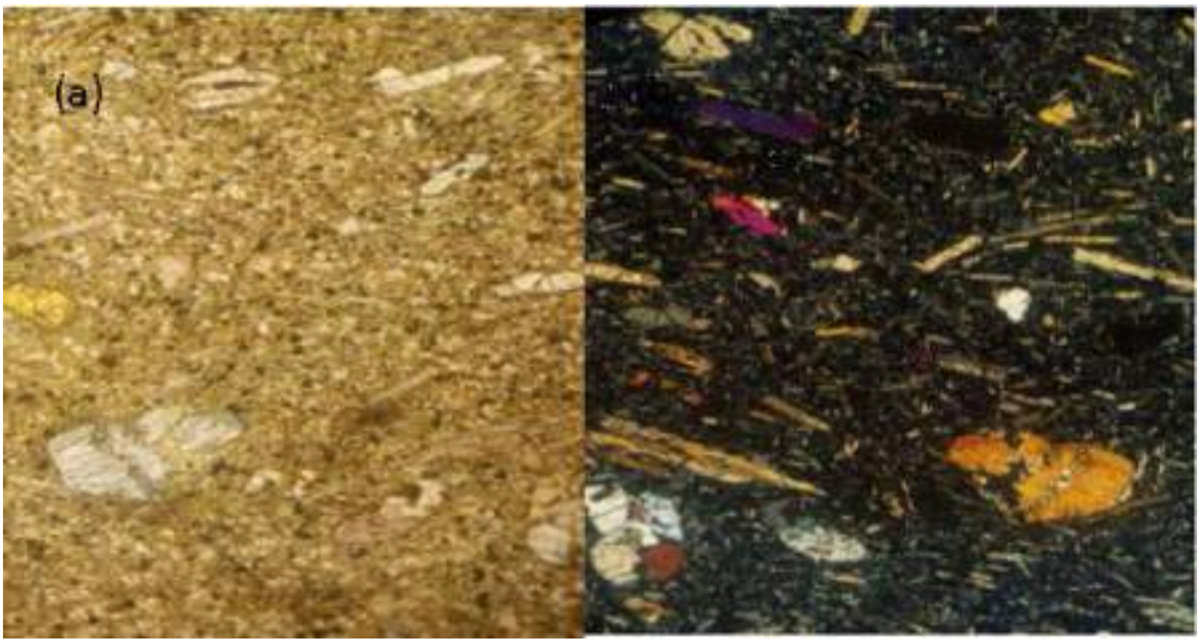



Figure 6.5 (a-b): Microphotograph showing olivine (high interference colours) and plagioclase (as phenocrysts) in groundmass of other minerals. {(a) Image under Plane Polarized Light - PPL and (b) image under Cross Polarized Light - XPL (5X magnification)}

iii. **Sample ID**: E22

**Rock Name**: Weathered Basalt

**Mineralogical Composition**

**Calcic-plagioclase** (60% in volume) - Colourless, anhedral to euhedral in shape and shows low interference colours (first order colour), fine to medium grained and tabular. Other optical properties like twinning are not well displayed due to the partial weathering nature of the rock.

**Mafic minerals** (37% in volume) – These minerals are probably pyroxene, olivine and/ or amphibole, they have high relief, dark red in crossed polarized light and reddish in plane polarized light. The reddish colour is actually contributed by weathering and not the real colours of the minerals under thin section. Other optical properties of each mineral are not described here due to partial weathering of the sample.

**Iron oxide (opaque)** (3% in volume)-black in colour, fine grained and distributed throughout the thin section.

**Summary Description**

The sample is fine grained, dark red to reddish in colour (most likely due to partial oxidation of iron containing minerals). It is partly vesicular and basaltic in composition. In the thin section, plagioclase is well recognized and are dominant in the rock. Due to weathering, individual mafic minerals are not easily identified because they do not display well their optical properties and they seem to be reddish in both plane polarised light as well as in crossed polarized light (Figure 6.6).

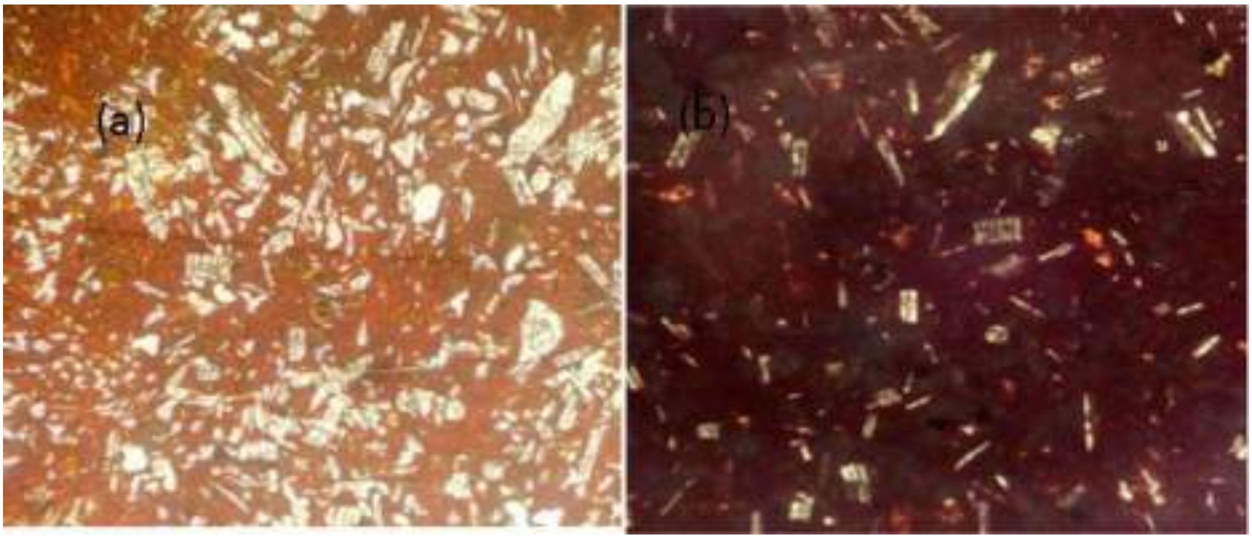



Figure 6.6.(a-b): Microphotograph showing plagioclase crystals (grey/white) and mafic minerals (reddish and dark red) {(a) under plane Polarized Light - PPL and (b) Cross Polarized Light - XPL (5X)}.

iv. **Sample ID**: E25

**Rock Name**: Trachyte

**Mineralogical Composition**

**Alkali feldspar (Sanidine)** (75% in volume) – some crystals occur as phenocrysts and some as fine grained (in the groundmass). The phenocrysts are rectangular/tabular, fractured, subhedral to euhedral in outline. The phenocrysts occur within fine grained groundmass of alkali feldspar which are colourless in thin section and having low relief. Simple twin of two lamella is very common which is a typical characteristic of alkali feldspar (sanidine). Sanidine crystals are clear which make them to be distinguished from orthoclase which is often cloudy in thin section. The crystals are aligned parallel to magma flow direction (flow texture). The minerals are partly fractured and the fractures are filled with coloured iron oxide as a result of alteration.

**Pyroxene** (10% in volume)- are present in the rock in a small amount and it shows high relief and interference colours in thin section. They are medium grained crystals, some showing an almost ninety-degree type of cleavage, some grains are observed in sanidine phenocrysts as inclusion. Some grains are partly altered to iron oxide.

**Olivine (**5% in volume**) -**They occur as phenocrysts but in small amount. One crystal is euhedral in shape, fractured, altered to iron oxide along the crystal boundaries and also show iddingsite alteration within the crystal.

**Biotite** (6% in volume)-very few crystals are observed in the sample but most of them seem to alter to muscovite and iron oxide

**Iron oxide** (opaque phase) (4% in volume) - fine grained and they are distributed evenly throughout the sample.

**Secondary minerals**- iron oxide, iddngsite.

**Summary Description**

The sample is dominantly composed of alkali-feldspar (sanidine) occurring as fine grains in the ground mass and as coarse phenocrysts (Figure 6.7). The sample also contain small amount of pyroxene, olivine and biotite. Under hand specimen, the rock is light grey coloured, light in weight and phenocrysts of rectangular alkali feldspar can clearly be seen by naked eyes. In thin section most minerals are colourless and occur in the form of groundmass and phenocrysts forming a trachytic texture. Phenocrysts of alkali feldspar are aligned in preferred orientation indicating a magma flow direction. The grains are generally subhedral to euhedral in outline. Some minor alterations have taken place forming brownish iron oxide and iddingsite. The alteration seems to be in olivine and some biotite grains are partly bleached and they look live muscovite.

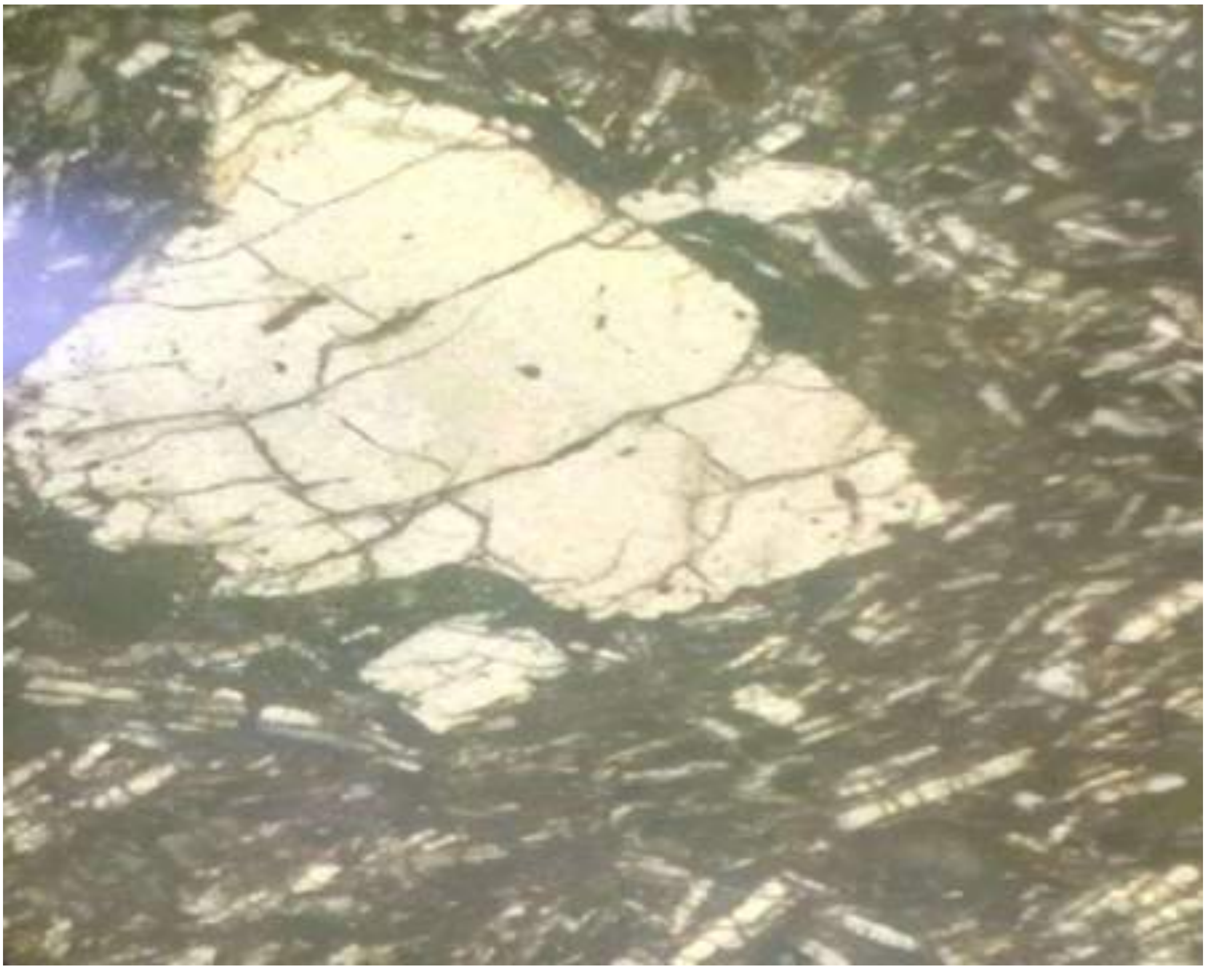


Figure 6.7. Microphotograph showing alkali - feldspar (Sanidine) phenocryst surrounded by fine groundmass (under Cross Polarize Microscope - XPL and magnification of 5X).

v. **Sample ID**: E29

**Rock Name**: Basalt

**Mineralogical Composition**

**Plagioclase** (60% in volume) – Colourless in thin section, low relief and grey to white in crossed polarized light. It is generally fine grained (groundmass) and anhedral in outline. They occur as thin elongated laths. Twinning is not observed in these minerals.

**Pyroxene and olivine** (36% in volume) -fine grained (groundmass), generally anhedral in outline with high relief and interference colours, the minerals occur in almost the same size forming an equigranular texture.

**Iron oxide** (4% in volume)-fine grained, black, mostly occur as a result of alteration and they are distributed evenly throughout the sample.

**Summary Description**

In hand specimen the sample is black in colour and fine-grained texture. In thin section the rock is rather fine-grained consisting of thin elongated laths of plagioclase which is colourless in plane polarized light. Mafic minerals in the rock are pyroxene and some olivine and they occur as fine matrix which can be well recognized in crossed polarized light where they tend to display high interference colours. Opaque minerals are fairly common as small grains or aggregates and most of them are probably formed by alteration of pyroxene and/or olivine. Twinning is not observed. Minerals in this rock are generally anhedral in outline with an equigranular texture (Figure 6.8).

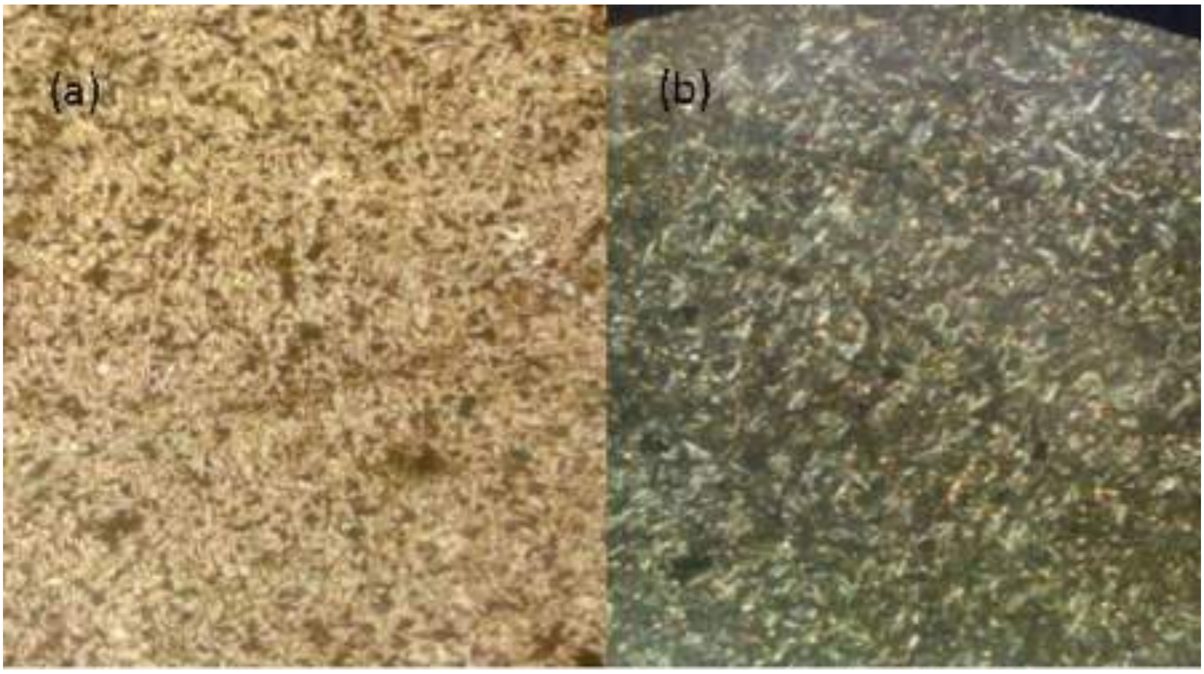



Figure 6.8.(a-b). Microphotograph showing plagioclase, pyroxene and olivine in groundmass {(a) under Plane Polarized Light - PPL and (b) under Cross Polarised Light - XPL (magnification = 5X)}.

***Chemical Analysis of Rocks and Soil Samples***

Rock and soil samples collected from different places representing different rock and soil units on the surface of Engaruka Basin were analysed at the NESCH-Mintec Laboratory in Mwanza to establish their chemical composition (including Total Carbon). Total Carbon content in the analysed samples is presented in Table 6.3 whereas compositions of other elements are presented in Appendix 9.2. When comparing Total Carbon content of rock and soil samples (Table 6.3) with their mineralogical composition (Appendix 9.1) it is clear that samples with carbon content higher than 1 % (Samples Number E-12 and E-23) are the one with carbonate (Calcite) content higher than 50% from results of X-Ray Diffraction analysis (Appendix 9.1).

Table 6.3. Total Carbon content in the surface rock and soil samples at Engaruka

| Sample Name | Sample ID Number | Total Carbon (%) |
|---|---|---|
| E01 | S19/3618/01 | 0.03428 |
| E02 | S19/3618/02 | 0.48143 |
| E03 | S19/3618/03 | 0.23778 |
| E04 | S19/3618/04 | 0.53504 |
| E05 | S19/3618/05 | 0.2568 |
| E06 | S19/3618/06 | 0.04375 |
| E07 | S19/3618/07 | 0.07847 |
| E08 | S19/3618/08 | 0.10754 |
| E08 B | S19/3618/09 | 0.12869 |
| E09 | S19/3618/10 | 0.01487 |
| E10 A | S19/3618/11 | 0.10667 |
| E10 B | S19/3618/12 | 0.01302 |
| E11 | S19/3618/13 | 0.07057 |
| E12 | S19/3618/14 | 2.5874 |
| E13 | S19/3618/15 | 0.63991 |
| E14 | S19/3618/16 | 0.51185 |
| E15 | S19/3618/17 | 0.1531 |
| E16 | S19/3618/18 | 0.04264 |
| E17 | S19/3618/19 | 0.24288 |
| E18 | S19/3618/20 | 0.07094 |
| E19 | S19/3618/21 | 0.2002 |
| E20 | S19/3618/22 | 0.00217 |
| E21 | S19/3618/23 | 0.09113 |
| E22 | S19/3618/24 | 0.71656 |
| E23 | S19/3618/25 | 1.01222 |
| E24 | S19/3618/26 | 0.14467 |
| E25 | S19/3618/27 | 0.012 |
| E26 | S19/3618/28 | 0.08213 |
| E27 | S19/3618/29 | 0.57075 |
| E28 | S19/3618/30 | 0.06509 |
| E29 | S19/3618/31 | 0.09686 |
| E30 | S19/3618/32 | 0.00821 |
| E31 | S19/3618/33 | 0.01325 |

Results of Whole Rock Multi-Element Chemical Analysis of rocks and soil samples collected from different places on the surface of Engaruka Basin are presented in Appendix 2. Apart from the common rock forming major elements (mainly Al, Si, Fe, Mg and Ca) which are commonly abundant in rocks, the table shows that some of the Engaruka rocks contain significant amount of Bismuth (up to 637 ppm), Manganese (up to 385.5 ppm), Strontium (greater than 350 ppm) and Uranium (up to 290.7 ppm). However, they may not be enriched into the brines depending on the solubility of their hosting minerals.

***Porosity***

The review of exploratory reports and re-sampling of diamond drill cores from BH 09 and BH 11 shows that the subsurface is dominated by clay layer, sand clay layer sandy layer, and massive salt crystal layers with alternating mudstone cement (Table 6.4). Clay soils were mainly from 0m to 14m with negligible salt crystals and for that reason its porosity was neglected while the other layers (clayey sand and sandy layer) were considered.

Table 6.4. Showing Lithology Types and Corresponding Porosities

| Lithology Type | Porosity | | Reference |
|---|---|---|---|
| | Range | Average value | |
| Clay soils | 0.51 – 0.58 | 0.545 | Wieczysty, 1982; Widomski et al. 2013 |
| Sandy clay layer (clayey sand) | 0.45 – 0.49 | 0.47 | Wieczysty, 1982; Widomski et al. 2013 |
| Sandy layer | 0.36 – 0.45 | 0.405 | Wieczysty, 1982; Widomski et al. 2013 |
| Mudstone/claystone | 0.41 – 0.45 | 0.43 | Karu, 2012 |

The clayey sand, sandy layer and mudstone/claystone (mainly hosting salt crystals) have an average porosity of 47%, 40.5% and 43% respectively with a total average of 43.5% porosity. However, this 43.5% porosity is based on literature review as the core samples were not good for practical determination of porosity. Following physical observation of core samples and professional judgment, a porosity of 40% was opted to be used in calculation of the brine resource. However, this value of 40% porosity may be revisited upon availability of proper core samples for practical determination of the porosity using scientifically acceptable methods.

### 6.3. Examination of current status of boreholes

Examination of current status of the boreholes that are reported in the study conducted in 2011 – 2013 was done. Out of the 16 boreholes that were reported, only 9 boreholes were found to be in place. Borehole BH1 was not accessible as it was covered by seasonal lake. Boreholes BH2, BH3, BH4, BH8 and BH9 were not seen. The status of these boreholes are summarized in Table 6.5 and their geographical positions are shown in Figure 6.9:, Following the status of boreholes presented in Table 6.5 only 7boreholes were flushed and 6 were pump tested as shown in Table 6.5**.** Additionally, during this exercise, three more boreholes (WH, WH 1, and WH 2) were found and their positions are shown in Figure 6.9**.** It was realized that these were water wells. However only two of them (WH 1 and WH) were studied in this program since the third one (WH 2) was completely blocked.

Table 6.5. Current Status of Boreholes in Engaruka Basin

| **Hole No.** | **Depth Reported by C.Z. Kaaya (m)** | **Actual Depth after probing (m)** | **X-coordinates** | **Y-coordinates** | **Status** | **What was Done in this Mission** |
|---|---|---|---|---|---|---|
| BH1 | 150 | - | 183681 | 9656225 | In the Water | Not reached |
| BH2 | 120 | - | 187733 | 9654477 | Not seen | Not studied |
| BH3 | 100 | - | 180528 | 9656539 | Not seen | Not studied |
| BH4 | 120 | - | 183125 | 9651230 | Not seen | Not studied |
| BH5 | 110 | 100 | 182442 | 9662586 | Seen but the Steel Case was filled with Concrete. | The concrete was removed and the well was studied in detail including pump tests. |
| BH6 | 130 | 65 | 180269 | 9660756 | Properly kept | The well was studied in detail including pump tests |
| BH7 | 150 | 14 | 181606 | 9660311 | Partly vandalized by filled with sand in the plastic casing. | The well was opened and flushed but there were very few waters therefore pump tests could not be done |
| BH8 | 130 | - | 188137 | 9658369 | Not seen | Not studies |
| BH9 | 200 | - | 180348 | 9654435 | It was reported as diamond drill bore hole but not seen | Not studied |
| BH10 | 150 | - | 180539 | 9659204 | Found with a cape but the borehole was blocked with very | Not studied |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | big animal borne that could not be removed | |
| BH11 | 170 | - | 188876 | 9652057 | It was reported as diamond drill bore hole and its position was seen | Logged and samples for laboratory analysis |
| BH12 | 145 | 73.45 | 185890 | 9649142 | Blocked by soils in the plastic casing ked | It was opened and studied including pump tests |
| BH13 | 140 | 92 | 188072 | 9647785 | Properly kept | The well was studied in detail including pump tests |
| BH14 | 110 | - | 182279 | 9648797 | Totally filled with soil in the plastic casing | Not studied |
| BH15 | 135 | - | 184934 | 9647552 | Totally filled with soil in the plastic casing | Not studied |
| BH16 | 120 | - | 187311 | 9646120 | It was blocked | Managed to open it but it was found to be dry |

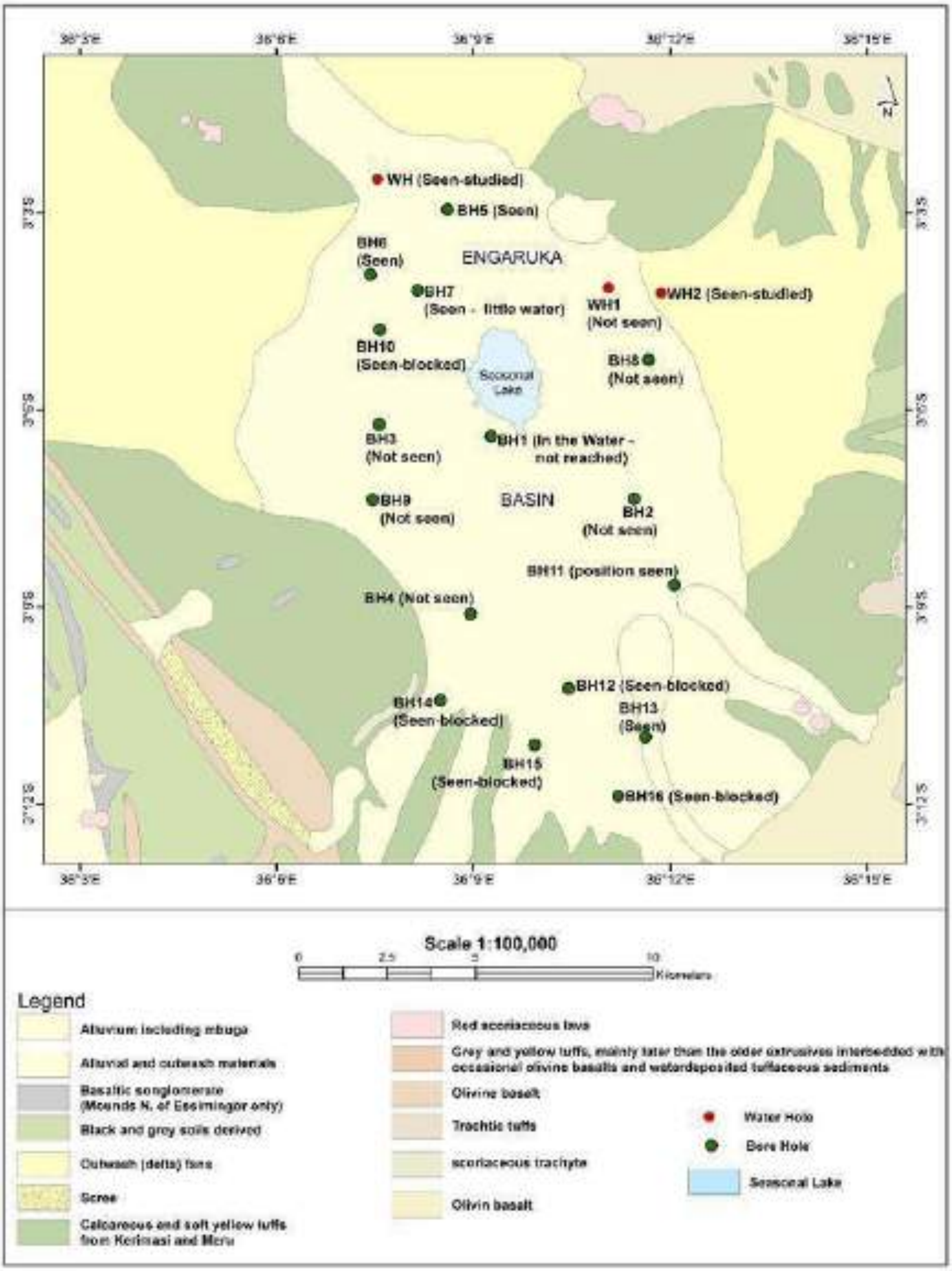



Figure 6.9: Location of boreholes in Engaruka Basin (Geological Map by Dawson, 1963).

### 6.4. Geophysical Surveys

***Interpretation of low-resolution Airborne Magnetic data***

Interpretation of Low-Resolution airborne Magnetic Data that are archived at the Geological Survey of Tanzania (Geo-survey International 1971-1980) was done to obtain regional geophysical pattern (Figure 6.10**)**. The pattern shows a dominant NW-SE trending anomaly and SW-NE trending anomaly; features which could be fault patterns. The figure also displays a NE - SW trending magnetic high domain in the central part of the basin suggesting a presence of sold magnetic high basement (most likely volcanic rocks) beneath sediments of the basin.

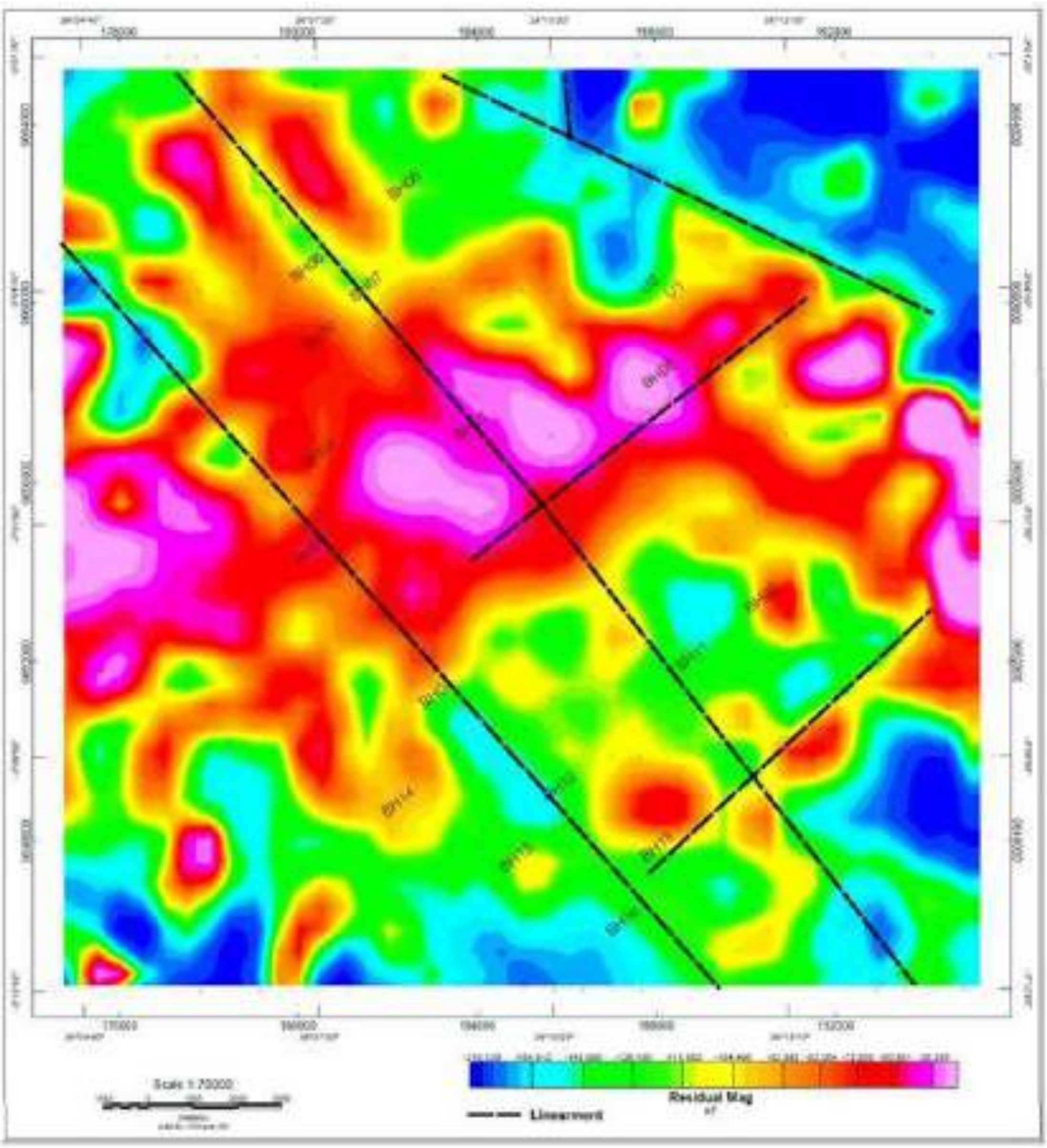



Figure 6.10. Low resolution airborne geophysical (magnetic) map showing lineaments (Source: Geological survey of Tanzania).

***Ground Magnetic Survey***

The interpretation of low resolution airborne geophysical surveys was followed by ground Geophysical Survey in each side of the project area (west, north, south and east) in order to verify and identify precise positions of the low-resolution anomalies identified from airborne geophysical survey. In this survey line spacing was generally 400 m with infill plus extension of 200 m and the sampling interval along profile line was 11 seconds (real time walking magnetic measurements). Total 95.3-line kilometres were surveyed (based on duration of this study) and it was realized that the main faults (areas with low resolution data) trends in NW direction and there are few with NNW trends (Figure 6.11). Results of ground magnetic survey are presented in Appendix 9.5.

These faults could be positions of underground conduits that re-charge the aquifers. However, some of them could also be hosting channels that drain water away from the aquifers of the basin. There is therefore a need to study in detail the effect of these faults to aquifers of the Engaruka Basin.

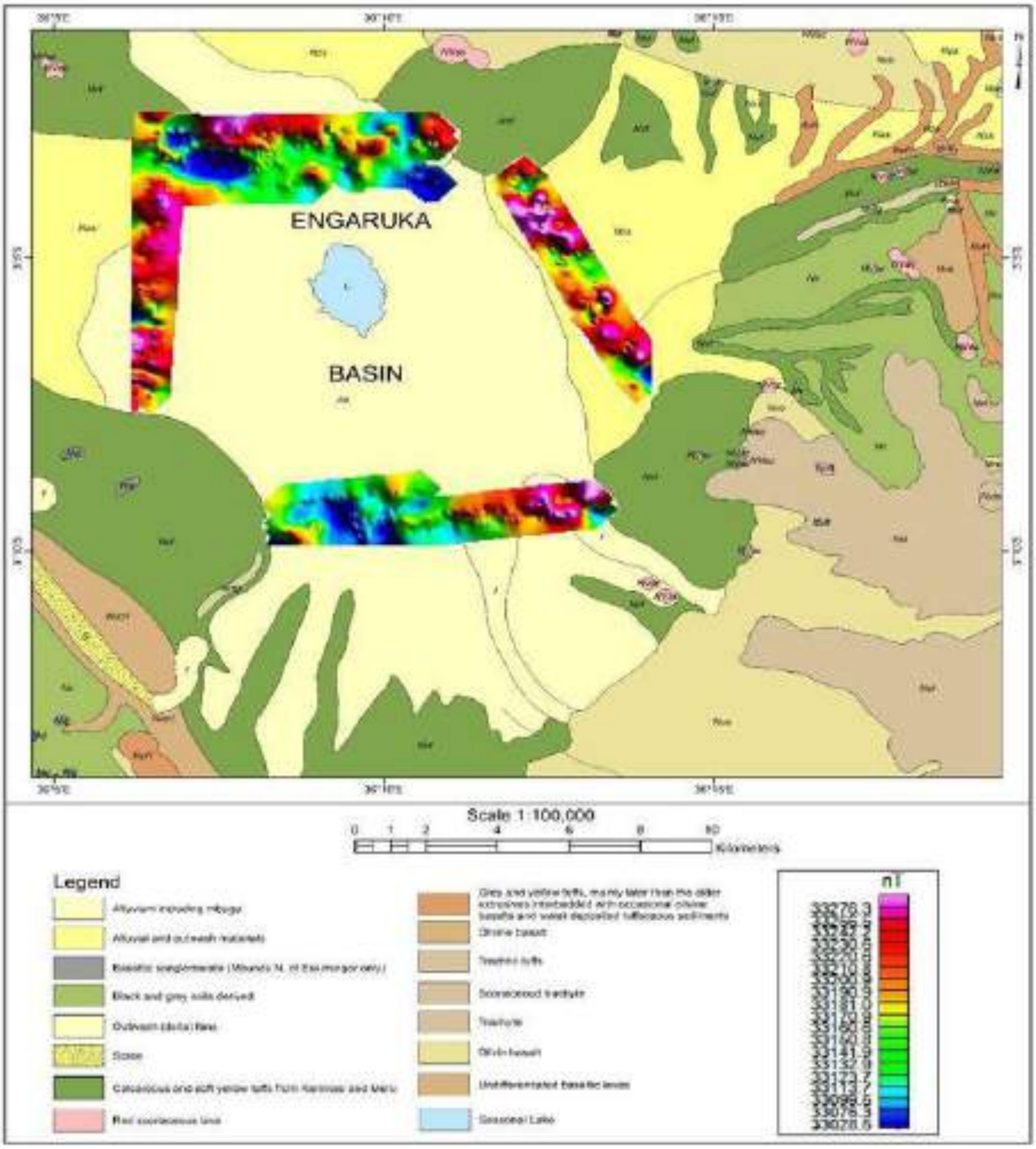



Figure 6.11. Ground geophysical survey results with NW – trending and NNW – trending magnetic low anomalies.

### 6.5. Boreholes Flushing and Pumping Test

Pumping test of Engaruka Soda-ash boreholes was carried out in order to determine aquifer characteristics that are necessary for resources estimations. Terms of references (ToR) for this assignment had stipulated the following objectives (i) assessment of performance of the boreholes (sustainable yield of boreholes), (ii) assessment of effect of pumping well(s) to other nearby wells (iii) determination of hydraulic parameters of the aquifer and (iv) analysis of physical/in situ water/brine parameters and collection of water/brine samples for chemical analysis in the laboratory to be selected by the client. The ToR also indicated that, before carrying out pumping test exercise, borehole flushing should be done.

Execution of the assignment was done for 31days from 7th October to 7th November, 2019. All standard procedures and professionalism were deployed in the execution of this assignment. In few cases where procedures had to deviate from known standards, they were communicated to client and consensus reached before the work progress further.

***Borehole Flushing***

The inspection of boreholes discovered that there are only 7 boreholes that flushing could be done; they include borehole BH5, BH6, BH7, BH12, BH13, BH-U1 and BH-U2. Flushing work was carried out on borehole BH5 and BH-U2 using ATC-514 machine, with air compressor capacity of up to 30bars. Boreholes BH6, BH7, BH12, BH13 and UNKNOWN BH1 were flushed using Atlas Corp machine with air compressor capacity of up to 20bars. Change of machine from large to small one was due to accessibility issues. Depth of the flushed boreholes and their diameters are shown in Table 6.6. Borehole BH-7 is a dry well and did not qualify for pumping tests.

Flushing was carried for at least two hours on each borehole until brine/water was clear of large particles. Very fine sediments in very little amount per volume collected during flushing were still observed at stoppage time of flushing and these were considered as constituent of the brine itself.

Table 6.6: Depth of Flashed Boreholes

| Sn | Borehole ID | BH Diameter (“) | Probed Depth (m) |
|---|---|---|---|
| 1 | BH-U1 | 5 | 96.00 |
| 2 | BH-U2 | 7 | 62.00 |
| 3 | BH5 | 8 | 100.00 |
| 4 | BH6 | 4 | 65.00 |
| 5 | BH7 | 4 | 14.00 |
| 6 | BH12 | 4 | 73.45 |
| 7 | BH13 | 4 | 92.00 |

***Pumping Tests***

After flushing of boreholes, pumping test was carried through calibration test, step-drawdown test and continuous pumping test. Step drawdown test was conducted in three steps for a period of one hour for each test. Six (6) boreholes (BH5, BH6, BH12, BH13, BH-U1 and BH-U2) out of seven (7) flushed boreholes were subjected to pumping test; borehole number (BH7) could not be pumped because discharge lasted only 10minutes after the pump was started.

***Step Drawdown Pumping Test***

Step-drawdown pumping test are pumping test carried out to help to decide the optimum pumping test rates which includes choosing the size and capacity of pump to be used for a variable rate or constant rate test. Three submersible pumps (Table 6.7) of different capacity were brought to the field for carrying out step drawdown.

However, the step drawdown test was not carried using all the three pumps because boreholes BH6, BH12, BH13, BH7 and BH-U1 have smaller diameters than pumps P1 and P2which have big diameter and power. Thus, the two pumps P1 and P2 could not be inserted in the mentioned boreholes. Borehole BH-U2 has smaller diameter than that of pump P1 and thus pump P2 was used. Borehole BH5was the only borehole with big diameter which allowed the flexibility of choosing the right pump to be used in the step drawdown test. Some repletion from above

On borehole BH5, the largest pump (P1) was tested first and it provided optimum draw down so the constant rate pumping test advanced without the need to test other pumps. For other boreholes, it was resorted to using a ***best-fit pump*** on each borehole. Pump P2 was used on borehole BH-U2 only while pump P3 was used on boreholes BH6, BH12, BH13 and BH-U1. Borehole BH7 pumping test lasted for only 10minutes and water didn't recover after 3hours (note that, the borehole is only 14meters deep).

Table 6.7*: Pump Specifications*

| Pump ID | Diameter (inch) | Power (HP) | Max Head (m) | Min Head (m) | Max Discharge* (liters/hour) |
|---|---|---|---|---|---|
| P1 | 6.0 | 20 | 195 | 50 | 75,000 |
| P2 | 5.25 | 15 | 112 | 38 | 35,000 |
| P3 | 3.0 | 10 | 120 | 55 | 26,000 |

*Maximum discharge at the minimum head

***Continuous Pumping Test***

The goal of a continuous pumping test is to estimate hydraulic properties of an aquifer system such as transmissivity, hydraulic conductivity and storability (storage coefficient). Continuous pumping tests were conducted for different hours for each borehole as agreed on terms of references. Table 6.8 summarizes basic information about pumping test carried.

Table 6.8. Pumping test information Summary

| Borehole ID | BH Diameter (") | Pump Used | BH Depth (m) | Pump Set Depth (m) | Flushing Duration (Hrs) | Step-Test Pumping Time (Hrs) | Continuous Pumping Time (Hrs) | Discharge (L/h) |
|---|---|---|---|---|---|---|---|---|
| BHU 1 | 5 | P3 | 96.0 | 93 | 2 | 3 | 12 | 20,000 |
| BHU 2 | 7 | P2 | 62.0 | 57 | 2 | 3 | 16 | 27,692 |
| BH5 | 8 | P1 | 100.0 | 93 | 2 | 3 | 43 | 62,937 |
| BH6 | 4 | P3 | 65.0 | 57 | 2 | 3 | 13 | 20,000 |
| BH12 | 4 | P3 | 73.45 | 68 | 2 | 3 | 13 | 20,000 |
| BH13 | 4 | P3 | 92.0 | 90 | 2 | 3 | 10 | 21,176 |

# NATIONAL DEVELOPMENT CORPORATION

# "TECHNO-ECONOMIC STUDY FOR ENGARUKA SODA ASH PROJECT AT MONDULI DISTRICT IN ARUSHA REGION, TANZANIA"

VOLUME VIII

## Final Report of the Environmental Impact Statement (EIS)

**Prepared by:**

**TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)**

*April, 2021*

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# EXECUTIVE SUMMARY

The Government of United Republic of Tanzania through National Development Corporation (NDC) is undertaking Techno-Economic Study (TES) for the establishment of Engaruka Soda Ash Project (ESAP) at Engaruka Basin in Monduli District, Arusha region. NDC is a Government institution which was established as a statutory body by Act of Parliament in 1962 to catalyse economic development in all sectors of the economy. NDC has a broad mandate as a development and promotion institution to stimulate industrialization in partnership with private sector. The overall objective of the proposed plan is to develop a Soda Ash plant (henceforth referred to as the project), with a capacity of producing up to one million tonnes per year. NDC has licences (PLs) of prospecting the underground resources, covering an area of 25,000 hectares (ha), and referred to as the concession in this report. In view of the aforesaid, NDC has engaged Tanzania Industrial Research and Development Organization (TIRDO) to carry out the TES for the establishment of the proposed ESAP. The TES will comprise a number of independent studies which will be used to develop a '*Bankable Feasibility Study (BFS)*' for mobilization of the required resources (human, technology, financial) for the project. In this regard, Environmental and Social Impact Assessment (ESIA) study was part of the TES to be conducted for the development.

The concession is located in the rural wards of Engaruka (within Engaruka chini and Irerendeni villages), Mfereji (within Idonyonaado village) and Selela (within Mbaashi village) at Monduli District in Arusha region, and which is situated in the northeast part of the Tanzania. The nearest city is Arusha (158 km to the east), the nearest town is Mto wa Mbu (49 km to the southwest) and the nearest township is Engaruka (18 km to the west). The approximated total area to be covered by the soda ash plant facilities is 100 ha, i.e. only 0.4% of the concession area.

## History of Project Development Plan and Rejection of EIS in 2008

Efforts to commercially recover soda ash from Lake Natron started way back in 1960s and followed by development drilling in 2007 until when the project was abandoned in 2008 for environmental concerns (Mwathe, 2008). Although ESIA study for the proposed development was done and a report submitted to the National Environmental Management Council (NEMC) for evaluation and approval, the Environmental Impact Statement (EIS) report found inadequate. The EIS report was heavily criticised by those attended the public hearing organised by NEMC at Karimjee hall Dar es salaam on 23rd January 2008 for lack of vital baseline information and data (i.e., such as hydrology of the area); lack of clear mitigation measures; weak consideration of cumulative impacts and project alternatives; lack of economic study (a clear cost-benefit analysis); and having consultation process which was not inclusive. Therefore, the proposed mitigation from key stakeholders was to site the soda ash plant as far away as possible from Lake Natron ecosystem (the crucially important breeding site for Lesser Flamingo *Phoeniconaias minor*) (MoET, 2012; Mmassy et al., 2019), which is designated as a wetland of international importance (Ramsar site by UNESCO in 2001).

Thereafter, the Government started to explore other areas and discovered the presence of huge underground brine deposits at Engaruka Basin in Monduli District, Arusha Region. The basin is located about 60 km south east of Lake Natron in the East Africa Rift Valley System. Exploration studies conducted by NDC have established preliminary findings that the basin hosted about 3,813,320,000.00$m^3$ as volume of brines with annual replenishment rate of 17,693,640 $m^3$ and aquifer safe yield of 3,538,728 $m^3$. Taking an average composition of these brines to be 17.90 g/lt for Sodium Bicarbonate and 201.61 g/lt for Sodium Carbonate, the Brines in Engaruka Basin is estimated to host 68.30 and 768.80 Million Tons of Sodium Bicarbonate and Sodium Carbonate, respectively. NDC, in partnership with strategic investor(s), intends to establish a soda ash extraction and processing plant with the capacity of producing up to 1.0 mil t/y of soda ash and other by-product salts. The proposed project has been designed to produce three products in the proportions in brackets, namely sodium bicarbonate (10%), light soda ash (20%) and dense soda ash (70%). The project will be generating 15 MW of electricity using a coal fired boiler. As the market grows the plant will be upgraded to produce 1,000,000 tonnes per year.

## Environmental and Social Impact Assessment (ESIA) Process

The ESIA study has been prepared in compliance with Tanzania's environmental laws and regulations, and in particular the National Environmental Management Act, Cap 191 and its subsequent Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018. The study has also been prepared to comply with the World Bank Policies and International Finance Corporation (IFC) Performance Standards on Environmental and Social sustainability.

This EIS report has been prepared by TIRDO under Dr. Julius Elias (Registered by NEMC as an Environmental Expert in 2011; specialized in executing ESIA studies). The report was enriched by a number of specialized studies namely fauna (mammals), archaeology and palaeontology, social, flora (vegetation), geology and/or soil analysis, economics and/or financial analysis, marketing, industrial technology, transport logistic, hydrology and/or water quality analysis, chemical processing and air quality studies.

### Project Components and Project Planning

The development of the Soda Ash Project will comprise the following main components:

**(a) Plant and machinery**

This includes:

- Soda ash processing plant facilities;
- Flue gas desulphurization (FGD) unit;
- Carbonation unit;
- Crystallization unit;
- Filtration and centrifugation;
- Packaging unit;
- Salt plant unit and auxiliaries; and
- Coal handling and storage system.

**(b) Electrical power distribution and control system**

This includes:

- Transformers and circuit breakers;
- Motor control systems;
- Plant control systems;
- Main distribution boards; and
- Capacitor banks.

**(c) Brine pumping system and storage**

This includes:

- Location of extraction wells/boreholes as per mathematical model;
- Extraction wells/boreholes network design;
- Construction of extraction wells;
- Solar ponds system design, if required;
- Solar ponds construction/establishment; and
- Piping and pumping system and storage.

**(d) Water Supply System**

These include:

- Boreholes' construction;
- Piping system to plant and township;
- Water treatment facilities;
- Water storage tanks; and
- Any other items or facilities relevant or supportive to water supply system.

**(e) Power supply system**

This includes:

- Design of power supply system; and
- Construction of power supply system including power supply auxiliaries.

**(f) Steam plant**

This includes:

- Steam Plant and auxiliaries (water treatment plant, ash handling system, water storage tanks, bag filters, and main fans);
- Power plant and auxiliaries (turbine system, substation, condenser, control system); and
- Emergency power supply system.

**(g) Mobile equipment**

This includes:

- Salt harvesting, stockpiling and feeding equipment;
- Solar pond maintenance equipment;
- Material handling equipment; and
- Plant vehicles.

## Description of the Natural and Human Environment

***Physical Environment***

Core Area (Area of Direct Influence)

The Project core area will cover an area of approximately 25,000 ha corresponds to the NDC's Prospecting Licenses that granted by the Ministry of Minerals to prospect the underground resources, develop exploratory wells for extraction and processing of brine resources *(Volume I – Appraisal of the Brine Resource Report)* at Engaruka Basin in Monduli District, Arusha Region.

The study area includes the villages of Engaruka chini, Irerendeni, Mbaashi and Idonyonaado; all of which are in Engaruka, Selela and Mereji Wards. Within these villages, the hamlets of Engorika, Ndinyi, Nengalashi, Alapalaseki, Endeseti (in Engaruka Chini); Mkaoo, Urumensulii, Urumunyushoi, Eng'oswa, Naisije (in Irerendenyi); Oluseteshi, Injoroi and Olkoikoi (in Mbaashi village); and Oljorokoo, Idonyoo and Orkermboji (in Donyanaado) are covered.

*Climatic Conditions*

Engaruka area (including the project site) being on the leeward side of Monduli Mountain has little rainfall and a long dry and sunny period. In general rainfall pattern is unequal with short rains season fall in November and/or December and the long rains fall in March to May. The total annual rainfall is in the order of 300 mm. In the month of October, temperatures are considerably high, in the range of 25-35$^{o}$C during day time and 10-20$^{o}$C during the night. The humidity ranges from 30% to 40% in the day time rising to 60% at night. The net annual evaporation in the Engaruka Basin is thus much higher than precipitation, an ideal condition for the formation of evaporates.

***Biological Environment***

Floristically, the vegetation of the study area falls under Phytocorion of Somali- Masai-*Acacia-Commiphora* bushland and thickets characterized by Edaphic grassland on volcanic soils, halophytic vegetation and thicket bushland. Ten (10) main vegetation types occurring in the project area with several number of life forms as well as individual species were classified during the ESIA study. From the survey findings, about 233 plant species represent 6 life forms includes: Herbs 98, trees 48, Grass 47, Shrubs 30, Climber 10 and sedges 2 respectively. Moreover, a total number of 233 of vascular plant species from 6 life forms have been identified growing in the project area. The identified species are from 41 families. The family with the highest number of species includes; *Gramineae* 47, *Acanthaceae 22, Papilionoideae 19* and *Compositae* 10 with *Amaranthaceae*, *Labiatae* & *Malvaceae* found having 8 species each. The rest are represented with species ranges 1-7 respectively.

The Project's fauna inventory carried out has identified a number of domesticated animals, wildlife, birds and insects covering mammals, reptiles (various snakes and lizard species), amphibians, avifauna (bird species), insects and other dwelling invertebrate assemblages present in the concession area. Mammals of wildlife category that frequented the project area include lion, leopard, warthog, wildebeest, giraffe, zebra and hare whereas the domesticated animals observed among the thickets were cattle, goats, sheep and donkeys. Moreover, footprints of gazelles and droppings of foxes were also seen in the project area, signalling the presence of the named animals in the area. Other spotted animals include some snakes and lizards (i.e., *Mabuya striata*); amphibians (guttural toads); avifauna (passerine birds, guinea fowls, francolins, flamingos, ostriches and herons. It was also reported that the lesser flamingos were occasionally visited the area during prolonged wet season.

***Human Environment***

A Social Baseline survey was conducted as part of the ESIA to establish the current social, economic and cultural context of the Project area. Currently, the Monduli District Council is estimated to have a population of 191,710 and about 4.7 people per household. However, the study area (covering Engaruka, Selela and Mfereji wards) has population of 27,424 with 5,074 households (14.3% of the entire population in Monduli district). The main economic activities of Monduli District and the study area in particular are livestock keeping, agriculture production and wildlife. More than 90% of the population is engaged in livestock keeping and agriculture.

Stakeholder's consultations have shown a positive perception of the project among the local population. The project is seen as an opportunity for local development: the inhabitants and local authorities expect the project to be a source of job creation (especially for young people) and poverty reduction (through social infrastructures such as schools, health centres and access roads). A great majority of consulted people would like to leave the area and thus sees the project as an opportunity to convert their hopes into reality, through the compensation they could get from the relocation plan (people have heard of similar experiences from other area). High expectations will be managed with an appreciation of the project positive impacts and early engagement with key stakeholders (community relations) to avoid misperceptions about the project.

Main issues of local concern are: employment opportunities for local people in an area where the great majority of the population is illiterate and unskilled and where the unemployment rate is very high, working conditions (workers' rights), pollution and water scarcity, compensation rights for relocation, health impacts especially because of dust and water pollution, accidents risks because of an increased road traffic. It is expected that most unskilled positions should be able to be taken up within the local study area (the three communes of Engaruka chini, Selela and Mfereji wards).

## Environmental Impacts and Mitigation Measures

***Impact on Land-Use***

During the construction phase, the construction of the project facilities will change the land-use of an area covering 100 ha; (0.4% of the concession area). The facilities will be constructed on areas of land currently used mainly for the seasonal grazing of animals. During the operation phase there will be no further impact on land-use.

***Impact on Water Resources***

There are four risks with respect to impacts on water resources; (i) reduced water availability for the local population due to water abstraction, (ii) risk of contamination of water resources from the discharge of sanitary, domestic and process wastewater, (iii) risk of contamination of groundwater from the waste management facility (seepage water), and (iv) increased turbidity in the seasonal streams.

The means of supplying water to the plant will be established in collaboration with, and approved by, the water basin authorities and Engaruka Water User Committee. The annual plant water consumption is not expected to exceed 250,000 cubic metres per year, which translates as approximately 833 cubic metres per day.

There is a risk that the abstraction of water from Engaruka river could result in reduced water availability for the local people who are depending of that water source. This risk is considered to be low because proponent will endeavour to abstract water from isolated water bearing sources that are not hydraulically connected to structures used by local people. These sources are Salade, Kabambe and Lositete springs, Selela, Losiyai, Kirurumo, Miwaleni, Burko A and B and Engaruka Rivers

A contingency plan will be established to supply water to local people affected by the project, in the event that existing water resources are depleted due to the project. The project proponent will make available to the local people water extracted from the named water sources. Two water storage tanks of 2,500 $m^3$ capacity each will be installed and water troughs for animals.

Sanitary and domestic wastewater will be directed to constructed soak away pits and pit latrines for initial handling. Once the pits are full will be emptied by septic emptying trucks available at Monduli and Arusha DCs for proper disponsal at municipal wastewater saturation ponds.

Water will be required during the extraction and processing of soda ash. However, the process wastewater will be pumped back to recharge the aquifer through injection wells as a recycling process to minimize the discharge of wastewater into the natural environment.

***Impact on Natural Habitat***

The layout of the project facilities has been designed to avoid areas of natural habitat (vegetation), or minimize impacts on other areas i.e., hunting blocks and animal corridors. However, only small area out of the 25,000 ha (mainly grassland) will be cleared. All clearing of trees will be carried out in collaboration with and with prior approval from the Forestry Authority (TAFORI).

***Impact on Flora***

The Project facilities will be constructed on land which is currently used for seasonal grazing of animals, and which is scrub land for much of the year. This land is the type of habitat (grassland) which is the least environmentally sensitive in the concession area. The construction of the facilities will therefore create a direct impact on the vegetation on this area but it is of low environmental sensitivity.

***Impact on Fauna***

The change in land-use as a result of the construction of facilities and loss of pasture/scrub land will represent a loss of habitat for some fauna. The fauna that will be affected by this change are the mammals that are present in this type of habitat, and which predominantly comprise small rodents, hare, zebra, wildebeest etc. This impact is expected to be negligible, as these animals can move to areas nearby. The loss of habitat is not expected to have a detectable impact on birds or reptiles. The impact will take place during the construction phase and no further impact is expected during the operation of the mine.

***Impact on Air Quality***

The baseline survey has measured the air quality and confirmed that there are minimal signs of air pollution. During the construction, dust will probably be generated by traffic moving along the access road, this will be minimised by controlling traffic speed and if necessary periodic spraying of sensitive areas along the road using water and a suitable proprietary dust suppressant. The earth works at the project site will create localised dust emissions, but this is not expected to affect the local people. It should be noted that the earth works will take place 15 km away from Engaruka centre. Households in close proximity to the site will be moved away from the site and the nearest dwellings are situated at least 5 kilometres from the site. There will be exhaust emissions as a result of fuel consumption, but this is expected to cause only localised changes in air quality. During the operation phase, there will be continued dust emissions associated with traffic and this will be managed as for the construction phase. Exhaust emissions from diesel combustion is not expected to cause a detectable change in air quality outside the concession perimeter.

***Impact on Background Noise Levels***

The baseline background noise levels were measured as part of the baseline survey and levels above standard limits were recorded. During the construction work, the noise will be generated by the earthmoving equipment at the site and movement of road vehicles along the access road. The road noise will be minimised by enforcing a speed limit near farms and hamlets. During the operation, noise will be generated by different machinery and vehicles at the site, though this is not expected to detectable at a distance of more than 5 or 15 kilometres from the site.

***Waste Management***

The waste generated during the construction phase is expected to comprise vegetation from land clearing, inert building waste, non-hazardous waste and small amounts of hazardous waste such as used oils, batteries, oily rags and empty drums. The waste generated during the operation phase is expected to comprise non-hazardous waste (food and packaging waste, general office waste) and small amounts of hazardous waste i.e., processing additives. All waste will be managed by a licensed local waste disposal contractor.

***Community Health and Safety***

The risks with respect to community health and safety comprise (i) risk of road accident, (ii) degraded groundwater quality, (iii) reduced water availability, and (iv) exposure to infectious diseases. These risks will be managed through the implementation of a number of environmental and social management plans: (i) a health and safety plan including road safety aspects, (ii) a water use and wastewater discharge plan, and (iii) a groundwater monitoring plan. A contingency plan which comprises supplying the project, workers and local people can be supplied with water from an alternative source. The exposure to communicable diseases is managed as part of the workforce health and safety.

***Workforce Health and Safety***

The risks with respect to workforce health and safety comprise (i) the risk of road accident, (ii) work place accident, (iii) exposure to poor sanitary conditions, and (iv) exposure to infectious diseases. These risks will be managed through the implementation of a working health and safety plan addressing the following aspects: (i) general workplace health and safety, (ii) hazardous substances, (iii) electrical safety and isolation, (iv) physical hazards, (v) fitness to work, (vi) remote site health, (vii) noise and vibration, and (viii) specific hazards of working underground. Communicable diseases will be managed by providing surveillance and active screening and treatment of workers, and preventing illness among workers in local communities by undertaking health awareness and education initiatives.

***Positive Socio-economic Impacts***

The project should contribute to a general improvement of quality of life and health in the area. The positive social impacts include:

- Creation of direct employment. During the construction phase there will be job opportunities for around 1,200 skilled and unskilled Tanzania workers. During the operation phase there will be job opportunities for 233 skilled and unskilled Tanzanian workers. It is highlighted that this figure has been estimated for the feasibility study and may change as the project matures.
- Payment of rent for the use of the collective lands, which will not vary in value with the quality of the growing seasons as do pasture and crop yields and this rent should contribute to offsetting poor yields.
- There is a current tendency for young people to leave the district to seek work elsewhere. The creation of job opportunities related to the area could reduce this tendency, thus creating a positive impact on the social structure and family units in the districts in the vicinity of the area.
- Local companies and people will have opportunities to provide different types of services.
- During the construction activities proponent will improve certain sections of the access road. This action will benefit the local people using the road.
- In the context of the project, the proponent will establish new water sources to supply water to the project, and this will be complemented with water abstracted from the existing rivers. Local people could benefit from improved water access through the installation of elevated water storage tanks from where the local people can draw water; and from installation of water troughs which will provide water for animals.

- Also, a positive aspect will be the payment of rent for land occupation, which will not vary in value with the quality of the growing seasons as do pasture and crop yields, i.e. rent will mitigate the risk of poor yields.

**Negative Socio-economic Impacts**

The negative project impacts comprise the following:

- Blocking of footpaths, wildlife corridors, grazing areas: Project facilities will be constructed on only a relatively small part of the concession area. Whilst in projects of this nature, there is a possibility that the presence of the facilities may encroach on footpaths used by local people and their animals no footpaths will be compromised by project development. In order to protect the health and safety of local people access to site facilities will be prohibited (to access the active project footprint) and there will be a fence around such areas to prevent entry.
- Loss of pasture land: The plant facilities will encroach on land which is used part of the year for the grazing of animals by the people living in the immediate vicinity. The area of grazing land that will be affected during the life of the project is estimated to be 100 ha. Interviews with the inhabitants of the study area and local authorities confirmed that the Monduli Community use the land for grazing and these people will be compensated (by cash/money).
- Increased road traffic: During the construction phase there will be a noticeable increase in road traffic along the project access road and along the road from Mto wa Mbu to Loliondo to the project access road, which passes through the villages of Engaruka chini. However, mitigation measures will be taken to avoid accidents and minimize dust impacts.

Because Project facilities will be constructed on only a relatively small part of the concession, it has been possible for proponent/NDC to minimise the need to relocate people; less than 600 households and 200 farmlands will be affected.

The ESIA has established that the project will not result in the need to modify the project area because of the grazing land and wildlife corridors.

## Stakeholder Engagement

The stakeholder engagement activities carried out prior to the performance of the ESIA comprise both formal meetings with representatives of the government and informal encounters with local residents of the project area. The ESIA team conducted formal meetings with the Ministry of Natural Resources and Tourisms, Ministry of Lands, Housing and Human Settlements Ministry of Minerals, Ministry of Livestock and Fisheries, Ministry of Water and Irrigation, Ministry of Industry and Trade, Arusha Regional Office, Local Government Authorities of Ngorongoro, and Monduli District Councils, Engaruka, Selela and Mfereji wards and their respective villages and hamlets, Mining Commission, Ngorongoro Conservation Area Authority (NCAA), Internal Drainage Water Board, TANAPA, TAWA, TAWIRI, TAFORI, UNESCO, TANESCO, OSHA, FIRE, TANROADS, TRC, PINGOS, CORDS etc.

Informal encounters have occurred between the ESIA team and the local residents in the project area. During these encounters information about the project has been exchanged. The local people know of the project and have not shown signs of being opposed to it.

## Environmental and Social Management and Monitoring

The key elements of the management organisation for the implementation of the Environmental and Social Management and Monitoring Plan (ESMMP) are described as follows:

- The proponent will have the oversight for the ESMMP and will be provide leadership and the resources necessary for effective implementation.
- The project site Manager will be responsible for the implementation of the ESMMP and will be assisted by the site's Environment, Health and Safety (EHS) Coordinator.
- The different contractors will be required to nominate an EHS coordinator and staff who will be responsible for the effective implementation of the contractual EHS requirements.
- Project's EHS coordinator will supervise and ensure that the actions are effectively carried out as per contract requirements.

The different environmental and social plans that will be prepared as the project moves forward and responsibilities are summarised as follows:

### Construction Phase

The plans and action for the construction phase are as follows:

- The construction contractor will implement the environmental and social management plans prepared in the planning phase, and
- Proponent will monitor construction contractor to ensure compliance with the environmental and social management plans.

### Operation Phase

The plans and action for the operation phase are as follows:

- The contract environmental/mining engineer will implement the environmental and social management plans prepared in the planning phase;
- Project proponent will monitor the contract environmental/mining engineer's activities to ensure compliance with the environmental and social management plans.
- Proponent will implement their environmental and social management and monitoring plans, and
- In the years leading to the end of the project life, proponent will further develop the outline project Closure Plan (PCP) into a detailed PCP.

### Project Closure Plan

Prior to the start of production activities, an outline PCP will be prepared, then over the project operating life a detailed PCP will be prepared and finalised at least three years prior to the end of the mine life. Once the mine has finished producing, the detailed PCP will be implemented.

## Conclusion and Recommendations

Environmental, socio-economic and cultural impacts associated with the proposed project were identified, assessed and discussed. Generally, the impacts mentioned in the assessment are not of sufficient importance to stop the proposed project. The management of the identified negative impacts will require implementation of the necessary mitigation measures together with the possible remedial options as detailed the Environmental and Social Management Plan (ESMP) prepared under chapter 8 of this EIS.

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# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| ACEM | Assistant Commissioner of Environmental Management |
| AC-MBVA | Assistant Commissioner of Mineral Beneficiaries & Value Addition |
| CBD | Convention on Biological Diversity |
| CITES | Convention on International Trade in Endangered Species of Wild Flora and Fauna |
| CMS | Convention on Migratory Species |
| DC | District Council |
| DED | Municipal Executive Director |
| DOE | Division of Environment |
| DMO | District Medical Officer |
| DPLO | District Planning and Land officer |
| DPP | Director of Planning and Policy |
| EA | Environmental Audit |
| ESIA | Environmental and Social Impact Assessment |
| EMA | Environmental Management Act |
| EMP | Environmental Management Plan |
| ESMP | Environmental and Social Management Plan |
| GCA | Game Controlled Area |
| GIS | Geographical Information System |
| HQ | Head Office |
| IUCN | International Union for Conservation of Nature |
| NCAA | Ngorongoro Conservation Area Authority |
| NEMC | National Environment Management Council |
| NEP | National Environmental Policy |
| NGOs | Non-Governmental Organisations |
| MEX | Manager of Explosive |
| MEV | Manager of Environment |
| MIT | Ministry of Industry and Trade |
| OSHA | Occupational Safety and Health Authority |
| PINGOs | Pastoralists Indigenous Non-Governmental Organization |
| RMO | Regional Mining Officer |
| SAC – CRCO | Senior Assistant Commissioner Community Research & Outreach |
| SAC–RAI | Senior Commissioner Reserve Area Management &Infrastructure |
| STDs | Sexually Transmitted Diseases |
| TAFORI | Tanzania Forest Research Institute |
| TANAPA | Tanzania National Parks |
| TANESCO | Tanzania Electric Supply Company |
| TAWA | Tanzania Wildlife Management Authority |
| TAWIRI | Tanzania Wildlife Research Institute |
| TBS | Tanzania Bureau of Standards |
| ToR | Terms of reference |
| TZS | Tanzania Shillings |
| UNESCO | United Nation Educational, Scientific & Cultural Organization |
| URT | United Republic of Tanzania |
| VPO | Vice President Office |

# CHAPTER ONE

# 1 INTRODUCTION

## 1.1 Project Background

The Government is currently implementing a strategic industrialization programme as the main catalyst to transform the economy, generate sustainable growth and reduce poverty. This is in line with the implementation of the Country's Vision 2025 as well as the Second Five Year Development Plan (FYDP II 2016/17 – 2020/21). The Second Five Year Development Plan emphasized the need to boost industrialization and productivity growth across the economy, targeting light manufacturing and resource-based industries in particular. Both the FYDP II and the ruling Party (CCM Manifesto 2015/16-2020/21) focus on the development of the economy through industrialization as a means to spearhead and achieve the middle-income status. It is therefore envisioned that comes 2025, the manufacturing sector will absorb at least 40% of the labour force while the same time contributing 15% of the GDP of the country.

One of the areas that have been given a priority to stimulate industrial growth is the establishment of soda ash plant. In that regard, the Government of United Republic of Tanzania (URT) through National Development Cooperation (NDC) is in the process of developing a Soda Ash plant (henceforth referred to as the project), with a capacity of producing up to one million tonnes per year. The proposed project is strategically located in an area of about 25,000 hectares at Engaruka basin in Monduli District, Arusha region, Tanzania. The basin was chosen due to its large brine resources enriched with high concentrations of Sodium Bicarbonate (17.90g/lt) and Sodium Carbonate (201.61 g/lt).

The project design covers brine extraction and soda ash processing plant and associated project components in an area of 100 ha (i.e., only 0.4% of the concession area). The associated project components include: brine's extraction wells, pipelines (to transfer extracted brine from boreholes to the plant's storage ponds), administrative offices, brine holding ponds, power substation, boiler and generator sheds, solid waste collection facilities, water storage tanks, wash rooms, car packing area, fence and living accommodations for staff. Clear information or demarcation to delineate the NDC's soda ash project and other projects (i.e., access roads, upgrading of Longido – Mto wa Mbu road) and/or railway for easy transfer of processed soda ash from the plant to Tanga port and/or neighbouring countries will be provided. All these facilities will occupy not less than 5,000 hectares, and the remaining 20,000 hectares will later be allocated for future expansion of the project. The total project investment cost is expected to be **USD 516.33 million** (*Volume IX – Project Appraisal Report*).

## 1.2 Project Rationale

Tanzania is endowed with abundant deposit of natural soda ash at different locations along the Rift Valley Lakes that runs from the Middle East. Tanzania is endowed with large amount of slurry and brine resources, but remains a net importer of soda ash as a raw material for local medical, glass, chemical, soap and detergent industries. Efforts to commercially recover soda ash from Lake Natron started way back in 1960s until when the project was abandoned for environmental concerns regarding the issues of UNESCO heritage site for lesser flamingos, *Phoeniconaias minor*. Thereafter, the Government started to explore other areas and discovered the presence of huge underground brine deposits at Engaruka Basin in Monduli District, Arusha Region. The basin is located about 60 km south east of Lake Natron in the East Africa Rift Valley System.

Exploration studies conducted by NDC have established preliminary findings that the Engaruka basin has about 3.81 billion cubic meters (3,813,320,000 $m^3$) of brines with good annual recharge rate of 17,693,640 $m^3$ and aquifer safe yield of 3,538,728 $m^3$. Taking an average composition of these brines to be 17.90 g/lt for Sodium Bicarbonate and 201.61 g/lt for Sodium Carbonate, the Brines in Engaruka Basin is estimated to host 68.30 and 768.80 Million Tons of Sodium Bicarbonate and Sodium Carbonate, respectively. NDC, in partnership with strategic investor(s), intends to establish a soda ash extraction plant with the capacity of producing 0.5 to 1.0 million tonnes per year and other by-product salts.

Moreover, the URT tempted to rethink its early plan due to the estimated demand of Soda Ash products in local, regional and international markets as follows:

- In the local market, Total Demand for dense soda ash will be growing from 30,865 tons (in 2020) to 130,128 tons (in 2030); at a price of US$ 185.64 to US$ 226.29 respectively (Tax exclusive)
- In the local market, Total Demand for Light Soda Ash will be growing from 31,380 tons (in 2020) to 59,439 tons (in 2030) at a price of US$ 301.6 to US$ 339.3 respectively (Tax exclusive)
- Total Local Market Volume potential will be growing from 32,245 tons (in 2020) to 189,567 tons (2030) at an average price of US$ 239.27 to US$ 282.80 respectively
- Total Estimated Local Market Value will be growing from US$ 16,968,808 (in 2020) to US$53,609,548 (in 2030).
- In the short run, the production may be constant at 500,000 tons per annum to cater for both local and export markets. The demand is expected to rise depending on marketing efforts that will be invested in both the local and foreign markets.
- Local Market Share will increase from 31% (in 2020) driven by increased production at Kioo Limited and investments in the detergents industry to 165% (in 2030), given the strategies to stimulate soda ash consumptions are implemented.
- Total projections in exportation will vary from 432,453 tons (in 2023) to 310,433 tons (in 2030) at average prices of US$314 to US$353 respectively
- Total value of exportation is estimated at US$ 135,818,502 (in 2023) and US$ 109,582,849 (in 2030)
- Total estimated value, combining both local sales and exportation range between US$ 152,787,310 (in 2023) and US$ 163,192,397 (in 2030).

Pursuing to the outcome of the above studies, the Government of United Republic of Tanzania (URT) has entrusted NDC to fast-track utilization of this resource for creation of formidable base for the development of Engaruka Soda Ash Project (ESAP). In the light of the foregoing, NDC has conceived the Government idea of setting up of extraction of soda ash plant at Engaruka and construction of associated infrastructure for the project. NDC has therefore engaged Tanzania Industrial Research and Development Organization (TIRDO) to carry out the Techno Economic Study (TES) for the establishment of the proposed ESAP. The TES will comprise a number of independent studies which will be used to develop a '*Bankable Feasibility Study (BFS)*' for mobilization of the required resources (human, technology, financial) for the project. In this regard, Environmental and Social Impact Assessment (ESIA) study was part of the TES to be conducted for the development.

## 1.3 Rejection of Previous Development Plans of Constructing a Soda Ash Processing Plant at Lake Natron in 2008

Since the 1950's Tanzania has considered the potential to abstract soda ash from Lake Natron; 1950 (Guest and Stevens); 1972-76 (Toyo Soda Manufacturing) and 1993 (Ingenierie). In 2006, an EIA study was carried out for the proposed soda ash extraction and processing plant and associated infrastructure at Lake Natron, with a capacity of producing 500,000 tons of soda ash per annum. The plans attracted concern and condemnation from a number of conservators around the world due to the following reasons:

- The selected project site (Lake Natron and its surrounding ecosystem) is extremely important for biodiversity conservation, ecosystem services and for supporting the livelihoods of the local communities, which depend on pastoralism, eco and culture tourism, and small-scale irrigation. Therefore, construction of soda ash project at Lake Natron would pollute the environment and destroy its ecosystem which is designated as a wetland of international importance (Ramsar site by UNESCO in 2001) and is a crucially important site for the Lesser Flamingo *Phoeniconaias minor* (MoET, 2012; Mmassy et al., 2019).
- The proposed method of soda ash extraction from Lake Natron, including a large network of pipes across the lake, incredible noise and 24-hour flood lights, would disorient Lesser Flamingos, which move mainly at night, and other night flying birds;
- The noise and light would create a high level of disturbance that may disrupt the Lesser Flamingo breeding process.

As a result, the project's EIS report found inadequate and was heavily criticised by those attended the public hearing organised by NEMC at Karimjee Hall Dar es salaam on 23$^{rd}$ January 2008 for lack of vital baseline information and data (i.e., such as hydrology of the area); lack of clear mitigation measures; weak consideration of cumulative impacts and project alternatives; lack of economic study; and having consultation process which was not inclusive. Therefore, the proposed mitigation from key stakeholders for the project was to site the soda ash plant as far away as possible from the nesting sites.

## 1.4 The Need for ESIA

The ESIA study has been prepared in compliance with Tanzania's environmental laws and regulations, and in particular the National Environmental Management Act, Cap 191 and its subsequent Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018. The study has also been prepared to comply with the

World Bank Policies and International Finance Corporation (IFC) Performance Standards on Environmental and Social sustainability.

This EIS report has been prepared by TIRDO under Dr. Julius Elias (Registered by NEMC as an Environmental Expert in 2011 specialized in the execution of ESIA studies). The report was enriched by a number of specialized studies namely fauna (mammals), archaeology and palaeontology, social, flora (vegetation), geology and/or soil analysis, economics and/or financial analysis, marketing, industrial technology, transport logistic, hydrology and/or water quality analysis, chemical processing and air quality studies.

## 1.5 Scoping Study

The aim of this stage was to ensure that the ESIA study adequately addresses all the crucial issues of environmental and social concern to the decision-makers. This was done by narrowing down on the proposed soda ash project issues and also to those requiring detailed analysis. The process involved dialogue with all project stakeholders to ensure that this aim was fulfilled. It also involved the collection of primary and secondary data. From an evaluation of this data, a rapid assessment of the project site and its surrounding areas was made.

The key benefits of scoping include:

- Identification and engagement of key stakeholders;
- Identification of the existing gaps;
- Ensures that the assessment focuses on the key likely environmental and social impacts; and
- Development of Terms of Reference to guide detailed ESIA study.

## 1.6 Terms of Reference (ToR) for the ESIA Approach

In summary, the ToR developed during scoping study and used to guide this ESIA study consist of the following:

- Provision of baseline and background information;
- Project and site description;
- Identification of environmental impacts of the proposed development in the various phases and their level of significance;
- Impact of the project on existing infrastructure;
- Evaluation of project alternatives;
- Stakeholder participation viz social survey of views from neighbours;
- Identification of possible conflicts;
- Suggest mitigation measures for identified negative impacts; and
- Prepare a comprehensive environmental management plan.

The detailed description of approved ToR is appended as Annex I in this report.

## 1.7 ESIA Objectives, Scope and Methodology

This environmental and social impact assessment has been undertaken to fulfil the legislative requirements of the Environmental Management Act of 2004, Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018 and World

Bank Safeguard polices. The ESIA identifies potential positive and negative environmental, social, and economic impacts of the proposed project and propose mitigation and enhancement measures to the anticipated negative and positive impacts, respectively.

### 1.7.1 Objectives of the ESIA

In accordance with the EMA, 2004, all new projects must undergo environmental impact assessment study such as to comply with the Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018 and to ensure provisions for environmental and human health protection. Therefore, the main objective of ESIA associated with development of the proposed project is to comply with the current requirements of the Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018 as established under the EMA, 2004, in addition to the requirements of World Bank Safeguard polices and in particular OP 4.01 requirements.

### 1.7.2 Scope of the ESIA

The scope of ESIA study, therefore, covered the following key areas;

- Provide a description of the environmental and socioeconomic issues associated with the proposed soda ash project;
- To generate baseline data for monitoring and evaluation of how well the mitigation measures will be implemented during the project cycle;
- Undertaking public and stakeholder consultations through interviews and holding meetings with members of the public, neighbouring communities, stakeholders and affected people;
- Identification of anticipated environmental and social impacts with focus on physical and social environment, socioeconomic factors and natural resources aspects;
- Development of mitigation measures and an environmental and social management and monitoring plan for identified negative environmental and social impacts;
- To prepare an Environmental Impact Statement (EIS) Report compliant with the Environmental Management Act (2004) including the Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018, World Bank safeguard policies and detailing findings and recommendations; and
- Obtain appropriate EIA License from NEMC.

### 1.7.3 ESIA Approach and Methodology

In accordance to the ESIA guidelines, the study included the following:

- A clear description of the proposed project including its objectives, design concepts, proposed interventions and anticipated environmental and social impacts;
- Description of the baseline conditions in the project area to cover the physical location, environmental setting, social and economic issues;
- A description of the legal, policy and institutional framework within which the proposed soda ash project will be implemented;
- Description of the project alternatives and selection criteria;
- Details of the anticipated impacts to the environment, social and economic aspects of the project area;

- Appropriate mitigation and/or corrective measures; and
- Development of an environmental and social management plan (ESMP) presenting the project activities, potential negative impacts, mitigation measures and responsibilities, associated costs and monitoring indicators.

The Environmental Management Act (2004) requires that all projects falling under the second schedule of the Act must undergo comprehensive environmental and social impact assessment studies. ESIA study should also comply with the Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018 on the minimum and other convectional environmental guidelines. ESIA studies are adopted as integrated approach where desk documentary reviews, field investigations, consultations as well as interviews and discussions with stakeholders and affected communities are considered. The overall study was undertaken following these stages:

(a) Environmental Screening

Screening process was undertaken to decide whether the proposed project needed to be subjected to an ESIA study or not. Based on literature review, the proposed project falls under Category A of projects to be subjected to EISA study as provided for by the second schedule of the Environmental Management Act of 2004 and Category B under the World Bank Environmental and Social Safeguards Policies as defined in the Bank's Operational Procedures (OPs).

(b) Environmental Scoping

The aim of this stage was to ensure that the ESIA study adequately addresses all the crucial issues of environmental and social concern to the decision-makers. This was done by narrowing down on the proposed project issues and also to those requiring detailed analysis. The process involved dialogue with all project stakeholders to ensure that this aim was fulfilled. It also involved the collection of primary and secondary data. From an evaluation of this data, a rapid assessment of the project site and its surrounding areas was made.

The key benefits of scoping include:

- Identification and engagement of key stakeholders;
- Identification the existing gaps;
- Ensures that the assessment focuses on the key likely environmental and social impacts

(c) Documentary Review

Several relevant documents were reviewed for a clear understanding of the terms of reference, environmental status of the project area, data on demographic trends (for the project area, the beneficiary areas and the adjoining villages, wards, townships, regions and counties), land use practices in the affected areas, development strategies and plans (Local, National and International) as well as the policy, legal and institutional documents.

The documents reviewed were:

- Relevant Legal, Policy and Regulatory documents;

- Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018;
- Arusha Regional Profile 2019;
- Monduli District Profile 2019;
- Tanzania National Bureau of Statistics (NBS) etc.

(d) Site Assessment

A physical inspection of the ground (proposed site and their surrounding environment) was conducted. This process was meant to appreciate the project's scope of land requirements, and establish actual baseline as well as verification of facts stated for project designs. This was done with an aim of establishing the anticipated positive and negative impacts on the physical and biological environment (hydrology, climatic patterns and geology), social and economic trends (population trends, settlement trends, economic patterns, cultural setting and linkages, land ownership issues, etc.) and the Project Affected Persons (PAPs) and beneficiaries. Specific objectives of the field assessment included:

- Obtaining available and relevant information and data from the local public offices including environment, water, lands and agriculture;
- Evaluating the environmental setting around the proposed site – observations and/or measurements were focused on the topography, land tenure, surface and ground water sources, public amenities, land cover, climate, flora and fauna, soils, air quality, noise, vibration, etc.
- Undertaking comprehensive consultative public participation exercises to reach a large section of the affected persons as well as other stakeholders. Public consultations were also organized with the stakeholders to evaluate the environmental setting around the proposed site.
- Evaluate social, economic and cultural settings in the entire project site.

(e) Public Consultation and Participation

It is stipulated in the Tanzanian Environmental policy that all stakeholders pertinent to project should be consulted to seek their views and opinions regarding the proposed projects before they are implemented. Interaction with the stakeholders, and communities living around the project area was undertaken through public and stakeholder consultation and participation meetings. Refer to (Chapters 5 & 6 and Appendix 4) for the Minutes and Attendance Registers of the meetings. Through this process, the stakeholders and the PAPs had an opportunity to contribute to the overall project design by making recommendations and raising any environmental and social concerns of the project. In addition, the process aimed at creating a sense of responsibility, commitment and local ownership for smooth implementation and operation of the proposed project.

## 1.8 Baseline Data and Information

Consultants identified information that will be required for the environmental impact assessment. The information on the bio-physical, socio-economic environment, institutional and legal regimes were collected from various sources, namely project documents and general literature review, visual observation and/or inspection and measurements, expert opinion, consultations with selected stakeholders and discussions with project proponent/manager, designing Consultant etc. Therefore, the specialized studies on biological (flora and fauna); archaeology and palaeontology; marketing, resource assessment, extraction and processing technology, economics (cost benefit analysis), land use, transport logistic, social and physical environment (meteorology, geology/soil analysis, hydrology, air quality, noise and vibrations) of the area were done and annexed and/or included in this Environmental Impact Statement (EIS) report as baseline data.

### 1.8.1 Physical Environment

Baseline information for the proposed project assumes the larger Monduli District's baseline environmental and social conditions. Discussed below is the physical and social environment particularly as related to geology, topography, soils, drainage, water quality, air quality, noise and vibration for the project area.

#### 1.8.1.1 Hydrology and drainage

Surface and ground water characteristics were assessed during field investigation as well as maps and data from previous related study reports. Water samples was collected from available water sources found in the area and transported to TIRDO laboratory for analysis. Moreover, other samples were collected while targeted unpolluted water sources for analysis at Ngurdoto Research Water Laboratory. The baseline data for the analysed physico-chemical and biological parameters are incorporated into this EIS report.

#### 1.8.1.2 Climate, geology, topography, soils

Information on the climate, geology, topography and soils were obtained by compiling data from existing reports and relevant agencies. Field and laboratory works were carried out to augment and verify existing information relating to geology and soils and to obtain first-hand knowledge of the topography among others.

#### 1.8.1.3 Air quality, noise and vibration

Seven (7) sampling stations for measuring air quality (i.e., dust, ambient pollutant gases), noise and vibrations were identified, covering both onsite and offsite receptors. The air quality, noise and vibrations measurement stations were selected based on the norms prescribed by Tanzanian standards (TBS and National Environmental Air Quality regulations) and International guidelines. These include predominant wind direction (leeward and windward) at the area during the study as well as site workers and nearest local communities, as possible receptors i.e., water bodies, plantations (vegetation), animals/wildlife and buildings/Maasai bomas and the areas that gaseous products, noise, vibrations and generated dust from the proposed project development phases are likely to dispersed to. The actual measurement and results of these parameters are incorporated into this EIS report.

1.8.1.4 Archeological and palaeontological study

Artefacts (like pottery, slag, *tuyérés* and so on), stone tool finds, fossil fauna and other finds were collected from localities established using the standardized 13-point protocol and would further be documented following a standardized ten-point protocol. Documentation was also including GPS coordinates, photographic record as well as preliminary notes pertaining to identification (taxonomic affinity for example), preservation and taphonomic features. Collected specimens were identified and sorted to extent feasible in the field. Parallel hard copy as well as electronic records was maintained for both specimens and localities. Excavations involved establishing 1 by 2 metres grids and collecting pottery, slag, *tuyéré*, fossil bone as well as stone tool materials within the grids and for fossil fauna, noting surface of faunal stance facing up when it was collected. The deliverable of the study is to map out all potential areas that would yield archaeological and palaeontological materials/objects and spiritual sites for either total recovery, as the case may be, to give way for desired project development or to preserve (in situ) as well as demarcate such objects for preservation including conservation, while at the same time suggest needed mitigation measures.

**1.8.2 Biological Environment**

The status of flora (vegetation) and fauna (animals and birds) of the study area was determined by a review of literature relevant to the study area and field investigation.

1.8.2.1 Flora

A simple 'walk through' survey of the terrestrial flora was conducted. Identification was carried out on dominant vegetation species in sample plots. The identified vegetative communities were classified into community types and assemblages based on their physiognomic characteristics following White (1983) and dominant species by a botanist direct in the field while some were taken to herbarium for verification and/or identification.

Also interviews with forestry personnel on the existence of forest protected areas, and locals especially traditional healers and furniture makers were conducted to identify a list plant species of medicinal, and socio-economic values i.e., those used for food and construction material.  In addition, attempts were made to include aspects of invading species, and an indication of biodiversity and species hinting important historical information among others. The vegetation species were identified and described for their taxonomical, rarity and whether they are endangered species or not. The identified list of plants found in the area and plant species of ecological conservation concern is included in the EIS report. Possible impact of the project activities on the flora was identified and their mitigation measures and monitoring plans suggested.

1.8.2.2 Fauna

The proposed project area was surveyed using methodology outlined in the African Forest Biodiversity (Leon *et al.*, 2002). Interviews with the locals to get information on commonly sighted animals in the area and if there exists any migration corridor was also employed. Large mammals were observed and identified while walking along transect in representative habitats and through observation of animal signs such as droppings, footprint or vocalization.

Small mammals, amphibians and reptiles will be studied in the detailed study through sighting. Birds were preliminary studied through visualization sighting, through vocalization while walking along the project area. Most importantly, information about the presence of any significant species (i.e., locally caught fish and observed animals) was obtained from local people in the area. List of fauna organisms found in the area, organisms of ecological conservation concern and mapping of any critical habitats were documented. Moreover, possible impact of the project activities on the organisms were preliminarily identified and their mitigation measures and monitoring plans suggested. All fauna information is included in this EIS report as baseline data.

### 1.8.3 Socio-economic Environment

Rapid field appraisal techniques in conjunction with desk research work were employed for investigations of the social-economic considerations within the proposed project area, viz:

- Land uses and livelihoods;
- Population and settlement characteristics;
- Nearby underway developments;
- Infrastructures in place;
- Water and Power supplies and other utilities;
- Waste management practices;
- Social activities e.t.c.

### 1.8.4 Policy, Legal and Institutional Arrangement

Policy, legal and institutional arrangement were compiled from review of documents i.e., policies, laws and regulations, guidelines and standards. Information and data on local by-laws, institutional structures and mandates/authority were obtained from Monduli District and Local Government Authorities (LGAs), and/or Engaruka, Mrefeji and Selela wards.

### 1.8.5 Project description

This involved reviewing available information on the project to gain a basic understanding of the project components and their operations. The documents reviewed include:

- Records, ToRs, Reports and/or existing information regarding the proposed project;
- Relevant National and International Policies, Laws, Treaties and Regulations; and
- Arusha region and/or Monduli District profile(s).

### 1.8.6 Impact Assessment and Mitigation Measures

The primary function of an environmental impact assessment study was to predict and quantify potential impacts, assess and evaluate their magnitude and importance and develop an Environmental and Social Management Plan to mitigate the impacts. Environmental impacts could be positive or negative, direct or indirect, local or regional and also reversible or irreversible. Assessment of impacts depends on the nature and magnitude of the activity being undertaken and also on the type of mitigation measures that are envisaged as part of the project concept. For the proposed project, the anticipated impacts are divided into three components of the project: impacts based on Project Location, impacts during Construction phase, and impacts during Operation and De-commissioning phases. The identified potential positive and negative impacts of the project are presented in Chapters 6 & 7 of this report.

#### 1.8.7 Environmental and Social Management and Monitoring Plans (ESMMPs)

The Consultants have developed an Environmental and Social Management and Monitoring Plans (ESMMPs) to guide the project team in eliminating or reducing the project negative impacts to acceptable minimum/ standards. The ESMMPs are based on good environmental practices of project implementation and safety of the operations. The proposed ESMMPs can be improved through continuous monitoring and audits during project implementation. The plans are provided in a matrix form in Chapters 8 and 9 of this EIS report and it identifies the anticipated impact; proposed measures to be undertaken; monitoring indicators; the party responsible for implementing the measures, and the estimated cost likely to be incurred to undertake the measures.

## 1.9 Report Structure

The report is presented in accordance to the format given in Section 18 (1 and 2) of the Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018. It is presented in as follows:

i) Executive Summary
ii) Table of Contents
iii) Acknowledgement
iv) List of Acronyms

1. Introduction
2. Project background and description
3. Policy, administrative and legal framework
4. Baseline/ Existing conditions
5. Stakeholders Analysis
6. Assessment of Impacts and Identification of Alternatives
7. Environmental Mitigation Measures
8. Environmental and Social Management Plan
9. Environmental and Social Monitoring Plan
10. Resource Evaluation / Cost Benefit Analysis
11. Decommissioning and Closure
12. Summary and Conclusions
13. References
14. Appendices

CHAPTER TWO

# 2 PROJECT LOCATION AND DESCRIPTION

## 2.1 Project Area

### 2.1.1 Project Location

The proposed project site (Figure 2.1) is located within Engaruka basin (3.112 S and 36.161 E) at Monduli District in Arusha region, north-eastern part of Tanzania about 610 km from Tanga, 439.9 km from Dodoma and 840 km from Dar es Salaam. It is 18 km from Engaruka township, 50 km northeast of Mto wa Mbu Town, 231.9 km from Longido, 257.3 km from Namanga, 212.1 km from KIA and more than 60 km south-east of Lake Natron at Monduli District in Arusha region. The site is bordered by Mbaashi village on the south, Irerendeni and Noondoto villages on the north, Lepurko and Idonyonaado villages on the west and Engaruka chini village on the east. Administratively, Monduli District Council is one among seven (7) districts (Monduli, Ngorongoro, Loliondo, Arusha Urban, Arusha Rural, Meru and Karatu), that form Arusha region, with Arusha Urban being its regional and economic capital.

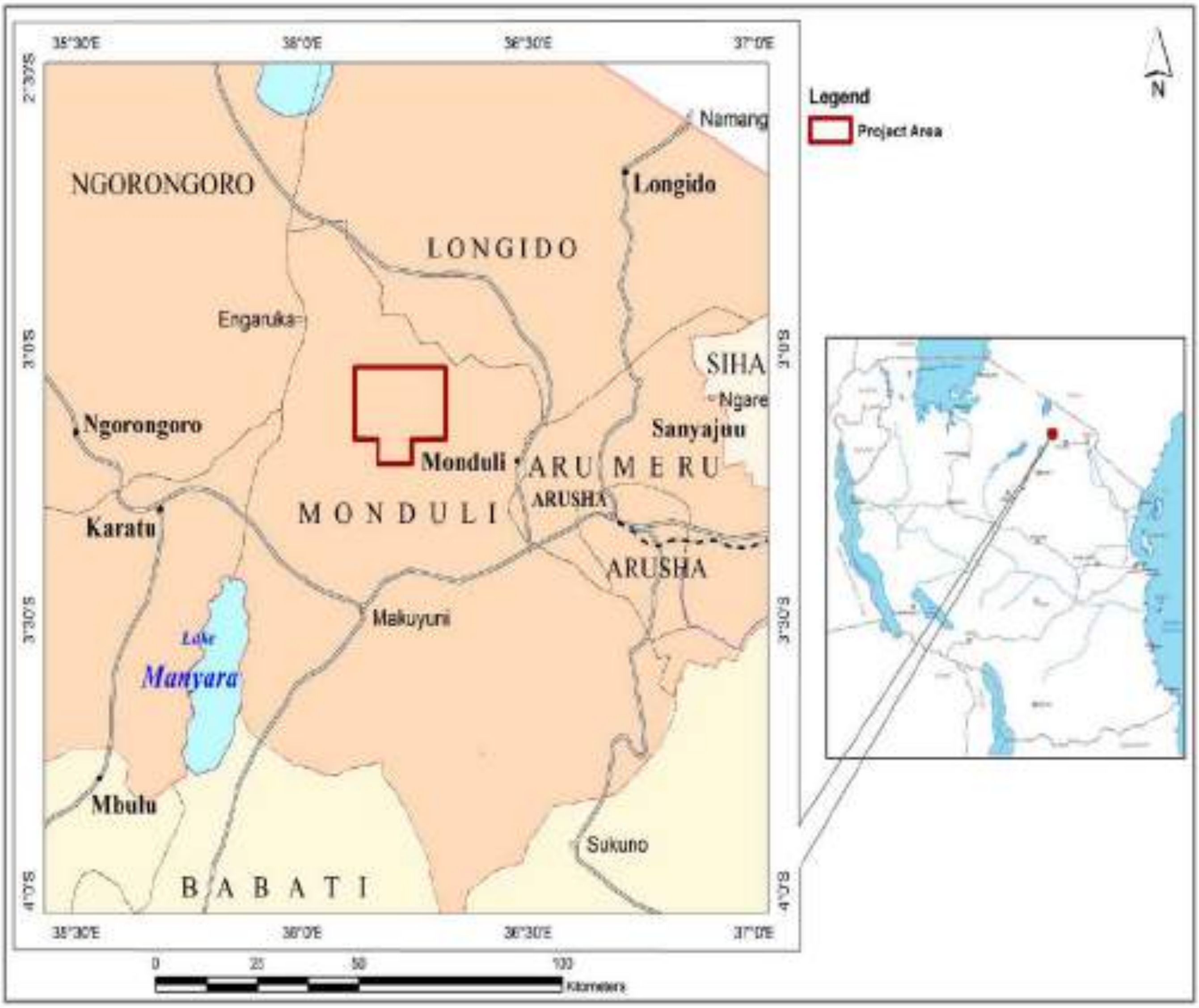


**Figure 2.1:** Map of Tanzania showing the location of the proposed project

### 2.1.2 Accessibility of the Project Site

The proposed project site can be easily accessed from Arusha through paved Monduli-Karatu road to Mto wa Mbu Town and via unpaved Loliondo road that passes at Selela to Engaruka centre and then toward unpaved Boloti road up to site. However, around the site there are existing trucks/pathways that can be up graded to internal roads.

Fundamentally, road transport is supposed to supplement railway transport during operation. However, where there is no railway line, the use of trucks becomes the only alternative as is the case at present of the proposed plant for Soda Ash in Engaruka, though the two modes of transport can work in tandem. From Arusha or Moshi, the existing road network has three alternative routes to reach the proposed plant site, all of them having almost the same distance as detailed in Table 2.1.

**Table 2.1: Existing Road Network between Tanga and Engaruka**

| SN | STRETCH | KM | TYPE OF ROAD | ALTERNATIVE |
|---|---|---|---|---|
| 1. | Tanga – Segera | 72 | Trunk | |
| 2. | Segera – Arusha | 366 | Trunk | |
| 3. | Arusha – Makuyuni | 77 | Trunk | I |
| 4. | Makuyuni – Mto wa Mbu | 32 | Trunk | |
| 5. | Mto wa Mbu- ESAP Junction | 31 | Being Paved | |
| 6. | ESAP Junction – Plant Site | 18 | New Construction | |
| **ALTENATIVE I (1+2+3+4+5+6)** | | **596** | | **I** |
| 7. | Arusha – Longido | 80 | Trunk | |
| 8. | Longido – Oldonyo | 102 | Unpaved Regional | II |
| 9. | Oldonyo – Engaruka Junction | 16 | Being Paved | |
| 10. | Engaruka Junction- ESAP Junction | 33 | Being Paved | |
| 11. | ESAP Junction- Plant Site | 18 | Being Paved | |
| **ALTENATIVE II (1+2+7+8+9+10+11)** | | **687** | | **II** |
| 12. | Arusha- Monduli Junction | 25 | Trunk | |
| 13. | Monduli Junction –Engusero Junction | 65 | Unpaved Regional | |
| 14. | Engusero Junction- Engaruka Junction | 50 | Unpaved Regional | **III** |
| 15. | Engaruka Junction – ESAP Junction | 33 | Being Paved | |
| 16. | ESAP Junction- Plant Site | 18 | New Construction | |
| **ALTERNATIVE III (1+2+11+12+13+14+15)** | | **629** | | **III** |
| 16. | Tanga – Moshi | 357 | Trunk | |
| 17. | Moshi – Longido (bypass Arusha) | 95 | Gravel | |
| 18. | Longido – Oldonyo | 102 | Being Paved | |
| 19. | Oldonyo – Engaruka Junction | 16 | Being Paved | **IV** |
| 20. | Engaruka Junction- ESAP Junction | 33 | Being Paved | |
| 21. | ESAP Junction- Plant Site | 18 | New Construction | |
| **ALTENATIVE IV (10+11+12+13)** | | **621** | | **IV** |

***Source:*** *Volume VII – Transport Logistics Report*

### 2.1.3 Land Ownership

The project area of about 25,000 ha corresponds to the NDC's Minerals Prospecting Licenses (PLs) that granted by the Ministry of Minerals through Mining Commission in 18$^{th}$ day of

October 2018 (Appendix 2) to prospect the underground resources, develop exploratory wells for extraction and processing of brine resources. However, the surface right for the earmarked piece of land is legally belongs to the Village Government Councils of Engaruka chini, Irerendeni, Mbaashi and Idonyonaado until the project proponent (NDC) finalized the valuation and compensation processes. Consultations with the Arusha Regional Office, Monduli District Council Office, Engaruka Ward Office, Selela Ward Office, Engaruka-chini Village Office, Irerendeni and Mbaashi Village Office as well as neighbours confirmed to the ESIA team that there are appended issues regarding cash compensation by cash between the URT and villagers and Village Government Councils of Engaruka chini, Irerendeni, Mbaashi and Idonyonaado. Moreover, over the years the site has been used as settlement area for villagers (mostly Maasai) and grazing land for both domestic and wild animals.

The demarcated project area is quite adequate to accommodate the proposed Soda Ash project including the further expansion plans when deemed necessary. However, the development will abide to the future developments in the project neighbourhoods as per Monduli District Council master plan.

## 2.2 Major Existing Features

The piece of land with an area of 25,000 ha is located within Engaruka basin, about 18 km from Engaruka township, 50 km northeast of Mto wa Mbu Town and 60 km south-east of Lake Natron at Monduli District in Arusha region. The area is currently used by traditional pastoral Maasai people who rely on natural habitats, particularly for grazing areas during dry season, to maintain their lifestyles. Apart from pasture land and few scattered Maasai bomas with cattle pen (Figures 2.2 & 2.3), there was no any major onsite developments or structure found within the project site. Therefore, the whole project site can be viewed as a basin with a seasonal lake and thus, there will be no major demolishment required during construction phase.


**Figure 2.2:** Features of the project site: Maasai bomas with cattle pen

**Figure 2.3:** Features of the project site

## 2.3 Adjacent Developments

The project site located 18 km away from Loliondo – Mto wa Mbu road that pass at Engaruka centre. The major development observed beyond the project site includes Irrigation canals, crops plantations, schools, churches, mosques, residential homes, shops/kiosks, restaurants, auction places (magulio) and gest house (Figure 2.4a-d). Activities conducted adjacent to the project site are farming and grazing (Figure 2.4c-d). The nearest household is located on the western side, about 2 km from the bourder of the project site.


**Figure 2.4a:** One of major irrigation canal in the project area

**Figure 2.4b:** Electricity supply system (which is recently connected under REA)


**Figure 2.4c:** Food crops grown in the study area

**Figure 2.4d: Grazing activities near the project site**

## 2.4 Land Acquisition Process (Cash Compensation)

Land acquisition process is ongoing in accordance to the land rights procedure. Administratively, the land under the project area falls under two categories: village land and privately occupied land. Both village and privately-owned land will be compensated (by cash) as per agreement in line with requirements of the Land Acts (Land Acquisition Act of 1967 (as amended), Village Land Act, 1999 (as amended and regulations (2001) which requires that all land to be acquired has to be fairly and promptly compensated. According to Monduli District Council, the land (and associated properties buildings and crops) to be acquired were valued in 2018 and valuation report submitted to Chief Valuer for approval. Much of the details regarding land acquisition will be contained in the Resettlement Action Plan (RAP) report.

## 2.5 Declaration if the Project Site is within or away from Sensitive Areas

Apart from GCA, migratory route, wildlife corridor and hunting blocks, there is no other sensitive areas and/or sensitive public (socio-economic) utilities such as schools and hospitals and military base within the project area. The nearest environmentally protected area or ecosystem are the Engaruka ruins and Ngorongoro Conservation Area and/or geopark boarder located about 25 and 14 kms away respectively, northwest of the project area. Lake Natron ecosystem which is designated by UNESCO in 2001 as a wetland of international importance (Ramsar site) and as a breeding site for the Lesser Flamingo (*Phoeniconaias minor),* found about 60 kms away from the proposed project site.

## 2.6 Nature and Scope of the Proposed Soda Ash Project

Engaruka soda-ash project is expected to provide direct employment to 250 people *(Volume III - Technological Assessment Report).* On other hand, the project is expected to create an industrial community of around 1,500 people that includes employee's families, outsourced services providers, businessman and visitors *(Volume VI - Plant and Township Site Selection and Infrastructures Report)*. Based on the market study (*Volume II – Market Analysis Report*), the proposed plant should have an initial production capacity of 500,000 metric tonnes of soda ash per year which will expand production to 1,000,000 metric tonnes per year as the market grows. With a recharge rate of more than 17,693,640 $m^3$ per year (*Volume I – Appraisal of the Brine Resource Report*), the resource is enough to sustain the production capacity of 1,000,000 tonnes per year. However, the smaller production capacity of 500,000 tonnes of soda ash per annum against the Government wish of one million tonnes per year is recommended because there are already two competitors of soda ash products in East African Community (EAC) and South African Development Corporation (SADC) regions (*Volume II – Market Analysis Report*).

The proposed project design covers brine extraction and soda ash processing plant and associated project components. The associated project components include: sixteen exploration wells, eight brine's extraction wells, pipelines (to transfer extracted brine from boreholes to the plant's storage ponds and/or processing plant), pumps, three brine holding pond, power substation, boiler and generator sheds, solid waste collection facilities, water storage tanks, administrative offices, wash rooms, car packing area, fence, living accommodations for staff and landscaping improvement.

Extraction of underground brine resource will be done by pumping the brine from the aquifer through eight production boreholes. The proposed plant facilities would therefore pump about 60 $m^3$ of concentrated brine per hour from a single brine's extraction borehole and convert it into calcified soda ash (sodium bicarbonate) crystals for local markets and exportation. In the process, the plant would require 11.5 megawatts of power and utilise approximately 250,000 $m^3$ of water per year (*Volumes III & IV – Technological Assessment Report and Project Engineering Design Report)*. Engaruka soda-ash industry is expected to provide direct employment to 250 people; with expectation of creating an industrial community of around 1,500 people that includes employee's families, outsourced services providers, businessman and visitors (*Volumes III, IV & VI – Technological Assessment Report, Project Engineering Design Report and Plant and Township Site Selection and Infrastructures Report)*. The development of the soda ash facility would also provide clear information and/or delineation of new access roads, upgrading plan of Loliondo - Mto wa Mbu or Arusha - Tanga tarmac road to the plant and railroad for easy transfer of processed soda ash from the plant to Tanga port and/or neighbouring countries.

According to the First Schedule of the Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018 made under sections 82(1) and 230 (2) (h) and (q) of the Environmental Management Act No. 20 of 2004, the proposed project falls under the list of projects requiring EIA and thus, the full ESIA study is mandatory.

## 2.7 Project Design and its Components

### 2.7.1 Design of the Proposed Soda Ash Project

The plant design, rules and regulations will be in accordance with Tanzania Government specifications and the planning regulations of Monduli District Council. The proposed soda ash plant and its associated facilities has been designed to conform to the principles set forth below:

- The life span of the proposed project 50 years;
- The plant design considered the volcanic activities and/or seismic nature of the area as well as cyclone/storm forces. Therefore, the plant facility has to be seismic resistant and cyclone/storm forces resistant in accordance with national standards;
- The structure of the plant should be well ventilated. It should be designed to maximise day light (by provision of appropriate size and height of the windows, vents and roofed with translucence iron sheet);
- The plant is to be designed while ensuring maximum safety and health of user;
- Appropriate water and sanitation handling facilities have to be provided;
- Plant design has taken care of easy accessibility for people with disabilities; and
- The plant has been designed to blend harmoniously with the existing wildlife corridors, hunting blocks and the local environment i.e., water bodies, valleys, vegetation, floods, erosion, and settlements. Consideration has also been given to climatic conditions to ensure maximum comfort and aesthetics. This includes orientation to the sun/prevailing winds. Similarly, air exchange and openings have been taken into consideration in the building layout and planning.

The other key elements that were considered by the design options are:

- Design of infrastructure based on identified and prioritized needs;
- Calculation of required space based on existing infrastructure standards;
- Site planning including layout of building and associated facilities; and
- Cost implications i.e., cost effective to meet production capacity while requiring minimum maintenance.

The types, sizes, number for the doors, windows and special facilities (i.e., toilets, urinals, vents, tube lights, air conditioning/fan etc) have been derived from the Architectural design guidelines from the local and internationally acceptable standards.

### 2.7.2 Components of the Proposed Soda Ash Plant

Soda ash production machinery can be supplied as a complete plant or as independent equipment/machinery. The more practised approach is supply of a complete plant. Using the crystallization and carbonation technology, three products can be obtained from the brine solution as the raw material. These products are dense soda ash, light soda ash and sodium bicarbonate. The technology proposed enables the plant to produce all the three products at the same time during operation as these products can share most of the equipment/machineries (Table 2.2). These are:

i) Brine Storage and Sedimentation in Ponds
ii) Holding in Tank(s)
iii) Rotary Vacuum Filtration
iv) Activated Carbon Filtration
v) Brine Filtrate Storage
vi) Brine Filtrate Pre-heating
vii) Carbonation Reaction
viii) Cooling Crystallization
ix) Hydrocyclone Separation
x) Crystals Washing
xi) Low Temperature Drying
xii) Sodium Bicarbonate Calcination
xiii) Densification of Soda Ash
xiv) Products Storage and Packaging

**Table 2.2: List of Major Project Components, Equipment and specifications**

| S/N | Name | Type | Design Capacity | | Dimensions | | Design Pressure | Material of Construction | Quantity |
|---|---|---|---|---|---|---|---|---|---|
| | | | Value | SI Units | Length/ Height (m) | Width/ diameter (m) | (bar) | | |
| 1 | R-101 | Carbonation Reactor | 1,029,605 | l | 20.5 H | 8.2 D | 1.52 | SS316 | 1 |
| 2 | R-102 | Calcination Reactor | 109,019 | l | 14.2 H | 3.2 D | 1.52 | SS316 | 1 |
| 3 | V-101 | Brine Holding Tank | 5,500,000 | l | 16.5 H | 20.6 D | 1.52 | SS316 | 2 |
| 4 | R-103 | Steam Hydration Unit | 31,709 | l | 6.4 H | 2.5 D | 1.52 | SS316 | 1 |
| 5 | R-104 | Dehydration Unit | 34,354 | l | 6.5 H | 2.6 D | 1.52 | SS316 | 1 |
| 6 | PC-101 | Pneumatic Conveyor | 76,505 | kg/h | 30 | 0.285 | pipe | CS | 1 |
| 7 | RVF-101 | Rotary Vacuum Filter | 111 | $m^2$ | Filter area | | | CS | 3 |
| 8 | V-102 | $CO_2$ Storage Tank | 120,000 | l | 11.1 H | 3.7 D | 1.52 | SS316 | 1 |
| 9 | CY-101 | Hydrocyclone | 465,508 | l/h | | | | CS | 1 |
| 10 | WSH-101 | Washer (Bulk Flow) | 155,283 | kg/h | | | | CS | 1 |
| 11 | HX-101 | Heat Exchanger | 1.5 | $m^2$ | HX-Area | | | CS | 1 |
| 12 | PM-101 | Centrifugal Pump | 16.4 | kw | | | | SS316 | 1 |
| 13 | PM-102 | Centrifugal Pump | 18.7 | kw | | | | SS316 | 1 |
| 14 | V-103 | Brine Filtrate Tank | 5,500,000 | l | 16.5 H | 20.6 D | 1.52 | SS316 | 2 |
| 15 | PM-103 | Centrifugal Pump | 17.5 | kw | | | | SS316 | 1 |
| 16 | PM-104 | Centrifugal Pump | 37.3 | kw | | | | SS316 | 1 |
| 17 | SC-101 | Screw Conveyor | 15 | m | Pipe | 0.4367 D | | CS | 1 |
| 18 | PC-102 | Pneumatic Conveyor | 25 | m | Pipe | 0.2513 D | | CS | 1 |
| 19 | BC-101 | Belt Con veyor | 15 | m | Belt | 0.7911 D | | CS | 1 |
| 20 | GAC-101 | GAC Adsorption Column | 47,121 | l | 6.4 H | 3.1 D | | CS | 4 |
| 21 | PM-105 | Centrifugal Pump | 17.5 | kw | | | | SS316 | 1 |

| S/N | Name | Type | Design Capacity | | Dimensions | | Design Pressure | Material of Construction | Quantity |
|---|---|---|---|---|---|---|---|---|---|
| | | | Value | SI Units | Length/ Height (m) | Width/ diameter (m) | (bar) | | |
| 22 | HX-102 | Heat Exchanger | 75 | $m^2$ | HX-Area | | | CS | 1 |
| 23 | V-104 | Fresh Water Tank | 25,611 | l | 6.7 H | 2.2 D | | SS316 | 1 |
| 24 | PM-106 | Centrifugal Pump | 0.9 | kw | | | | SS316 | 1 |
| 25 | FBDR-101 | Fluidized Bed Dryer | 38,813 | l | 17.1 H | 1.7 D | | SS316 | 1 |
| 26 | HX-104 | Heat Exchanger | 71.4 | $m^2$ | HX-Area | | | CS | 1 |
| 27 | PC-103 | Pneumatic Conveyor | 50 | m | | 0.2938 | | CS | 1 |
| 28 | BC-102 | Belt Conveyor | 15 | m | | 0.0678 | | CS | 1 |
| 29 | BC-103 | Belt Conveyor | 35 | m | | 0.0849 | | CS | 1 |
| 30 | BC-104 | Belt Conveyor | 25 | m | | 0.02977 | | CS | 1 |
| 31 | PM-107 | Centrifugal Pump | 5.7 | kw | | | | SS316 | 1 |
| 32 | HX-105 | Heat Exchanger | 62 | $m^2$ | HX-Area | | | CS | 1 |
| 33 | CR-101 | Crystallizer | 149,058 | l | 10.3 H | 4.1 D | 1.52 | SS316 | 7 |
| 34 | SL-101 | Dense Soda Ash Silo | 11,795,257 | l | 33.8 H | 21.1 D | 1.11 | Concrete | 2 |
| 35 | BE-101 | Bucket Elevator | 36 | m | 36 H | 0.1*0.15 | | CS | 1 |
| 36 | SL-102 | Light Soda Ash Silo | 4,196,088 | l | 25.9 H | 14.4 D | 1.11 | Concrete | 2 |
| 37 | BE-102 | Bucket Elevator | 28 | m | 28 H | 0.1*0.15 | | CS | 1 |
| 38 | SL-103 | Bicarbonate Silo | 3,348,576 | l | 24.0 H | 13.3 D | 1.11 | Concrete | 2 |
| 39 | BE-103 | Bucket Elevator | 26 | m | 50.0 H | 0.1*15 | | CS | 1 |
| 40 | AF-101 | Air Filter | 164,570,489 | l/h | | | | CS | 1 |
| 41 | M-101 | Centrifugal Fan | 164,570,489 | l/h | | | | CS | 1 |
| 42 | HX-103 | Heat Exchanger | 40 | $m^2$ | HX-Area | | | CS | 1 |
| 43 | SC-102 | Screw Conveyor | 14 | m | | | | | 1 |
| 44 | SC-103 | Screw Conveyor | 10 | m | | | | | 1 |
| 45 | SC-104 | Screw Conveyor | 9 | m | | | | | 1 |
| 46 | V-105 | Receiver Tank | 769,222 | l | 13.0 H | 8.7 D | | | 1 |
| 47 | V-106 | Receiver Tank | 79,017 | l | 9.7 H | 3.2 D | | | 1 |
| | | Unlisted Equipment | | | | | | | 1 |

***Source:*** *Volume IV – Project Engineering Design Report*

**Table 2.3: Design components for a 15-MW co-generation (pulverized) coal power plant**

| S/N | Equipment | Pressure [bar] | | Temperature [°] | | Mass flowrate [kg/h] | | Work [kW] | |
|---|---|---|---|---|---|---|---|---|---|
| | | In let | Outlet | In let | Outlet | In let | Outlet | In let | Outlet |
| | Boiler | 30 | 30 | - | 500 | - | 130,600 | - | - |
| | Turbine | 30 | 1.013 | 500 | 99.97 | 65,378 | 65,378 | - | 15,000 |
| | Expansion Valve | 30 | 10 | 500 | 250 | 65,222 | 65,222 | - | - |
| | Process Heater | 10 | 10 | 250 | 179.9 | 58,700 | 58,700 | - | - |
| | Process Steam | 10 | - | 250 | - | 6,522 | 0 | - | - |
| | Condenser | 1.103 | 1.013 | 99.97 | 99.97 | 65,378 | 65,378 | | - |
| | Pump I | 1.103 | 30 | 99.97 | 100.2 | 65,378 | 65,378 | 54.93 | - |
| | Pump II | 10 | 30 | 179.9 | 180.3 | 58,700 | 58,700 | 36.76 | - |
| | Mixing Chamber | 30 | 30 | - | 163 | 124,078 | 124,078 | - | - |
| | Make-up water | | | | | 6,522 | | | |

***Source:*** *Volume IV – Project Engineering Design Report*

**Table 2.4: HDPE pipe specification**

| Pipe Category | Specifications | Unit |
|---|---|---|
| Pipe type | PN 8 PE 100 | |
| Outside Diameter | 400 | mm |
| Minimum Wall thickness | 19.1 | mm |
| Total length required | 4,630 | m |
| Unit cost | 38.18 | USD/m |
| Total Costs | 176,773.4 | USD |

***Source:*** *Volume IV – Project Engineering Design Report*

**Table 2.5: Specifications of the surface centrifugal pumps**

| Description | Value |
|---|---|
| **Operating Data** | |
| Nominal Capacity | 400 $m^3$/hr |
| Nominal Head | 76 m |
| Power consumption at Nominal Capacity | 100 kW |
| Efficiency at Nom. Capacity | 82.4 % |
| **Dimensions** | |
| Base plate length | 2140 mm |
| Base plate width | 1050 mm |
| Height (Base plate + pump) | 1225 mm |
| **Material** | |
| Pump casing | CrNiMo-steel (1.4408) |
| Impeller | CrNiMo-steel (1.4408) |
| Pump shaft | CrNiMo-steel (1.4462) |
| Suction casing | CrNiMo-steel (1.4408) |
| **Total Weight** | **1800 kg** |

***Source:*** *Volume IV – Project Engineering Design Report*

### 2.7.3 Raw materials and Products

Material and energy balance calculations for the planned production of 500,000t/yr of soda ash, has established the quantity of brine required for soda ash production by carbonation process as summarised in the table 2.6 below.

**Table 2.6: Summary of material and energy balance for the Soda Ash process**

| No. | Component | Unit | Yearly | Daily | Hourly |
|---|---|---|---|---|---|
| 1 | Brine | $m^3$ | 2,940,000 | 9,612 | 400 |
| 2 | Carbon Dioxide (l) | tons | 293,000 | 980 | 40 |
| 3 | Process Water | $m^3$ | 250,000 | 903 | 38 |
| 4 | Process Steam | tons | 2,352,000 | 7,800 | 325 |

***Source:*** *Volume IV – Project Engineering Design Report*

Once the raw materials received, a number of processing steps will take place to obtain the finished soda ash products of three main grades namely: dense, light and washing soda.

- *Dense Soda Ash:* Dense soda ash, an anhydrous substance, is an important industrial chemical and is used in the manufacture of many products.
- *Washing Soda:* Washing soda is a hydrous substance made by combining light soda ash with additional water molecules. It is used most often to improve the cleaning properties of detergents and soaps;
- *Light Soda Ash:* Light Soda Ash is used as a buffering/pH regulator in many industrial processes.

### 2.7.4 Quantity and Quality of Wastes (Solids/Liquids/Gases) to be generated

The wastes generated in the carbonation process in large quantity are the mother liquor, used process water, and mud sludge (Table 2.7). From the calculations, it is estimated that a total of 2,500,000 $m^3$/yr of mother liquor and 250,000 $m^3$/yr of process water will be used. And 33,670 t/yr of mud sludge will be generated annually. Additionally, 49,500 tons carbon dioxide will be generated annually from the calcination step. However, almost all the carbon dioxide will be recovered and reused.

The type of technology chosen and the number of unit operations involved depends on the quality of raw materials. Based on the soda ash concentration reported, solar ponds system design may not be required, instead brine storage / settling ponds will be required. These will capture the slurry from the boreholes. Clear solution will then be pumped to the production plant.

**Table 2.7: Summarized quantity of waste (effluent) to be generated/discharged**

| No. | Component | Unit | Yearly | Daily | Hourly |
|---|---|---|---|---|---|
| 1 | Mother Liquor (Bittern) | $m^3$ | 2,500,000 | 8,300 | 350 |
| 2 | Mud Sludge | $m^3$ | 33,670 | 122 | 5 |
| 3 | Spent Process Water | $m^3$ | 250,000 | 903 | 38 |
| 4. | Industrial and Domestic waste water | $m^3$ | 111,953 | 373.2 | 15.5 |

***Source:*** *Volumes IV & VI – Project Engineering Design Report and Plant and Township Site Selection and Infrastructures Report*

## 2.8 Project Cost

The project cost (which includes project design, procurement of soda ash processing technology, transportation facilities, construction of plant building, installation of procured machines and equipment, building of staff quarters, construction of internal access roads, car parking, fence, power substation, brine storage ponds, waste water storage ponds, water intake and water pipelines) is expected to be **USD 516,330,000** (*Volume IX – Project Appraisal Report*).

## 2.9 Project Activities

The actual development of the project on the ground will involve four major phases as indicated hereunder:

### 2.9.1 Planning Phase

The design of Plant layout for desired functional relationship to facilitate efficiency, cost-effective and ease of operation can be based on:

- Minimum Travel: Operations manager must design layout in such a way that the distance between operations is minimum which in turn helps in avoiding the labour and time wastages there by reducing the cost of material handling;
- Sequence: The machines and operations must be arranged sequentially. This principle is effectively attained in product/ line layout;
- Usage: The available space needs to be optimally utilized. This principle has wide acceptance in towns and cities where a piece of land is very much expensive;
- Compactness: All the significant factors need to be fully integrated and related, producing a well-integrated and final layout;
- Safety and Satisfaction: The layout must have provisions for safety of workers. It must be planned, based on the comfort and convenience of the workers for making them feel satisfied;
- Flexibility: The layout must allow improvements with less difficulty and at minimum cost; and
- Minimum Investment: The ideal layout must provide savings in fixed capital investment not by ignoring the installation of required facilities but by efficiently and optimally using the available facilities (economies of scale).

For instance, the location of raw materials receiving or feeding point (transfer of extracted brine from brine's extraction wells via pipes to the brine's storage ponds and/or plant) in relation to brine processing unit → soda ash products (goods) unit → processed products store will be in close proximity to facilitate easy manoeuvrability of material being processed and/or manufactured products from one unit to another (Figures 2.5a-b). Administration offices will be strategically placed to have command of both main entrance and the soda ash processing unit, packaging, sales and store units. Common facilities like toilet, kitchen, pedestrian ramps (in consideration of disable people) and reception will be located centrally for convenience of use and easy accessibility by staff at the administration unit. Moreover, all movement between the areas with relative differences in topographical levels will be by way of both stairs and ramp in consideration of disable people. The internal access road system that connected to unpaved Loliondo – Mto wa Mbu road (which is under upgraded plan) will match with in size, hierarchy and classification with approved road standards in the country. Other facilities such as health facilities, tarmac access road, some commercial activities, etc for service provision to serve the proposed project and/or surrounding neighbours will either be upgraded or provided as per anticipated population projections.

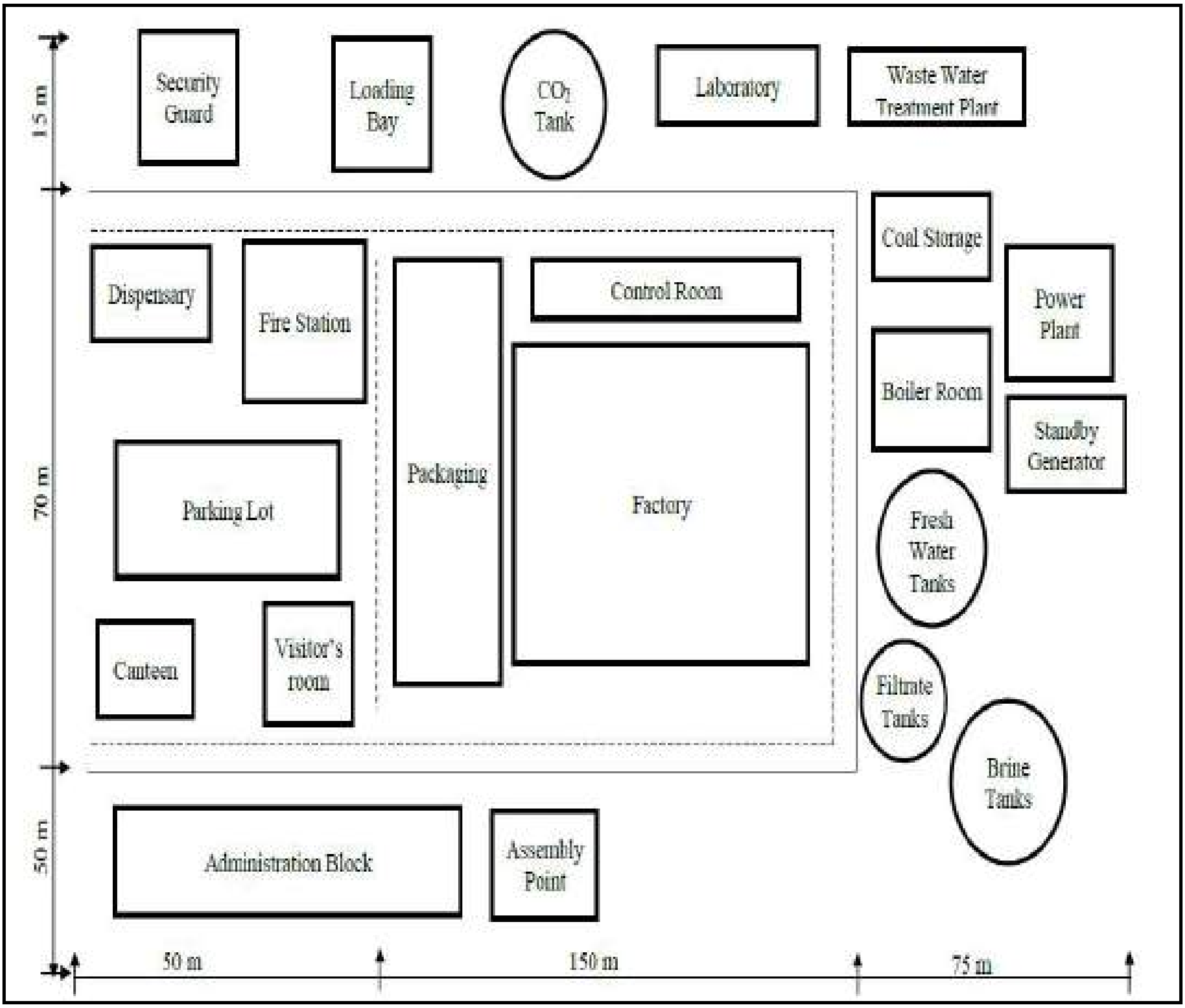


**Figure 2.5a:** Plant site layout showing functional relationship-based design
***Source:*** *Volume IV – Project Engineering Design Report*

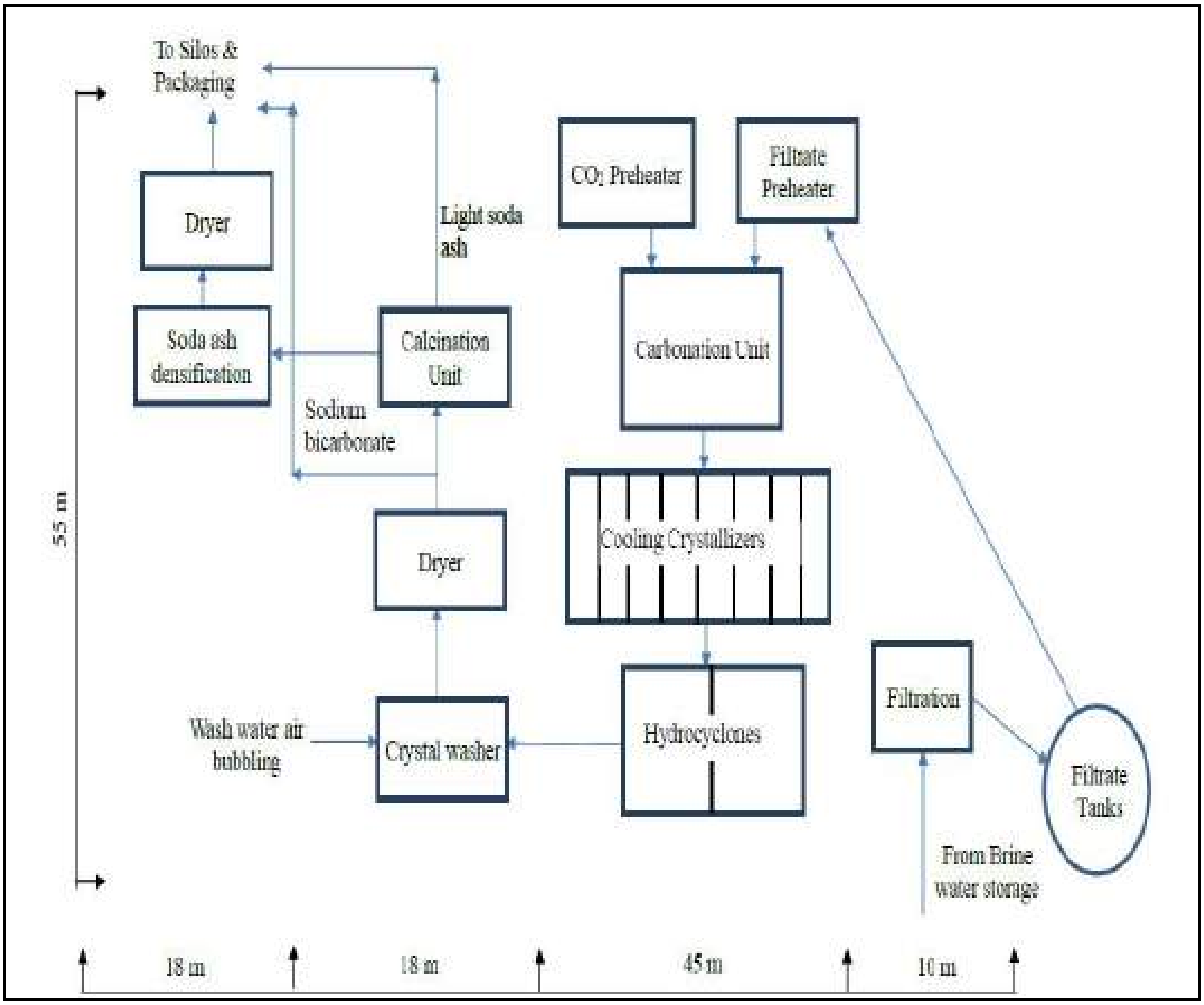


**Figure 2.5b:** Machineries and equipment layout
***Source:*** *Volume IV – Project Engineering Design Report*

### 2.9.2 Mobilization Phase

The mobilization phase will mainly involve deployment of required construction tools and machinery for the work and their transportations from the point sources to site as well as the recruitment of the construction crew for the work. The phase will also involve setting up the temporary campsite for the storage of materials and construction equipment and machinery.

### 2.9.3 Construction Phase

The actual land cover and type of facilities and structures to be established at site will be $0.68km^2$. The construction phase (covering construction work and related activities) will start with clearance of the vegetation in the project core area. The obtained site will need to be reworked to be able to contain the project facilities. This phase will include vegetation clearing and topsoil removal; construction of drainage; levelling, dredging and excavations and compaction to prepare the base for construction. Once earth works are done actual construction will be followed by mechanical and electrical works. Landscaping of the area and pavements lying will be among of the final activities of the construction phase.

The construction of the building walls, foundations, floors, pavements, drainage systems, perimeter fence and parking area, among other components of the project, will involve a lot of masonry and related activities. These will include stone shaping, concrete mixing, plastering, slab construction, construction of foundations, and erection of building walls and curing of fresh concrete surfaces. Such activities are labour intensive and will be supplemented by machinery such as concrete mixers. Some sections of the structures to be built will need to be reinforced with steel for stability. Structural steel works will involve metal cutting, welding and erection. Roofing activities will include raising the roofing materials such as concrete, iron sheet and structural timber to the roof and their fastening to the roof canopy lattice.

The construction crew will be in the region of 1,000 – 1,200 in number, residing in the nearby areas and shuttling to and from the construction site. A Contractor will be responsible for this phase with supervision from the consultants/project manager appointed by the Client.

The project will use locally available construction materials. The construction materials such as sand, stone, gravel and clay expected to be obtained from authorized area at Mto wa Mbu in Monduli which are somehow nearby to the site and Arusha. Industrial made construction materials such as tar, cement, pipes, poles, electrical cables, sanitary ware, pavement, and steel materials, mostly will be procured from various hardware centres or shops in Arusha and Dar es Salaam. There are no hazardous substances that will be used in construction works. The quantities of these will be generated during the BoQ, however the amount will be huge.

The contractor is responsible for transportation of all construction materials and equipment from point source to the site mainly by using the Monduli-Karatu road to Mto wa Mbu Town and via unpaved Loliondo road that passes at Selela to Engaruka centre and then toward unpaved Boloti road up to site. Some of the construction material such as cement, steel, wood, sand and aggregates etc. will be brought from places (i.e., Mto wa Mbu, Arusha, Kilimanjaro and Dar es Salaa) far away from the project site. Apart from drilled exploration borehole, the area is still in its virgin state as no activity for the project has started yet.

Auxiliary operations during production stage will include activities such as pond maintenance, drilling of exploration/production boreholes, soda ash plant and equipment servicing. In order to handle operations in both stages, a number of mobile equipment will be needed to facilitate construction activities as shown in

Table 2.8.

**Table 2.8: Mobile equipment required during construction and production stage**

| S/N | Equipment Type | Specifications | Fleet | Purpose | Stage |
|---|---|---|---|---|---|
| 1. | Bulldozer | Power angle -tilt dozer | 1 | Clearing the construction sites and spreading of earth material during embankment construction. | Construction |
| 2. | Excavator | 3 $m^3$ backhoe bucket excavator | 1 | Excavating the trenches. | Construction |
| 3. | Wheel Loader | 4.4 $m^3$ bucket capacity | 1 | Loading of construction earth material to trucks and during embankment construction. | Construction |
| 4. | Dump truck | 10 tonnes dump truck | 3 | Hauling earth material from different sources. | Construction |
| 5. | Water bowser | 20,000 litres tank capacity | 1 | Water supply and spreading of water for dust suppression and moisture control. | Construction/ Production |
| 6. | Compactor (Sheep Foot Roller) | 314 compacted $m^3$/hr. | 1 | Compaction of embankment layers. | Construction |
| 7. | Drill Rig | Water wells drill rig- 406 mm bit diameter size | 1 | Drilling of production boreholes. | Construction/ Production |
| 8. | Mobile crane | Mini Hydraulic 1.5 tonnes Mobile Folding Arm Truck Mounted Crane | 1 | Lifting of heavy loads.<br>Towing trailer mounted equipment. | Construction/ Production |
| 9. | Solar Power Lighting plant | 360,000 Lumens Lighting 360 Degree Rotation Compacted and Towable | 2 | Provide light during night operations. | Construction/ Production |
| 10. | Fuel and Lube Truck | Diesel fuel capacity of 2000 litres.<br>Oil and coolant product capacity of 500 litres. | 1 | Fuelling machines | Construction/ Production |

***Source:*** *Volume IV – Project Engineering Design Report*

### *2.9.3.1 Storage of materials*

Weather sensitive building materials such as cement and paint, will be stored on site in a temporary store in the camp. Inert materials such as stones, ballast, sand and steel will be carefully piled on site. To avoid piling large quantities of materials on site, the proponent will order materials such as sand, gravel and stones in quotas.

### *2.9.3.2 Electrical work*

Electrical work during construction will include installation of electrical fixtures and appliances including electrical cables, conduits, lighting, sockets etc. In addition, there will be activities requiring the use of electricity such as welding and metal cutting. Power will be supplied by a standby generator to be installed at site while the principal source will be TANESCO supply system which is located 20 km from the project site. The project will procure a generator that its emission characteristics complies with the national standards.

#### *2.9.3.3 Plumbing*

Water supply and distribution will be carried out within the facility which will call for extensive installation of pipe-work and plumbing. There will also be pipe-work for the collection and channelling of storm water from the rooftops. Plumbing activities will include metal and plastic cutting, the use of adhesives, metal grinding and wall drilling among others.

#### *2.9.3.4 Management of wastes*

*(i) Liquid waste management*

Main sources of construction waste will be generated from site preparation, earth moving works, and domestic waste from construction crew. On average about 40 litres of water will be used by a single person per day (making total consumption of 84,000 litres per day by 2,100 workers). The amount of domestic wastewater that will be generated by 2,100 workers during construction phase is estimated to be 67,200 litres per day. On average about 40 litres of water will be used by a single person per day, and 80% of this amount is discharged as wastewater. This is based on the assumption that 80% of domestically consumed water will become wastes water. Small pit latrines will be established at the temporary campsite for the construction workers at site to accommodate the generated wastewater. Once the pits are full will be emptied by septic emptying trucks available at Monduli and Arusha DCs for proper disposal at municipal wastewater saturation ponds. The latrines will be easily decommissioned after the finalization of the phase and commissioning the project.

*(ii) Solid waste management*

A number of solid wastes (i.e., food remains, packaging materials, plastic and glass bottles, filters, paper wastes, metallic wastes and other glass nature wastes) will be generated. The amount of solid wastes to be generated during this phase is estimated to be 30-40 kilogram per day by the 1,200 workers. Assuming that 1,200 workers will be needed during construction and each person will generate about 0.35 kg of waste per day. Therefore about 420 kg of solid waste will be generated by 1,200 site crew per day.

Bottles of all kinds will be recycled or reused, biodegradable and paper wastes will be collected and sorted for subsequent transportation to the approved dumping site in Monduli. Metallic nature wastes such as piece of remaining metal, tins, cans, will be sold to smelting plant while glass nature wastes such as bottles will be sent to KIOO limited for re-cycling. The system for solid waste collection and separation at source will also be used at the temporary campsite. It will involve among other things wastes segregation at source, reuse of some wastes or selling/sending for recycling, and final disposal of some wastes to the nearby approved dumpsite or landfill. Structures to deal with solid wastes like collection points and transferring points/ areas will be considered during the planning/design of the College.

### 2.9.4 Operation Phase

Main activities that will be undertaken by the Soda Ash project during operation phase are mainly the extraction of underground brine resource from extraction wells, transportation of brine materials via pipeline system, storage of brines into storage ponds, brine processing as well as manufacturing of soda ash, equipment and machines maintenances, soda ash storage, various loading and unloading services and domestic and institutional activities. In general, the proposed soda ash plant will use huge underground brine deposits of about 3,813,320,000m$^3$ discovered at Engaruka Basin of 18 km by 13 km (234 km$^2$) in Monduli District, Arusha Region. The brine resources will be extracted from underground aquifer and derived to the brines' storage ponds and/or processing plant through pipeline system (Figures 2.6). The soda ash plant will use both carbonation (with recovery rate of 82%) and crystallization (with recovery rate of 85%) technologies to produce about 500,000 to 1,000,000 metric tons of dense and/or light soda ash per annum.

In the process, the extracted brines will first be treated with carbon dioxide gas in carbonation process to convert the sodium carbonate in solution to sodium bicarbonate, which will precipitate under these conditions. The sodium bicarbonate will then be separated from the remainder of the brine by settling and filtration before been calcined to convert the product back to soda ash. Second step will involve dissolving, precipitating (with car bon dioxide), filtering, and calcining the light soda ash to dense soda ash, results in a refined product of better than 99% sodium carbonate. Starting with brine pumping from the aquifer, the technology comprises of operations shown in block flow diagram (BFD) in Figures 2.6-2.7.

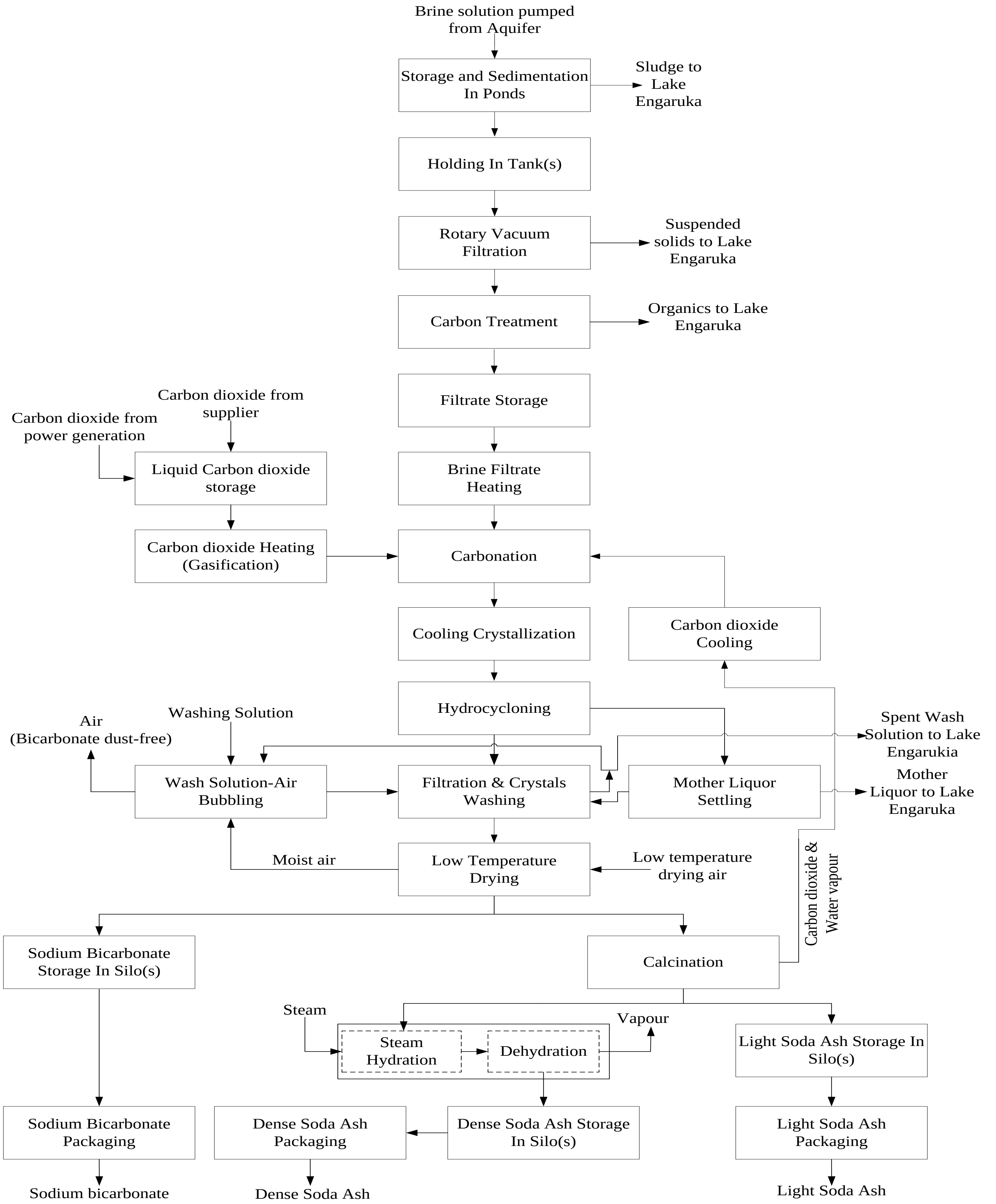


**Figure 2.6:** The carbonation technology for production of soda ash and sodium bicarbonate (*Source: Volume IV – Project Engineering Design Report)*

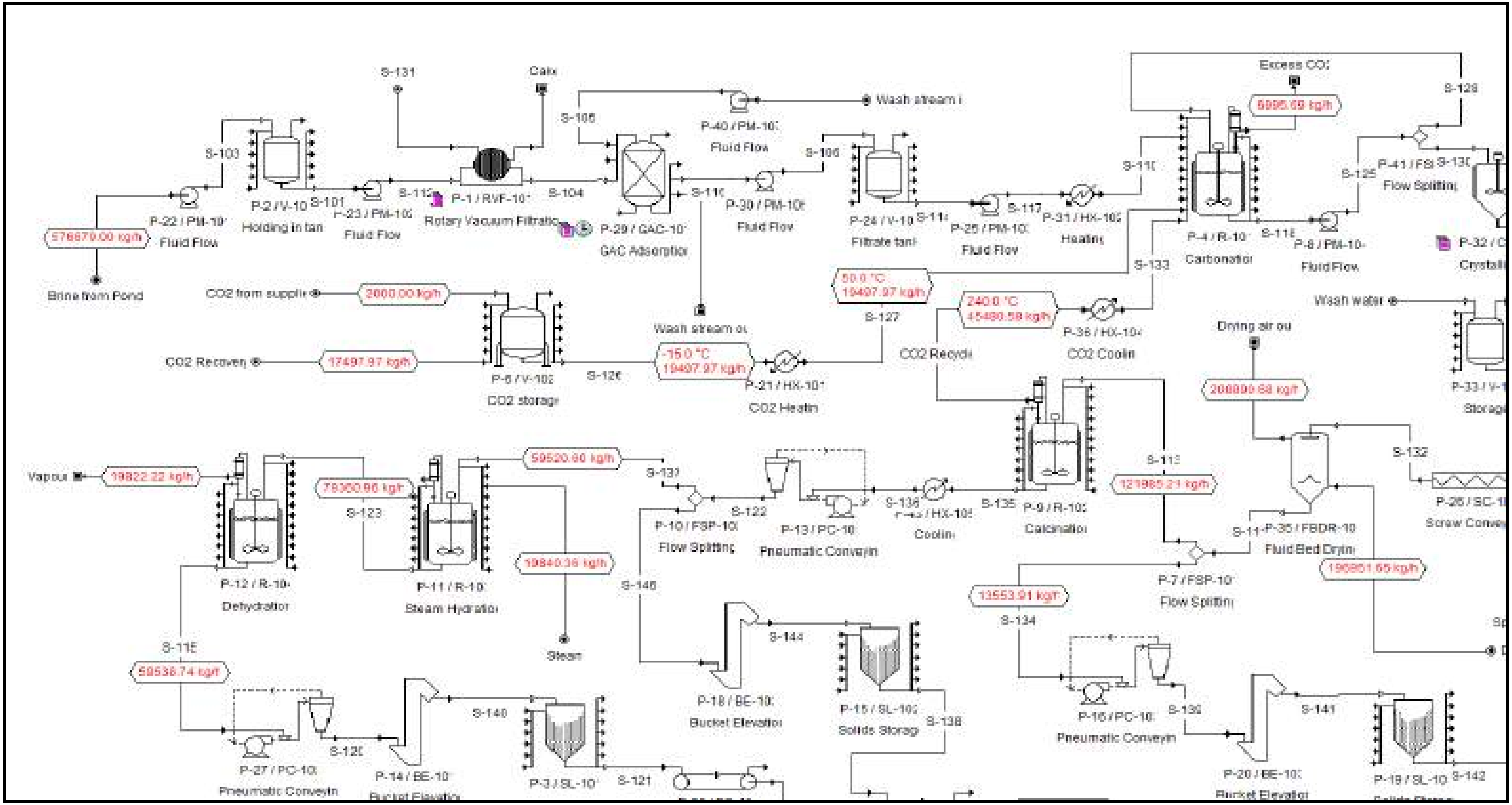

**Figure 2.7:** Process flow diagram of the soda ash plant
***Source:*** *Volume IV – Project Engineering Design Report*

#### *2.9.4.1 Main Required Resources and Materials for Soda Ash Plant*

The project will involve importation of soda ash processing machines and/or equipment from overseas specifically in Europe/Asia (to be named in EIS report). The machineries and equipment will be supplied by supplier, who specialized in such kind of supplies for some years. The defined area for sourcing other construction and operation materials will be determined based on the reserve availability, distance to the site, processing methods, and type, quality and quantity required by the project. The key resources and/or raw materials required for Soda Ash production include:

- Land and buildings;
- Plant and machinery;
- Mobile vehicles (Table 2.9)
- Raw extracted brine;
- Skilled and non-skilled workers;
- Fresh water for plant operation and domestic use;
- Diesel, HFO, Coal and/or electricity (for generator, boilers and water pumps)
- Coke, coal and limestone (for boilers);
- Lube Oil (Lubricants)
- Packing materials like packing bags, paper and labels.

**Table 2.9: Mobile equipment required during production stage**

| | | | | | |
|---|---|---|---|---|---|
| 1. | Light Vehicles | 4-wheel Land cruiser- single cabin | 4 | Support movement of supervisors and light tools. | Construction/ Production |
| 2. | Mobile Slurry Pump | 3.5 tonnes per hour | 1 | Mud removal | Production |
| 3. | Forklift | 5 tonnes | 1 | Handling of Heavy Unit Loads | Production |

***Source:*** *Volume IV – Project Engineering Design Report*

Non-perforated pipes are proposed to be used to case the production boreholes from surface to a depth that will vary depending on the intersections of the stratigraphy during drilling (intersection point of the first aquifer). The non-perforated pipes will be followed by perforated pipes for the remaining borehole depth. Both perforated and non-perforated casing pipes will be having internal diameter of 10 inches. The specifications and cost of the casing pipes to be used is shown on Table 2.10.

**Table 2.10: Specifications of casing pipes**

| S/N | Item | Specifications | |
|---|---|---|---|
| 1. | Pipe Category | Non-Perforated | Perforated |
| 2. | Connection Type | C | C |
| 3. | Outside Diameter (mm) | 280 | 280 |
| 4. | Wall thickness (mm) | 12.5 | 12.5 |
| 5. | Thread Depth (mm) | 4.5 | 4.5 |
| 6. | Thread Pitch (mm) | 12.0 | 12.0 |
| 7. | Standard Slot Width (mm) | - | 1.5 – 1.7 |
| 8. | Approx. % open area of screen with STD slot width | - | 7.0 |
| 9. | Total length required | 320 | 1280 |

***Source:*** *Volume IV – Project Engineering Design Report*

The size of the casing pipes was selected by considering that they should leave a gap between the surface of the drilled borehole and the outer surface of casing pipe. This gap will be filled with half inch granite gravels, which will help to trap the sediments that might get into the borehole chamber. Figure 2.8 shows the setup of a typical cross-section view of the production borehole.
Belek from the NE.

**Figure 2.8:** Existing boreholes at Engaruka Basin

The following inputs (Table 2.11) would be required to facilitate the production of 500,000t/yr of $Na_2CO_3$ (volume of feed solution is used as a basis).

**Table 2.11: Summary of input requirements for soda ash production during operation**

| S/N | Process | Amount of $Na_2CO_3$ in feed stream to process | Amount Recovered (kg $Na_2CO_3/m^3$ of brine) by: | | | Yield | Amount of $CO_2$ required | Amount of coal required | Amount of steam required | *Wash water required (3 stage) | **Amount of drying air |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Solar evaporation | Carbonation process | Crystallization process | | | | | | |
| | | kg/ $m^3$ of brine | kg/ $m^3$ of feed brine | kg/ $m^3$ of feed brine | kg/ $m^3$ of feed brine | (%) | kg/ $m^3$ of feed brine | kg/ $m^3$ of feed brine | kg/ $m^3$ feed brine | l/ $m^3$ feed brine | $m^3$ air/ $m^3$ feed brine |
| 1 | Brine from borehole cooling & Solar evaporation (30 to 25 ºC) | 374.5 | 134.9 | | | 36.0 | | | | | |
| 2 | Carbonation process | 239.5 | | 173.4*** | | 72.4 | 99.4 | | | 23.1 | 86.0 |
| 3 | Crystallization process | 239.5 | | | 179.3 | 74.9 | | 180.4 | 800 | 23.9 | 88.9 |
| 4 | Required amount of brine for production of 500,000 t/yr of $Na_2CO_3$ | | | | | | | | | | |
| 4.1 | Per year (300 days) in '000,000 | | 3.71 | 2.94 | 2.80 | | 286.62 | 503.1 | 2,230.9 | 66.67 | 247.94 |
| 4.2 | Per day (24 hrs) | | 12,355 | 9,612 | 9,295 | | 955,402 | 1,676,892 | 7,436,327 | 222,222 | 826,465 |
| 4,3 | Per hour | | 514.78 | 400.49 | 387.31 | | 39,808.4 | 69,870.5 | 309,846.9 | 9,259.3 | 34,436.02 |

* Amount of wash water in 3 stages = Amount of wet solid*0.4/3 (assuming solids voidage is 40%)
** Amount of drying air = Amount of wash water *0.2/ (120*1.011) (assuming filtration removes 80% of water and drying air is at 120 ºC)
*** Expressed as equivalent $Na_2CO_3$. Actual $NaHCO_3$ is 274.8 kg.

***Source:*** *Volumes III & IV – Technological Assessment Report & Project Engineering Design Report*

### *2.9.4.2 Estimated water requirements*

Estimation of water required for the project was done by calculating water required by each sub-sector of the industry. The sub-sectors are the soda-ash plant (for processing the soda-ash and sanitation requirement within the plant premises), industrial community and landscaping uses.

Water required by the plant was estimated based on the recommended soda-ash production process, installed plant capacity and/or production rate. The water requirement was estimated at 903m$^3$/day (*Volume V – Assessment of Availability of Plant Utilities Report*).

Estimates of water required by the industrial community were guided by Ministry of Water-Water Supply Design Manual Guidelines (2009). Engaruka soda-ash industry is expected to provide direct employment to 250 people (Technology Assessment Report), on other hand, the industry is expected to create an industrial community of around 1,500 peole that includes employee's families, outsourced services providers, businessman and visitors. This population is expected to grow to 2,556 people in 20years. The 20years time frame is the planning time-frame recommended by Ministry of Water Design Manual guidelines. This population will require 383.4m$^3$ per day for domestic use (*Volume V – Assessment of Availability of Plant Utilities Report*).

Water required for landscaping purposes was estimated by using evapotranspiration method. The inputs for calculation are climate variables and landscaped area. Evapotranspiration values were generated through SWAT Model and landscaped area was estimated from expected built area in the project site (Engaruka Soda Ash Industry Township and Infrastructure Report). The demand was found to be 98.7 m$^3$ per day (*Volume V – Assessment of Availability of Plant Utilities Report*).

Therefore, total volume of water required for the project (plant + community + landscaping water requirement) is 1,385.1m$^3$/day. Applying water supply systems water loss factor (20%) added to this demand, total demand becomes 1,662.1m$^3$/day (606,667m$^3$ per year).

### *2.9.4.3 Applications of Soda Ash*

Numerous applications of Soda Ash cover both domestic and commercial usage including the following major categories of use.

*(i)* ***Industrial Applications:*** Being a highly soluble substance, soda ash is used for numerous chemical reactions. It's mostly used as an ingredient in the manufacturing of dyes and colouring agents, curative dugs, cosmetics, synthetic detergents and fertilizers. It's also an important chemical agent used in enamelling, textile industries, petroleum industries, in manufacture and sealants and glues, preparing pulp in paper manufacture, and sometimes in soil preparation.

*(ii)* ***Glass Manufacture:*** Soda ash is an important ingredient in the manufacture of glass, since it helps reduce silica's melting point.

*(iii)* ***Environmental Applications:*** Soda ash can be used to improve and treat the alkalinity of lakes that have been affected by rain (acidic rain). It is also used to reduce the acidity of emissions being generated from a power plant.

*(iv)* ***Detergent Manufacture:*** Soda ash is replacing phosphates that were earlier being used in a number of household detergents. Many other cleaning products such as dishwashing soaps also contain varying amounts of soda ash in their formulations.

*(v)* ***Metallurgy:*** In metallurgy industries can be used to remove or de-clarify phosphates and sulphurs from a number of non-ferrous and ferrous ores. It's also used in recycling of aluminium and zinc.

*(vi)* ***Other Applications:*** Soda ash can be used as a preservative for meat and fish where it is sprinkled on the meat and then it helps in removing water thus drying the meat and preventing it from getting spoilt.

***2.9.4.4 Wastewater Management Systems***

*(i) Solid waste management*

Main possible types of solid wastes that will be generated include boxes that will be mainly for packaging and may vary with size and type of the consignments. Others are office and domestic wastes such as papers, wooden plastic and glass bottles, vegetables and food remain. The anticipated wastes amount is in the range of about 30-40kg of solid wastes per day. Wastes which can be recycled like plastic bottles will be sorted and accumulated in allocated site for certified collectors/agents to access and/or handle part of the recycleable solid wastes. Some of the solid wastes will be disposed through a burning chamber to be built on the site. Other types of bio-degradable solid wastes will be transported and dumped at the dump site located at Monduli District Council.

*(ii) Liquid waste management*

There will be some liquid ponds from both the soda ash production line and floor washing water as well as sewerage from washrooms. Liquid effluents will contain alkali impurities that require treatment prior to discharge in the drain. Hence, effluent water will be treated suitably to remove harmful contents before discharging the effluent. Wastewater from washing rooms as well as the offices will drain through the system that will consist of a number of septic tanks and soak away pits for initial handling. Once the pits are full will be emptied by septic emptying trucks available at Monduli and Arusha DCs for proper disposal at municipal wastewater saturation ponds.

Industrial (process) water will be directed back underground to recharge aquifer through injection wells to dissolve more Sodium Carbonate. Moreover, the project proponent will ensure that amount of waste water generated from utilized water in their operations is quantified and analyzed before been discharged into environment, so that no pollutants will be allowed to enter into water streams or groundwater.

*(iii) Air pollution (Gaseous emissions, dust, noise and vibration)*

Dust, noise, fumes, vibrations and emitted pollutant gases is expected to be generated from construction activities, soda ash processes and associated facilities i.e., the use of vehicles, standby generator, boilers etc. The levels of generated air pollutants, noise and vibrations will be mitigated as per Environmental management Plan.

#### *2.9.4.5 Health and Safety Measures*

During project life cycles, fire safety awareness training, fire detections and alarming systems, architectural drawings and fire protection plan, fire safety certificate, warning signs, reservoir water tank and fire hydrant, fire extinguishers, emergence Preparedness and Response Plan, logbook and emergence lighting, exit signs first aid kit, insurance cover and first aid training for constructionand operation crew members will be provided on site as per OSHA Act of 2003 and any minor and manageable injuries will be treated at site before being transferred to hospital. During operations the dispensaries within Engaruka area will serve minor health treatments for workers, and emergency cases. The major cases will be referred to other nearby referral hospitals, government hospitals and health centres.

#### *2.9.4.6 Security*

The various components will be planned in such a way that the security measures of the various components do not interfere one with another. The planning of the project shall provide for adequate security for the workers and normal security measures for the staff quarters and general offices. Although the public will have free access to the project site, the whole active project footprint will be fenced and/or provided with adequate security measures during their operations.

#### *2.9.4.7 Management of the Project*

During construction, the execution of all project work is the responsibility of the main contractor. The main contractor will:

- Develop a project plan, acquire approval of plan and building permit;
- Manage the implementation of all activities described in it;
- Update the plan as changes occur and communicate the changes to project manager and consultant(s);

The main contractor will also be responsible for the employment of the required personnel and preparation of schedule of works. About 1,200 people (permanent and casual workers) are expected to be employed during the construction phase. There will be planned site meetings under the project manage and/or consultant(s) to assess the progress of the works. During these meetings the main contractor will present progress reports including plans for the next phase.

After testing and commissioning of the projects, the project will be operated by the project proponent. During the guarantee period as shall be specified in agreements, it will be the responsibility of the contractor to rectify all problems as per the agreement.

The proponent through project manager and consultant (TIRDO) will have responsibility and authority to properly administer the project. The Project manager through TIRDO will be responsible, among other things, to ensure that:

- The Soda Ash plant and associated facilities are constructed in accordance with the plans and specifications;
- The contract is administered in a proper and fair manner;
- The Contractor is paid for all contract items that are satisfactorily completed in accordance with the contract;
- The work is adequately inspected; and
- The work is properly documented.

#### *2.9.4.8 Environmental Management*

The project proponent will assign staffs to do day-to-day environmental monitoring, while doing overall periodical monitoring. Overall periodic audits will be done in accordance to the approval conditions of certificate.

### 2.9.5 Decommissioning phase

The proposed project may last for a very long time if the maintenance of its structures will be scheduled and done as required. However, the project may stop its operations and thus, rehabilitation of the project site will be carried out to restore the site to its original status or a better status than it was originally. This will include replacement of top soil and re-vegetation which will lead to improved visual quality of the area.

Also, if the decommissioning happens the proponent will develop the decommissioning plan. This plan will establish feasible decommissioning schemes that can be accomplished without undue risk to the health and safety of the public and decommissioning personnel, without adverse effects on the environment, and within established guides and limits of the appropriate regulatory agencies.

### 2.9.6 Other Amenities

#### *2.9.6.1 Power Supply*

The study area depends on the different sources of energy. Fuelwood is the main source of cooking and heating energy while electricity (which is recently connected under REA) and kerosene are used for lightning. Other sources of energy are coal, charcoal, gas and other natural sources such as sun (solar). The project proponent will negotiate with TANESCO on the possibility to divert the passing power line to the site (about 20 km away) to carter for the project needs. Worth noting, the power situation in Tanzania is unreliable and power outages are frequent. On this regard, a powerful diesel generator big enough to operate the Soda Ash plant needs to be in place. The generator specification include: 500 kVA, 400 V, 50 Hz, 1500 rpm, Caterpillar diesel generator, complete with automatic change over switch, sound canopy and all necessary accessories and connecting kits. It is vital that power interruption should not cause unnecessary delays and/or damage to machines during operation.

#### *2.9.6.2 Water*

During construction, water will be obtained from the surveyed water sources through pipeline supply system. Water will be required for manufacturing processes, cooling of machines, gardening and for domestic use by works. During operation, a significant amount of water will be pumped for industrial and other (domestic) uses. However, about 606,667 $m^3$ of water will be required during operations to produce 500,000 MT per annum, equivalent to 1,662.1 $m^3$ per day. After the process has stabilized, water requirement will be reduced tremendously due to recirculation that takes place in the system and any water loss will be mainly due to evaporation. Apart from the pipeline water supply system from surveyed nearby natural sources, other water sources will be explored during the detailed environmental assessment i.e., rainwater harvesting from the facility will be investigated and if found feasible will be implemented.

# CHAPTER THREE

# 3 POLICIES AND LEGAL FRAMEWORKS

## 3.1 Introduction

There is a growing concern in Tanzania and at global level that many forms of development activities cause damage to the environment. As such during development of the proposed soda ash project, various environmental issues may arise at any phase of the development i.e. during the planning or during pre-construction, construction, post-construction (operation) and decommissioning stage. These need to be addressed so that the envisaged operations do not jeopardize the integrity of environment but also to ensure that they are in line with policies and/or legal regime operating in a particular country. This section discusses the relevant sector policies and legislation, which are relevant to environmental and social issues pertaining to the planning and implementation of the project in question.

## 3.2 Need for Environmental Impact Assessment

There are several policy documents that recommend EIA as a tool for ensuring sustainable development is achieved. These include the National Environment Action Plan (URT, 1994), the National Conservation Strategy for Sustainable Development (NEMC, 1995) and the National Environmental Policy (URT, 1997) etc. The Government enacted the Environmental Management Act, Cap 191 (Act No. 20 of 2004) and produced the Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018 to guide EIA process in Tanzania. The Regulations provides a list of projects, which must be subjected to full EIA before they are implemented, the major construction project such as the proposed soda ash project is one of them. In addition, there are a number of sectoral laws, which categorically state that environmental impact assessment is a necessity before the project is approved for implementation. This chapter briefly presents some pertinent policies and laws that need to be observed in the whole cycle of this project.

## 3.3 Relevance Policies

Recently environmental awareness in the country has been significantly increased. The government has been developing and reviewing her national policies to address environmental management in various sectors. Among others, the objective of these policies is to regulate the development undertaken within respective sectors so that they are not undertaken at the expense of environment. The National Policies that addresses environmental management as far as this project is concerned and which form the corner stone of the present study include inter alia.

### 3.3.1 The National Environmental Policy (URT, 1997)

Tanzania currently aims to achieve sustainable development through rational use of natural resources and incorporating measures in any development activities in order to safeguard the environment. The environmental policy document seeks to provide the framework for making fundamental changes that are needed to bring environment consideration into the mainstream of decision-making in the country. Among the main objectives of the NEP is to improve the condition of degraded areas including rural and urban settlements in order that all Tanzanians may live in safe, healthy, productive and aesthetically pleasing surroundings.

The policy states the use of Environmental Impact Assessment (EIA) as an instrument for achieving sustainable development. Chapter 4, Paragraph 64 of the NEP states that "*It is in the context of an EIA regime that policy guidance on choices to maximise long-term benefits of development and environmental objectives can be revealed and decided upon. EIA as a planning tool shall be used to integrate environmental considerations in the decision-making process in order to ensure unnecessary damage to the environment is avoided".* The policy also advocates public consultation in carrying out EIA. Specifically, paragraph 66 states that *"One of the cornerstones of the EIA process will be the institution of public consultations and public hearing in the EIA procedures"*.

The policy recognises the importance of promoting use of environmentally sound technologies that protect environment based on careful assessment of the carrying capacity of the environment. In undertaking the EIA, the project proponent has observed one of the requirements of the National Environmental Policy (NEP) and will continue to observe the requirements of the policy during the whole life cycle of the project.

### 3.3.2 The Land Policy (URT, 1995)

The National Land Policy promotes and ensures a secure land tenure system, to encourage the optimal use of land resources, and to facilitate broad-based social and economic development without upsetting or endangering the ecological balance of the environment. Among other things the policy requires that project development should take due consideration the land capability, ensures proper management of the land to prevent erosion, contamination and other forms of degradation. Important sections of the policy relevant to the Developer are 2.4 (on use of land to promote social economic development), section 2.8 (on protection of land resources) and section 4 (on land tenure). Land ownership and land utilization issues related to the construction of the project have been addressed in the ESIA study in response to this Policy.

### 3.3.3 The National Energy Policy (URT, 2015)

The policy (replaced that of 2003) aims at improving business environment to attract more private investment and local participation in the energy sector. The policy promotes the energy conservations and efficiency by focussing on the increasing access to modern energy service and increasing the share of renewable energies in the electricity generation mix to enhance availability, reliability and security of supply. The policy defines the energy situations in Tanzania by category. The policy dictates that the dominant energy sources in Tanzania include biomass in form of charcoal and firewood and thus contributing to about 85% of the total National Energy consumption.

The policy elaborates how each energy section contributes in the energy sector. These sections/industries include the electricity industry, petroleum industry, etc. The Energy Policy's main objective is to provide guidance for sustainable development and utilization of energy resources to ensure optimal benefits to Tanzanians and contributes towards transformation of the National economy.

The proponent or Investor of the proposed Soda Ash Project will make use of the National energy in execution of the Project activities. The selection of energy sources for the Project and utilisation will need to be in line with the provisions of this policy.

### 3.3.4 The National Health Policy (URT, 2003)

The National Health Policy is aimed at providing direction towards improvement and sustainability of health status of all people by reducing disability, mobility and morbidity, improving nutritional status and raising life expectancy. The objectives of the policy among others include reduction of the burden of disease, maternal and infant mortality, and increase life expectancy through the provisions of adequate and equitable services. Furthermore, the policy aims at facilitating the promotion of environmental health and sanitation, adequate nutrition, control of communicable diseases and treatment of common conditions. The policy also emphasizes on enhancement of environmental cleanliness, monitoring of food and water quality and the safety achieved through collaboration with other stakeholders.

The proposed Project will adhere to policy requirements to prevent transmission of such communicable diseases between company's workers and the community, and protect workers from all sorts of health risks and hazards. The Project will also facilitate the availability of adequate and equitable services in support of health programs.

### 3.3.5 The National Construction Policy (URT, 2003)

The construction project such as the project is among key areas embraced by the construction policy. Among the major objectives of the policy, which support sustainable construction sector include: to promote application of cost-effective, green and innovative technologies and practices to support socio-economic development activities such as water supply, energy, sanitation, shelter delivery and income generating activities and to ensure application of practices, technologies and products which are not harmful to both the environment and human health.

### 3.3.6 The National Water Policy (URT, 2002)

The policy objective is to develop a comprehensive framework for sustainable management of the national water resources. In this case the policy recognizes the need to protect water sources against pollution and environmental degradation. Also the policy seeks to ensure that water plays important role in poverty alleviation. The inadequate system affects the effective implementation of water resources management activities in terms of higher cost of monitoring, supervision, policing and data transfer. This project development will help to alleviate accessibility problems and thus facilitate enhancement water resources management within the project influence area. However, appropriate measures shall be taken to ensure that the construction activities are minimally affect the quality and quantity of water bodies in the project area. The proponent has to observe judicious use of water by putting in place water conservation measures.

### 3.3.7 National Forestry Policy (1998)

The national forest policy is based on macro-economic, environmental and social framework. Its overall aim is to manage Tanzania's forest resources as a national heritage on an integrated and sustainable basis to optimize their environmental, economic and social and cultural values. The policy drives towards implementing the directives contained in the National Environmental Policy (1997) in regard with forest resources management. For instance, the forest policy advocates and directs the conduction of EIA for development projects. The forest policy also strives to ensure sustainable supply of forest products and services as well as environmental conservation. The issues of control of environmental degradation and protection and enhancement of biodiversity are well addressed by the policy. In view of the above, the proposed project is consistent with the provisions of the policy, especially that the project area has some vegetation or trees which are important habitats for wild animals.

### 3.3.8 The National Gender Policy (2000)

The key objective of this policy is to provide guidelines that will ensure that gender sensitive plans and strategies are developed in all sectors and institutions. While the policy aims at establishing strategies to eradicate poverty, it puts emphasis on gender equality and equal opportunity of both men and women to participate in development undertakings and to value the role played by each member of society. This project will respond to the policy by ensuring equal opportunities in employment during construction and operation phases. This project shall also ensure that Engaruka women, will be adequately involved at all levels of project implementation.

### 3.3.9 National Policy on HIV/AIDS, 2001

The Policy identifies HIV/AIDS as a global disaster, hence requiring concerted and unprecedented initiative at local, national and global levels. It recognizes HIV/AIDS as an impediment to development in all sectors, in terms of social and economic development with serious and direct implication on social services and welfare. Thus, the policy recognizes the linkage between poverty and HIV/AIDS, as the poor section of the society are the most vulnerable.

Relevant objectives of the policy are:

- Prevention of transmission of HIV/AIDS;
- Enhance sectoral roles through participation and financial support;
- Promote and participate in research on HIV/AIDS, including dissemination of scientific information and development of HIV vaccine;

Moreover, the policy recognizes that HIV infection shall not be grounds for discrimination in relation to education, employment, health and any other social services. The proponent shall therefore adhere to the policy guidance while implementing the project.

### 3.3.10 The National Employment Policy (URT, 2008)

The major aim of this policy is to promote employment mainly of Tanzania Nationals. Relevant sections of this policy is Section 10.6, which deals with employment of special groups i.e. women, youth, persons with disabilities. It is one of the objectives of the proposed project to have notable trickle-down positive impact to the locals through various means one of which is direct employment in the area. The project will provide direct employment to the locals in the area. Special attention will be to the marginalized groups to include disabled, women, and youth while strictly avoiding employing children as required by the law. Thus, the project shall be in line with the objectives of the policy.

### 3.3.11 The National Livestock Policy of 2006

The Act guides the development of the **livestock** industry. It focuses on encouraging the development of commercially oriented, efficient and internationally competitive livestock industry; support the emergence of a more diverse structure of production with a large increase in the numbers of successful smallholder livestock producer enterprises and; conserve livestock resources and put in place policies and institutions for sustainable resource development and use. The proponent should therefore abide with this policy simply because the proposed project site is developed in the area demarcated as grazing land and typically belonging to the local Maasai pastoralist.

### 3.3.12 National Mineral Policy 2009

The Policy aims at strengthening integration of the mineral sector with other sectors of the economy; improving economic environment for investment; maximising benefits from mining; improving the legal environment; 6strengthening capacity for administration of the mineral sector; developing small scale miners; promoting and facilitating value addition to minerals; and strengthening environmental management. Moreover, the Government will remain as the regulator and facilitator of the mineral sector; promoter of private sector investment in the mineral sector; and will participate strategically in mining projects.

In the implementation of the above objectives, the Government will continue to give priority to the mineral sector in the National Strategy for Growth and Reduction of Poverty (NSGRP) and contribute to the achievement of the National Development Vision 2025. The proponent should therefore abide with this policy while prospecting the underground brine resources.

### 3.3.13 The Wildlife Policy, 1998

The Wildlife Policy aims at providing management frameworks for wildlife and their ecosystems through participation of communities and the private sector. Communities should be trained to develop skills and knowledge concerning wildlife management through awareness and capacity building campaigns. Likewise, the participation of the private sector is achieved by ensuring that EIAs are undertaken for all projects that have an impact of wildlife.

In undertaking the EIA for Project, proponent has observed requirements of the Wildlife Policy and will continue to observe the requirements of the policy during the entire Project life span.

### 3.3.14The National Construction Industry Policy, 2003

The major objectives of the policy include the promotion and application of cost effective and innovative technologies and practices to support socio-economic development activities. The Project shall adopt this policy by using modern technology during construction but with emphasis on value for money for a cost-effective Project.

The project proponent will make sure that the tender document for various contractors are available and will provide priority for local suppliers.

### 3.3.15 The National Investment Promotion Policy, 1996

The National Investment Promotion Policy seeks to promote the growth of exports by strategically utilizing the scarce natural, social and capital resources to accomplish national development. One of the key features of this policy is the promotion of exports emanating from domestically produced goods and services in order to enhance development of a dynamic and competitive export sector. In order to achieve this objective, the policy encourages all investments to be accompanied by strategies that aim at increasing export production.

As one of the key investors in the Country, the proponent or Investor of the proposed Soda Ash Project will strive to ensure that its operations contribute to the growth of the export sector in Tanzania.

### 3.3.16 Community Development policy (1997)

The policy puts in place measures that enables communities to realise their potential through wise utilisation of natural resources. Although there are many sections that are relevant to the project, sections 15 and 16 elaborate on the objectives of the policy.

Since land is a resource that is mainly depended upon by local communities for their development, losing land may have severe consequences on community development.

### 3.3.17 Cultural Heritage Policy, 2008

The Cultural Heritage Policy provides guidance on the implementation of the Tanzania Antiquities Act (Act No. 10 of 1964; amended 1979, Act No. 22) for government and non-government stakeholders. Key elements of the policy include the following:

- Defines the roles and responsibilities of different cultural heritage stakeholders including the public, individuals, corporations, and academic institutions in managing cultural heritage resources;
- An analysis of the ways in which cultural heritage activities are managed and administered by the government;

- Clarifies measures by which cultural heritage resources will be protected, managed, preserved, conserved, and developed; and
- An analysis of best practices for conducting research and conservation of cultural heritage resources.

A key element of the policy is the stipulation that cultural heritage impact assessments should be mandatory prior as part of private and public development Projects (MNRT, 2018).

An assessment of the impacts on cultural heritage will be included in the EIA. The proponent will observe the requirements under this policy to conserve the cultural resources available at the Project Site.

### 3.3.18 The National Agriculture and Livestock Policy, 1997

The Agriculture and Livestock Policy of 1997 addresses changes that affect the agricultural sector in Tanzania, specifically restrictions to agricultural practices stemming from the national Land Use Policy of 1995. The Policy also addresses the needs of women in agriculture and the need for agricultural practices to evolve in order to ensure protection of the environment. The Policy promotes good husbandry and increased agricultural production.

It is established that the local communities around the Project Site predominantly practice agriculture and fisheries, as such; the proponent/investor will observe and implement feasible measures to minimise negative impacts on agricultural activities.

### 3.3.19 National Human Settlement Development Policy, 2000

This policy outlines major objectives, which among others include protecting the environment of human settlements and of ecosystems from pollution, degradation and destruction in order to attain sustainable development. The policy puts more emphasis on:-

- Effective management of solid and liquid waste in most urban areas, limited controls on industrial and other gaseous emissions, which also contribute to urban pollution. Decrease encroachment on fragile and hazardous lands (river valleys, steep slopes, and marshlands). Such developments contribute to land degradation, pollution and other forms of environmental destruction.

The policy also states that the government will ensure that human settlements are kept clean and pollution effects of solid and liquid wastes do not endanger the health of residents. It also institute mechanisms for monitoring pollution levels.

The proposed project will observe the requirements of this policy during disposal of waste, both solid and liquid wastes, and control of emissions.

### 3.3.20 Sustainable Industry Development Policy (SIDP), 1996 - 2020

The factors accounted for the need to prepare the policy were the expiry of the Basic Industrial Strategy (BIS) and the Government decision to phase itself out of investing directly in productive activities and let the private sector be the principal vehicle for that role. In that regard it was pertinent for the Government to articulate a clear policy framework that will guide government institutions and private sector on how to execute their new roles in the process of industrial development in Tanzania.

The proposed Project aims at developing sustainable mining operations that will lead to general economic developments of the surrounding community and of the nation at large.

## 3.4 Relevant National Plans/Strategies

### 3.4.1 The Tanzania Development Vision 2025

The National Vision 2025 foresees the alleviation of widespread poverty through improved socio-economic opportunities, good governance, transparency and improved public sector performance. These objectives not only deal with economic issues, but also include social challenges such as industrial developemn, health, the environment and increasing involvement of the people in working for their own development. The Vision articulates the desirable condition or situation that is envisaged by the government and people of Tanzania. The Vision 2025 seeks to mobilize the people and resources of the nation towards achievement of shared goals and achieving sustainable semi-industrialized middle market economy by year 2025. The proposed project which is owned by the Tanzanian Government is expected to improve the livelihoods of the local communities through direct and indirect employment opportunities.

### 3.4.2 The National Poverty Eradication Strategy (2000)

The National Poverty Eradication Strategy intends to alleviate the widespread poverty, hunger, diseases, illiteracy, environmental degradation through improved socio-economic opportunities and improved public sector performance. It strives to widen the space for country ownership and effective participation of civil society, private sector development and fruitful local and external partnerships in development and commitment to regional and other international initiatives for social and economic development. These objectives not only deal with economic issues, but also include social challenges such as education, health, the environment and increasing involvement of the people in working for their own development. The poverty reduction strategy is to large extent, an integral part of ongoing macro-economic and structural reforms. Among the areas of the concentration the following are relevant to the project:

- Achieving the target of accelerated growth will require significant efforts to enhance increase investment in both human and physical capital;
- Ensure sustainable investment and services in terms of quality and quantity are delivered; and
- Pay greater attention to mainstreaming cross-cutting issues i.e., education, HIV/AIDs, gender, environment, employment and employability.

### 3.4.3 Rural Development Strategy (RDS, 2001)

The RDS provides strategic framework to facilitate coordinated implementation of various sector policies and strategies that focus on development of rural communities. The strategy identifies the need to fight against poverty, ignorance, diseases including HIV and AIDS.

Furthermore, it addresses the problem of unemployment/underemployment, environmental degradation, food insecurity as well as rural-urban migration. On environment, the RDS recognizes the need for improved capacity for environmental management and conservation for local authorities and local communities. It relates environment with economic growth, vulnerability, empowerment and health aspects. The proposed project, if successful, will contribute significantly to some of the above e.g., road improvement, enhancing reliability of water and energy supply etc.

Generally, all aforementioned policies and strategies underscored the importance of applying Environmental Impact Assessment in developing projects as it provides policy guidance on choices to maximize long-term benefits of development and environmental objectives. EIA as a planning tool shall be used to integrate environmental consideration in the decision-making process to ensure that unnecessary damage to environmental is avoided.

## 3.5 Legal Framework

The Environmental management Act, 2004 constitutes the main part of the legal and regulatory framework. Nevertheless there are several other pieces of sector legislations with environmental aspects that complement the environmental legal and regulatory framework. Legislations normally contain provisions that empower certain authorities to make regulations that become binding under the particular legislation.

Table 3.1 below shows the key applicable legislation to the implementation of this project. Some specific requirements to the project have been provided and procedures to follow to be in line with the legislation have been provided. For easy follow up, implementing agencies of the legislation have been also provided.

**Table 3.1: Overview of National Legislation Relevant to the project**

| S/N. | Legislation | Summary and its relevance to the project | Requirements | Compliance | Implementing Agency |
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| 1. | The Environmental Management Act, Cap. 191 | The Environmental Management Act (2004) introduces a concept of right of people living in Tanzania to clean, safe and healthy environment and right of them to access various segment of environment for recreational, educational, health, spiritual, cultural and economic purposes (Section 4 (1) and (2)). | The Act imposes an obligation on developers to conduct an EIA prior to the commencement of the project to determine whether the project may/or is likely to have, or will have a significant impact on the environment. Furthermore, to stipulate clearly and implement measures to offset significant impacts. | By conducting this EIA study for the project, the project complies with one of the key requirements of the Environmental Management Act. | National Environmental Management Council (NEMC) |
| 2. | The Environmental Impact Assessment and Audit Regulations, 2005 as amended in 2018 | Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018 provide rules relative to the procedures for and carrying out of environmental impact studies and environmental audits as provided for under the Environmental Management Act (2004). They prohibit the carrying out of projects without an environmental impact assessment required under the Environmental Management Act and define the contents and form of an environmental impact assessment and the basic principles of an environmental audit. | The regulations cemented the requirements of undertaking EIA study for the project and Audits for ongoing projects, likewise annual monitoring to ensure efficacy of the performance. Further it provides procedure to be followed while undertaking Environmental studies i.e., EIA and EA. | As noted under EMA Cap 191 above, this detailed ESIA study is undertaken in accordance to the procedures set forth by the EIA and EA regulations. Moreover, annual monitoring and audit shall be undertaken as required. | NEMC |

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| 3. | The Environmental Management (Air Quality Standards) Regulations, 2007 | The object of these regulations is to set baseline parameters on air quality and emissions and enforce minimum air quality standards. They are also meant to help developers to keep abreast with environmentally friendly technologies and ensure that the public health as well as the environment is protected from various air pollution emissions sources. These Regulations stipulates the role and powers of the National Environmental Standards Committee. According to the regulations, the approval of a permit for emission of air pollutants shall be guided by ambient, receptor, emission and specification standards approved by the Minister. Offences and penalties for contraveners are also provided for in the regulations. | The project ESMP for managing wastes will adhere to permissible emission limits and quantities of emissions of $SO_X$, CO, black smoke and suspended particulate matters, $NO_X$, hydrocarbon, and substances in exhaust of motor vehicles prescribed by the regulations.<br><br>Emission limits of sulphur and nitrogen dioxides, carbon monoxide, lead, ozone, black smoke and suspended particulate matter together with their test methods are specified. Tolerance limits and test methods for dust, sulphur dioxide and nitrogen oxides from project(s) into the air as well as from motor vehicles are also given. These pollutants are not expected to be generated from the project activities in significant amounts since special measures will be implemented to avoid emissions during operation. | The proponent and contractor will ensure that mitigation measures on dust and gaseous emission are enforced on implementation of the project throughout the life cycle. | NEMC, Proponent, Contractor, Monduli District Council |
| 4. | The Occupational Health and Safety Act No. 5 of 2003 | This Act makes provisions for the safety; health and welfare of persons at work places. Also provides for the protection of persons other than persons at work against hazards to health and safety arising out of or in | The Act requires registration of workplace to OSHA for subsequent compliance monitoring by the Authority. It further requires the employer to ensure the safety of workers by providing safety gear at work place, undertaking pre- | The proponent shall register its workplace before construction and undertake other subsequent | Occupational Safety and Health Authority (OSHA) |

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| | | connection with activities of persons at work.<br>The project will create a workplace for a number of people to be employed or temporary hired by the project from the development phase to operation phase and thus the relevance of the Act. | medical checks before employment, periodic medical surveillance during operation and post medical checks on contract ends. | requirements as per the Act. | |
| 5. | The Land Act, [Cap. 113 R.E. 2019] | The Act seek to control land use and clarify issues pertaining to ownership of land and land-based resources, transactions on land and land administration.<br>Since the project activities is taking place on land, the land legal related issues need to be addressed or looked at and thus the relevance of the Land Act. | The Act requires the development on land to bring harmony to the existing land use plans. | The project proponent shall ensure that issues pertaining land use plan are well addressed. | Ministry of Lands Housing and Human Settlement Development, and Monduli District Council. |
| 6. | The Contractors Registration (Amendments) Act No. 15 of 2008 | The Contractors Registration Board (CRB) is a government autonomous regulatory body established to register all types of contractors and regulate their conduct for the purpose of protecting consumers of construction services in Tanzania.<br>The body is governed by the Contractors Registration Act No. 17 of 1997 as amended by The Contractors | Only registered contractors are required to undertake major construction activities like construction of the building i.e., proposed project and related facilities. | The project proponent shall appoint a registered contractor for its construction works. | Contractors Registration Board |

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| | | Registration (Amendments) Act No. 15 of 2008. | | | |
| 7. | The Engineers Registration Act No. 15 of 1997 and its Amendments of 2007 | The Act regulates the engineering practice in Tanzania by registering engineers and monitoring their conduct. | The Act stipulates that no person shall employ or continue to employ its professional engineer or any person who is not a registered engineer. | The proponent shall engage only registered engineer to the engineering related works during both development and operation phases. | Engineering Registration Board |
| 8. | The Water Resource Management Act, No. 11 of 2009 | The Water Resource Management Act 2009, a principal legislation dealing with the protection of water resources against pollution and degradation, and control of water extraction for different uses. Since the project will drill boreholes to source water for project use the Act is relevant to the project as it regulates the water use and water abstraction from the different sources. Likewise, development phase and operation of the project might cause pollution to the water resources around the area and thus the Act is relevant to the project. | The Act requires any person who diverts, dams, stores, abstracts or uses water from surface or underground water source to secure a water use permit from respective water basin office.<br>It requires owner or occupier of land on which any activity or process is performed or undertaken, or any other situation exists which causes has caused or is likely to cause pollution of a water source, shall take all reasonable measures to prevent any such pollution from occurring, continuing or recurring. | Project proponent shall apply for borehole permits as required by the Act.<br><br>The proponent shall ensure all its activities do not impair quality of the waters in the area (pollution control measures are detailed in chapter 7) | Monduli District Council Water Authority |
| 9. | The Environmental | The object of the regulations is to | The Regulations specify permissible | The developer will | NEMC, |

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| | Management (Water Quality Standards) Regulations, 2007 | enforce minimum water quality standards prescribed by the National Environmental Standards Committee, enable the National Environmental Standards Committee to determine water usages for purposes of establishing environmental quality standards and values for each usage and ensure all discharges of pollutants take into considerations the ability of the receiving water to accommodate contaminants for protection of human health and conservation of marine and aquatic environments. The regulation requires periodic and independent assessment of water quality parameters and that the levels of measured parameters shall comply with their respective standards/limits. | limits for selected physical, inorganic, organic and microbiological components of municipal and industrial effluents and the respective test methods of the pollutants. Regarding drinking water, the regulations specify microbiological requirements and classification of non-chlorinated piped water sources, chemical and physical limits as well as radioactive materials limits for quality of drinking water supplies. Also specified in the regulations are minimum distances from sources of water contamination and sampling frequency for water quality monitoring of various sources. | minimize the impacts of the project activities to groundwater and nearby surface water sources. | Proponent, Monduli District Council |
| 10. | The Employment and Labour Relations Act, No.6 of 2004 | This Act guarantees fundamental labour rights and establishes basic employment standards. The Act provides broad protection against discrimination.<br>Since 30-80 people will be employed by the project during construction and/or operation, the issues of labour and their rights are inevitable in this | The Act requires the employers to promote equal opportunity in employment and strive to eliminate discrimination in any employment policy or practice against gender, pregnancy, marital status, disability, HIV/AIDS and age.<br>Key issues to note: - provision of an opportunity to participate in the trade | The project proponent shall adhere to the requirement of this Act among others to have defined contracts as per the Act. | Ministry of Labour and Employment |

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| | | respect and thus relevance of this act to the project. | unions or employers' associations. The Act also requires employers to take "positive steps" to guarantee women and men the right to a safe and healthy environment. | | |
| 11. | The HIV and AIDS Prevention and Control) Act, No. 28 of 2008 | The HIV/AIDS Act (Act No. 28/08) calls for prevention, treatment, care, support and control of HIV and AIDS for promotion of public health in general. The law also provides for public education and programmes on HIV and AIDS. Since the project will involve large number of workers' social interactions cannot be restricted among students/workers and between students/workers and the members of the nearby community. Further, with this number possibility of employing workers with HIV/AIDs is high. Thus, the Act is relevant in this respect. | Of particular importance to this project is found in part II, section 6 (1), which insists for designing and implementing gender and disability responsive HIV/AIDS plans in its respective area, and the plans to be mainstreamed and implemented within the activities of such project. Section 9 calls for establishment and coordination of a workplace programme on HIV/AIDS for employees under his control and such programmes shall include provision of gender responsive HIV/AIDS education. | The proponent shall establish HIV/AIDs education programs to its workers and other mechanisms to deal with HIV/AIDs which are in compliance with the Act requirements. | Ministry of Health, Tanzania Commissioner of Aids (TACAIDS). |
| 12 | The Industrial and Consumer Chemicals (Management Control) Act, No. 3 of 2003 | The Industrial and Consumer Chemicals Act provides for proper management and control of industrial and consumer chemicals in mainland Tanzania. | The Act requires that any person dealing in industrial chemicals has to register with the Industrial and Consumer Chemicals Management and Control Board. The Third Schedule of the Act provides a long list of chemicals that | The majority of chemicals that proponent is intending to use are found in this Schedule; as such it has to register with the | Government Chemist Laboratory Agency (GCLA) and NEMC |

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| | | | need to be registered. | registrar. The majority of chemicals that proponent is intending to use are found in this Schedule; as such it has to register with the Registrar. | |
| 13 | The Mining Act, [Cap. 123 R. E. 2019] | The Mining Act is the principal legislation for the management of all mining activities in the country. The proponent or Investor of the proposed Soda Ash Project, being the registered holder of a Prospecting license (PL) and in accordance to the EMA, 2004, implementation of the proposed Soda Ash extraction and processing Project will have negative impacts on the environment and the surrounding communities, and therefore requires an EIA. Completion of an EIA supports the Project development continuation under both the Environmental Management Act, 2004 and the Mining Act, 2010. | Section 47 (a) and (d) of the Mining Act requires the holder of a PL/Mining License/SPL, as a condition of the license to:<br>Develop the mining area and carry on mining operations in substantial compliance with the programme of mining operations and their environmental management plan and commence production in accordance with the programme of mining operations; and<br>Prepare and update mine closure plans for making safe the mining area on termination of mining operations in a manner prescribed in relevant regulations.<br>To engage in any form of activity in the mining sector, whether it be prospecting or mining, one is required to obtain the appropriate mineral right from the several that can be issued by the Commission. | The proponent shall apply for permit required to have mineral rights before conduct exploration and exploitation of soda ash; subject to terms and conditions specified by the law or specified in the mineral rights.<br>In the Mining Act, relocation and compensation has been aligned with the requirements of the Land Act of 1999. This means that there should be fair and prompt compensation before locals are | Ministry of Minerals, Mining Commission, NDC or proponent |

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| | | | Therefore, the proponent would be required to have extraction licence from Mining Commission. | relocated by a mining project as per Section 41(4d) of the Act to ensure that involuntary resettlement is avoided and where it can't be avoided.<br>The proponent or Investor of the proposed Soda Ash Project will comply with the above legal requirements throughout the Project lifespan. | |
| 14 | The Grazing Land and Animal Feeds Resources Act No. 13 of 2010 | This Act concerns quality of feed resources for livestock in Tanzania and for the management and control of grazing-lands, animal feed resources and trade and to provide for other related matters. | Since the project is located within the grazing land, the proponent shall be responsible for the administration and sustainability of grazing-land utilization and animal feed resources to livestock found in the project area. Also reallocation of pastoralists shall consider the availability and compatibility of water and grasses or pastures to livestock. | The proponent shall ensure the project design consider the availability of grazing-land utilization and animal feed resources to livestock. | MoLF, National Grazing-land and Animal Feed Resources Advisory Council |
| 15 | Wildlife Conservation Act, No. 5 of 2009 | This Act makes provision with respect to management and conservation of biodiversity and wildlife, i.e. any wild | The project site is within GCA and wildlife corridors according to MNRT, TAWA and TAWIRI. Therefore, the | The proponent shall ensure the project design consider the | MNRT, NCAA, TAWA, |

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| | | and indigenous animals and plants, and their constituent habitats and ecosystems found on or in land or water, and provides for establishment and management of protected areas in mainland Tanzania. | project developer should support the protection and conservation activities to that wildlife. | wildlife corridors and all project activities do not impair wildlife and their habitat. | TAWIRI |
| 16 | The Local Government (District Authorities) Act, Cap. 287 | This Act outlines and describes the nature of local government, from District to the lowest levels of government (e.g. hamlet) and the need for people involvement and participation in the making of decisions on matters affecting or connected with their livelihood and well-being at all local levels. | Project planning and implementation should incorporate the relevant requirements of Monduli District in which it is located. | Since the Project area is in close proximity to Engaruka chini, Mbaashi, Irerendenyi and Idonyanaado villages, the provisions under this Act and other associated laws and regulations has been taken into account during planning and potentially implementation of the Project. | LGAs |
| 17 | The Village Land Act, [Cap. 114 R. E. 2019] | The Village Land Act, (No. 5), 1999 was enacted specifically for the administration and management of land in villages. | Under the provisions of this act, the village council is responsible for the management of the village land and is empowered to do so in accordance with the principles of a trustee managing property on behalf of a beneficiary. As provided under Section 8 of the Act, the | The proposed project area is surrounded by Engaruka chini, Irerendeni, Mbaashi and Idonyonaado villages and management of land | LGAs |

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| | | | village council is required to manage land by upholding the principles of sustainable development, relationship between land uses, other natural resources and the environment. | within these villages is under the jurisdiction of the Village Land Act and hence the importance of the knowledge of this legislation. | |
| 18 | Village Land Planning Act, No. 58 of 2007 | It was enacted specifically for the orderly and sustainable development of land in village areas in order to: preserve and improve amenities; to provide for the grant of consent to develop land and power of control over the use of land; and to provide for other related matters of administration and management of land in villages. | The village council is responsible for the management of the village land and is empowered to do so in accordance to the principles of a trustee managing property on behalf of a beneficiary. In addition, the village council is required to manage land by upholding the principles of sustainable development, relationship between land uses, other natural resources and the environment. | The proposed project area is surrounded by Engaruka chini, Irerendeni, Mbaashi and Idonyonaado villages. The management of land within these villages is under the jurisdiction of the Village Land Act No.8 of 2007, and therefore knowledge of this legislation is very important. | LGAs |
| 19 | The National Land Use Planning Act, No. 6 of 2007 | It established the National Land Use Planning Commission. The Commission is the principal advisory organ of the Government on all matters related to land use. | The areas surrounding the project area may find themselves in land conflicts that may be a result of lack of land use planning, project proponent will hence seek to harmonise its land use with those of its neighbours through the provisions | This project shall involve resettlement of people and their properties; this law shall govern the whole process of valuation | LGAs and Proponent |

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| | | | of the land use planning legislation. | and compensation. | |
| 20 | Tanzania Investment Act, Cap. 38 | The act established TIC as one-stop centre for investors and aimed at providing favourable conditions for investing in Tanzania. | In practice investors are required to submit an environmental status report as part of the bid document to the TIC. | Being one of the major investors, the proponent will observe the provisions of this legislation and its relations to environmental management. | Proponent, TIC |
| 21 | The Workers Compensation Act, No. 20 of 2008 | The Act focuses mainly on:<br>Provision for adequate and equitable compensation for employees who suffer occupational injuries or contract occupational diseases arising out of, and in the course of their employment, and in the case of death to their dependants;<br>Promote prevention of accidents and occupational diseases. | This Act provides the right for compensation to workers for occupational injury in section 19 (1) - (5) or accident in section 20 and 21. Also in section 22 (1) - (5), employee has the right to compensation for occupational diseases. | The proponent/investor will operate within the requirements of this legislation and abide by all relevant sections provided by this Act. | Proponent, Workers, URT, NHIF |
| 22 | The Standards Act No. 2 of 2009 | This Act provide for the promotion of the standardization of the specifications of commodities and | The relevance of this act to this project is in a manner that the project contains some components which require | The proposed project will ensure compliance to these | TBS, NEMC, Proponent |

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| | | services, to re-establish the Tanzania Bureau of Standards (TBS) and to provide better provisions for the functions, management and control of the Bureau, to repeal the standards Act, cap.130 and to provide for other related matters. | compulsory compliance. Under this act compulsory standards are categorized as generic or specific. Specific standards relevant to the Project include Tolerance Limits of Emissions discharge including water quality, discharge of effluent into water, air quality and control of noise and vibration pollution. | standards. | |
| 23 | The Fire and Rescue Force Act, Cap. 427 | The act provides for the better organization, administration, discipline and operation of Fire and Rescue Force. The act gives power for the establishment of a national fire brigade (the Fire and Rescue Force (FRF)). | It aiming at preventing and minimizing death rates, injury to the people, and damage to properties arising from fire, floods, earthquakes, road traffic accidents and other disasters. | The proposed project will comply with the provision of this act in order to avoid any fire hazard that may occur as the result of the project operations. | Fire-Arusha, Proponent |
| 24 | Antiquities Act, Cap. 333 | The Antiquities Act is the principal cultural heritage legislation in Tanzania. | The purpose of the act is to provide legal statutes for the preservation and protection of sites and articles of palaeontological, archaeological, historical, or natural interest. The act provides legal protection for relics, monuments, and protected objects. | The proposed Project will abide to the provision of this act during project execution. | MNRT, UNESCO, Proponent |
| 25 | Graves (Removal) Act, Cap. 72 | It was enacted specifically to provide for the removal of graves from land required for public purposes as specified in section 4 of the Land | Under the provision section 3 the Minister of Land is given the power to cause removal of the graves where any land on which the grave is situated is | The proposed Project will observe and abide to the provisions of this Act. | Ministry of Lands, Housing and Human |

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| | | Acquisition Act. | required for a public purpose. | | Settlements Development, Proponent, LGAs/Village Elders |
| 26 | The Water Supply and Sanitation Act, No.5 of 2019 | This legislation provides for sustainable management and adequate operation and transparent regulation of water supply and sanitation services. The Act provides for establishment of water supply and sanitation authority as well as community owned water supply organisations. Furthermore, the Act provides for appointment of service providers. | The main aim of this legislation is to ensure the right of every Tanzanian to have access to efficient, effective and sustainable water supply and sanitation services for all purposes by taking into account the production and conservation of water resources, development and promotion of public health and sanitation; and protection of the interest of customers. | The proposed Project will comply with the requirements under this Act during all phases of project implementation. | Ministry of Water and Irrigation, Internal Drainage Basin Water Board, Proponent |
| 27 | The Social Security Regulatory Authority Act, Cap. 135 | The Act regulates all social security scheme and sector through Social Security Regulatory Authority (SSRA). The SSRA is charged with protection of interest of members of Social Security Schemes, SSRA registers, supervises Pensions, Supplementary & Health Insurance Schemes, as well as Fund Managers, Custodians and Administrators. | The execution of the proposed Project during construction will utilize Contractors and their employees in collaboration with the current company employees on site. Most of the employee’s especially unskilled ones are expected to be sourced from the local communities for the works which do not require expatriates. | The project owner will continue to ensure that all employees are served under this regulation for all their relevant benefits as required by SSRA Act. | PSSPF, NSSF, SSRA, NHIF, Proponent |
| 28 | The Road Act, No. 13 of 2007 | It governs the deviation, widening, construction or realignment of a road or access road, as well as describing | Section 15 provides details on the power of the Minister for provision of consent for the new construction of such | The execution of any road to the Project area which is under | TANROADS, TARURA, Monduli DC |

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| | | the compensation details for people that need to be resettled. | infrastructure. Section 16 provides details on the compensation cases of used land and cut vegetation during road construction. | TANROADS will have to be undertaken according to the requirements of the Road Act, 2007 in collaboration with TARURA and the Monduli District Council. | |
| 29 | The Electricity Act, No. 10 of 2008 | This Act provides for facilitation and regulation of generation, transmission, transformation, distribution, supply and use of electric energy to provide for cross border trade in electricity and the planning and regulation of rural electrification and to provide for related matters. | Section 25 is about Power Purchase Agreements which is applicable only to legally binding agreements concluded subsequent to the entry into force of this Act. Section 25 (2) A licence may by rules made by the Authority conclude agreements for the purchase or sale of electricity. | The proponent for this case falls under category (b) and will conclude a Power Purchase Agreement with TANESCO as per this Law. | Proponent, TANESCO |
| 30 | The Public Health Act, No. 1 of 2009 | This Act provides for the promotion, preservation and maintenance of public health with a view to ensuring the provisions of comprehensive, functional and sustainable public health services to the general public and to provide for other related matters. | Part (IV) c on Solid and Liquid Waste Management, it recommends management of solid and liquid wastes generated in accordance with sustainable plans prepared by respective Authority; and ensure appropriate sorting of wastes is made at the source, and that it is in accordance with standards or specifications prescribed by the authority. | The proponent is responsible for managing all solid and liquid wastes which will be produced during the project construction and operation phases. | Proponent, NEMC |

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| | | | It further explains that one should ensure that the solid and liquid wastes are classified and appropriately stored depending on whether they are organic, plastic, glass or metal waste; and prescribe appropriate methods for storage of different categories of solid and liquid wastes. | | |
| 31 | The Environmental Management (Soil Quality Standards) Regulations, 2007 | The regulation has set limits for soil contaminants in agriculture and habitat, enforce minimum soil quality standards, prescribe measures designated to maintain, restore and enhance the sustainable productivity of the soil and prescribe minimum soil quality standards for sustaining ecological integrity and productivity of the soil. | Most of the pollutants covered in these regulations will not be produced from the project activities in appreciable concentrations. However, there is a potential for soil pollution from diesel used by generator and vehicles during the construction phase. Fossil fuels will be applied in a rational manner to minimize residues and consequently soil and water pollution. | The proponent will manage well all solid and liquid wastes to be generated and oils pills at each project phase to avoid the soil contamination. | NEMC, Proponent, Contractor, Monduli District Council |
| 32 | The Grazing Land and Animal Feeds Resources (Standards of Animal Feed Resources) Regulations, 2013 | It provides for the management and control of grazing-lands, animal feed resources and trade and to provide for other related matters. Relevant to this project the Regulation imposes control, manufacture and composition of animal feed resources including the restriction on the manufacture, importation or selling of animal resources. | It provides for general provisions which include the protection of grazing-land, offences and penalties, powers of arrest, facilitating powers of the Court and powers of the Minister to make regulations. | Since the project is located within the grazing land, the proponent shall be responsible for the quality, management and control of grazing-lands, and animal feed resources to livestock found in | MoLF, National Grazing-land and Animal Feed Resources Advisory Council |

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| | | | | the project area. Also reallocation of pastoralists shall consider the availability and compatibility of water and grasses or pastures to livestock. | |
| 33 | The Grazing Land and Animal Feeds Resources (Storage Requirements for Animal Feeds) Regulations, 2013 | This Regulation concerns on the availability and sustainability of animal feeds for livestock in Tanzania. | The proponent shall be responsible for the administration and sustainability of animal feed resources to livestock found in the project area. | The proponent shall ensure the project design will not distruct animal feed resources. | MoLF, National Grazing-land and Animal Feed Resources Advisory Council |
| 34 | The Land Acquisition Act, [Cap. 118 R.E. 2019] | The Act defines the circumstances in which public interest could be invoked, e.g., for exclusive government use, public use, for or in connection with investment purposes. The acquisition of the land for the proposed project as well as for the resettlement sites is within the provision of this Act. | The Act specifies other requirements prior to the acquisition of the land such as investigation for the land to be taken, issuing notice of intention to take land and mode in which notices will be served. It further defines the requirements for and restrictions on compensation. | NDC is observing this requirement and it has already consulted the land owners in respective areas through the public meetings and it is expected that compensation for the affected persons will be paid accordingly and the notice for | Proponent, Monduli DC |

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| | | | | taking land will be issued as early as possible. | |
| 35 | The Land Registration Act, [Cap. 334 R.E. 2019] | The Act provides for procedures for Land registration and administration of the Registry. It provides for an official record of right in defined area of land or an authoritative record of information concerning land for legal purposes and establishment rights in land. | Most conveyancing on registered land has to conform to the statutory requirements on registration as provided under the Land Registration Act. | The proponent should observe this requirement by applying land right for surface resources before the commencement of the project. | Project proponent, Village Government and Monduli DC |
| 36 | The Valuation and Valuers Registration Act, No. 7 of 2016 | This *Act* provides with respect to the process in which the value of an interest in real property is assessed by a *valuer*. It also requires a Chief *Valuer* to be appointed within the Ministry responsible for lands and provides for the registration of valuers. Chief Valuer is appointed by the President and shall be responsible for advising the Government on all matters relating to valuation practice and activities. | Every registered valuer or person practicing valuation shall comply with guidance on valuation practice set out under this Regulation. | NDC is observing this requirement and valuation process is await for approval by Chief Valuer, to be followed by the affected persons to be compensated. | Proponent, Monduli DC |
| 37 | The Valuation and Valuers (General) Regulations, 2018 | It provides all specific requirements for management and administration, granted right of occupancy, mortgage, lease, easement and co-occupancy. | All assessment of the value of land and unexhausted improvements for the purpose of this Regulation shall be prepared by a Registered Valuer. Every assessment of value for land and | The proposed Project will observe and abide to the provisions of this Regulation. | Ministry of Lands, Housing and Human Settlements |

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| | | | unexhausted improvements for the purpose of payment of compensation shall be verified and approved by the Chief Valuer. | | Development, Proponent, LGAs/Village Elders |
| 38 | The Weights and Measures Act, Cap. 340 | The Act to revise and consolidate the law relating to weights and measures and to provide for the introduction of the International System of Units (SI) and for related matters. | It provides that every contract, bargain, sale or dealing made or had after the commencement of this Act whereby any work, goods, wares, merchandise or other thing is or are to be, or is or are done, sold, delivered, carried, measured, computed, paid for or agreed for by weight or measure shall be made and had according to one of the relevant units of measurement specified in this Act | The proposed Project will observe and abide to the provisions of this Act. | Project Proponent |
| 39 | The Water Resources Management Act, No. 11 of 2009 | The Act provides for institutional and legal framework for sustainable management and development of water resources; outlines principles for water resources management; provides for the preventions and control of water pollution; provides for participation of stakeholders and the general public in implementation of the National Water Policy; repeals the Water Utilization (Control and Regulation) Act, 1974 and vests all water in the country to the Government of United Republic of | The Act also sets standards for receiving waters and effluent. It is anticipated that the project proponent will use water possibly drawn from existing public water supply system within the project area. | The contractor and the proponent will observe all the requirements including use of the abstracted water for construction activities and ensure that no pollution or mismanagement of the existing water resources and thus respect and maintain the existing system of | Proponent, Contractor |

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| | | Tanzania and sets procedures and Regulations for the extraction of water resources. | | water rights. | |
| 40 | The National Social Security Fund Act, Cap. 222 | The Act ensure provision of social security services to employees in Tanzania. | All employers registered by NSSF are required to pay monthly contribution. If any contribution is not paid within the period stated under the Act, a sum equal to five per centum of the amount unpaid shall be added as penalty for each month or a part of a month after the date when payment should have been made and the amount of the penalty shall be recovered as a debt owing to the Fund by the employer. | Project Proponent will observe and abide to this Act by ensuring monthly contributions for all employees are timely paid. | Project Proponent |
| 41 | The Income Tax Act, Cap. 332 | It provides for the charge, assessment and collection of Income Tax, for the ascertainment of the income to be charged and for matters incidental thereto. | The proposed project will be source of revenue to the Government through taxes of what produced. | The proponent will observe and abide to the requirement of this Act by ensuring all taxes are timely paid to the Government. | Proponent |
| 42 | The Standards (Certification) Regulations, 2009 | The Act provides for the promotion of the standardization of specifications of commodities and services. It also provide better provisions for the functions, management and control of the Tanzania Bureau of Standards, and other relation matters. | These Regulations allow standards marks to be applied to any commodity or process only by a holder of a licence granted in accordance with the standards framed by the Tanzania Bureau of Standards. | Proponent will ensure that the products produced are of good standards, specified quality and registered by Tanzania Bureau of Standards. | Proponent |

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| 43 | The Wildlife Conservation (Wildlife Corridors, Dispersal Areas, Buffer Zones and Migratory Routes) Regulations, 2018 | These Regulations shall apply to conservation areas, wildlife ranches, wildlife farms, zoo and game sanctuaries or other areas with wildlife resources for sustainable non-consumptive use. | It protects GCA's, Wildlife Corridors, Dispersal Areas, Buffer Zones, hunting blocks and Migratory Routes. | The project design will consider the existence of wildlife corridors and hunting blocks and where necessary negations deemed can be started between the Government, key Ministries, proponent and stakeholders to find the better means of the issues especially the possibility of revoking the hunting block license. | Proponent, TAWA |
| 44 | The Environmental Management (Solid Waste Management) Regulations, 2009 as amended in 2016 | The Regulations detail the requirements and responsibilities for managing solid waste in Tanzania. It highlights waste minimisation and cleaner production principles alongside the duty to safeguard the public health and the environment from adverse effects of solid waste. | It details permitting requirements, notably which any person dealing with solid waste as collector, transporter, waste depositor or manager of a transfer station will be required to apply to the LGA for a permit. The local authority will also issue licences to individuals or companies qualified to operate solid waste disposal sites. | The proponent shall ensure all enerated solid wastes from its activities are well managed. | Proponent |
| 45 | The Environmental Management | The Regulations detail the requirements and responsibilities for | The Regulation details permitting requirements, notably the requirement for | If hazardous waste will be generated, the | Proponent, NEMC, GCLA |

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| | (Hazardous Waste Control and Management) Regulation, 2019 | controlling and managing hazardous waste in Tanzania. This includes implementing the safeguarding principles for solid waste disposal and management. | a permit to handle and/or transport hazardous wastes, and procedures for applying for a licence for transporting or storing hazardous waste. Article 14 describes the conditions with regards to facilities, procedures, personnel and equipment required to obtain this type of licence. | Proponent should ensure proper handling and disposal. | |
| 46 | The Environmental Management (Prohibition of Plastic Carrier Bags) Regulations, 2019 | The Regulation apply to import, export, manufacturing, sale, supply, storage and use of plastic carrier bags within Mainland Tanzania.<br>It imposes a total ban on the import, export, manufacturing, sale, and use of plastic carrier bags regardless of their thickness. | The Regulations categorically state that no person shall sell or offer for sale beverages or other commodities wrapped in plastics unless the nature of such commodities require wrappings by plastics, and restricts any licensing authority from issuing any licences after the Regulations come into force. The Regulations further provide that any imported consignment of plastic carrier bags found at any entry point shall be repatriated to the country of export at the cost of the importer. Possession of plastic bags can lead to fines up to TZS 200,000 or imprisonment of up to 7 days, or both. | The proponent will observe and abide to the requirement of this Act by avoiding and/or prohibiting the use of plastic carrier bags. | Proponent |
| 47 | The Tanzania Development Vision, 2025 | The National Development Vision 2025 (NDV 2025) recognizes the leading role of the industrial sector in the process of transforming Tanzania's economy from a weather and market | It seeks to actively mobilize the people and other resources towards the achievement of shared goals. The vision provides hope and an inspiration for motivating the people to search and work | The proposed project could contribute to the attained of the vision in its area of educating the society providing | Project Proponent |

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| | | dependent agricultural economy to a self-sustainable semi-industrial one by 2025. It foresees the alleviation of widespread poverty through improved socio-economic opportunities, good governance, transparency and improved public sector performance. | harder for the betterment of their livelihood and for prosperity. | more chance for student to join further studies and in service worker for improving their working skills through training of short and long courses. | |
| 48 | The Integrated Industrial Development Strategy 2025 | The Integrated Industrial Development Strategy 2025 (IIDS2025) responds to the need for a dynamic strategy to guide the process of resource-based industrialization. | Through the implementation of the strategy, IIDS targets the manufacturing sector to grow by 15 % per annum on average, to attain a gross manufacturing value of 16 billion US Dollars and 23% share in GDP composition by 2025. | Proposed project is in line with the strategy to support industrialization process. | Proponent |

## 3.6 Relevant Regulations and Guidelines to the Project

### 3.6.1 The Environmental Impact Assessment and Audit Regulations, 2005

The regulations consist of 12 parts, and three schedules. Section 4(1) states that no developer or proponent shall implement a project:

- That is likely to have a negative environmental impact; or
- For which an EIA is required under the Act, the regulations or any other written law, unless an EIA has been concluded and approved in accordance with these regulations.

Part IV of the regulations details the requirements for the EIA, and stipulates the general objectives of the EIA and the procedures required to be followed.

Part VIII provides for the right of access to environmental information presented to NEMC by the public. Section 39(1) states that any project brief, EIS, terms of reference, public comments, report of a person presiding at a public hearing, decision letter or any other information submitted to the Council under these regulations, shall be public documents.

Part IX stipulates that if an EIA certificate has been issued, but no development has started within three years, the developer or proponent shall re-register with the Council any intention to develop.
Part X of the regulations details audit requirements and procedures.
These regulations have now been amended as outlined in the following Section below.
All activities for the proposed Project development for proponent will be carried out in compliance with these regulations.

### 3.6.2 The Environmental Impact Assessment and Audit Regulations, 2005 as amended in 2018

This regulation makes amendments to the EIA and Audit Regulations of 2004, to enhance environmental planning and management. Described below are the key amendments relevant to the proposed Project. Section 3, has been amended by adding sub regulation 4, which requires that an EIA certificate is to be issued if the proof of land ownership and proper location of the proposed Project has been determined. The whole part III of the principal regulations has been deleted and substituted with the new part III accordingly. Thus, the project categories have been described in four categories as set out in the first schedule of these regulations ("A" category for Mandatory Projects; "B1" category for Borderline Project; "B2" category for Non- Mandatory; and "Special Category). Therefore, part III regulation 4A (2) specifies the requirements for the person who wishes to attain EIA certificate.

The regulation also requires any person who wishes to apply for the EIA certificate to pay particular attention to the screening criteria set out in the second schedule of these regulations. Part III regulation 6, guides on the format of the EIA certificate for the category B2 projects. Regulation 7(7) is about the purpose of inspection or verification of the project and states that the council may visit the project site at the proponent's or developer cost.

The EIA for the proponent has been undertaken in line with the requirements of these regulations.

### 3.6.3 The Mining (Local Content) Regulations, 2018

The local content regulation amongst others, require the mineral right holder to buy goods which are produced in Tanzania or the services that are rendered by local companies or citizens. A local company is defined as a company or subsidiary companies incorporated under the Companies Act, which is 100 per cent owned by a Tanzanian citizen or a company that is in a joint venture partnership with a Tanzanian citizen or citizens whose participating shares are not less than 51 per cent. However, there is an exception with respect to goods that are not available in Tanzania – these goods can be provided by a majority non-Tanzanian owned company provided that such a company has a local partner company holding at least a 25 per cent interest in the company. The mineral right holder is required to submit to the Commission a procurement plan of five years indicating the local services which will be used in the insurance, financial, cooking and catering, legal and security sectors. The Project will ensure that the Procurement of goods and services for the Project will to comply with the requirements of these regulations.

### 3.6.4 The Mining (Mineral Rights) Regulations, 2018

It regulates the application for mineral rights licenses and the renewal of the same. The regulations also cancelled retention licenses which were issued prior to the Regulations and accordingly all previous license areas have been reverted back to the government. The regulations also provide costs and requirements for mining licenses. It also provides for the expenditure on a prospective mining licensee which should depend on the prospected area.

Among the notable features of the Mineral Rights Regulations is the requirement of giving an indigenous Tanzanian company first preference in the granting of mining licenses. The Mineral Rights Regulations have defined an indigenous company as a company incorporated under the Companies Act that has (i) at least 51 per cent of its equity owned by a citizen or citizens of Tanzania and (ii) Tanzanian citizens holding at least 80 per cent of executive and senior management positions and 100 per cent of non-managerial and other positions. With respect to the employment aspects, the Mineral Rights Regulations require Jacana Resources (T) Limited to have a well-documented training and succession plan, and impose increasingly stricter requirements for employing non-Tanzanians in the mining company. Specifically, the Regulations have made it compulsory for mining companies to solely employ Tanzanians in all junior or middle level positions. However, in the event that the expertise or skills are lacking at these levels, companies would be required to provide training to Tanzanians in that field, either locally or outside Tanzania. Another important and notable feature of the Mineral Rights Regulations is the requirement for exclusive use of insurance services being provided by Tanzanian insurers, as well as legal services being provided by Tanzanian law firms. Companies are also required to maintain operating accounts in indigenous Tanzanian banks which are either exclusively owned by

Tanzanians or have majority shareholding by Tanzanians. As such, the proponent will continue to ensure compliance under this regulation.

### 3.6.5 The Mining (Minerals and Mineral Concentrates Trading) Regulations, 2018

This provides for the licensing requirements for mineral trading and regulates the permit requirements on the exportation and importation of minerals. As such, the proponent will continue to adhere to all relevant conditions under this regulation.

### 3.6.6 The Mining (Mineral Beneficiation) Regulations, 2018

The processing and refining of minerals, the Regulations incidentally call for transfer of beneficiation technology through the requirement to employ Tanzanian's and plan for succession of expatriates as a condition for renewal. As such, the proponent will continue to adhere to all relevant conditions under this regulation.

### 3.6.7 The Mining (Audit and Inspection of Records) Regulations 2018

Among other provisions, sets the mechanism for inspection of record and reporting as may be required by the Commission. As such, the proponent will continue to adhere to all relevant conditions under this regulation.

### 3.6.8 The Mining (Integrity Pledge) Regulations, 2018

These regulations defines "Integrity Pledge" as a formal and concrete expression of commitment by a mineral right holder to abide in ethical business practices and support a national stand against corruption, as defined under Rule 3 of these Regulations. The Regulations applies to all holders of Mineral Rights who undertake prospecting and mining activities in Tanzania Mainland. Furthermore, the Regulations foster on raising awareness of integrity pledge principles to any Contractor, Sub-Contractor, Licensee, or any other person conducting mining activities to adhere to the underlying integrity requirements on promoting integrity values, transparency and good governance, strengthening internal systems that support prevention of corruption, complying with laws, policies and procedures relating to anti-corruption and to ensure proper operations in the course of carrying out mining activities to avoid losses, injuries or damage to environmental, communities, individual and properties.

As such, the proponent will continue to adhere to all relevant conditions under this regulation.

### 3.6.9 The Mining (Safety, Occupational Health and Environment Protection) Regulations, 2010

These regulations set out procedures on safety, occupational health and environmental protection for all mines and quarries during exploration, evaluation, development, construction, production, closure, reclamation and abandonment.

General Safety Procedures are described in Part III 20 (1)(3), including safety precautions to be observed, while emergency preparedness is described in Part IV, including industrial first aid and rescue. More specifically, in terms of the regulations, the following are directly applicable to construction, management and closure of a mine site:

- The Manager shall make an application for approval to construct major impoundment, dam, or waste dump, complete all necessary supporting documents, to the Chief Inspector and copies of the complete application shall be sent to other relevant regulatory agencies specified by the Chief Inspector;
- The Manager must ensure that no work is commenced on a major waste dump, dam or impoundment without the written acceptance of the design by the Chief Inspector and possession of all other applicable permits and licences; and
- The Manager shall implement and maintain a monitoring program in the design accepted by the Chief Inspector.

Major waste emplacements and major impoundment or dams shall:

- Be designed by a qualified professional engineer registered according to the Engineers Registration Act; and
- Comply with the specifications established by the Chief Inspector.

Prior to the abandonment of any impoundment or dam, the long-term stability of exposed slopes shall be assured to the satisfaction on the Chief Inspector.

The level of land productivity to be achieved on reclaimed areas shall not be less than what existed prior to mining on an average property basis unless the owner, agent or Manager can provide evidence which demonstrates to the satisfaction of the Chief Inspector the impracticality of doing so.

Waste dumps shall be reclaimed to ensure:

- Long-term stability;
- Water quality released from waste soil dumps to the receiving environment is of a standard specified into these Regulations; and
- Land use and productivity objectives are achieved.

With regard to closure of the mine: “all potential acid generating material shall be placed in a manner which minimizes the production and release of acids to a level that assures protection of environmental quality. The proponent will observe the applicable requirements under these regulations and comply with them during the Project implementation.

### 3.6.10 Water Resources Management (Dam Safety) Regulations, 2013

Part II of these regulations states that no person is allowed to design, construct, modify or rehabilitate any dam without engaging a professional person registered in accordance with the Act and these regulations. Part III of the regulations detail permit and other requirements for the construction and classification of dams and tailing dams. The requirements for regular safety monitoring and technical audits of dams and tailings dams are described in part IV of the regulations. Section 13 (1) states that the owner of a dam or tailing dam shall prepare a monitoring program which shall include but not be limited to inspection, operation and maintenance of completed dams or tailing dams and associated structures such as spillways, diversions or decant works and submit to the Director for endorsement.

Part V details the requirements for the owner of a dam or tailing dam to ensure registration of the facility with the Director of Water Resources. The proposed project will comply with all applicable requirements under this regulation throughout all its operations in managing of the storage of ponds and other infrastructural requirements for compliance.

#### 3.6.11 Groundwater (Exploration and Drilling) Licensing Regulations, 2013

These regulations detail the procedures and process to undertake for any person who wishes to exploit groundwater. Part II 4 (1) states that, a person who wishes to undertake groundwater exploration activities should make an application for groundwater exploration licence in the prescribed form. The application shall be determined within thirty days from the date of the receipt of the application.

The licence shall be valid for the duration of one year and may be renewed upon such terms and conditions as may be prescribed by the Director. An applicant of the ground water exploration licence is required to pay the application fees as well as the annual licence fees as prescribed in the fifth schedule to these regulations. Part II 8 of the regulations furthermore list methods to be employed in groundwater exploration activities which include:

- Geological/ hydrogeological methods;
- At least two geophysical methods, one of which should be vertical electrical resistivity method;
- Exploratory drilling; and
- Any other method as may be approved by the Director.

Section 9 (1) requires the person who intends to undertake groundwater exploration to consult the respective Basin Water Board prior to commencing of exploration regarding to suitability of the proposed site for exploration of the ground water.

The proponent will consult the Internal Drainage Basin Water Board and will comply with all requirements under this regulation throughout all its operations.

## 3.7 District / Local By-laws

The Client will abide with local by-laws that guide the investment and environmental / natural resources conservation in the Monduli District.

## 3.8 International Agreements, Conventions and Treaties

International agreements, convention and treaties which are relevant to this project include:

- United Nations Framework Convention on Climate Change (1992);
- Kyoto Protocol (1997);
- The Convention on Wetlands of International Importance (RAMSAR Convention);
- Lusaka Agreement (1994); and
- Regional Agreements.

### 3.8.1 United Nations Framework Convention on Climate Change (1992)

The objective of the United Nations Framework Convention on Climatic Change (UNFCCC) is to stabilise the concentration of greenhouse gas (GHG) in the atmosphere, at a level that allows ecosystems to adapt naturally and protects food production and economic development. Article 4 commits parties to develop, periodically update, publish and make available national inventories of anthropogenic emissions of all GHGs not controlled by the Montreal Protocol (by source) and inventories of their removal by sinks, using agreed methodologies. It commits parties to mitigate GHG as far as practicable.

Since some of the mineral processing activities and equipment used for both quarrying and treatment of ore will emit $CO_2$, Tanzania is obliged to include such activities in its published national GHG statistics. Since Tanzania is a Party to the Convention, she will have to account for all sources of GHG in her future National Communications. Undertaking of this ESIA study will enable the country to identify some of the GHG that will be emitted by the project activities. The proponent will abide with the requirements of this agreement on control and prevention of greenhouse gases in Tanzania.

### 3.8.2 Kyoto Protocol (1997)

The Kyoto Protocol is an international agreement linked to the UNFCCC. The Kyoto Protocol binds 37 industrialised countries and the European Community to reduce their GHG emission by 5% from 1990 levels in the commitment period 2008-2012. The Protocol differs from the Convention in that, while the Convention encourages industrialised countries to stabilise GHG emissions, the Protocol commits them to do so. It recognises that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity. As a result, the Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities."

It provides mechanisms to achieve this objective, including the carbon trading, joint implementation and the clean development mechanism (CDM). Though Tanzania is not among the 37 industrialized countries but the proponent is obliged to obey to this protocol up on the implementation and operations of its project.

### 3.8.3 The Convention on Wetlands of International Importance (RAMSAR Convention)

The Convention on Wetlands (Ramsar, Iran, 1971), called the "Ramsar Convention”, is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their Wetlands of International Importance and to plan for the "wise use", or sustainable use, of all of the wetlands in their territories. Unlike the other global environmental conventions, Ramsar is not affiliated with the United Nations system of Multilateral Environmental Agreements (MEAs), but works very closely with the other MEAs and is a full partner among the "biodiversity-related cluster" of treaties and agreements. Site selection for the proposed project has considered the conservation and/or protection of Ramsar site by locating the Engaruka soda ash project far away (about 60km) from Lake Natron ecosystem (the crucially important breeding site for Lesser Flamingo *Phoeniconaias minor*); which is designated as a wetland of international importance (Ramsar site by UNESCO in 2001). The proponent will observe and abide to the requirement of this Convention.

### 3.8.4 Lusaka Agreement (1994)

The Lusaka agreement details co-operative enforcement operations directed at illegal trade in wild fauna and flora. The objective of this Agreement is to reduce and ultimately eliminate illegal trade in wild fauna and flora and to establish a permanent Task Force for this purpose. Tanzania has entered into this agreement, and therefore, URT/NDC being an investor in Tanzania will have to cooperate with the local community to prevent illegal trade and protection of wild fauna and flora. The proponent will observe and abide to the requirement of this agreement.

### 3.8.5 Other relevant International Conventions Ratified by Tanzania

- ILO Convention: C138 Minimum Age Convention, 1973 (Ratified by Tanzania (United Republic of) on 16:12:1998) which prohibits Child labour.
- ILO Convention: C182 Worst Forms of Child Labour Convention, 1999 (Ratified by Tanzania (United Republic of) on 12:09:2001). Therefore, in accordance with these Convention requirements, NGP will have to adhere to the ILO Convention, particularly in child labour employment. The company will ensure that no child labour is practised throughout the project’s life cycle.
- ILO Convention: C148 Working Environment (Air Pollution, Noise and Vibration) Convention, 1977 (Ratified by Tanzania (United Republic of) on 30:05:1983) which protects Workers against Occupational Hazards in the Working Environment Due to Air Pollution, Noise and Vibration. The proponent will ensure that workers are protected against occupational hazards.

## 3.9 International Standards

### 3.9.1 Equator Principles

The Equator Principles provide a set of 10 principles of voluntary standards that present a credit risk management framework for determining, assessing and managing social and environmental risk in Project financing. The Equator Principles are based on the IFC Performance Standards on social and environmental sustainability and on the World Bank Group Environment, Health and Safety (EHS) Guidelines. The Project has committed to complying with this set of principles, which together with the IFC Performance Standards and the EHS Guidelines will be used as a benchmark for international good practice.

### 3.9.2 International Finance Corporation

The IFC, a division of the World Bank Group that lends to private investors, released a Sustainability Policy and set of Performance Standards (PSs) on Social and Environmental Sustainability (January 2012). These Standards are used to evaluate any Project seeking funding through the IFC. The PSs are directed towards providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate and, manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to Project-level activities. In the case of direct investments for the IFC (including Project and corporate finance provided through financial intermediaries), the IFC requires that its clients apply the PSs to manage environmental and social risks and impacts so that development opportunities are enhanced (IFC, 2012). The proponent will observe and abide to the requirement of this guideline.

#### 3.9.2.1 IFC Environmental, Health and Safety Guidelines

The Environmental, Health and Safety (EHS) Guidelines are technical reference documents that address IFC's expectations regarding the environmental management performance of its Projects. They are designed to assist managers and decision makers with relevant industry background and technical information. This information supports actions aimed at avoiding, minimising, and controlling EHS impacts during the construction, operation, and decommissioning phase of a Project or facility. The EHS Guidelines serve as a technical reference source to support the implementation of the IFC Performance Standards. General EHS Guidelines exist which contain information on cross-cutting environmental, health, and safety issues potentially applicable to all industry sectors; ncludes a summary of the EHS topics covered by the General Guidelines.

In addition to the above General EHS Guidelines, the Guidelines for Mining are also relevant to the Project. The Guideline for Mining contains information on environmental, health, and safety issues potentially applicable various types of mining, including underground and open-pit mining, alluvial mining, solution mining and marine dredging.  It contains performance levels and recommendations that are normally acceptable to the IFC and that are generally considered to be achievable in new facilities at reasonable costs by existing technology. These recommendations relate to water use and quality, wastes, hazardous materials, land use and biodiversity, air quality, noise and vibrations, energy use, and visual impacts will be observed by proponent.

## 3.10 Institutional Framework

The EIA practice in Tanzania gives different functions and responsibilities to all parties involved in the ESIA process of any proposed development undertaking to which EIA is obligatory. Table 3.2 provides key institutions to the proposed project.

The Environmental Management Act (EMA, Cap 191) give mandate to NEMC to undertake enforcement, compliance, review and monitoring of environmental impact assessment and has a role of facilitating public participation in environmental decision-making, exercise general supervision and coordinating over all matters relating to the environment. The Act empowers NEMC to determine whether a proposed project should be subjected to an EIA, approves consultants to undertake the EIA study, invites public comments and also has the statutory authority to issue the certificates of approval via the Minister responsible for environment. NEMC is currently the designated authority to carry out the review of EIA including site visit and handling TAC meeting, monitoring and auditing of environmental performance of the project (periodic and independent re-assessment of the undertaking).

## 3.11 Institutional Framework

The Tanzania ESIA practice gives different roles and responsibilities to all parties involved in the ESIA process of any proposed development to which ESIA is obligatory. Important institutions to the proposed project are as summarized in Table 3.2.

**Table 3.2: Key Institutions to the ESIA Process**

| LEVEL | STAKEHOLDERS GROUP | ROLES AND RESPONSIBILITY |
|---|---|---|
| National level | Ministry of Finance and Planning | ➢ Planning and supporting of activities those are in line with Development Vision 2025 in order to transform Tanzania into a middle-income economy.<br>➢ Monitoring of financial logistics and project impacts. |
| | Vice President's Office - Division of Environment | ➢ Coordinate various environment management activities in Tanzania;<br>➢ advise the Government on legislative and other measures for the management of the environment;<br>➢ advise the Government on international environmental agreements;<br>➢ monitor and assess activities, being carried out by relevant agencies in order to ensure that the environment is not degraded;<br>➢ prepare and issue a report on the state of the environment in Tanzania; and<br>➢ Coordinate the implementation of the National Environmental Policy. |
| | Vice President's Office - NEMC | ➢ Verify ESIA, environmental audit and environmental monitoring studies;<br>➢ assist in the proper management and conservation of the environment;<br>➢ undertake and co-ordinate research, investigation and surveys in conservation and management; |

| LEVEL | STAKEHOLDERS GROUP | ROLES AND RESPONSIBILITY |
|---|---|---|
| | | ➢ review and recommend for approval of environment impact statements;<br>➢ enforce and ensure compliance of the national environmental quality standards;<br>➢ initiate and evolve procedures and safeguards for the prevention of accidents which may cause environmental degradation and evolve remedial measures where accidents occur;<br>➢ Undertake in co-operation with relevant key stakeholders' environmental education and public awareness. |
| | The Ministry of Livestock and Fisheries (MoLF) | The roles and responsibilities of MoLF are: To give directives to the project proponent (NDC) on fulfilment the requirement grazing land area during relocation of the local people, simply because the proposed project area is used for livestock grazing. |
| | Ministry of Natural Resources and Tourism (Forestry Division) | ➢ Implementation of the Forestry Policy;<br>➢ Enforcement of laws and regulations for forestry resources management;<br>➢ Issuance of permits for exploitation of forest resources;<br>➢ Issuance of permits to conduct activities in the forest reserve areas. |
| | Ministry of Industry and Trade (MIT) | ➢ Issuing policy guidance;<br>➢ Providing legal frameworks;<br>➢ Issuing licenses, provisions of certificates of compliances;<br>➢ Enforcement of laws and regulations;<br>➢ Setting operation standards for energy generation projects; and<br>➢ Project monitoring. |
| | Ministry of Energy and Minerals | ➢ Issuing Licenses (prospecting, mining, etc.);<br>➢ Oversee implementation of the Mining Policy;<br>➢ Enforcement of laws and regulations for mining and protection of environment;<br>➢ Mining conflict resolutions. |
| | Ministry of Water and Irrigation | ➢ Enforce laws and regulations for water quality and utilization;<br>➢ Issuance and regulation of water rights;<br>➢ Enforce water and effluent discharge laws (standards, monitoring & regulation). |
| | Tanzania Investment Centre (TIC) | ➢ Facilitating investment activities in the country; and<br>➢ Overseeing investment activities. |
| | Ministry of Land, Housing and Human Settlements Development | ➢ Oversee implementation of the Land Policy;<br>➢ Enforcement of laws and regulations for land and natural resources protection of environment;<br>➢ Enforcement of laws and regulations on Land sector<br>➢ Land use planning Land conflict resolutions; and |

| LEVEL | STAKEHOLDERS GROUP | ROLES AND RESPONSIBILITY |
|---|---|---|
| | | ➢ Issuing Licenses (i.e., tittle deed).<br>➢ Valuation and compensation. |
| | National Development Corporation (NDC) | ➢ Ownership of land and infrastructure of the proposed project;<br>➢ Carrying out EIA study and regular environmental monitoring and internal auditing;<br>➢ Manage the project implementation including mitigation measures;<br>➢ Project support and services; and<br>➢ Ensure sustainability of the project. |
| Regional Level | Arusha Regional Administrative Secretary Offices | ➢ Oversee current land uses, neighbouring activities and developments;<br>➢ Official Public notices; and<br>➢ Ensure day-to-day environmental management and monitoring. |
| | NGOs and CBOs | ➢ Regional environmental watchdog;<br>➢ Education and awareness raising on environmental management;<br>➢ Stakeholders' platform to be heard. |
| | Land Allocation Committee | ➢ Land allocation and approvals |
| District Level | Monduli District Council Executive Director Offices | ➢ Oversee all development activities at the district/council level;<br>➢ Baseline data on social and economic conditions;<br>➢ Extension services;<br>➢ Plan and coordinate activities on community-based natural resource and environment management;<br>➢ Enforcement of laws & regulations; and<br>➢ Coordinate environmental matters at the district levels. |
| | Environmental Committees (District, Ward & Village) | ➢ Coordinating and advising on environmental policies and implementation obstacles;<br>➢ Promoting environmental awareness;<br>➢ Information generation, assembly and dissemination from any person;<br>➢ Initiate inquiries and investigation on any environmental disputes or violation of the Act;<br>➢ Resolve conflicts among individual persons, companies, agencies, NGOs, Government Departments;<br>➢ Inspect any source of pollution in the area;<br>➢ Initiate proceedings of civil nature against any person, company, and agency for failing or refusing action under the Act. |
| Ward level | Engaruka, Selela and Mbaashi Wards | ➢ Oversee general development plans for their Wards;<br>➢ Provide information on local situation and Extension services;<br>➢ Technical support & advice; |

| LEVEL | STAKEHOLDERS GROUP | ROLES AND RESPONSIBILITY |
|---|---|---|
| | | ➢ Project Monitoring; |
| Village levels | All villages within Engaruka, Selela and Mbaashi Wards | ➢ Information on local social, economic and environmental situation;<br>➢ View on socio-economic and cultural value of the sites and tanning operations;<br>➢ Rendering assistance and advice on the implementation of the project;<br>➢ Project Monitoring (watchdog for the environment, ensure well-being of residents; |
| The community | The local residents neighbouring the project site at all Villages within Engaruka, Selela and Mbaashi Wards | ➢ Information on local socio-economic and environnemental situation ;<br>➢ View on socio-economic and cultural value of the sites and on proposed project during the construction and operation phases. |
| | NGOs | ➢ National Environmental watchdog.<br>➢ Initiating dialogue on national environmental concerns among stakeholders |

## CHAPTER FOUR

# 4 ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS

This chapter provides a description of relevant environmental, economic and social characteristics of the project core area (site specific), and areas in the immediate vicinity of the project as well as broad description of the area of influence for the proposed project. The Consultant relied on both primary and secondary data found in literature covering the project area, measured and/or observation at the site. The level of details in the various sections depends on the interactions between the project activities and the particular environmental or socio-economic aspect. This will be elaborated into three sections namely***: Physical Environment, Biological Environment*** and ***Human Environment.***

## 4.1 Project Area of Influence

### 4.1.1 Core Area (Area of Direct Influence)

The Project core area will cover an area of approximately 25,000 ha corresponds to the NDC's Prospecting Licenses that granted by the Ministry of Minerals to prospect the underground resources, develop exploratory wells for extraction and processing of brine resources at Engaruka Basin in Monduli District, Arusha Region.

### 4.1.2 Area of Indirect Influence

The study area includes the villages of Engaruka chini, Irerendeni, Mbaashi and Idonyonaado; all of which are in Engaruka, Selela and Mereji Wards. Within these villages, the hamlets of Engorika, Ndinyi, Nengalashi, Alapalaseki, Endeseti (in Engaruka Chini); Mkaoo, Urumensulii, Urumunyushoi, Eng'oswa, Naisije (in Irerendenyi); Oluseteshi, Injoroi and Olkoikoi (in Mbaashi village); and Oljorokoo, Idonyoo and Orkermboji (in Donyanaado) are covered.

Some of the environmental and socio-economic effects of the project are anticipated to extend beyond the boundaries of the current study area or likely PLs. The environmental impacts that could affect the wider area include air pollutants (dust and pollutant gases), noise and vibrations generated by heavy vehicle movements, and visual. As such, the study area has been mapped beyond the project area in an attempt ensure that all potential impacts associated with the project activities are identified, even if these are outside of the NDC's PLs. Assessment of the various potential impacts, e.g., those associated with air pollutants, noise, vibrations, seepage and surface runoff will be used to determine the spatial boundaries for the overall environmental management and monitoring protocols.

## 4.2 Physiography

The project area has a series of intermittent elevated mountains rising above basin floors especially to the northern, western, northern-west, eastern and southern-east parts of the project area. Four major mountains occur in the area are Kitumbaine mountain at the northern and northeast parts of the project area; Monduli mountain to the east; Engaruka mountain to the west; and Issimingoro and Burko mountains to the south and southeast. Kitumbaine Mountain dominates the northern part of the project area, and slopes to the south to form the floodplain that hosts the Engaruka River.

### 4.2.1 Climatic Conditions

Engaruka area (including the project site) being on the leeward side of Monduli Mountain has little rainfall and a long dry and sunny period. In general rainfall pattern is unequal with short rains season fall in November and/or December and the long rains fall in March to May. The total annual rainfall is in the order of 300 mm. In the month of October, temperatures are considerably high, in the range of 25-35$^{o}$C during day time and 10-20$^{o}$C during the night. The humidity ranges from 30% to 40% in the day time rising to 60% at night. The net annual evaporation in the Engaruka Basin is thus much higher than precipitation, an ideal condition for the formation of evaporates.

### 4.2.2 Geological Setting of the Engaruka Basin

According to Dawson, (1961) and Pickering, (1963) Engaruka Basin, is a playa lake, covered mostly by superficial deposits of recent volcanic origin consisting of tuffaceous beds, alluvial, outwash materials and alluvium including mbuga. The slopes of the hills on the north-northeast are dominated by rounded gravels and boulders consisting of pumice, magnesite and basalt, which are floating on top of the volcanic soils derived from surrounding hills and from the adjacent Gregory Rift escarpment. Remnants of the conglomerates are also found on small rounded hills north of Issimingori hill. Much of the fault block area west of Engaruka Basin is covered with grey calcareous soil. On the southern slopes of Issimingori and Burko are black soils with high phosphorous content (Dawson 1961).

Younger extrusive rocks are associated with, or post-date, the main phase of faulting. The largest centers are Kerimasi dominated by carbonatitic materials, followed by Issimongori and Burko. For the case of Issiningori its earliest activity was highly explosive giving rise to central cores of nephelinitic and ijolitic pyroclastic with a thin covering of later lavas. In the pyroclastics, which grade from tuff to agglomerates, the commonest minerals are soda pyroxene, nepheline, magnetite and various carbonate minerals. On Burko the nephelinitic and phonolitic lava are the most prominent eject blocks.

The older extrusive rocks comprise the Tarosero and Kitumbaine volcanoes and the faulted terrain of lava-plateau of Monduli hills. The faulted terrains and the lower slopes of the volcanoes consist mainly of feldspar-phyric-olivine basalt overlain by olivine and augite-phyric-basalts and trachybasalts associated with trachyandesites.

Existence of highly saline spring in the severely incised valley just east of the highest point on Issimingori hill and the small lakes in the Monduli Juu Caldera indicate that it is quite likely that

Engaruka Basin is being recharged by underground springs. On entering the basin, the spring water may dissolve some of the buried salts crust and form underground brines.

### 4.2.3 Topography and Hydrology or Drainage Systems

Engaruka basin lies within the East Africa Rift Valley System (Figure 4.1). It is bounded by two main faults trending in a NW-SE direction. Surrounding the basin is a typical lava plateaus broken into gently tilted or horizontal fault blocks bounded by fault scarps and occasional volcanic cones like Kerimasi, Ketumbaine, Issimingori, Monduli and Burko mountains (Figure 4.2). The basin itself is very flat, an indication that it was once covered by an extensive lake. Its surface is now covered by soils of alluvium including mbuga clays, alluvial and outwash materials including boulders, pebbles, sand and pumice derived from the surrounding volcanic rocks. In some places, particular near the edges of the basin (far from the lake) these loose sediments have been re-worked by wind to from thin layers of Aeolian Deposits.

Rivers and streams, most of them seasonal, flow into the Engaruka Basin from all directions thus forming an internal drainage system. During the rainy season, a shallow lake is formed at the basin centre which becomes an expense of alkaline dust with occasional thin crust of sodium bicarbonate and other salts in the dry season (Figure 4.1). The largest water flows are that of Engaruka River from the NW, Ngurumo ya Komani River from the SE and Emugut Belek from the NE.

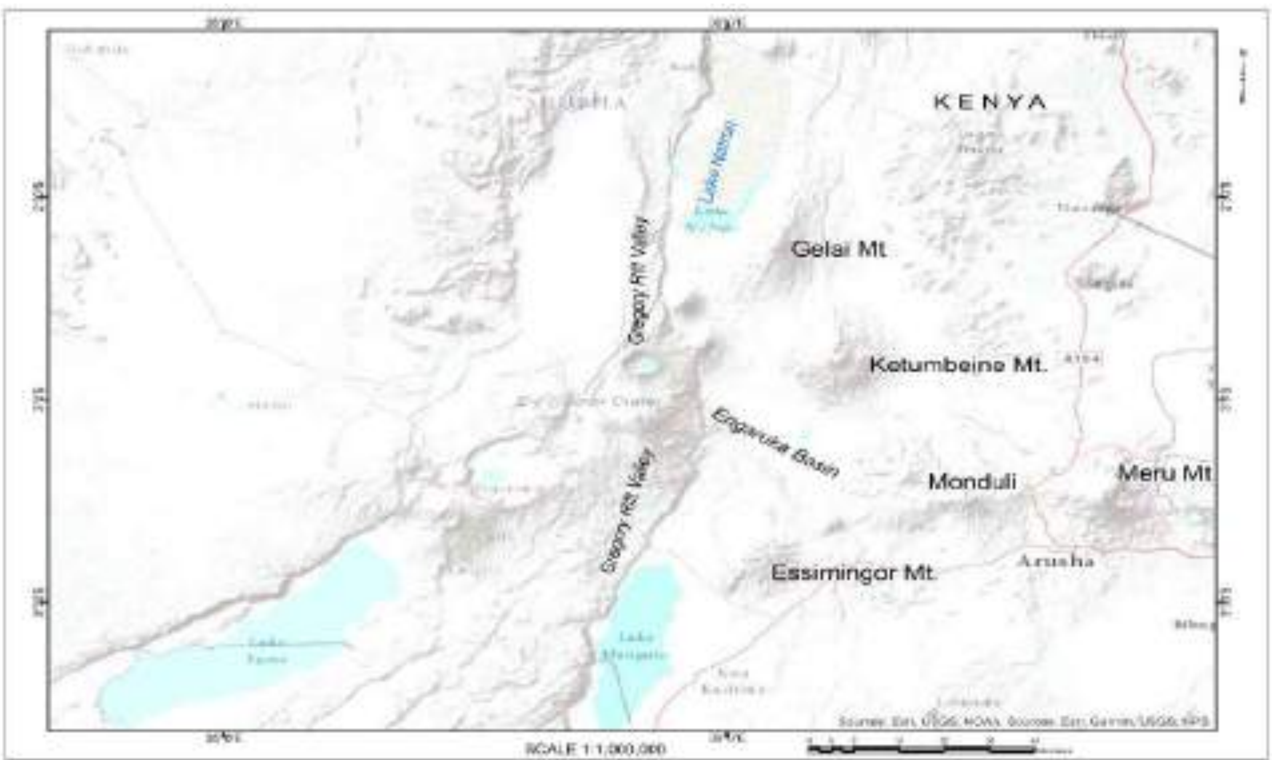


**Figure 4.1.** Position of Engaruka Basin within the East African Rift System (Dawson, 2008)

## 4.3 Air Quality

### 4.3.1 Ambient Dust and Pollutant Gases

A limited spot check air quality survey and analysis was undertaken in the Project site as part of this ESIA process at seven air quality monitorin stations (Fiure 4.2). Measurements of the baseline suspended particulate matter (SPM) namely $PM_{10}$ and $PM_{2.5}$ (Table 4.1a); and pollutant gases (i.e., CO, $NO_X$, $O_3$, VOC, $SO_2$ and $H_2S$) levels (Table 4.1b) were undertaken using Aeroqual series 500 monitors (S-500) within and beyond the proposed project site. The results obtained were well within local standards (TBS and National Environmental Air Quality regulations). However, the $PM_{10}$ and $PM_{2.5}$ concentrations slightly above the WHO standards limits were recorded at AQMS5) and AQMS6. Such high concentrations above WHO limits can be associated with wind impact on bare land and animal grazing. The air quality is expected to be impacted by construction, operation and demolition activities; BUT the implementation of the proposed recommended mitigation measures will keep the levels within the acceptable limits. The detailed air quality baseline study which include the methodologies for results presented in Tables 4.1a-b overleaf, annexed as Appendix 10.

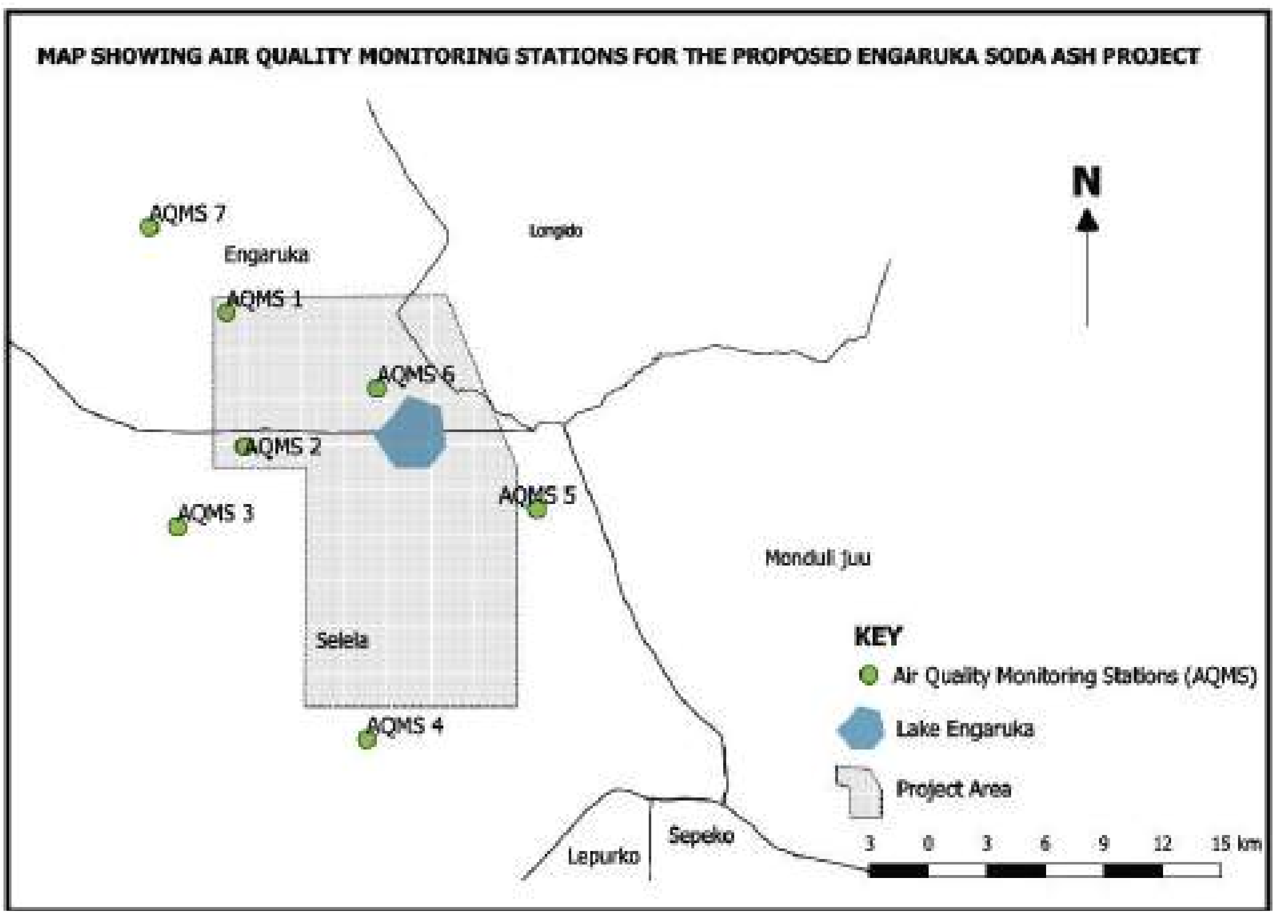


**Figure 4.2. Map showing distribution of air quality monitoring stations**.

**Table 4.1a: Summary of average Particulate Matter (PM2.5 & PM10) results**

| S/N | Sampling Location | Coordinates | | Daily Average Particulate Matter in $mg/m^3$ | |
|---|---|---|---|---|---|
| | | Latitude | Longitude | $PM_{2.5}$ | $PM_{10}$ |
| 1 | AQMS1 (Near Masai boma Residence) | -3.0410194 | 36.0689694 | 0.015 | 0.038 |
| 2 | AQMS2 (Area proposed for project plant) | -3.0991 | 36.0889 | 0.01 | 0.02 |
| 3 | AQMS3 (Near Masai Boma Residence) | -3.13486 | 36.05797 | 0.012 | 0.044 |
| 4 | AQMS4 (Near Masai Boma Residence | -3.2301 | 36.14516 | 0.007 | 0.009 |
| 5 | AQMS5 (Near Masai Boma residence) | -3.12691 | 36.22392 | 0.047 | 0.083 |
| 6 | AQMS6 (Near the lake Engaruka) | -3.0728722 | 36.15009722 | 0.052 | 0.059 |
| 7 | AQMS7 (at the TGA church ground) | -3.00055 | 36.04496 | 0.016 | 0.058 |
| **TBS Limit [TZS845:2005]** | | | | **0.075** | **0.1** |
| **WHO Air Quality Guideline (2006)/IFC (2007)** | | | | **0.025** | **0.05** |

Source: Field Measurements, July 2020

**Table 4.1b: Summarized pollutant gases, relative humidity and temperature results**

| Air Quality Sampling location | Levels of ambient gases, relative humidity and temperature | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $SO_2$ | CO | $NO_2$ | $O_3$ | VOC | $H_2S$ | RH% | Temp$^0$C |
| AQMS1 | 0 | 0.106 | 0.132 | 0.077 | 0.03 | 0.03 | | |
| AQMS2 | 0 | 1.043 | 0.061 | 0.065 | 0.083 | 0.025 | 47.49 | 28.04 |
| AQMS3 | 0 | 0.202 | 0.106 | 0.056 | 0.085 | 0.013 | 43.5 | 29.78 |
| AQMS4 | 0.005 | 1.088 | 0.08 | 0.102 | 0.078 | 0.073 | 40.11 | 31.32 |
| AQMS5 | 0 | 0.542 | 0.091 | 0.059 | 0.093 | 0 | 40.21 | 31.25 |
| AQMS6 | 0.003 | 0.773 | 0.094 | 0.040 | 0.093 | 0.048 | 42.35 | 29.12 |
| AQMS7 | 0.001 | 2.722 | 0.118 | 0.086 | 0.055 | 0.028 | 36.54 | 30.27 |
| **TBS Limits** | **0.2** | **10** | **0.38** | **0.1** | 6 | | | |
| **WHO/IFC Guidelines** | **0.5** | | **0.2** | **0.1** | | | | |

Source: Field Measurements, July 2020

### 4.3.2 Ambient Noise Levels

Noise surveys were taken between 19th July 2020 and 1st August 2020 as part of this assessment. Measurements were undertaken at seven (7) locations while targeting the proposed project site using Environmental Sound Level Meter type DT-8852, in accordance with international standards for sound level meter specifications IEC 61672:1999, IEC 61260:1995 and IEC 60651, as well as ISO 19961:2003 and ISO 3095:2001 for the measurement and assessment of environmental noise.

Ambient noise levels measured at all sites ranged between 48.50 dB (A) and 62.75 dB (A) as shown in Table 4.2. The noise levels at all measured stations were found to be slightly above the TBS standards for residential and Environment standards. This may be caused by wind blowing at high wind speed at the area (the lowest wind speed recorded was 2.4 m/s and the highest was 9.3 m/s). Other sources of noise are local people and livestock (for points taken near residence houses (Table 4.2). The levels are also expected to increase during construction, operation and demolition phases. However, implementation of the proposed recommended mitigation measures will reduce and keep the levels within the acceptable limits. The detailed noise levels baseline section as part of Air quality baseline study is appended as Appendix 10.

**Table 4.2: Summary of mean noise levels recorded from seven (7) sampling stations**

| S/N | Noise sampling Location | Noise Levels | TBS limit for Residential areas | TBS limit for environment |
|---|---|---|---|---|
| 1 | AQMS1 (Near Masai boma Residence) | 58.32 | 50 | 45 |
| 2 | AQMS2 (Area proposed for project plant) | 62.4 | | |
| 3 | AQMS3 (Near Masai Boma Residence) | 61.95 | | |
| 4 | AQMS4 (Near Masai Boma Residence | 58.6 | | |
| 5 | AQMS5 (Near Masai Boma residence) | 57.92 | | |
| 6 | AQMS6 (Near the lake Engaruka) | 62.75 | | |
| 7 | AQMS7 (at the TGA church ground) | 48.50 | | |

Source: Field Measurements, July 2020

### 4.3.3 Ground Vibrations

Ground vibrations were monitored at as part of ESIA study using vibrometer data logger, which is designed to measure ground vibrations according to European standard EN 14253:2003. The recorded levels were compared with both British Standard of 0.3mm/s and 0.15 mm/s PPV (Peak Particle Velocity), the levels that human beings and/or animals can detect or may experience stress resulted to vibrations. The average ground vibration levels recorded were 0.2 mm/s at all stations as mm/s PPV (Table 4.3). However, the anticipated impact resulting from the measured vibrations is considered less-than significant as the levels did not exceed the 0.15 mm/sec PPV criteria established to evaluate the extent that can easily be detected by human. These ground vibration studies are annexed as part of air quality baseline report in Appendix 10.

**Table 4.3: Mean ground vibration measured at seven monitoring stations in mm/s PPV)**

| Measured Station (AQMS) | Morning hours vibration | Afternoon hours Vibration | Evening hours Vibration | Nighttime hours Vibration | 24 hours Average Vibration |
|---|---|---|---|---|---|
| AQMS1 | 0.01 | 0.01 | 0.02 | <0.01 | 0.01 |
| AQMS2 | <0.01 | 0.02 | 0.02 | <0.01 | 0.01 |
| AQMS3 | 0.01 | 0.02 | 0.03 | <0.01 | 0.02 |
| AQMS4 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| AQMS5 | <0.01 | 0.01 | 0.02 | <0.01 | 0.01 |
| AQMS6 | 0.01 | <0.01 | 0.03 | <0.01 | 0.02 |
| AQMS7 | 0.01 | 0.01 | 0.01 | <0.01 | 0.01 |
| **Human detection level** | | | | | **<0.15** |
| **TBS-NES Limit** | | | | | **5** |
| **% of Stations > Human detection level** | | | | | **0.00%** |
| **% of Stations > TBS-NES Limit** | | | | | **0.00%** |
| **Human detection level** | | | | | **<0.15** |

***Source:*** Field measurement, July, 2020

## 4.4 Water Quality in the Study Area

Water sampling was done using a number of tools including sampling bottles (plastic and glass) of 1000ml, clean cool box, ice bags, Ethanol 70%, masking tape, marker pen, notebook, YSI professional pro multi probe system and Cotton wool. Plastic bottles were used for sampling of water for physical and chemical analyses, while sterile glass bottles were used to collect samples for microbiological analyses of water from three Rivers (Engaruka, Serela and Buko Rivers). Sampling bottles were rinsed with river water three times before filling. After rinsing, the bottles were submerged below the water level and allowed to fill up to the neck of the bottles. The lids were screwed on tightly to prevent leakage. For microbiology sampling, the bottles and lid were kept close to avoid contamination during filling. Samples were collected from downstream, midstream and upstream and transported to TIRDO laboratory for physical, chemical and microbiological analysis (Appendix 11).

Chemical oxygen Demand (COD) for WSP2, WSP3, WSP4, WSP5 were not detected except for WSP1 (Appendix 11). Na, Zn, Mg, Ca, Pb and $SO_4$ were found to be within the limits but Cr, Mn, Cd, Ni, exceed limits of Natural portable water standards (TBS). Physical parameters measured onsite (pH, conductivity, Total Dissolved Solids (TDS) and turbidity, Colour) from all sampling locations were within the acceptable Natural portable water standards (TBS). High temperature of 43.7˚C was recorded at WSP4 because the water is taped from the source by using black plastic pipe which is exposed direct to sunlight. For microbiology analysis, faecal coliforms and total coliforms for WSP3, WSP4, results were within the limits but WSP1, WSP2, and WSP5 the results exceed the limits.

## 4.5 Archaeology

The baseline archaeology and palaeontology study was also conducted to obtain a good understanding of overall archaeological and cultural heritage conditions of the area through a desktop study; to locate, identify, record, photograph and describe sites of archaeological, cultural or historical importance within the development footprint; to identify potential impacts and to suggest pertinent measures to manage the potential impacts; and to ensure that local heritage requirements (Antiquities Act of 1964 and Antiquities Act, Amendment Act of 1979) are met as well as international the best practice including IFC Performance Standard 8, Cultural Heritage.

The study did not identify any archaeological or palaeontological materials in the project area. That pattern justifies the scoping exercise that was done before. Besides, in terms of cultural heritage assets, notably, graves and ritual places, based on Wamasaai cultural traditions, they relegated disclosure to their leaders. Although no archaeological or palaeontological materials were spotted, the client is advised to facilitate publication of archaeological and palaeontological materials recovered from adjoining areas (for example, those from Olduvai Gorge), which are cultural heritage resources to be designed by experts in Kiswahili and English. They will be suitable for both work cadres who will be informed of possible encounter of similar objects whereby they will be required to report to the project authority. Upon such revelation from workers concerning the said materials, the project authority will have to call upon archaeologist and palaeontologists who will inspect the spotted materials for decision-making about authenticity, value and integrity. Then they may decide to remove or pave the way for their conservation and care so as to permit smooth proceed of desired project operations.

### *4.5.1 Archaeological and Palaeontological Resources in Areas at Close to Project Site*

Not very close to the project area, there the only protected, conserved and presented archaeological materials by the government through Antiquities Division, Ministry of Natural Resources and Tourism. Such materials encompass world famous ancient irrigation channels at Engaruka Juu village in Engaruka ward interpreted to be some 500 years ago by farming community of several thousand people (Sassoon, 1978, 1971, 1967; Sutton, 1984, 1978). They include iron age materials that are dated in the same time period (*ibid*.). Although they have been extensively documented, they are still being studied to quench scientific knowledge at diverse dimensions. However, it has to be noted that the said cultural heritage resources are outside the proposed project area by far.

### *4.5.2 Verdict Pertaining to Archaeological and Palaeontological Resources*

The described world-famous ancient irrigation channels at Engaruka Juu village in Engaruka ward interpreted to be some 500 years ago by farming community of several thousand people including iron age materials in the same vicinity are outside the proposed project area by far. They will never be disturbed by any undertakings in the proposed project. Therefore, the desired Project should be carried out as planned because there will be no effect for archaeological or palaeontological materials.

Moreover, the survey involved noticing geological formation in form of pillars (Figure 4.3). They stand in Engaruka Chini village outside the project area whereby during the meeting at Mbashi village, participants mentioned them as pyramids. They informed that they take tourists to such rock structures. They have to be closely examined by geologists so as to ascertain their formation. Are they volcanic rocks or sedimentary rocks? So far, literature has never led to determination of such pillars.

**Figure 4.3: Geological formation in form of pillars observed at Engaruka chini village**

The only protected, conserved and presented archaeological materials are the famous ancient irrigation channels at Engaruka Juu village in Engaruka ward interpreted at some 500 years ago by farming community of several thousand people (Sassoon, 1978, 1971, 1967; Sutton, 1984, 1978). They have been thoroughly documented and they are still being studied to quench scientific knowledge at diverse dimensions. The said cultural heritage resources are outside the project area by far.

## 4.6 Biological Characteristics of the Proposed Project Site

### 4.6.1 Flora

The vegetation in the proposed project area has largely been transformed by impacted associated by domesticated animals, wildlife and human settlements. Floristically, the vegetation of the study area falls under Phytocorion of Somali- Masai- *Acacia-Commiphora* bushland and thickets characterized by Edaphic grassland on volcanic soils, halophytic vegetation and thicket bushland. According to floristic division of Tanzania which ranges T1-T8 Engaruka falls under floristic region T2 which is known to harbor 113 purely endemic plant species. Those endemic species include; 11 Trees, 32 shrub, 62 herbs and 8 climbers according to Least of East African Plants database LEAP (1996). Therefore, it is likely that some of these plant species might be occurs in the proposed project area of which they need to be identified for conservation concern.

From the Flora inventory baseline report (Appendix 12), about 233 plant species represent 6 life forms includes: Herbs 98, trees 48, Grass 47, Shrubs 30, Climber 10 and sedges 2respectively. *Commiphora campestres* which is restricted to T2 and T3 floristic regions in Tanzania has been identified as one endemic tree species in the area. However, currently there is no project activity allocated to be executed in this vegetation category therefore there is no risks of extinction of this habitat as well as loss of biodiversity due to the project activities. It is highly recommended to protect this habitat as it hosts the key plant species as mentioned above. Moreover, a total number of 233 of vascular plant species from 6 life forms have been identified growing in the project area. The identified species are from 41 families. The family with the highest number of species includes; *Gramineae* 47, *Acanthaceae 22*, *Papilionoideae 19* and *Compositae* 10 with *Amaranthaceae*, *Labiatae* & *Malvaceae* found having 8 species each. The rest are represented with species ranges 1-7 respectively.

#### 4.6.1.1 Vegetation categories classified into four main project impact areas

Ten (10) main vegetation types occurring in the project area with several number of life forms as well as individual species were classified during the ESIA study (Figure 4.4). These include Edaphic grassland (Figure 4.5a), Bushed grassland (Figure 4.5b), Riverine thickets (Figure 4.5c), *Acacia- Commiphora* open woodland (Figure 4.5d), Thicket bushland (Figure 4.5e), *Acacia tortilis* woodland (Figure 4.5f) and Seasonal swamp marshland (Figure 4.5g), with Edaphic grassland covering 35% of the concession area followed by Bushed grassland with 25%. Other classified vegetation categories presented by Flood plain bushed grassland, Settlements (Maasai Bomas), and Semi-desert grassland and bushes.

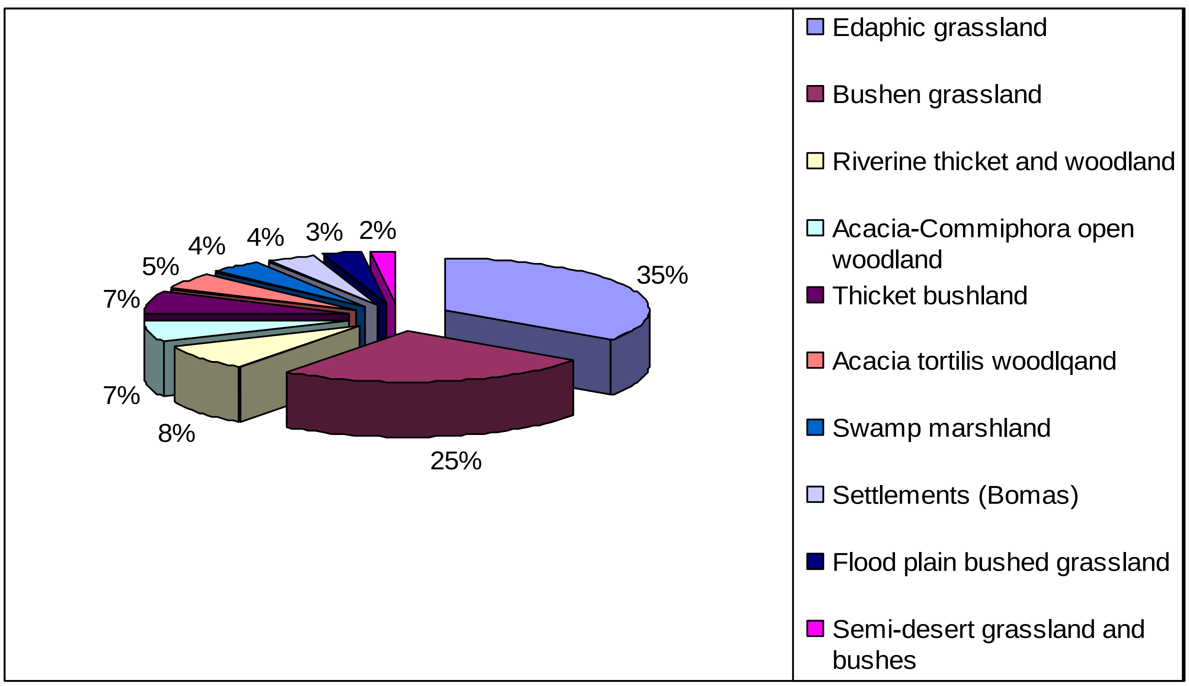


**Figure 4.4: Classified vegetation types and their estimated percentage cover**

### (a) <u>Edaphic grassland:</u>

This vegetation category is characterized by a land which is covered with grass species with very few clumps of herbs and single tree. This vegetation type becomes barely during dry season due to animal grazing both domestic and wild. In the project area this vegetation category occupies the

largest percentage cover 35% of the entire vegetation of the project area. Dominant grass species are: *Chloris pycnothrix, Chloris gayana, Digitaria velutina, Heteropogon contortus, Aristida babicolis, Cynodon dactylon, Sporobolus consimilis* and *Panicum infestum* Scattered few shrubs are *Boscia coriacea, Dobera Lorathifolia* and *Cadaba faricosa* as shown on Figure 4.5a.
This vegetation type is dominated by annual species; therefore the project activity will have no impacts on it as it can easily regenerate. Also this vegetation is locally and regional common and it supports no species of conservation concern. Therefore, any of the project activities which will cause vegetation clearing it will cause no possible loss of biodiversity.

**Figure 4.5a:** Edaphic Grassland

**(b)** **Bushed grassland:**

This vegetation characterized by an area covered by grass, dwarf bushes and woody herbs growing on rocky volcanic soils. The dominant grass species in this category includes: *Setaria homonyma, Chloris virgata* and *Cynodon nlemfuensis.* The dominant woody herbs and bushes includes: *Barleria grandicalyx* subsp., *Mucronata*, *B. acanthoides, Hermannia uhligii*, *Heliotropium stedneri Sericocomopsis hildebrandtii,* and *Justisia heterocarpa* as shown on Figure 4.5b below. This category is the second largest in the project area with an estimated 25% cover of the entire vegetation of the project area which is currently used for cattle grazing. In the project area this category is the second largest occupies an estimated cover of 25% of the entire area.

The proposed area for the construction of the plant is falling in this vegetation category. Therefore, part of it will be cleared for the construction activities. However, this vegetation category is locally and regional common with no species of conservation concern.

**Figure 4.5b:** Bushed grassland

### (c) <u>Acacia –Commiphora Open woodland:</u>

This vegetation type is characterized by a stand of scattered trees with single layer dominated by two genera of tree species of *Acacia* and *Commiphora* and the ground layer is covered with grass and herbs on rocky soil. Dominant tree species includes; *Acacia torilis, Commiphora africana, C. campestres* and *Acacia nubica.* The ground layer is dominated by woody herb of *Barleria grandicalyx* subsp. *mucronata* and *Aerva lanata.* The grass species are *Chloris pycnotrix* and *Aristida keniensis* as shown on Figure 4.5c. This vegetation category is located at the eastern boundary of the project area at Embaashi area. This vegetation type harbor an endemic tree species of *Commiphora campestres* which is restricted to T2 and T3 floristic regions in Tanzania. However, currently there is no project activity allocated to be executed in this vegetation category therefore there is no risks of extinction of this habitat as well as loss of biodiversity due to the project activities. It is highly recommended to protect this habitat as it hosts the key plant species as mentioned above.

**Figure 4.5c:** *Acacia –Commiphora* open woodland

## (d) Thicket bushland:

This vegetation category is characterized by an assemblage of woody species with canopy height less that 5m tall forming a dense impenetrable on the under storey. In the project area this vegetation type is growing in small patches at Engaruka chini near extraction well no U2. It is dominated by small trees includes: *Acacia tortilis*, *A. mellifera*, *A. nubica*, *Maerua edulis*, *Grewia tembensis, Balanites aegyptiaca,* and *Cordia ovalis* includes; *Barleria grandicalyx, Sida cordifolia*, *Duosperma crenatum* and *Cucumis dipsaceus* as shown in Figure 4.5d below. This vegetation category is locally and regionally common and it supports no species of conservation concern. Therefore, the execution of the project activities will have caused no risks of loss of biodiversity.

**Figure 4.5d:** Thicket bushland

## (e) Acacia tortilis woodland:

This vegetation type is characterized by an assemblage of woody species dominated by a single species of tree layer which is *Acacia tortilis* as shown on Figure 4.5e. The ground layer is dominated with herbaceous and few shrubs of which mostly are the tree lets of the same canopy species. The height of this vegetation ranges from 3-6m tall and the growing layer is sometimes bare due to over grazed.

In the project area this vegetation type is commonly found at Engaruka chini and it falls in an area where the residential and business are to be constructed. Part of this vegetation will be cleared during the project implementation. This vegetation is a good habitat which harbors various animals including birds. Also, it is a good source of building materials as it dominated with woody species. However, this vegetation category is locally and regionally common and it support no species of conservation concern. Therefore, the project activities will cause to possible loss of habitat and biodiversity. Also, similar vegetation category is available at Mbaashi area where it will not be cleared. In addition, the listed below recommendations should be implemented during the constriction time by the project developer.

**Figure 4.5e:** *Acacia tortilis* Woodland

**(f) <u>Riverine thicket- woodland:</u>**

This vegetation type is characterized by an assemblage of woody species with small trees and shrubs forming a dense impenetrable thorn bushes underneath growing along the seasonal river. In the project area this category is found in patches growing along the valley dominated with the following shrubs; *Grewia tembensis, G. similis, Harrsisonia abyssinica, Cadaba faricosa, Dombeya shupangae, Lycium shawii,* and *Ziziphus mucronata.* Scattered small trees includes*; Dobera loranthifolia Cordia sinensis* and *Acacia tortilis.* The ground *cover* is dominated with *Achyranthes aspera, Capparis tomentosa* and *Aerva lanata* as shown Figure 4.5f. This vegetation category is a major source of building materials and fuel wood to the villagers of Engaruka chini near the lake. Although this vegetation category fall within the project foot prints but it is located away from the extraction wells. Besides the fact that this vegetation category harbours a diverse of woody species but it supports no species of conservation concern. Therefore, the execution of the project activities will have no impacts onto this category as well as there are no possible risks of loss of biodiversity.

**Figure 4.5f:** Riverine thickets

**(g) Seasonal swamp marshland:**

This vegetation category is characterized by a land which is dominated by water loving plants either in areas with permanent water body or areas with high water table. The dominant plant species includes sedges rushes and grass. In the project area this vegetation category is found permanent foung along the lake shores during dry season and in wet season is also found in areas with depression in the flood plain. Dominant grass species are *Soporobolus concimilis Echnochloa pyramidalis* and *Leersia hexandra.* The dominant reed is *Typha capensis* and the sedge species are *Cyperus exaltatus,* and *C. rondus* as shown Figure 4.5g.

This vegetation category is very fragile hence it is totally depending on the availability of water. Also, this vegetation type is highly used by pastoralist for grazing cattle during dry season and it has catchments values. The project activities will have a slightly impacts on this vegetation as some of the extraction wells are near the lake shore on both sides. Hence the extracted soda ash will be pumped to the factory thorough big pipes it is expected that the excavation work for burring the pipes from the lake to the factory will only occupy a small corridor. Therefore, little vegetation will be cleared. However, this vegetation type is locally and regional common and it supports no species of conservation concern therefore there is no risks of loss habitat loss and biodiversity due to execution of the project activities.

**Figure 4.5g:** Seasonal swamp marshland *Cyperus rotundus*

### (h) <u>Settlements (Bomas):</u>

This vegetation category is characterized by a land which its natural vegetation has been cleared being replaced by houses and other human activities. In the project area this vegetation category is found in scattered patches commonly known as Maasai bomas, where few houses surrounded by cattle encloses are found as shown Figure 4.5h. This vegetation type part will be affected by the project activities especially those ones which will fall within the project foot prints where project infrastructures will be constructed. However, resettlement action plan (RAP) will be negotiating with the victims and a reasonable compensation should be done to avoid land use conflicts as well as an alternative land should be allocated for new settlements.

**Figure 4.5h: Settlements (Bomas) and Cattle enclosure (Boma)**

## (i) <u>Flood plain bushed grassland:</u>

This vegetation type is characterized by a land which is covered with grass and scattered bushes which is subjected to floods during wet season. During dry season the grass species has been over browsed by cattle only non-palatable herbs becomes dominant. The most dominant herb is *Justicia scandens* followed by, *Aerva lanata*, *Abutilon longicuspe*, *Leonotis mollisima*, *Monechma debile*, *Solanum coagulans*, *xanthium strumarium*, *Melhania velutina* and *Heliotropium steudneri.* Remnants of grass species includes; *Eriochloa fatmensis*, *Setaria homonyma*, *Eragrostis aspera* and *Panicum trichocladum.* The dominant climber *is Cucumis dispsaceus.* Emergent trees species includes; *Dobera loranthifolia*, *Acacia tortilis* and *Boscia corieacea* and *Cadaba faricosa* ssp. *Adenotricha* as shown in figure 4.5i below. In the project area this vegetation category is commonly found at Endorokoko village in Mbaashi ward. Five soda ash extraction wells are located in this area such as well no 12, 13, 14, 15 and 16 respectively. Therefore, the project activities will slightly disturb this vegetation type during the implementation period. However, this vegetation type is already highly disturbed due to grazing and also it supports no species of conservation concern. Either this vegetation category is locally and regionally common. Therefore, there are no risks of loss of biodiversity due to implementation of the project activities.

**Figure 4.5i: Degraded flood plain bushed grassland at Endorokoko village**

## (j) <u>Semi-desert grassland and bushes</u>

This vegetation category is being characterised by a mixture of bare land with scattered clumps of dry bushes less than 2m tall, few grasses and herbs. In the project area, this vegetation type is commonly found near the lake where most of the extraction wells/ bore holes are located. Common species of bushes includes; *Grewia sp. Boscia coriacea* and *Dobera lorathifolia.* The dominant herbs on the ground are *Portulaca orelacea* and *Aerva lanata* Common grass species includes; *Sporobolus spicatus* and *Cynodon dactylon* as shown Figure 4.5j.

This vegetation category is common in the area found in small patches and it supports no species of conservation concern. Therefore, the project activities will have very minimum impacts on it, as there is no much plants to clear during the construction.

**Figure 4.5j: Semi-desert grassland & bushes vegetation type**

### 4.6.1.2 List of IUCN Threatened Plant species Categories (Version 2009)

The globally threaten plant species from the **IUCN** Red List (Figure 4.6) falls under the following main categories: -

**(a) <u>Extinct (Ex):</u>**

*A taxon is extinct when there is no reasonable doubt that the individual has died. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.*

In the project area, non-of the plant species in this category have been identified.

**(b) <u>Extinct in the Wild (EW):</u>**

*A taxon is Extinct in the will when it is known only to survive in cultivation, in captivity or as a naturalised population (populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.*

In the project area, non-of the plant species in this category have been identified.

**(c) <u>Critically Endangered (CR):</u>**

*A taxon is critically Endangered when the best available evidence indicates that it is facing an extremely high risk of extinction in the wild.*

In the project area, non-of the plant species in this category have been identified.

**(d) <u>Endangered (E):</u>**

*A taxon is endangered when the best available evidence indicates that it meets any of the criteria for Endangered is therefore facing considered to be facing a very high risk of extinction in the wild.*

In the project area, non-of the plant species in this category have been identified.

**(e) <u>Vulnerable (VU):</u>**

*A taxon is Vulnerable when the best available evidence indicates that it is facing a high risk of becoming endangered in the wild.*

In the project area, non-of the plant species in this category have been identified.

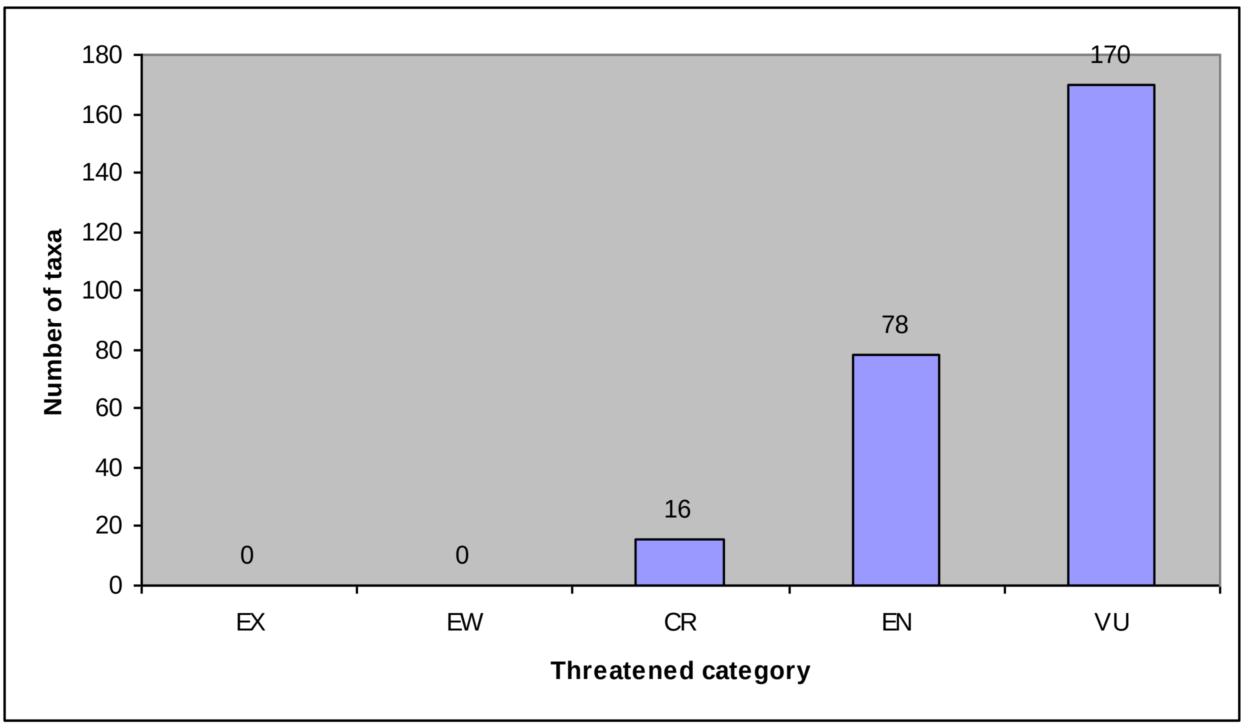


**Figure 4.6: Current status of IUCN threatened plant species in Tanzania, 2019**

**4.6.1.3 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)**

The basic principles of the CITES is to control and monitor international trade in endangered and threatened species. The Convention establishes the international legal framework for co-operation of the producer and consumer is essential for the conservation of the species traded from the wild. The convention operates by means of a licensing system. At the core of the Convention are three appendices-in effect three species lists or Appendices as follows:

(a) *Appendix 1 includes those species of animals and plants in which, with a few exceptions trade in wild specimens is prohibited.*
In the project area, non-of the plant species in this category have been identified.

(b) *Appendix II includes those species whose survival is not yet threatened but may become so. Here trade is allowed in both wild and artificially propagated or captive bread specimens-subject to licensing.*
In the project area, non-of the plant species in this category have been identified.

(c) *Appendix III in this category acts as a support mechanism to domestic legislation, where countries ask other parties to monitor trade taxa not listed on appendix 11 or Appendix 1.*
In the project area, non-of the plant species in this category have been identified.

**4.6.1.4 Endemic plant Species**

*Endemic plant species are plants which are native and confined to a particular region and not native to other areas.*

In the project area, one tree species *Commiphora campestres* has been identified growing in the *Acacia-commiphora* open woodland vegetation category as shown in Figure 4.7 below.

**Figure 4.7: Commiphora campestres – (Burceraceae family)**

### 4.6.1.5 Possible Impacts of Project Activities on the Vegetation in the Project Area

From the survey findings, it has been established that the proposed establishment of the Soda ash factory falls in areas with significant cover of natural vegetation with human settlements. The project area also falls in the vegetation types which supports the lives of key plant species such an endemic tree. Although the project foot prints fall in vegetation which supports the growth of an endemic tree species, but the endemic tree is well distributed in the areas outside the foot prints. Therefore, there will be slightly **negative direct impact** on the vegetation during the Construction work.

There is a high possibility of introducing an invasive and alien plant species in the area during construction and operating time due to high movements of vehicles to and from the factory to urban areas. Animal road kills might increase due to increase of traffic to and from the project area during construction and operating time.

There is a chance of creating land use conflicts between pastoralist and agriculturists during the operating time as some people might establish commercial agricultural activities due to increase of population into the surround areas which leads into high demand of food.

The existing natural woody vegetation such *Acacia tortilis* woodland and *Acacia-commiphora* open woodland in the project area and its surrounding will be vulnerable as a source of energy such as charcoal and building materials. The factory employers and influx of business man to the area will increase the demand of forest products especially charcoal which are limited.

*(a) Mitigation Measures and Recommendations*

- During the construction time most of the infrastructures such as road and buildings should be placed in areas which does not bear woody vegetation to avoid unnecessary tree cutting which are rarely life form in the project area.
- The use of fuel woody as a source of energy in the project area especially in camps and residential areas during the construction and operating time should be prohibited to discourage the demand of fuel wood.
- Unnecessary tree cutting and vegetation clearing should be avoided during the construction time to avoid loss of biodiversity and habitat loss.
- To avoid much destruction of the natural habitats within and surrounds of the project area, it is recommended that quarrying materials should be collected in the areas with scattered rocks lather than on the hills of kopjes which forms the natural beauty of the areas suitable for scenery tourism**.**
- The-project developer should liaise with the forest department of Monduli district on managing and monitoring the business of charcoal to make sure that there is no sporadic exploitation of the trees from the natural vegetation within the project area.
- During digging soil pits and quarrying areas, the top soil should be pulled aside in one place, then after finishing the work the top soil should be recovered on top of the pits so as to allow

the regeneration of the indigenous plants of which their seed bank always stays with the top soil.

- In order to maximise the utilisation of the existing natural resources, some of the large quarrying and soil collecting pits can be modified onto dams and small lakes which can be used as a source of water for green house irrigation, animals, fish farming and recreation.
- The project developer should liaise with the district land use office to make sure that land for agricultural activities are not allocated near the project area as it used to be currently. This is to avoiding land use conflicts between the pastoralists and agriculturist who they have been there for many years without cropland.
- In order to avoid excessive road killing for the wildlife and cattle along the route after the implementation of the project, the road reserve areas should be made wider enough and being cleared regularly so as to allow both animals and the drivers to have a clear vision before crossing or passing on the road. Also signs of speed limit should be placed every after short distances.
- In areas where rehabilitation or vegetation restoration is to be conducted indigenous plant species should be planted instead of exotic species which they can be invasive. After construction activities landscaping should be directed to use native plant species for decoration and gardening instead of exotic ones.
- Finally, it is strongly recommended that the project developers should try to recruit labourers from among the villages which falls on the project foot prints so that they can learn about various construction techniques used to avoid environmental degradation as well as conservation techniques.

*(b) Vegetation Monitoring*

Monitoring should assess the effect of the project on the natural and cultural environment. Monitoring programmes would improve significantly the effectiveness of the project since it can provide a mechanism for ensuring that the proposed mitigation measures have been carried-out and determining whether predictions were accurate. Therefore, monitoring programme of the vegetation should be carried out during and after the implementation of the project especially the invasive species.

*(c) Conclusions as per Vegetation Baseline Study*

From the survey findings it has been concluded that, the execution of the Soda Ash project has very little direct negative impact onto the vegetation. This is due to the fact that major part of the project foot prints falls on common vegetation categories such as the Edaphic grassland and Bushed grassland. These vegetation types can easily regenerate after clearance and they are locally and regionally common.

### 4.6.2 Fauna

The Project's fauna inventory baseline study (Appendix 13) carried out in dry and wet seasons has identified a number of domesticated animals, wildlife, birds and insects covering mammals, reptiles (various snakes and lizard species), amphibians, avifauna (bird species), insects and other dwelling invertebrate assemblages (Figures 4.8a-b) present in the concession area. Mammals of wildlife category that frequented the project area include lion, leopard, warthog, wildebeest, giraffe, ostriches, gazelles, zebra and hare whereas the domesticated animals observed among the thickets were cattle, goats, sheep and donkeys. Moreover, droppings of foxes were also seen in the project area, signalling the presence of the named animal in the area. Other spotted animals include some snakes and lizards (i.e., *Mabuya striata*); amphibians (guttural toads); avifauna (passerine birds, guinea fowls, francolins, ostriches and herons. It was also reported that the lesser flamingos were occasionally visited the area during prolonged wet season.

**Figure 4.8a: Some domesticated animals grazing in the project area**

#### 4.6.2.1 Wild animals

The wild big and small mammals that were observed and reported in and around the project area durin dry and wet seasons are listed in Table 4.4 below. However, impacted few wild animals will move to nearby areas i.e., Ngorongoro, Serengeti, Tarangire and Manyara.

**Table 4.4: Wild animals identified in the project area**

| S/N. | Common name | Scientific name | Dry season | Wet season | conservation status |
|---|---|---|---|---|---|
| 1 | Burchell's zebra | Equus bruchelli | | v | Lc |
| 2 | Thompson gazelle | Gazelle thompsonii | | v | Lc |
| 3 | Impalas | Aepyceros melamps | | v | Lc |
| 4 | Wildebeest | Connochaetes gnou | | v | Lc |
| 5 | Baboons | Papio cynocephalis | | v | Lc |
| 6 | Savanna Hare | Lepus victoriae | v | | Lc |
| 7 | Elephant shrew | Rhynchocyon chrysopygus | v | | Lc |
| 8 | Giraffe | Giraffe camelopadalis | | v | Lc |
| 9 | Leopard | Panther pardus | | v | Vu |
| 10 | Lion | Panthera leo | | v | Vu |
| 11 | Spectackled dormouse | Graphiurus ocularis | v | | Lc |

**Lc= Least concern, Vu= Vulnerable**







**Figure 4.8b: Some of the wildlife animals and birds sported within project area**

### 4.6.2.1 Reptiles

The arid conditions favour only a few reptilians' species that can withstand prolonged dry conditions. The observed reptiles included some snakes and skinks (Table 4.5).

**Table 4.5: List of identified Reptilians within the project area**

| S/N. | Common name | Scientific name | Dry season | Wet season | Concervation status |
|---|---|---|---|---|---|
| 1. | African rock python | Python sebae | V | | LC |
| 2. | Tropical gecko | Hemidactylus mabouia | V | | LC |
| 3. | African striped skink | Trachylepis striata | V | V | LC |
| 4. | Leopard tortoise | Stigmochelys pardlis | V | | LC |

### 4.6.2.2 Amphibians

The arid conditions in the area do not favour colonisation of amphibians because they need freshwater always although they can survive on land for some time. The only amphibian types that were observed in the area include some guttural toad and the clawed frog (Xenopus sp).

### 4.6.2.3 Birds

A number of passerine birds including Lesser Flamingo were observed visitin and/or perching on the trees and Engaruka basin during dry and wet seasons. However, the basin is not a breeding site for Lesser Flamingo rather than visiting site hence the impact of the project to these species considered insignificant. A checklist of birds that were observed /reported (by Birdlife international. 1996) in the project area is given in Table 4.6.

**Table 4.6: List of identified Birds' species within the project area during dry and wet seasons**

| S/N. | Common name | Scientific name | Dry season | Wet season | Ecological status |
|---|---|---|---|---|---|
| 1. | Ostrich | *Struthio camelus* | V | V | LC |
| 2. | Namaqua Sand grouse | *Pterocles namaqua* | V | V | LC |
| 3. | Grey headed sparrow | *Passer griseus* | V | V | LC |
| 4. | Red winged starling | *Onychognathus morio* | | V | LC |
| 5. | Greater commorant | *Phalectocorax carbo* | | V | LC |
| 6. | Pink- banded pelican | *Pelecanus rufescens* | | V | LC |
| 7. | Squacao heron | *Ardeolle relloides* | | V | LC |
| 8. | Greta white egret | *egrettavalba* | | V | LC |
| 9. | Grey heron | *Ardea cinerea* | | V | LC |
| 10. | saddle billed stork | *Ephipprorhynchus senegalensis* | | V | LC |
| 11. | Marabou stork | *Leptoptilis cruneniferus* | | V | LC |
| 12. | Glossy ibis | *Plegadius falcinellus* | | V | LC |
| 13. | African spoonbill | *Platalea alba* | | V | LC |
| 14. | Cape wigeon | *Anas capensis* | | V | LC |
| 15. | Crowned crane | *Balearica pavonina* | | V | LC |
| 16. | Avocet | *Recuvirostra avosetta* | | V | LC |
| 17. | Wood sandpiper | *Triangea glare* | V | V | LC |
| 18. | African black crow | *Corvus capensis* | V | V | LC |
| 19. | Pied crow | *Corvus albus* | V | | LC |
| 20. | White naked raven | *Corvus albicolis* | V | | LC |
| 21. | Superb starling | *Lamprotornimus superbus* | | V | LC |
| 22. | Burchells starling | *Lamprotornis australis* | | V | LC |
| 23. | Red-winged starling | *Onychognathus morio* | | | LC |
| 24. | Scarlet chested sunbird | *Nectarinia senegalensis* | | V | LC |
| 25. | Mariqua sunbird | *Nectarinia mariquensis* | | V | LC |
| 26. | Lesser masked weaver | *Ploceus intermedius* | | V | LC |
| 27. | African red-eyed bulbul | *Pycnonotus nigricans* | V | V | LC |
| 28. | Bearded woodpecker | *Thripias namaquus* | | | LC |
| 29. | Southern yellow billed hornbill | *Tockus leucomelas* | | V | LC |
| 30. | Speckled mousebird | *Colius striatus* | | V | LC |
| 31. | Secretary bird | *Sagittarius serpentarius* | | V | LC |
| 32. | Crested francolin | *Francolinus sephaena* | | V | LC |
| 33. | Helmented Guinefowl | *Numida meleagris* | V | | LC |
| 34. | Laughing dove | *Streptopelia senegalensis* | V | | LC |
| 36. | Greater flamingo | *Phoenicopterus ruber* | | V | LC |
| 37. | Lesser flamingo | *Phoeniconaias minor* | | V | NT |

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**4.6.2.4 Fishes**

A trial fishing in the Engaruka Lake never yielded any fish catch. This can be associated with the seasonality of the lake as well as the soda ash content/characteristic of the lake which appeal to the tolerant levels of fish species. Moreover, the locals could not give definitive answers on the existence of fishes in the rivers because Maasai tribe do not eat fish or interested.

#### 4.6.2.5 The animal habitats

At the time of the baseline study, some habitats had changed especially the grass had dried out rendering some areas bare. Only a few areas still had some habitat that could provide refugia to animals. The animal habitats in the proposed project area include the ten terrestrial vegetation categories as was described by the vegetation expert ie., Edaphic grassland, Bushed grassland, Riverine thickets, Acacia- Commiphora, open woodland, Thicket bushland, Acacia tortilis woodland, and Seasonal swamp marshland, the seasonal rivers/ streams for aquatic habitats. However, there also exists an extensive open scrubland adjacent to the project site which is also utilized by both domesticated and wildlife.

#### 4.6.2.6 Unique and endangered species

As far as the ESIA study has managed to determine, there are no unique or particularly national-listed threatened or endangered animal species present within or in the near vicinity of the project area except for the lesser flamingos. It was reported by the locals that the lesser flamingos were occasionally visited the area during prolonged wet season. The in-depth baseline study will therefore reveal if there is any fauna species with some ecological significance.

#### 4.6.2.7 A Declaration of Sensitive Ecosystem or Areas

The proposed project area lies within the GCA, hunting block, migratory corridior and wildlife dispasal area (Figure 4.9). The wildlife migration corridor lies between Tarangire National Park and the Northern Gelai plains south of Lake Natron. The Tarangire Ecosystem is defined by the large migratory ranges of the eastern white-bearded wildebeest and Grant's zebra as they move in and out of Tarangire National Park in their age-old search for water and food. Research has shown that 30-50% of Tarangire wildebeest migrate northward to give birth in the Northern Plains, and thousands of Tarangire's zebra, eland, oryx, and gazelles also use the plains south of Lake Natron each wet season. Only 2 of the former 10 migration routes remain – one north to the Opirr Calving Grounds on the Gelai Plains, and one east to the Simanjiro Plains. These populations migrated along 10 routes between their dry-season range in Tarangire and their wet-season ranges outside the park, with annual distances up to 250 km. The wet-season range is critical because it provides nutrient-rich grass necessary for reproduction.

Genetic evidence indicates that Tarangire population of wildebeests is unique, as it has not mixed with the population in Serengeti/Ngorongoro for thousands of years. Thus, the loss of these wildebeests could mean the extinction of an entire species. Because neither route is adequately protected, habitat within these migration corridors continues to be rapidly lost to farming and permanent human settlements, and illegal poaching of wild ungulates along the migration routes. Not surprisingly, the eastern white-bearded wildebeest declined from 40,000 animals in 1988 to just 7,000 in 2014. Therefore, conserving the migration from Tarangire to the Northern Plains is very important as it will protect the notably the unique population of eastern white-bearded wildebeest. Conservation of the migration corridor will preserve the economy, ecology, and culture of the Tarangire Ecosystem and provide an engine for economic growth in the region for generations to come.

Ecologically, the closest sensitive biological ecosystem to the project area is the Ngorongoro Conservation Area (NCA) located about 14 kms away northwest of the project area. Another is lake Natron (which harbouring the lesser flamingos) located about 60 km on the norther side of the project site and Engaruka ruins about 25 km away from the project site. Strategically, there is no sensitive public utilities such as schools and hospitals and military base in the project area.

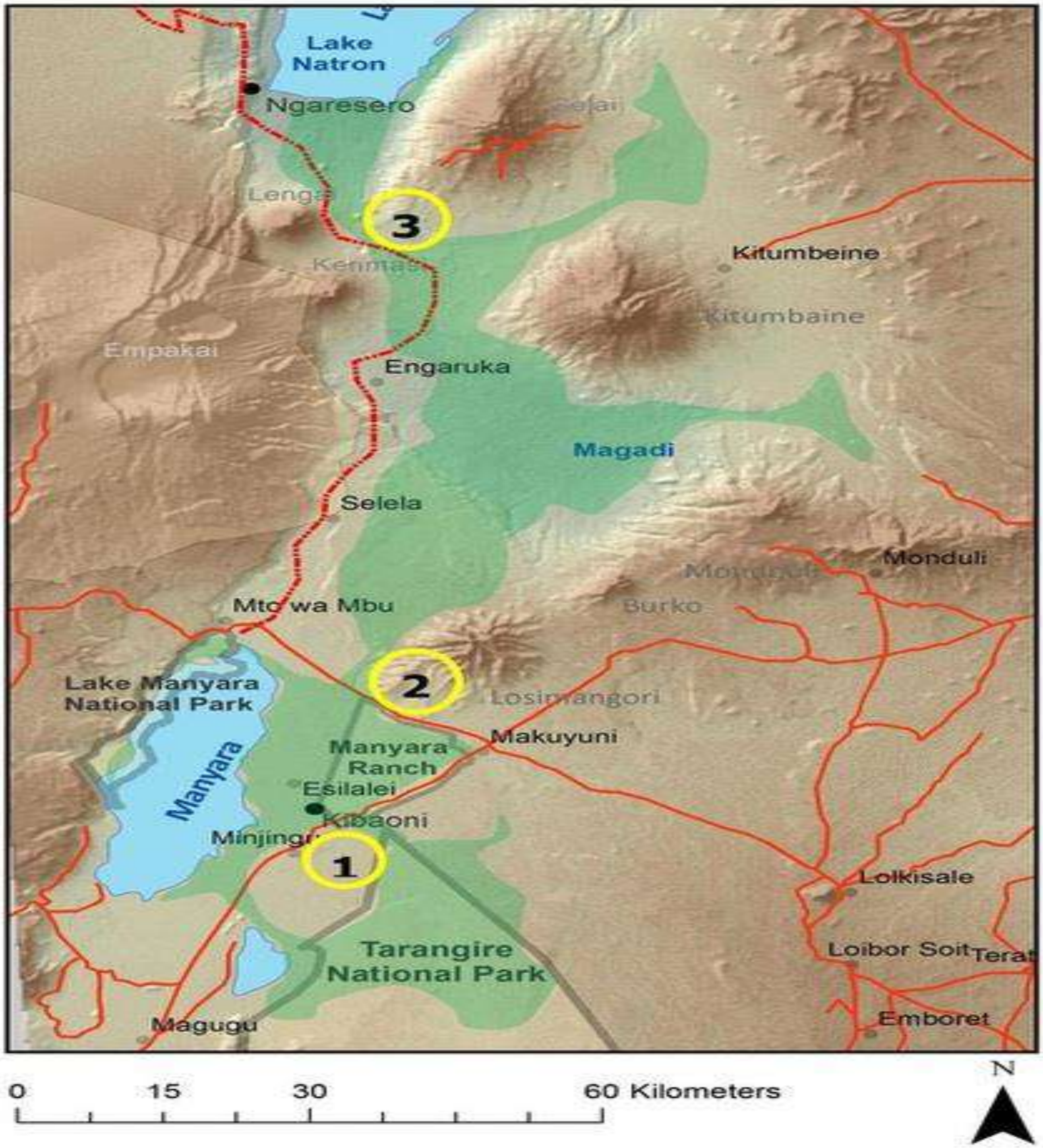


**Figure 4.9: Map showing the wildlife migration corridor**
Source: Adopted from: https://www.wildnatureinstitute.org/corridor-campaign.html

## 4.7 Socio-Economic Set-Up (Human Environment)

### 4.7.1 Population Characteristics

According to Population and Housing Census (2012) result, the Monduli District Council was having 158,929 people out of which; 75,929 are males and 83,314are females. The population growth rate rests at 2.77% per annum which is slightly higher than that of Arusha region and the National respectively. For year 2020, the Monduli District Council is estimated to have a population of 191,710 and about 4.7 people per household. However, the study area (covering Engaruka, Selela and Mfereji wards) has population of 27,424 with 5,074 households (14.3% of the entire population in Monduli district). The villages within project area having a population of about 7,375 and 2,307 households (Table 4.7).

**Table 4.7: Population by Sex and Households for villages within Project area**

| SN | Villages | Population | | | Households number | HAMLETS |
|---|---|---|---|---|---|---|
| | | Males | Females | Total | | |
| 1 | Engaruka chini | 1,315 | 1,450 | 2,765 | 927 | 5 |
| 2 | Irerendeni | 997 | 1,180 | 2177 | 594 | 5 |
| 3 | Mbaashi | 731 | 940 | 1671 | 394 | 3 |
| 4 | Idonyonaado | 358 | 404 | 762 | 392 | 3 |
| | **TOTAL** | **3.401** | **3,974** | **7,375** | **2,307** | **16** |

Sources: Engaruka, Selela and Mfereji wards' statistics, (July, 2020)

### 4.7.2 Socio-economic and Cultural Environment

The main economic activities of Monduli District and the study area in particular are livestock keeping, agriculture production and wildlife. More than 90% of the population is engaged in livestock keeping and agriculture. The District is estimated to have about 105547.5 hectares of potential arable land but only 87632.5 hectares which is 13.65 % are under cultivation (Monduli Socio-economic profile, 2016). Although large scale farming is practiced in the Southern part of the District (Lolkisale), subsistence farming is the main form of farming in the study area. Maize, beans and paddy are the leading staple food crops whereas, coffee and sunflowers are the cash crops grown at a small scale. Livestock keeping is the main predominant economic activity - which if properly managed, could contribute significantly to the District economy. The district per capita income in 2008 was estimated at Tshs. 500,010/-.

**Livestock keeping**

Livestock rearing is generally part of most households in Monduli as such livestock keeping plays a significant role in the district economy. The District is estimated to have a livestock population of 888,749 of which 234,876 are cattle, 186,266 goats, 5162,188 sheep, 28,793 donkeys, 8 camels, 8,653 dogs, 1,863 cats, 265,218 poultries and 884 pigs (Table 4.8). With such population, the construction of soda ash plant on 25,000 ha hectares will result into negative impact of shortage of grazing land for livestock and wildlife.

**Table 4.8: Livestock population in the study area**

| SN | Ward | Types of livestock | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Cattle | Goats | Sheep | Donkeys | Pigs | Chickens | Other fowls |
| 1 | Engaruka | 16,295 | 21,928 | 41,107 | 3,054 | - | 7,433 | - |
| 2 | Selela | 24,253 | 29,099 | 45,707 | 2,356 | | 4,310 | - |
| | **Total** | **40,548** | **51,027** | **86,814** | **5,410** | **-** | **11,743** | **-** |

Source: Field data, July, 2020

**Agriculture**

The District has a total area of 641,900 hectares of which 105,547.5 hectares is arable land. Land under cultivation amounts to 87,632.5 hectares which is equivalent to 13.65% (Monduli Socio-economic profile, 2016). Although large scale farming is practiced in southern part of the District, subsistence farming dominates in the study area whereby smallholders with an average of 2 hectares per farming household. Productivity is low and marketing system is not well developed. Looking at the project area maize, beans, bananas and paddy are gown practically in water basins, river banks and areas with reliable irrigation (Figure 4.10). Irrigation is practised in two wards, covering about 1,054 hectares (Table 4.9).

**Table 4.9: Irrigation potentials in the study area**

| Village/Ward | Water source | Potential Area – For irrigation (Ha) | Current Irrigated Area (Ha) |
|---|---|---|---|
| 1. Selela | Rivers;Kabambe, Lositeti, Selela, Springs; Orkereiyani, Loseyai. | 2800 | 700 |
| 2. Engaruka | Rivers; Engaruka, Lemelepo tributary. | 1500 | 354 |
| **TOTAL** | | **4,300** | **1,054** |

*Source: DAICO – Monduli. 2016*

**Figure 4.10: Food crops grown (left) and the irrigation canal (right) in the area**

**Micro and small-scale enterprises**

The Micro and small-scale enterprises/activities include but not limited to retail shops, small restaurants, and petty trade.

*Retail shops*

The study area has a number of retail shops and kiosks particularly in business centres like Engaruka juu and Selela. These shops and kiosks stock a wide range of goods i.e., foodstuffs, household utensils, school supplies, textiles and minor spare parts for bicycles. However, the majority of the goods are slow moving commodities. Construction materials such as corrugated iron sheets and cement are found at Mto wa Mbu, about 50 kms from project site. The shop operations adopt various techniques to keep the operation costs low. For example, some shops are often located in one of the rooms within the homestead, and usually attended and managed by members of the household. Procurement of goods to be sold in their shops is done in bulk to optimize transport costs of hiring vehicle otherwise household members are physically responsible for procuring and transporting small amounts of goods using motorbikes or public transport when available.

*Restaurants and food vending*

There are small restaurants and numerous food vendors in Engaruka and Selela wards in the study area. The restaurants serve soft drinks, tea snacks and meals basically to external visitors and limited number of residents. It was noted that during the peak of the agricultural season some of the restaurant operators in the area withdraw temporarily from their restaurant activities to attend agriculture. Food vending, snacks and evening coffee / tea selling are also very much affected during this time because the potential customers migrate to the farm plots.

*Petty trade*

Petty trade includes selling a range of products in small and medium quantities in homes and, in other areas particularly at the local markets (*magulio*) in two days a week – Wednesday at Selela and Thursday at Engaruka. The products sold include beans, sugar, rice, maize and cassava flour, vegetables, and fruits. Other products dealt by petty traders include household utensils and textiles, mainly Maasai garments and second hand clothes. Construction and Operation of Soda Ash factory may stimulate petty trading since there will be more people in the study area especially Engaruka whereby workers and tourists become potential customers.

*Tourism*

Tourism is one of the upcoming economic activities in Engaruka and surrounding villages where the Soda ash extraction and processing plant is proposed to be constructed. The area is a transit/corridor and/or dispersal area for many types of wild animals to several national parks. Furthermore, the area hosts Game Controlled Area (GCA) as well as Mto wa Mbu, Burko and Ngorongoro hunting blocks. The trunk road transverse Engaruka to Northern part of Tanzania notably Lake Natron where lesser Flamingo are found there in abundant, Ngorongoro Game Reserve make Engaruka as a stopover point. Also, Engaruka is famous for having ruins of the ancient people. Many Archaeologists and Historians come to Engaruka for tourism and for archaeological and/or paleontological studies. It is within these few tourist and archaeological features make Engaruka unique area in Monduli district. Residents of Engaruka particularly women of Maasai origin sell ornaments, beads and other attractive materials to the tourists passing through or coming for wildlife hunting.

The proposed Soda ash project in the area will increase income of the community residents in the area through causal employment, skilled labour employment and business which will be stimulated by the establishment of the factory. Considering natural setting of Engaruka, environmental, social and engineering aspects will consider current status and place the factory where Environmental impacts will be very minimum.

#### 4.7.3 Community Structure

The main organization of village government in Monduli District is the village Assembly and Council (Figure 4.11). The village Assembly is made up of the adult members of the community and the village council is composed of between 15 to 25 representatives. The village council is responsible for overseeing day to day activities in the village as well as to make decisions on matter concerning the whole community. Functions of the village Assembly are the maintenance of peace and order the promotion of social welfare and economic development. The village council manages the village and implements decisions made by the Assembly Like the district council, the village government is arranged into a series of committee’s and overseen by the village chairperson, village Executive officer (VEO), and village leader members of the council). The main committees include Finance and Planning, safety and security, construction and finally Education and social services. The sub-committee of the latter includes the water and sanitation committee, health committee, Environment committee and the school committee.

**Example of village's organization structure**

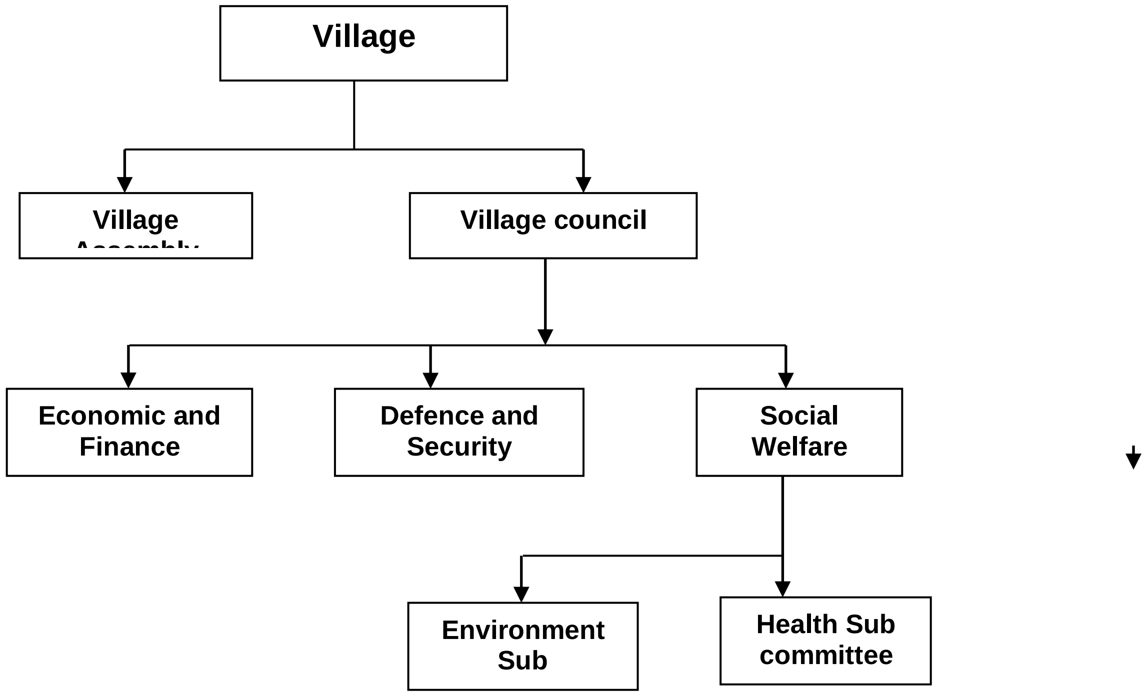


**Figure 4.11: Village Administrative Structure**

### 4.7.4 Employment

Prominent occupations recognized for salaried employment are found in the sectors of Education, Health and Local Government. These sectors employ teachers, Village Executive Officers (VEO), Ward Executive Officers and medical personnel. However, in urban settlements like Monduli pattern of employment is different due to existence of various sectors.

### 4.7.5 Distribution of Income

Possession of capital asserts is discussed as part of household wealth and investments for accessing social services. It was noted that majority of households possess cattle as capital assets. As a measurement of poverty, availability of assets implies that communities in the area are slightly above the soft-core poverty line. A random sampling carried out in two wards of Engaruka and Selela for households within the project area revealed the wealth status of residents of which life style, type of houses, nutritional status of children and clothing classify the community as poor. Changing of life style, gender relations and adaptation of new technology among the Maasai in the study area will be a benchmark for future development since the area is endowed with fertile and arable land with abundant livestock.

During the discussion it was revealed that due to low income many household or individual are not able to pay for common problems when they come for example medical care and uniforms of their children. According to them, at the extreme cases few households have to solve their problems at the expenses of selling of cattle, selling or pawning available asset or through some form of loan. Low income and lack of assets to some households show incapability of the household to cater for its basic needs. Even if the household gets a soft loan may fail to pay back. Eventually the household would be compelled to sell any of its asset if the loan is not from close relative. Disposing assets to meet contingency reduces household future productive and earning capacity. Through discussions with the communities in three villages complained on the delay of construction of the factory which is passive as development hub in the area. The factory may increase income through employment, house renting, food selling and other related income generating activities.

### 4.7.6 Goods and Services

The proposed Soda Ash Factory is very important in stimulating transportation of goods from and to the market. The factory will lead to construction of tarmac road from Mto wa Mbu to Engaruka which will be used to transport livestock, factory products and other raw materials to external markets. Currently few goods supplied to the project area include manufacture goods for retail and semi-whole sale shops (food staff and building materials) and tourists and researchers who visit Engaruka Ruins as well as wild life along Tarangire – Ngorongoro corridor. On the other hand, goods from the project area include cattle to the auction market in nearby districts like Babati and Arusha. Transportation of passengers to and from the study area is continuously throughout the year although in rain seasons transport of passengers and goods become difficult. The construction of Soda Ash factory and Road section is regarded as a backbone of the economy of Engaruka area.

Provision of basic amenities is essential to the livelihood and human development. In the study area the core interest was the extent of provision, access among the villagers and their impact in the village development. Some of the visited were education, health, transportation, water supply, energy and others. Provision of goods and services in the study area is indicated in the table 4.10 - 4.18.

**Table 4.10: Provision of basic services in the three wards of the study area**

| **WARD** | **TYPE OF SERVICE** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Primary schools | Secondary schools | Dispens aries | Health centres | Primary courts | Churche s | Mosque s | Polic e posts |
| Engaruk a | 2 | 1 | 1 | - | - | 17 | 1 | - |
| Selela | 3 | 1 | 2 | - | - | 10 | 2 | - |
| Mfereji | 1 | - | 1 | - | - | 2 | 1 | - |
| **Total** | **6** | **2** | **4** | **-** | **-** | **29** | **4** | **-** |

*Source: Field data July, 2020*

*Education*

Currently, there are 65 primary schools in Monduli district of which 60 is owned by government and 5 owned by private sector, the schools have a total of 25,453 pupils (12,717 boys and 12,736 girls). There are 60 pre-primary classes total of 3,117 pupils (males 1642: female 1469). In the study area wards, there are five (5) primary schools. Literacy rate in rural area is 73.87% which indicates that majority of residents have attended school and acquired basic education. The table 4.11 below indicates the rate according to age cohort.

**Table 4.11: Level of literacy rate in rural and urban areas in the district**

| SN | GROUP | RURAL | URBAN | AVERAGE |
|---|---|---|---|---|
| 1 | Literacy rate (5 – 14 years) | 67.3 | 94.3 | 76.4 |
| 2 | Adult literacy (15 + years) | 70.9 | 96.4 | 80.3 |
| 3 | Youth Literacy (16 – 24 years) | 80.1 | 98.7 | 87.4 |
| 4 | Youth literacy (15 – 35 years) | 77.2 | 98.5 | 85.6 |

*Source: URT Basic Demographic and Socio-economic Profile. Arusha Region 2016*

Looking at enrolment it shows that Net Enrolment Rate (NER) in Rural Monduli DC is 74.8% and in urban is 95%. It means there is a good number of school aged children who are not enrolled in schools (about 25.2%) compared to urban areas where only 5% of school aged children are not enrolled. At these trend rural areas has a higher illiteracy rate than urban and when we consider the establishment of the factories in rural area, communities in rural areas will lack basic skills for employment. On Gross Enrolment Rate (GER) in rural areas the rate is 92.3% while in urban is 113.6% which means in urban areas children above the school age (>14 years) are enrolled in schools while in rural areas there is no above school age children who are in schools.

Establishment of factories demand skilled and knowledgeable people who can run the machines, balancing accounts, provide transport logistics and laboratory works. The number of graduates in rural areas in Monduli DC is alarming. Very few graduates from secondary to tertiary education are very few as shown in the table 4.12 below.

**Table 4.12: Number of Graduates in rural areas**

| SN | GRADE/CLASS | PERCENTAGE % |
|---|---|---|
| 1 | Completed primary school | 83.3 |
| 2 | Undergo Training after primary Education | 0.9 |
| 3 | Completed secondary education | 12.8 |
| 4 | Undergo Training after secondary Education | 1.2 |
| 5 | Completed University | 1.7 |

*Source: URT Basic Demographic and Socio-economic Profile. Arusha Region 2016*

The number of graduates in rural areas including the project area implies that contribution ratio of workers for the coming factory will be very minimal. Efforts of sending the youth to vocational training is vital in order to enter into workforce market. Besides the number of graduates, the rate of dropouts in primary school is also high. The main reasons for dropout are long distance between home and school. In the study area the nearest school is about 18Km from the proposed soda ash factory. Children from the proposed factory walk almost 36 Km daily during the school sessions. In this situation school performance of these children is always poor. For example, in Engaruka chini primary school dropout rate is as shown in the table 4.13 below. Second reason for dropout is initiation rites of pastoral Maasai when a youth is initiated into adulthood, he joins his peers who are looking after cattle. Third reason is early marriages of school girls. However, the Government has established boarding schools to avoid dropout in a large scale.

**Table 4.13: Dropouts at Engaruka chini Primary school for the year 2018 – 2020**

| **Year** | **2018** | **2019** | **July 2020** |
|---|---|---|---|
| No. Of dropouts | 15 | 18 | 22 |
| Total number in the school | 824 | 663 | 914 |

*Source: Field data July, 2020*

*Repetition rate*

Repetition rate among pupils of lower primary education is also very high. Pupils who fail to pass standard four examination is supposed to repeat a class. According to discussions with head teacher and chairman of the school committee confessed that distance to school from home is the leading factor of poor performance of pupils residing from the proposed factory area. It is within this context that they supported the establishment of the factory with the expectations that the factory will construct a school and dispensary for social services. In the study area in Engaruka chini primary school the repetition is as shown in the table 4.14 below.

**Table 4.14: Number of Repeaters from 2018 to 2020**

| **Year** | **2018** | | **2019** | | **July 2020** | |
|---|---|---|---|---|---|---|
| | **Boys** | **Girls** | **Boys** | **Girls** | **Boys** | **Girls** |
| No. of Repeaters | 14 | 8 | 30 | 6 | 21 | 1 |
| In percentage | 27.5% | | 34.6% | | 17% | |
| Total number of pupils | 80 | | 104 | | 130 | |

*Source: Field data July, 2020*

*Transition Rate*

One of the expected indicators in education performance is transition from primary education to secondary education. Pupils who set for Primary School Leaving Examination (PSLE) are expected to join form one in available secondary schools. In the study area however, pupils have joined secondary schools as shown in Table 4.15 below.

**Table 4.15: Transition rate from 2016 to 2019**

| Year | 2016 | | | 2017 | | | 2018 | | | 2019 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Boys | Girls | Total | Boys | Girls | Total | Boys | Girls | Total | Boys | Girls | Total |
| Std vii | 23 | 13 | 36 | 23 | 11 | 34 | 24 | 15 | 39 | 45 | 10 | 55 |
| Joined form 1 | 18 | 6 | 24 | 7 | 12 | 19 | 20 | 15 | 35 | 28 | 10 | 38 |

*Secondary Education*

The District has 12 Government schools which are registered, 9 private secondary schools which in total makes 21 secondary schools in the district. Among of these schools there are 3 boarding Government schools and the rest are Hostel. Secondary education is coupled by problems such as:

- Shortage of teacher especially science teachers.
- Shortage of infrastructures such houses, classrooms, dormitories etc.
- Most of our schools facing water shortage especially during dry seasons.
- No schools' vehicles while other schools are situated at animal corridors and/or hunting blocks and/or far from social services.

*Health sector*

Monduli District has 41 health facilities which includes 1 Government Hospital, 1 Government Health centre, 32 Government dispensaries, 3 FBO (Faith Based Organization) Dispensaries. 1 private dispensary and 3 belonging to public institutions. These facilities are unevenly distributed from one to another. Tanzania standards, a dispensary is required to serve between 5,000 and 10,000 people. In the study area there are four dispensaries – 1 in Engaruka, 2 in Selela and 1 in Mfereji. The health facilities provide curative, preventive services while rehabilitative is mainly delivered in referral/District hospital. The study area and Monduli at large is facing communicable and non-communicable diseases as indicated below in Table 4.16 for under 5 and above 5.

**Table 4.16: Ten Common Diseases occurring in the project area**

| Type of Disease | Number of cases | |
|---|---|---|
| | <5years | >5 years |
| Malaria | 13524 | 39891 |
| ARI | 11551 | 30115 |
| Diarrhoea diseases | 3496 | 1770 |
| Intestinal Worms | 1004 | 1578 |
| Pneumonia | 8801 | 5802 |
| Eye Infection | 2888 | 1000 |
| EAR | 917 | 433 |
| Skin Infection | 2017 | 1215 |
| PID | 0 | 123 |
| TB | 22 | 145 |

*Source: DMO – Monduli*

*Water sector*

The current District capacity to supply water to the population is at 63.2% in relation to the total population of 158,929 (as per 2012 population census). This has been contributed by rehabilitation and construction of 13 dams and charco dams. The status of water supply in the district is piped schemes cover 60.8% in rural areas and 80.6 in urban areas. Other protected sources in rural area are 9.8% and urban is 8.5%. Unprotected sources in rural areas are 29.4% while in urban setting is 2.9%. In the study area the provision of water is shown in the Table 4.17 below.

**Table 4.17: Provision of drinking water in the study area**

| SN | Source of water | Population served in % per ward | | |
|---|---|---|---|---|
| | | Engaruka | Selela | Mfereji |
| 1 | Piped water | 20 | 35 | 30 |
| 2 | Bore holes with pump | - | - | - |
| 3 | Shallow wells with pump | - | - | - |
| 4 | Shallow wells without pump | - | 3 | 8 |
| 5 | Rivers/streams | 40 | 12 | 42 |
| 6 | Dams/carco-dams | 35 | 50 | 24 |
| 7 | Others (roof harvesting) | 5 Rain water harvesting | - | 2 Rain water harvesting |

*Source: Field data July, 2020*

*Housing*

Shelter is one of the most important human basic needs. Good housing has a close correlation with good health and other aspects of human dignity and wellbeing. Although there is no clear-cut definition on which is proper and good housing facility, but enough and well-ventilated rooms, kitchen and toilets provision were used to determine the quality of the shelter in the study area. Moreover, type of structures and materials used in construction were also primarily used to determine the quality of the house in the villages. The situation of housing in the village's exhibit typical rural infrastructure. About 31.5 percent of houses are roofed by iron sheets, while 68.5 percent comprises of houses made of baked/ burnt bricks, or poles thatched with grass (Table 4.18). However, almost all houses in the study area have separate building for kitchen and toilets constructed by wood mud and thatched by grass. Most of the buildings are categorized as low class which call for new technology of building modern houses of low cost.

**Table 4.18: Type of houses in the study area**

| SN | Type of houses | Engaruka | Selela |
|---|---|---|---|
| | | % | % |
| 1 | Poles thatched with grass | 60 | 70 |
| 2 | Poles with galvanized roof | 20 | 5 |
| 3 | Mud bricks thatched with grass | - | - |
| 4 | Mud bricks with galvanized roof | 5 | 6 |
| 5 | Baked bricks thatched with grass | - | 5 |
| 6 | Baked bricks with galvanized roof | 5 | 5 |
| 7 | Block with galvanized roof | 10 | 7 |
| 8 | Others (specify) | - | - |
| | Total | 100 | 100 |

*Source: Field data July, 2020*

*Market place*

Market places in the study area like other rural areas in Tanzania have several simple "small shelters" and semi advanced shelters referred to as a market place. Petty trading activities are scattered along the streets particularly in business centres in Engaruka and Selela wards, selling variety of agricultural produce such as potatoes, fruits, vegetables, as well as processed and semi processed items such as rice, maize and millet flour. In some cases, villagers sell small amounts of crops to each other in the homes and in the farm plots. Sometimes payment for such trade in effected in both cash and in kind (say provision of labour or exchange of a different product). Despite permanent market centres, villagers depend on gulio/minada markets which shift from one place to another (Every Wednesday is Selela and Thursday is Engaruka). Magulio are equipped with varieties of goods ranging from food stuff, garments and other textiles materials, cattle auctions and alike. Villagers buy goods which satisfy them for couple of days until next market day (gulio). Magulio also have become important source of respective district revenue where different taxes are collected for council development purposes.

*Transport issues*

The project area is traversed by several Kilometres of unclassified roads, most of them being village streets and others being used in the collection of crops from the fields. Both, foot paths and roads are generally in bad condition characterized by rough, sandy and muddy/dusty surface in dry/wet seasons respectively. These situations are attributed to prevalence of sandy and clay soils. Transportation is also difficult in the areas dominated by sand/surface soil, which in all cases driving or cycling is difficult. Transport available in the study area can be categorized into, walking and craft animal loading, cycling, and motorized transport. Walking and head – loading dominate travel and transport that take place within the vicinity of villages especially villages away from the regional road. The main purposes for such trips include water and fuel wood collection, milling grains, agricultural and meeting social and cultural obligations. Travel to the long distances, road transport is commonly used.

In transportation, culturally, women are responsible for drawing water and collection and transporting fuel-wood household use, and transporting grains for milling using donkeys.

All areas potential for economic development are connected to relatively passable roads in dry seasons. During rain seasons transport from Engaruka to Mto wa Mbu can take a one or two days (Km 60 in length) which ferment losses in goods transportation to the markets as well as getting people home. In such season delivery of social services is hampered for example getting vaccine to the health facilities normally delays.

*Energy*

The study area depends on the different sources of energy. Fuelwood is the main source of cooking and heating energy while electricity (which is recently connected under REA) and kerosene are used for lightning. Other sources of energy are coal, charcoal, gas and other natural sources such as sun (solar).

*Sanitation and Waste Management*

Overall sanitation situation in the project area is relatively poor. Discussions held with the community during the study revealed that more than 70% of the households have pit latrines which are poorly constructed and lack hygienic facilities. Those without latrines about 30% use neighbouring facilities or outdoor in the bush. Outdoor practices are the main cause of diseases like typhoid, cholera, dysentery and intestinal worms. The latrines are temporary constructed with temporary materials and during the rainy seasons they collapse. Contrary to the sanitation, most of the households do not have solid and liquid waste disposal system. Solid wastes are used as biomass for backyard gardens by women while others burn or bury the waste.

### 4.7.7 Recreation

Recreation in the project area is commonly found in traditional and religious ceremonies. Other recreation activities are post-harvest festivals, local pubs and drinking moments during market/gulio days and marriage occasions. These recreation ceremonies are done through traditional dancing, ritual practises (*jando na unyago*), drinking and singing.

### 4.7.8 Gender Issues

Gender empowerment ensures that, all sexes particularly women are fully participating in policy and decision-making processes and in all aspects of economic, socio-cultural, participation in managerial, political, professional and technical personnel. It is within this context women are encouraged to participate fully in this Soda ash project from planning stage, construction and operation stages as one of the most beneficiaries of employment in the factory. The photograph 4.12 shows women contributing in the village consultation meeting. This situation in previous time was very rare for a woman to speak before men.

In the project area women are significantly involved in implementing activities especially in economic activities besides agriculture, 60% of the interviewed women were engaged in business activities such as selling of ornaments to tourists, livestock produce, selling of food crops, local brewing, and food vending and alike.

The unequal access to economic opportunities such as sharing of livestock and farm produce and other family/clan wealth existing between men and women leaves women with minimal options of earning their lives decently. It is reported that sometimes some of the women resort to promiscuity in order to meet their needs. With the prevalence situation of HIV/AIDS, they place themselves in a high-risk. Furthermore, women and girls are more vulnerable as they face early pregnancies, school dropout, early marriages, sexual genital mutilation, raping, unequal gender roles and prevalence of STDs among women and girls.


**Figure 4.12: A Maasai women contributing in the consultation meeting at Mbaashi village**

On homes-based Gender Based Violence (GBV) in the study area, much has not yet revealed because the type for interview was not enough since revealing of such information needs familiarization with respondents and trust to the person who interrogates.

#### 4.7.9 HIV / AIDS Prevalence

According to Tanzania HIV/AIDS and Malaria Indicator Survey (THMIS, 2017/18), Tanzania is experiencing some recent decline in national HIV prevalence. Between 2004 and 2012, the overall adult prevalence rate fell from 7% to 5.0 (from 6% to3.8% % for men and from 8%to 6.5% % for women). Declines in HIV prevalence were also observed among pregnant women attending antenatal clinics and among blood donors.

The downward trend in levels of HIV infection correlates with the reduction in behaviours known to have a high risk of transmitting HIV. For example, in the 15-49 age group, casual sex with non-marital, non-cohabiting partners declined from 46% to 29% among men, and from 23% to 16% among women (National HIV and AIDS Policy, 2013). Looking at the study area and District in general, an effort to control the problem of HIV/AIDS the district in collaboration with NGOs, CBOs and FBOs has made service related to HIV/AIDS to be readily available to people. Although residents in the study area and Socio-economic profile (2016) of Monduli have failed to reveal the magnitude of the epidemic in the area but they have witnessed that HIV/AIDS is prevailing in the area.

Regarding the life style of local people and socio-cultural and traditional practices, the project area is not exceptional from other communities with similar traditions which in one way or another early marriage, raping cases, circumcision and early pregnancies are indicators of activities fuelling the prevalence of HIV. With the coming project stern measures should be taken to prevent the spread of it through HIV awareness campaigns including safe sexual relations and fidelity to couples.

#### 4.7.10 Cultural and Historic Properties

Graves were the only cultural properties found within some *Maasai boma*s in the proposed project area. These graves might be affected during construction phase. Other significant historic feature is wild animals' corridor (*ushoroba*) within Rift valley.

#### 4.7.11 Ethnic groups and Customs

The major Ethnic group is the Wamaasai who constitute about 40% of the entire population, frontrunners in livestock keeping. The second ethnic group is the Waarusha, constituting about 20% of the entire population. The main activities for Waarusha are Livestock keeping and farming. The rest who are not indigenous of Monduli District constitute the remaining 40%. The main activities of this group are farming and trading. Christianity is the dominant religion in the project area followed by Muslim. Traditional beliefs are also practised in the area by secret societies and in specific occasions.

### 4.7.12 People's Aspirations and Attitude to the Project

One of the service priorities among people of Engaruka and particularly in the study area is to have Soda ash factory which will be accompanied with a tarmac road. In the discussion with communities and Regional and District leaders explained that Soda ash extraction factory is their dream. Besides the land/grazing pastures which will be taken by the factory maternal deaths happening during referral to district hospital are alarming. The distance and poor road have contributed to such dismay. Communities in the study area feel that the factory and tarmac road will be the development main factor which will stimulate both health and economic activities and bring about other facilities and utilities as well as investors. The factory will be the backbone of district's economy. In additional to the above, tarmac road will ease access to district headquarters and business city of Arusha.

# CHAPTER FIVE

# 5 STAKEHOLDERS ANALYSIS: PUBLIC CONSULTATION AND DISCLOSURE

## 5.1 Overview

The process of stakeholders' disclosure and consultation is an ongoing overarching requirement that applies to the entire ESIA process. The consultation was of critical importance in gaining insights into the key environmental and social issues, concerns of communities and other stakeholders, and in aiding the development of potential strategies for addressing the expected impacts.

The consultant recognizes the importance of stakeholders' consultation, participation and disclosure during the life of the construction of Soda ash extraction project in Engaruka in Monduli District Council. Effective consultation with stakeholders is;

- Key to understanding the concerns and requirements of affected communities and ensure their participation in the formulation and refinement of the project design.
- A prerequisite for sustainable development of the market.

Effective disclosure through the release of timely accurate and comprehensive information to stakeholders is essential to ensure that the likely impacts (both positive and negative) are understood by stakeholders and allow the stakeholders to provide feedback to the project. It also enables the consultant in;

- Determining the scope of the ESIA
- Deriving specialist knowledge about the site
- Evaluating relative significance of the likely impacts
- Improve project design and, thereby, minimize conflicts and delays in implementation;
- Proposing mitigation measures
- Ensuring that the ESIA report is objective, truthful and compete
- Facilitate the development of appropriate and acceptable entitlement options;
- Increase long term project sustainability and ownership;
- Reduce problems of institutional coordination;
- Make the resettlement process transparent; and Increase the effectiveness and sustainability of income restoration strategies, and improve coping mechanisms.
- Monitoring any conditions of the development agreement.

## 5.2 Legal Requirement

The Environmental Management Act of 2004 requires that all ESIA Studies undertake Public Consultation as part of the study. The aim of the Public Consultation and Disclosure is to ensure that all stakeholders interested in a proposed project (including project beneficiaries and the

general public in the vicinity of the proposed project) be identified and their opinions considered during project planning, design, construction, and operation and decommission phases.
In compliance to the requirements of the regulations, the consulting team conducted Public Consultation starting with Arusha Regional office, Monduli District Council Officers, Ward Executive Officers in respective wards, Counsellors and community members in the whole project areas.

## 5.3 Objectives of Public Consultations

The main objective of the Public Consultation was to:

- To collect opinion of Regional and District administrators on the project
- Inform the local administration, ward leaders, Village leaders, NGOs on the proposed project and collect their views on the project.
- provide an opportunity to all the stakeholders and communities in the proposed project area to raise issues and concerns pertaining to the project,
- conduct socio-economic survey and
- identify alternatives for the proposed project

## 5.4 Methodology and Data Collection

The public consultation for the proposed project was conducted simultaneously with the field work targeting the various groups of stakeholders. The consultations were conducted through use of questionnaire and public forums. The consultants developed several formats of questionnaires/checklists to target the various groups of stakeholders which included the community members (elders, youth, and women), the local administration and ward and village executive officers.

The key stakeholders were interviewed through holding consultative discussions and administration of questionnaires. Samples of questionnaires administered are annexed to this report. Consultation of community members was done at communal level. List of names of all those consulted is also annexed to the report.

The interviewers targeted the general public residing in the vicinity of the proposed Soda ash factory to be updated on the construction. Data collected during the public consultation included data on the particulars of the community members and their opinion on the proposed project. Public forums were also held with the assistance of the local leaders in several areas within the proposed project areas. The agenda of the meetings were divided into four main sections namely:

- Project Introduction
- Project Socio-Economic and Environmental Impact Discussions
- Questions and discussion sessions
- Closing of the meeting

First section namely project description was conducted by the experts who introduced the proposed project stating its aim, components, area covered and locations as described in the Terms of Reference. After the project introduction phase, the community members were given a chance to comment on the proposed project. The socio-economic survey was conducted through the use of predefined questionnaires targeting the various groups including the PAPs, women, youth, elders, vulnerable members of the community. The stakeholders were identified and consulted with the objective of understanding the existing socio-economic conditions of the area of influence and the immediate surroundings of the proposed project. The questionnaires were administered in Kiswahili. The responses received from the local community, the local administration and departmental heads from the public consultation and socio-economic survey. At this juncture should be noted that more consultation with other stakeholders like respective Ministries, Institutions i.e TANAPA, Ngoronoro Conservation Area Authority (NCAA), TAWA, TAWIRI, TAFORI, UNESCO, Internal Drainage Water Board, Mining Commission, TANROADS. TANESCO, OSHA, Fire, LGAs etc) and NGOs i.e., PINGOs, CORDs etc) were consulted during scoping and/or detailed ESIA study.

## 5.5 Responses from Public Consultations and Socio-Economic Survey

The following sections present the views of the stakeholders on the proposed project. The views are presented as issues requiring clarification, the anticipated benefits of the project, its negative impacts and proposed recommendations to abate the negative impacts or enhance the project benefits. The views are presented in a tabular form indicating locations at which the discussions were held and, the names of persons interviewed and their views.

### 5.5.1 Response of Regional and District Administrators on the Proposed Project

Consultation at Municipal level included discussions with municipal officers, specialists and other knowledgeable people and key informants were made through interviews.
These consultations were conducted through:

- Presenting the Project;
- Defining the Regional/District institutional framework;
- Discussing recent experience in the Region/District with respect to compensation eligibility criteria and entitlement packages;
- Obtaining from the authorities their environmental and socio-economic concerns and perceptions regarding the proposed factory and
- Discuss the role of the authorities in public information dissemination, monitoring and management plan

This section below summarizes the views collected from the key stakeholders in the project area which includes Regional and District administrators. The table 5.1 below summarizes the views of key stakeholders. Some points were repeated hence noted on the earlier speaker only.

**Table 5.1: Summary of views of key stakeholders from Regional and District levels**

| Date | Name | Position | Location | Contact | Views | Response |
|---|---|---|---|---|---|---|
| **DISTRICT AND REGIONAL LEVELS** | | | | | | |
| 24/01/2020 | Hargeney R. Chitukuro | Assistant Administrative secretary Economic & Productive sector | Arusha Region | 0767 263523 | The project will bring significant development to the people of Engaruka, Monduli and Arusha region in general.<br>The role of the region is to oversee the development of the factory from preliminary design, design, and construction/implementation and during operation. The region also is monitoring every stage and advice when deemed so.<br>We are encouraging the district to prepare land use plan to every village including Engaruka to avoid land use conflicts.<br>On service levy is stated in the law so every beneficiary will get his due according to the stated law. | It is the time for the Regional Administrative to foster more development and transparency to all issues related to community properties.<br>We believe communities in the study area will receive their compensation dues as planned. |
| 24/01/2020 | Julius N. A | Regional Natural Resource Officer | Arusha Region | 0754 831144 | | |
| 21/01/2020 | Idd H. Kimanta | District Commissioner (DC) | Monduli District | 0767 880580 | The district's concern is payment of compensation because is too long since assets inventory were conducted.<br>We expect the project to prepare Resettlement Action Plan (RAP) to relocate displaced households. | During your routine RCC meetings you will raise this issue to inform the region on the delay of compensation and the need of conducting RAP |
| 21/01/2020 | Rose Mhina | Ag. DED | Monduli DC | 0754 895485 | The project should also plan for capacity building to the local people in order to exploit the resources around them.<br>Education on Gender relations is vital to curb challenges like early marriages, early pregnancies, sexual genital mutilation and imbalance gender roles. | Education on gender roles is very important since the communities are pastoral with age set system where patriarchy dominates. |

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| 21/01/2020 | Adil Mwanga | Land Planning and Natural Resources | Monduli DC | 0784 300444 | Bureaucracy in compensation payments might result in reluctance of some community members going against land take proposal agreed before. | The district should communicate with the Client on the delay of compensation. |
| 21/01/2020 | Joseph Rutabingwa | Ag. DPLO | Monduli DC | 0719 955280 | The district has other plans parallel with establishment of Soda ash extraction like improving roads, encouraging tourism and business in the project area. Currently electricity is available in Engaruka and Selela. | The plans should be participatory that all beneficiaries will participate and knowing their roles |
| | Reginald Tesha | Town Planner Monduli | | 0692 155797 | | |
| **MINISTERIAL LEVEL** | | | | | | |
| 11/8/202020 | Yusuf H. Selenge | Ag. HEMU, Ministry of Livestock and Fisheries (LIVESTOCK) | Ministry of Livestock and Fisheries | 0754586095 | Since the proposed project area is legally belong to village council of Engaruka chini, Irerendeni, Mbaashi and Idonyonaado until the project developer (NDC) finalize a valuation process. The process should be precisely speed up and ensure appropriate land compensations to the above villagers(pastoralists)<br>Since development of the proposed soda ash project is expected to touch the interests of several institution and organization. The ministry of livestock and fisheries(livestock) should be mentioned as one of the institutions to be touched in its interests simply because the proposed project site is current used for grazing of livestock especially during dry seas<br>List of relevant sectoral policies pertaining to the planning and implementation of the proposed soda ash project should include **The Nation Livestock Policy (2006)** simply because the proposed project site is typically belonging to the local Maasai pastoralist.<br>List of relevant sectoral legislation pertaining | All comments will be taken and included in the detailed ESIA report<br>The Consultant will review more policies, Acts and Regulations to harmonize the final report |
| | Omary A. Mafitah | Environmental Officer – Ministry of Livestock and Fisheries (LIVESTOCK) | | 0714074723 | | |
| | Owen Kibona | Principal Fisheries Officer – Ministry of Livestock and Fisheries (FISHERIES) | | 0655579335 | | |
| | Fredrick Francis | Senior Fisheries Officer – Ministry of Livestock and Fisheries (AUACULTURE) | | 0655637026 | | |

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| | | | | | to the planning and implementation of the proposed soda ash project should include **The Grazing Land and Animal Feed Resources Act (2010)** together with its regulation (2013) simply because the proposed project area is a livestock grazing land used by the local Maasai pastoralist.<br>Since all parties (institution) involved in the ESIA process/exercise have been mentioned and given their roles and responsibilities to play. Therefore, **The Ministry of Livestock and Fisheries (Livestock)** has to be indicated as one of the institutions (at National level). Its roles and responsibilities should be: To give directives to the project proponent (NDC)on fulfilment the requirement grazing land area during relocation of the local people, simply because the proposed project area is used for livestock grazing.<br>The project should also promote aqua-culture opportunities because water bodies like dams, ponds and rivers are existing in the project area. Since communities in the project area are dynamic due to new developments, fish might be needed as nutritional supplement to local people and migrants who will come for employment when the factory starts. Also the Consultant should review the Fisheries Act of 2003, Fisheries Policy of 2015 and Regulations of 2019 as inputs in aqua-culture and ESIA in general.<br>One among important component in | |

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| | | | | | establishing factory is workers' health and safety, it is vital to establish dispensary in the factory during construction and in operations instead of First Aid Kits as stipulated in the report.<br>Establishment of Soda Ash factory in Engaruka seemed to implement the broad programme of Agriculture Sector Development Programme II. In this regard the project should consult the document to harmonize its objectives. | |
| 11/08/2020 | Ms. Africo Simon | Head Wildlife division | Ministry of Natural Resources and Tourism | 0767 274174 | Hydrological study should be done according to technical know how to avoid foreseen impacts<br>TIRDO to study on other water sources to meet the operation demand.<br>The plan should look at social pleasure to accommodate workers' social services, hunting blocks in the project area and influx of job seekers<br>Lesser flamingo do visit Engaruka basin during wet season. TIRDO should conduct a 2 -3 wet season census as baseline to get the way of mitigating the impact<br>The project should have a plan of controlling human activities regarding population growth and demand for social and economic needs.<br>Water pollution should be monitored frequently.<br>Potential economic benefits analysis should consider revenues accruing to the state, local Government and at community level to justify | Stern measures to make sure that the project benefit the nation and the community around project area will be taken.<br>For potential workers all safety measures will be in place before and during operational phase. |
| | Mzamilu Kaita | Wildlife Division | | Box 1251 Dodoma | | |

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| | | | | | the investment. | |
| 12/08/2020 | Bertha H. Wizabiko | Ag. AC-MBVA Ministry of Minerals | Ministry of Minerals and Mining Commission | 0754 514282 | The proponent should seek for all permits from the Ministry of Minerals through the respective regional offices. In this case Arusha region.<br>The developer/investor should advice to apply for Special Mining License due to the nature and scope of the proposed project.<br>The project should increase income to the community around the project area.<br>The factory should look for alternative sources to replace firewood to rescue forests in the study area.<br>The project should address means of improving sanitation in communities around the factory and neighbourhood.<br>ESIA should highlight gender issues particularly early marriages, pregnancies and all kinds of GBV and prevalence of HIV.<br>All environmental and social negative impacts should be addressed with alternatives to restore community livelihoods. | All comments will be taken care of to minimize impacts. |
| | Sundi R. Malomo | MEV | | 0767 258055 | | |
| | Abeid S. Kidindi | Engineer MoM | | 0714 502373 | | |
| | Eng. Assa Mwakilembe | Value Addition | | 0753 640230 | | |
| | Andrewous Masero | Mining commission | | 0768 560308 | | |
| | Monica Augustino | Principal Environmentalist | | 0754 763014 | | |
| | Eng. Aziza Swedi | Ag. MEX | | 0755 731070 | | |
| | Jackson Birore | Ag. ACEM | | 0769 865505 | | |
| | Jaji H. Ligalwike | Geologist MoM | | 0716 46704 | | |
| | Tryphone M. Luhangula | Environmentalist | | 0766 102721 | | |
| 11/08/2020 | Eng. Durusia Mulahani | Director-Coordinator Water supply programme | Ministry of Water and Irrigation | 0784 299207 | We advise the proponent to observe Water policy (NAWAPO).<br>Protect all water sources and catchments for water supply sustainability.<br>Waste water should be handled in a manner to avoid water pollution and reduce water borne diseases<br>Pay all dues for water abstraction, consumption and discharge as instructed in the | All requirements for water utilization will be guided by the ESIA and implemented during construction and operation phases of the project. |
| | Praxeda Paul Kalugendo | Hydrologist | | 0784 864144 | | |
| | Eng. Kisina Simlizy | P/Engineer | | 0716 240888 | | |

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| | | | | | Water Act. | |
| 12/08/2020 | Gatami F. Mrimi | Economist MIT | Ministry of Industry and Trade | 0683 803073 | The Ministry is supporting the project that it could have started.<br>We advise the Government to seek for investors and share the capital in PPP. | We will advise the Client in applying Private Public Partnership (PPP) in running the factory |
| 12/08/2020 | Prof. W. Magigi | DPP | Ministry of Land Housing and Settlement Development | 0767322277 | The proposed area for factory construction the project should examine the existing GN to avoid land disputes.<br>Pay compensation to the PAPs as per Land laws.<br>Process all permits required for land take.<br>Conduct RAP as required and consider vulnerable groups. | RAP procedures and consultation meetings with the communities are in place and RAP implementation is about to start. |
| **PUBLIC INSTITUTIONS AND DEPARTMENTS** | | | | | | |
| 10/08/2020 | George L. Makhaya<br>Gloria Bideberi<br>Habiman Nyanda | SGD-RAI<br>SAC -CRCO<br>Wildlife Officer | TAWA | Box 2658 Morogoro<br>0756 294611 | The factory should never become an obstacle of wildlife since the area is a corridor and there are hunting blocks.<br>The factory should avoid spillage of waste into water used by wild animals.<br>The Government Notice (GN) for Game Controlled Area (GCA) should be revoked (de-gazetted) to ensure that the land use of the proposed project is compatible with intended development.<br>The Woldlife Act No. 5 of 2009 and its subsequent Regulations should be adhered during project implementation.<br>Wildlife expert should be hired and enaed full time onsite during project implementation so as to implement the requirements of the | Necessary measures to avoid environmental and social destruction will be the paramount agenda in establishing the factory.<br>The project design will consider the existence of wildlife corridors and hunting blocks and where deemed necessary negations can be started between the Government, key Ministries and stakeholders to find the |

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| | | | | | Wildlife Act of 2009.<br>A strong fence around the active project site and staff house should be constructed to avoid interference with wildlife. | better means of the issues especially the possibility of revoking the hunting block license. |
| 10/08/2020 | Dr. Sima Bakengeja | Director – Forest Production | TAFORI | 0754 784545 | The project should do inventory of all species of flora to identify endangered species.<br>Provide a plan of restoration of endangered species | The project currently has employed a team to carry out inventory of all plants in the study/project area<br>Conserving proposal provided will be practised. |
| 14/08/2020 | Yustina A. Kiwango | Conservator TANAPA HQ | TANAPA | 0784 711338 | Wildlife should maintain free movement and construction of the factory should not block the corridor<br>Spur roads to the factory must have safety signs to alert the drivers on wild animals crossing<br>The project and Conservers to prepare awareness programme to residents living in the vicinity of the project on how best to live with wildlife (to reduce poaching etc)<br>Areas where the boreholes and pipes will be located may be let without fence to allow grazing of livestock. | When the project is about to start the collaborative programme with various stakeholders will be initiated for good health of wildlife and livestock. |
| | Malima Mbijima | Conservator TANAPA HQ | | 0754 028781 | | |
| 14/08/2020 | Mussa Shanyangi | Ag RMO Arusha | MINING COMMISSION Arusha office | 0767 583296 | Before commencement of any activity the Proponent should seek licence from the ministry via regional mining office. The developer/investor should apply for Special Mining License due to the nature and scope of the proposed project. | Your comments and suggestions will be considered during operation phase. |
| | Tecla Anthony Mponda | Mining Engineer | | 0712 775719 | | |

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| | | | | | It is ideal if most of the works will be done by the citizens.<br>If the factory will be solely owned by the investor at least 16 % of shares will be owned by the Government. | |
| 20/07/2020 | Rose Stephen Sempindu | Hygiene Inspector Arusha region | OSHA | 0754 327158<br>0713 547790 | The project should be registered by OSHA before commencing production as per Act No. 5 of 2003.<br>Attend health and safety training, carryout health and safety assessment regularly<br>Adhere with OSHA regulations and instruction every day of operations | OSHA guidelines will be 100% followed for better health and safety of the workers. |
| 20/07/2020 | Y.Y. Semtana SACF | Regional Fire Officer Arusha | FIRE | 0785 810054 | Submit architectural design/plan for assessment.<br>Attend safety training and obtain certificate.<br>Provide assembling sites, put warning signs, purchase fire equipments like extinguishers etc<br>Provide PPE to workers and purchase First Aid kits and train First Aiders | Since these are instruction governed by the law the Client will follow them to the last point. |
| 23/07/2020 | Novatus Magoma | Senior Ecologist | Ngorongoro Conservation Area Authority (NCAA | 0752 761765 | Before the commencement of soda ash extract and refinery the Proponent should review the Multiple Land use model if the project area is within the plan or outside the plan<br>Proponent should assess the geological structure and find out (i) rocks structure and source and amount of deposits, (ii) availability of water i.e. gravity direction whether water is flowing from Ngorongoro or Monduli or Longido (iii) level of recharge (iv) Life span and how the communities within the project area as well as Government could benefit?<br>The distance of the proposed project is only 14 | Baseline studies on resource assessment, Project Technology design, Land Use Plan, Transport logistic, geology and hydrology will capture all the concerns and policies to enrich detailed EIS report. |
| | Linus G. Tiotem | Conservation Officer | | 0763 256727 | | |
| | Benson P. Mhagama | DMO – Ngorongoro DC | | 0767 562580 | | |

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| | | | | | Km from Ngorongoro Conservation Area boundary and since the area is a wildlife corridor to Tarangire, Ngorongoro, Manyara and Serengeti, the project should consider the factory not to interfere with the animals on their free transit to areas mentioned above. Furthermore, the project area contains a dam with saline water which gives animals nutrients for breeding so the factory should not share this potential resource with wildlife and livestock.<br>The Proponent/Consultant should harmonize some Acts and policies on Land use plans, Game Control Area, Wildlife etc | |
| 15/08/2020 | Dr. Hamza Kija | GIS Expert? Conservator | TAWIRI | 0768611844 | The project should negotiate with other authorities since the proposed project area falls within wildlife corridors and hunting blocks. | Different Authorities will be contacted to moderate the establishment of Soda Ash factory. Project design will find a way to minimize the interference with wildlife corridors and hunting blocks |
| 13/08/2020 | Eng. Erasmus M. Tarimo | Ag. BWO/ Hydroloist | Internal Drainage Basin Water Board | 0787277930 | During conduct of both hydrology and Hydrogeology the proponent should contact Internal Drainage office for technical support and clearance.<br>During investigation of water sources for the plant our office should be contacted as well as Water Users Groups of Mto wa Mbu and Engaruka. | All comments will be taken care of when the factory / respective studies will be established/undertaken.<br><br>Investor will follow the required procedures for |
| | Nyacheri Mtamba | Environmental Engineer | | 0742528992 | | |
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| | | | | | Any water source established for the plant should also benefit the community around the project.<br>During drilling and extraction of brine, if water comes out the Basin office should be informed.<br>Investor should pay water abstraction and discharge permits as per instructed by water laws. | water abstraction and discharge during project execution. |
| **OTHER INSTITUTIONS AND DEPARTMENTS** | | | | | | |
| 08/08/20 | Professor Hamisi Masanja Malebo | Executive Secretary National Coordinator for UNESCO | UNESCO | Box 20384 Dar es Salaam | In order to cover every aspect related to extraction of soda ash and construction of factory to process brine, we urgently need Stakeholders meeting whereby every expert will contribute to the following:<br>➢ On economy- how the production will benefit the country<br>➢ Pollution to surface and ground water, flora and fauna, air quality and soil<br>➢ Radiation (Radioactivity) and geohazards.<br><br>Prepare project presentation to all stakeholders in order of increasing understanding of the project<br>Assessment on hydrology regimes and modelling as well as Environmental safety and health in all project life cycles is important particularly on effects of spillage, leakage, pile-ups of raw materials and products and during transportation<br>We believe Soda Ash project will stimulate other industries which will use soda as their basic production material i.e., Intravenous (IV) | This request will be channelled to TIRDO higher authority to check if the budget (under Government fund) can accommodate your concern.<br>During the stakeholder meetings, presentation of the entire project were done as we did with UNESCO.<br>The issue about economy has been considered in the market study and economic study.<br>There are specialized studies on air quality, water quality, soil analysis, flora and fauna as well as hydrological and geological studies |

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| | | | | | Infusion Fluid, detergents, chemical, glass etc. Currently the country is importing soda for various uses, if this material will be available in the country, chemical industries will get soda ash in a reasonable price and secondary schools which are using soda bicarbonate in the laboratory practical will also equally benefit.<br>Soda bicarbonate is not among the high volatile elements so we believe the project will get the support from UNESCO.<br>Moreover, the current project site is well located far from Lake Natron, area designated by UNESCO as Ramsar site to protect Lesser Flamingos (*P. minor)* | done specifically or the project.<br><br>The distance from Lake Natron to the current proposed project site measuring more than 60 km. The EIS report will be shared across all key stakeholders including UNESCO for reference. |
| 29/07/2020 | Edward Porokwa | Director | PINGOS FORUM | Box 14437 Arusha | Monduli DC Land use plan has left very little area for pastoralism. Main area is given to TPDF, Manyara Conservation area, Forest reserve, Hunting blocks and Engaruka area is only place where pastoral communities could graze their livestock's. Proposing establishment of Soda Ash is like adding petrol on the dry grass.<br>Census and baseline socio-economic survey should be done with approaches that include traditional leaders and not only political leaders.<br>We propose that NDC could look or another material and leave Engaruka intact with livestock activities.<br>If resettlement will relocate PAPs outside Engaruka, the impact on ecology and | Resettlement is a linear so PAPs will reside within Engaruka.<br><br>Only active project site of less than 1km2 out of 9.746ha will be fenced to allow the community, wildlife and other users to use the unfenced area.<br><br>Moreover, the project design has considered the other land uses and opted for underground pipeline system that will be used to transport |
| | Emanuel Saringe | C. Officer | | Box 14437 Arusha | | |
| | Isaya Naimi | C. Officer | | Box 14437 Arusha | | |
| | Emmanuel L. Mvula | C. Officer | | Box 14437 Arusha | | |
| | Nawaya Ndaskoi | C. Officer | | Box 14437 Arusha | | |

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| | | | | | community cohesiveness should be observed because cattle in Engaruka cannot survive in Ngorongoro or other places with different ecology. | extracted brine to the storage ponds and/or plant. |
| 20/07/2020 | Lilian Loolotai | Director | CORDS | 0784 999823 | The Community in the project area need capacity building to adopt modern technology. When implementing the project the Client should consider land rights of the pastoral community.<br>Adopt approaches that seek their consent before embarking on project implementation. | All appropriate approaches and/or procedures were followed during stakeholders' consultations and the same will be largely adopted during RAP exercise. |
| 29/07/2020 | Eng. Twaha B. Kisaka | Planning Engineer | TANESCO | 0713 066080 | Upon commencement of the factory the Proponent/ Contractor should apply for power from TANESCO. The application should be accompanied with design and capacity of the factory.<br>TANESCO Engineers will visit the site before accepting the request. | The Proponent will be advised accordingly |
| 29/07/2020 | Johnny D.E. Kalupale | Regional Manager Arusha | TANROADS | 0754 295337 | TANROADS will continue to maintain Mto wa Mbu – Ngorongoro road; but spurs to the factory's access roads the Proponent should request assistance from TARURA. | The Proponent will be advised accordingly |
| 20/07/2020 | Dr. Raphael Mwambashi | Veterinary Officer | Zonal Veterinary Centre (ZVC) | 0713 819394 | The project should take necessary measures to minimize the spread of anthrax if livestock will be pushed to mix with wildlife since the area is a corridor and hunting blocks of wild animals. | Awareness on such diseases will be conducted by the respective Authorities |


**Figure 4.11: Public Consultative Meeting at Engaruka juu village in Engaruka ward**

**Figure 4.12: Public Consultative Meeting at Idonyanaado village in Mfereji ward**

**Figure 4.13: Public Consultative Meetings at Maasai Bomas near project site**

**Figure 4.14: Consultative Meeting with Ministry of Minerals and Mining Commission staff**

### 5.5.2 Results of Consultation with the General Public in the Project Area

These included villages' council leaders, elders and the community living closely and within the vicinity of the project areas, which are mostly likely to be directly affected by the Soda ash project. A number of public meetings, were held at selected villages in each ward within the project area. During the field work, the ESIA team took advantage of knowledge of the local people to gather specific knowledge about the project site, such as presence and location of cultural sites, concealed public services/utilities, which are likely to be affected by the project, potential sources of construction materials, which are likely to affect the environment etc. Table below shows the response of community member with regard to the proposed project. The views are not categorized according to village/meeting because there were many repeated points/concerns.

**Table 5.2: Comments and Response during the Consultative Meeting from Residents**

| S/N | Issues/Comment from community | Remarks by Consultant |
|---|---|---|
| 1 | The pastoral communities are nomadic and during assets inventory other people were not in the project villages so they were not included in the valuation exercise. We request the Government to repeat the exercise so that all affected communities will be identified/valuated for compensation. | The Client and Government will consider this problem when implementing RAP whereby census and socio-economic exercise will be conducted to each PAP. |
| 2 | The factory and approach roads will guarantee more physical development and investment opportunities. There will be relatively low transport and transportation costs and travelling time saving for passengers and goods | It is obvious that the factory and feeder roads to the factory will be the driving development factor in the area. It is within this context that communities should be prepared to exploit this opportunity. |
| 3 | We have had about the construction of this factory for more than three years now. Will this factory be constructed real or it is just another way of campaigning next general election? When will the construction start? | It is definite that the factory is going to be constructed. However, the consultant cannot fix time as to when the construction is going to start. It should be well-known that this report and other ongoing studies reports will inform/determine the actual environmental and/or project cost, designs and mitigation measures that the government will use to justify the project. |
| 4 | The district Authority should explain clearly on how much each village will get as loyalty for releasing the land | All required taxes and loyalties are already established under the law and regulations established on building such factory so, everything is under control. |
| 5 | Majority of Engaruka, Selela and Mfereji have worries over their grazing/pasture land and water body which is the source | The factory is not going to use water from the lake. Soda will be obtained from the boreholes drilled in the area which are piped. |

| S/N | Issues/Comment from community | Remarks by Consultant |
|---|---|---|
| | of water during dry seasons and its water is saline and suitable to livestock and wild life | Since the whole area will not be fenced like a prison cattle may be allowed to graze and wild animals will move freely along the corridor (*ushoroba*). Only active project site of less than 1km$^2$ out of 25,000 ha will be fenced to allow the community, wildlife and other users to use the unfenced area.<br>Moreover, the project design has considered the other land uses and opted for underground pipeline system that will be used to transport extracted brine to the storage ponds and/or plant. |
| 6 | Compensation has been delayed for so long and people are doubting on the construction of the project. | In fact the project will be constructed soon after Techno-Economic Study including this exercise of ESIA been accomplished and all necessary measures being taken to facilitate the development of a '*Bankable Feasibility Study (BFS)*' for mobilization of the required resources (human, technology, financial) for the project. |
| 7 | People should be informed in advance so that they have time to demolish their house. | The aim is to recover some materials from their house and reuse them. Time for salvage the properties will be provided. |
| 8 | Employment Opportunities. The contractor should give the priority of employment to the people hailing from the villages along the project site during the construction. The villagers may be involved in some activities as labourers during the construction phase. | Factory construction will stimulate individual's income for those who will be employed by the project. Skills acquired during recruitment and construction will remain as asset to community members.<br>However, employment opportunities will only be provided to those people aged l8 years and above. The women are also encouraged to participate in the construction activities |
| 9 | There will be spread of HIV/AIDS and other sexually transmitted infections: | The contractor will identify local capacity in dealing with HIV/AIDS and arrange for HIV/AIDS prevention programme targeting both the construction camp and local communities.<br>Positive discrimination in favour of resident workers to minimize risk of increased infection among local population.<br>Programme on HIV/AIDS will target groups at risk such as food vendors, and business women in the construction area.<br>There will be a separate consultant to implement and manage HIV/AIDS alleviation programs. The contractor will implement HIV/AIDS programs |

| S/N | Issues/Comment from community | Remarks by Consultant |
|---|---|---|
| | | on his part by allowing his employees to attend awareness seminars and campaigns and carrying out any directives of the Consultant in this regard. |
| 10 | The project should facilitate town centres and village growth. These towns should be assisted by the government in planning (e.g. Land use and plot surveying) in order to curb/cut limit/control unplanned growth of settlements | The recommendation is acceptable. Village governments should consult district council for guidance on planning.<br>However, the district has already made land use plan for Engaruka. |
| 11 | Deaths of pregnant women will decrease during operational phase of the factory and approach roads as there will be easy accessibility of road to the health centres and hospitals. | The proposed action contributes to the implementation of health policy which intends to make health facilities accessible by every citizen. |
| 12 | Graves, places of worships, and shrines may be affected | Possible sites have been identified and as much as possible, the factory boundaries/ alignment will avoid affecting those properties. For those properties which will be affected will be compensated in accordance with the national laws.<br>All archaeological sites, graves and worship area in the project area will be identified by Archaeologist and the findings will be included in the EIS report for further consideration. |
| 13 | It is feared that the Soda ash factory will claim people’s lives through air and water pollution. It was recommended to use modern technology which is environmentally friendly | The best choice of modern technology with environmental user friendly will be opted. |
| 14 | The communities supporting the project expect to benefit from the project, during construction and operation phase. | Villagers are encouraged to take part in the implementation of the proposed project as well as during operations |
| 15 | Construction of Soda ash factory may interfere with wildlife because the factory area if fenced will block the route of wild animals’ movement from and to Tarangire and Ngorongoro respectively.<br>This situation will also limit the villages from collecting revenues from tourists who come to watch wild animals in their free range. | The larger part of acquired 25,000 hectares for soda project will remain unfenced to allow free movement of wildlife and collection of revenues will not be hampered. |

## CHAPTER SIX

# 6 ANALYSIS OF THE ALTERNATIVES

## 6.1 Introduction

The discussion and analysis of alternatives in Environmental Impact Assessment considers other practicable strategies that will promote the elimination of negative environmental impacts identified. This section is a requirement of the Environmental Management (Environmental Impact Assessment and Audit) (Amendment) Regulations of 2018, and is critical in consideration of the ideal development with minimal environmental disturbance.

In analysing the environmental impacts, there are usually two or more development alternatives to consider for each issue. The alternatives may encompass a wide range of consideration and can represent a choice between the construction and operation of a development and the non-development option. With this in mind, the general principle involved in identifying the option(s) of the proposed soda ash project is to ensure that the option chosen would result in optimal social, economic and environmental returns. In effect the option chosen should corroborate well not only for the proposed project, but also for the environment and stakeholders in the area. The option with the highest cost benefit factor, the most technically feasible and with least residual impact is identified as the preferred option. The following alternatives have been identified and have been discussed as means of reducing environmental and social effects. They are discussed in further detail below:

## 6.2 Alternative Site

The ADB EIA Guidelines, Annex 2 (1992) states that "*project options should be provided within the constraints of the aim and broad economic, technical, social and environmental factors*". In the context of this study therefore the choice of site has been dictated by the following the factors:

(a) Site Location and/or selection: Site selection and or location adhere to the proposed mitigation (recommendation) that laid down by key stakeholders those attended the public hearing organised by NEMC at Karimjee hall Dar es Salaam on 23rd January 2008. It was proposed to site the soda ash plant as far away as possible from Lake Natron ecosystem which is designated as a wetland of international importance (Ramsar site by UNESCO in 2001) as the crucially important breeding site for Lesser Flamingo *Phoeniconaias minor*). The project site is 60kms away from Lake Natron.

(b) Scope of ESIA study: The EIS report has put all environmental concerns on check by incorporating vital baseline information and data (i.e., air quality, water quality/hydrology of the area, noise, vibrations, ecology, flora and fauna, resource assessment, transport logistic, marketing and economic studies, technology design and archaeology); clear mitigation measures; considering strongly the cumulative impacts and project alternatives; and inclusion of participatory consultation process as oppose to 2008 EIS report.

(c) Ownership of the site. The project area of about 25,000 ha corresponds to the NDC's Minerals Prospecting Licenses (PLs) that granted by the Ministry of Minerals through Mining Commission in 18th day of October 2018 (Appendix 1) to prospect the underground resources, develop exploratory wells for extraction and processing of brine resources. However, the surface right for the earmarked piece of land is legally belongs to the Village Government Councils of Engaruka chini, Irerendeni, Mbaashi and Idonyonaado (Appendix 2) who have agreed to be compensated by URT/NDC once the valuation and compensation processes been finalized. Consultations with the Arusha Regional Office, Monduli District Council Office, Engaruka Ward Office, Selela Ward Office, Engaruka-chini Village Office, Irerendeni and Mbaashi Village Office as well as neighbours confirmed to the ESIA team that valuation exercise was completed a-wait for Chief Valuer to sign and/or approve the valuation report to trigger compensation process. Over the years the site has been used as settlement area for villagers (mostly Maasai) and grazing land for both domestic and wild animals. The proposed site is quite adequate to accommodate the proposed Soda Ash project including the further expansion plans when deemed necessary. Moreover, the development will abide with the future development master plan of Monduli District Council.

(d) The proposed project site/land located meets the user requirements for such development i.e., easily accessible from Mto wa Mbu centre via under construction Loliondo road; very close to Engaruka centre with nearby power supply.
(e) Land is fairly enough and flat therefore allow economical construction and design of the proposed soda ash project.
(f) Availability of plenty brine resource of high quality in the area, allowing the sustainable production of 1,000,000 per annum.
(g) Availability of the soda ash project market and/or demand locally and internationally.

Based on the above, the recommended alternative is the "Proposed Alternative" because it recognizes the viability and need for the proposed development, is designed to address environmental issues and concerns, and meets all local regulatory requirements during all stages of the development between the developers and the surrounding communities. Therefore, the alternatives considered are the 'No Project Alternative' and 'Project Alternatives' with respect to site selection, site location, Ownership of underground resources/PLs, demand/ capacity and environmental concern/relocation and safety-based/designed technology and waste management options. These alternatives are discussed in detail in the following sub-sections.

### *6.2.1 Relocation Option/Alternative*

The initial proposal was to construct the soda ash project at Lake Natron site but this was reversed due to the environmental concerns, consideration of the Lake Natron is a wetland of international importance (Ramsar site by UNESCO in 2001) an is the crucially important breeding site for Lesser Flamingo *Phoeniconaias minor*). Relocation of the selected project site to a different site is best option available for the sustainability and environmentally friendly implementation of the proposed project. This is because the current site is considered the most suitable compared to Lake Natron site as it is located 60kms away from Lake Natron ecosystem.

***Decision: Relocation Option Recommended.***

### *6.2.2 Plant site selection Alternative*

**Criteria used to select the suitable plant site**

6.2.2.1 Plant site 1

Plant site 1 of an area of 0.68 $Km^2$ is located 1 Km apart from proposed plant site 2; 15 Kms from Engaruka town (South West) and around 10 Km from the centre of Lake Engaruka (South West). With a scoring factor of 4.95 over the whole three selected criteria (*Volume VI – Plant and Township Site Selection and Infrastructures Report*), the site size can accommodate the current plant design and associated facilities while allowing future expansion plan. It is characterized by shallow slope, good terrain and absence of seasonal water stream and swamps.

***Decision: Recommended based of higher scored value 4.95 (****Volume VI – Plant and Township Site Selection and Infrastructures Report****).***

6.2.2.2 Plant site 2

Plant site 2 has an area of 0.51 $Km^2$. It is found just outside of the project boundary, at the western edge. It is located 15 Km from Engaruka town and 10 Km from the centre of Lake Engaruka on the South West. Its proximity to Lake Engaruka and exploration and/or production boreholes, may block or bring some difficulties to the extraction logistics.

***Decision: Fairly Recommended based of fairly scored value (****Volume VI – Plant and Township Site Selection and Infrastructures Report****).***

6.2.2.3 Plant site 3

Plant site 3 with 0.65 $Km^2$ size, is the only site found within a project area, closely to production boreholes. It is located about 13 Km from Engaruka town (North East) and 2 Km from the Lake Engaruka (North West) and near the center of the Drilling Boreholes

***Decision: Not Recommended based of lower scored value (****Volume VI – Plant and Township Site Selection and Infrastructures Report****).***

### *6.2.3 Zero or No Project Alternative*

The No Project option in respect to the proposed project implies discontinuation of the project proposal hence the status quo is maintained. The result is the site being retained in its existing form. This option is the most suitable alternative from an extreme environmental perspective as it ensures non-interference with the existing conditions. This option will however have the greatest implications on the socioeconomic environment of the area and surrounding communities. This will mean the soda ash project will not be developed, and the land will remain underutilized for the specific purpose it is supposed to serve. Therefore, the current Government income will rely only from tourisms. The No Project Option is the least preferred from the socio-economic and partly environmental perspective due to the following factors:

- Supply of soda ash products to local and international markets will not be possible under this option and thus, Tanzania will continuous to rely on exportation of soda ash product from other countries,
- The endowed underground brine resources will stay underutilized and thus impinge economic growth of the country;

- No employment opportunities will be created for local people who will work in the project area during construction and operation phases;
- Development of infrastructural facilities (road networks, water systems, health centres and associated infrastructure) will not be undertaken; and
- No comply with statutory requirements (such as public health, safety and environmental standards).
- From the analysis above, it becomes apparent that the Zero or No Project alternative is not attractive to the local, regional and international markets as the Government of Tanzania as it is depriving the development of soda ash project to tap available markets. This design is reasonable to meet the demands for local, regional and the international markets. It is estimated that the exports of soda ash is likely to be 87% of the total produce. The local market is expected to absorb 13% to 30% at the end of 2030 given promotion of local industrial uses of the soda ash as suggested in this plan. The main consumers in the local market will be glass as well as soap and detergent industries, which absorb more than 60% of the current soda ash, globally.

Moreover, the estimated demand for Engaruka Soda Ash will be as follows:

- In the local market, Total Demand for dense soda ash will be growing from 30,865 tons (in 2020) to 130,128 tons (in 2030); at a price of US$ 185.64 to US$ 226.29 respectively (Tax exclusive)
- In the local market, Total Demand for Light Soda Ash will be growing from 31,380 tons (in 2020) to 59,439 tons (in 2030) at a price of US$ 301.6 to US$ 339.3 respectively (Tax exclusive)
- Total Local Market Volume potential will be growing from 32,245 tons (in 2020) to 189,567 tons (2030) at an average price of US$ 239.27 to US$ 282.80 respectively
- Total Estimated Local Market Value will be growing from US$ 16,968,808 (in 2020) to US$53,609,548 (in 2030).
- In the short run, the production may be constant at 500,000 tons per annum to cater for both local and export markets. The demand is expected to rise depending on marketing efforts that will be invested in both the local and foreign markets.
- Local Market Share will increase from 31% (in 2020) driven by increased production at Kioo Limited and investments in the detergents industry to 165% (in 2030), given the strategies to stimulate soda ash consumptions are implemented.
- Total projections in exportation will vary from 432,453 tons (in 2023) to 310,433 tons (in 2030) at average prices of US$314 to US$353 respectively
- Total value of exportation is estimated at US$ 135,818,502 (in 2023) and US$ 109,582,849 (in 2030)
- Total estimated value, combining both local sales and exportation range between US$ 152,787,310 (in 2023) and US$ 163,192,397 (in 2030).

***Decision: No Project Option Not Recommended.***

### *6.2.4 Extraction methods*

6.2.4.1 Open pit method

Extraction of brine resource by pumping the slurry from Lake Engaruka through pipelines. The proposed method of soda ash extraction would include large network of pipes across

Lake Engaruka, incredible noise and 24-hour flood lights, would disorient aquatic and terrestrial fauna/wildlife, which move mainly at night, and other night flying birds. Moreover, Lake Engaruka is seasonal lake and thus no assurance of the availability and/or sustainability of the slurry to produce soda ash products of high quality to meet local, regional and international market.

***Decision: Not Recommended***

6.2.4.2 Underground method

The raw material for the manufacture of soda ash will be naturally occurring brine discovered deep at the Engaruka Basin. The resource is composed mainly with saline salts of sodium carbonate and sodium bicarbonate. The underground method involves abstraction of brine from the underground aquifers by pumping followed by the recovery of dissolved salts. This method was evaluated as the least cost option and environmental friendly when compared with other methods such as; open pit mining or underground mining. In addition, the method has the advantage of producing a better quality of soda products through controlled precipitation and crystallisation of salts. This method will minimize contamination to the brine during extraction as well as avoid environmental destruction which might be experienced if open pit method will be used to extract sodium bicarbonate which is in the solid, crystalline structures.

***Decision: Recommended***

### *6.2.5 Processing systems (settling ponds and solar ponds system design)*

In any soda ash processing plant, the type of technology is chosen based on the number of unit operations involved and quality of raw materials. Based on the soda ash concentration reported, solar ponds system design may not be required, instead brine storage / settling ponds will be required.

The solar salt pond technology was evaluated and noticed that it has some drawbacks with respect to its application to Engaruka Basin resource. The technology has demerits on the purity of the product, which will require reprocessing and environmental reasons. Albeit, it has merits on the cost of energy and its technology is simple. However, the method was not recommended to be applied at Engaruka Basin being a wildlife sanctuary and due to large pond sizes required to meet the production capacity. These will capture the slurry from the boreholes. Clear solution will then be pumped to the production plant.

***Decision: Brine storage / settling ponds Recommended***

### *6.2.6 Processing systems (Carbonation and precipitation)*

The process selected is the carbonation process. This process involves treatment of clear and odourless brine with carbon dioxide gas in carbonation towers to convert the sodium carbonate ($Na_2CO_3$) in solution to sodium bicarbonate ($NaHCO_3$), which is less soluble and precipitates out. The precipitated sodium bicarbonate is separated from the mother liquor by hydro-cyclone followed by belt filtration. Precipitated salt is washed then dried. Fraction of this product is market as bicarbonate and the major faction is calcined to convert the sodium

bicarbonate to light soda ash. Finally, the soda ash is compacted in roller mills to convert it into dense soda ash pellets or it is steamed to produce fine dense soda ash.
***Decision: Carbonation process Recommended***

### *6.2.7 Appropriateness of processes (Evaporation or Carbonation technologies)*

Market study has shown that there is a clear market for dense and light soda ash, with the former dominating the market (*Volume II – Market Analysis Report*). However, there are two main approaches for production of dense soda ash worldwide. The first approach is the evaporation process which employs evaporators followed by crystallizers. The second approach is the carbonation process which produces sodium bicarbonate and later light soda ash, which can be processed further to dense soda ash. The first approach is more energy intensive and more expensive, hence opted out. The carbonation technology is less energy intensive and is more flexible in terms of supply of soda ash and sodium bicarbonate.
***Decision: Carbonation Technology Recommended.***

### *6.2.8 Environmental and Safety based Technology Alternative*

- Extraction method of brine resources: Underground extraction method opted over open pit method for safety of domestic and wildlife animals and thus would mitigate the visual impact to birds, domestic animals and wildlife. The proposed underground method of soda ash extraction would avoid having of a large network of over round pipes across the entire area that will impact the wildlife corridors and grazing area. Absence of large network of underground pipes across the entire area would mitigate the disorientation of wildlife animals, which move mainly at night, and other night flying birds.
- Construction materials and/or facilities: Big windows and double doors have to be considered to ensure good ventilation to minimise the use of power, fans and air conditions or in case of total failure of electricity power. Orientation of the plant to enhance good ventilation is of vital in the designing. In addition, placing of the proposed structures will be such that western solar radiation is minimized.
- Safety issues: Main exit double-doors would be part of the design to open outward for safe evacuation in case of emergency. The design of the proposed project shall incorporate the use of advanced firefighting system provided with fire alarms, fire detectors, and smoke detectors. The proposed project shall be equipped with $CO_2$ fire extinguishers and/or hydrants for safety purposes.
- Vegetation clearance: Design would consider native, rare and endangered vegetation. When deemed necessary the sprout or seeds of cleared native, rare and endangered vegetation would be revegetated elsewhere in the same locality.
- Wind impact on bare land: The general onsite area will be landscaped with paving tiles and grasses for preventing wind impact on bare land with loose soil. A consideration of avoiding or minimising the use of pavement blocks on the surrounding grounds of the building in the project site has to be considered during project construction to minimise negative impact to the environment.

#### *6.2.9 Waste Management Alternatives*

Solid and liquid wastes will be generated from the proposed project, which could be detrimental to the environment. An integrated solid and liquid waste management system has been recommended to mitigate any impacts of solid and liquid waste generated from the project during construction and operation of the proposed project. First, the proponent will give priority to reduction at source of the materials. Recycling and reuse options of the waste will be the second alternative in priority i.e., the spent mother liquor will be returned back to the underground at a suitable location, to further dissolve the crust.. The third priority in the hierarchy of options is combustion of the waste that is not recyclable. Finally, the proponent will need to establish an agreement with Monduli District Council to ensure regular waste removal and disposal in an environmentally friendly manner. In this regard, a registered solid and liquid waste handler would have to be engaged. This is the most practical and feasible option for solid waste management considering the described options.

#### *6.2.10 Analysis of Alternative Construction Materials and Technology*

The proposed project will be constructed using modern, locally and internationally accepted materials to achieve public health, safety, security and environmental aesthetic requirements. The project construction works will be made using locally sourced materials that meet the Tanzania Bureau of Standards requirements. The consultant presented three options for BoQ construction materials, which are:

- **Option 1:** Traditional material. This is primarily represented by concrete structures, and concrete bricks;
- **Option 2:** Concrete bricks, concrete foundation, steel frame and precast concrete/granite panels; and
- **Option 3:** Steel frame and thermo-acoustic aluminium panels

The construction materials selected for the modules by the Client is Option 2 as outlined below:

- Concrete foundation;
- Metallic structures for columns, beams and roof;
- Thermo-acoustic panel for the roof;
- Precast concrete panels;
- Aluminium windows;
- Wooden doors;
- PVC and/or aluminium louvers vents and windows;
- Granite tiles in the floor and/or concrete finishing non-skid with hardener in the floor

These materials were selected for these advantages:

- Use of recycled materials;
- Reduction in noise levels at construction sites;
- Reduction in the amount of construction waste;
- Reduction in transport cost;
- Reduction in site disturbance; and
- Savings in construction time and cost.

***Option 2 Recommended***

## CHAPTER SEVEN

# 7 ENVIRONMENTAL AND SOCIAL IMPACTS ASSESSMENT AND MITIGATION MEASURES

## 7.1 Introduction

This chapter outlines the potential negative and positive impacts that will be associated with the project. The impacts will be related to activities to be carried out during construction and operation and decommissioning phases of the project. The operational phase impacts of the project will be associated with the activities carried out within the premises. In addition, closure and/or decommissioning phase impacts of the project are also highlighted. The impacts of the project during each of its life cycle stages (construction, operation and decommissioning) can be categorized into: impacts on the biophysical environment; health and safety impacts and socio-economic impacts.

## 7.2Approach

The process involved in assessing the potential impacts of the project used the following steps:

- **<u>Prediction:</u>** What will happen to the environment as a consequence of the project?
- **<u>Evaluation:</u>** Will it have beneficial or adverse effects? How big is the change expected to be? How important will it be to the affected receptors? The impact is then assessed in the context of the whole environment to establish the “significance” of the impact. This assessment incorporates all social, cultural, historical, economic, political and ecological aspects of the impact. Thus, the severity or benefit of an impact within a specialist discipline is first assessed before the significance of the impact is evaluated in a broader context. Consequently, two rating scales are required, one to determine the severity or benefit, and one to determine environmental significance i.e., low/short term (less than 2 years), medium (between 2 and 5 years), high/long term (between 5 and 20 years) and permanent (above 20 years). Significance of an impact is not always directly proportionate to severity, despite the fact that one would expect a direct relationship i.e., an impact with severe ***severity*** would be expected to be of ***high significance***. However, this is not always the case. For example, changes to the geology might be ***severe,*** but the significance is regarded as ***low,*** since the change in the environment is considered by society as being unimportant.
- **<u>Mitigation:</u>** If the impact is of concern, can anything be done to avoid, minimize, or offset the impact? Or to enhance potential benefits?
- **<u>Assessment of Residual impact:</u>** After mitigation, is the impact still of concern?

## 7.3 Anticipated Positive Project Impacts

### *7.3.1 Employment creation*

This project is anticipated to create employment opportunities for many people within Monduli District particularly Engaruka, Selela and Mfereji Wards. Direct Job creation will begin from the construction phase of the project whereby the locals will be employed to undertake both informal and formal jobs at the construction site. Moreover, the project will attract more youth and women to establish peripheral business (i.e., mama ntilie, kiosk etc) or venture into other trade business and hence reduce the number of the unemployed population in the society.

### *7.3.2 Source of revenue*

The project can be source of revenue through collection of levies from sells of soda ash products to local and international markets and the traders associated with peripheral business. This contribution enables the Government through NDC to maintain the plant and carry out other developments within the area.

### *7.3.3 Socialization*

Socialization and interactions realized among workers, contractors, visitor, researchers, tourists and other users within the project area encourages sharing and dissemination of important and helpful information among people of the same social groups and interests.

### *7.3.4 Improved public health*

Construction of the soda ash project would improve the state of public health for the project area and its vicinity as the project will entail provision of good drainage system, adequate water provision, sanitary facilities, health services, road systems, and organized waste management systems.

### *7.3.5 Economic growth and reduced importation*

Construction of the project is likely to spur economic growth in the area such as Development of other business activities including; food ending, shops, banking, transportation and residential among others. The upcoming development will enable reduction of importation of soda as products from overseas and channels the money to other development activities to enhance GDP based on the following expectations and/or facts:

- In the local market, Total Demand for dense soda ash will be growing from 30,865 tons (in 2020) to 130,128 tons (in 2030); at a price of US$ 185.64 to US$ 226.29 respectively (Tax exclusive)
- In the local market, Total Demand for Light Soda Ash will be growing from 31,380 tons (in 2020) to 59,439 tons (in 2030) at a price of US$ 301.6 to US$ 339.3 respectively (Tax exclusive)
- Total Local Market Volume potential will be growing from 32,245 tons (in 2020) to 189,567 tons (2030) at an average price of US$ 239.27 to US$ 282.80 respectively
- Total Estimated Local Market Value will be growing from US$ 16,968,808 (in 2020) to US$53,609,548 (in 2030).
- In the short run, the production may be constant at 500,000 tons per annum to cater for both local and export markets. The demand is expected to rise depending on marketing efforts that will be invested in both the local and foreign markets.
- Local Market Share will increase from 31% (in 2020) driven by increased production at Kioo Limited and investments in the detergents industry to 165% (in 2030), given the strategies to stimulate soda ash consumptions are implemented.

- Total projections in exportation will vary from 432,453 tons (in 2023) to 310,433 tons (in 2030) at average prices of US$314 to US$353 respectively
- Total value of exportation is estimated at US$ 135,818,502 (in 2023) and US$ 109,582,849 (in 2030)
- Total estimated value, combining both local sales and exportation range between US$ 152,787,310 (in 2023) and US$ 163,192,397 (in 2030).

#### *7.3.6 Solid Waste Management*

Solid waste management will be a shared responsibility among all the stakeholders who are the Central and Local Governments, vendors, shoppers, contracted and licensed waste handlers, owners and occupiers of premises (NDC/Investor management). The project will be provided with separate collection bins for biodegradable and non-biodegradable waste at the new facility. Waste from such bins shall be collected on daily basis by the County workers for proper disposal. The project will also be provided with bins near their merchandising points to ensure waste generated is collected at garbage stations or transfer points and later disposed at the main collection points for further disposal by the Monduli District Council.

### 7.4 Anticipated Negative Project Impacts and Mitigation Measure

#### *7.4.1 Biodiversity, settlements, wildlife corridors and hunting blocks loss*

The project will have a direct impact to the existing biodiversity in the area since the construction phase will involve removal of the vegetation cover, trees, grasses and shrubs in the proposed project site. However, this development will have impact to the biodiversity because of the nature of multiple uses of the area (i.e., grazing, GCA/hunting blocks and settlement area) as categorised by Monduli District Council, MNRT NCAA, TAWA and TAWIRI.

**Mitigation**

Resettlement is linear so PAPs will reside within Engaruka including project area. Only active project site of less than 1km$^2$ out of 25,000 ha will be fenced to allow the community, wildlife and other users to use the unfenced area. Moreover, the project design has considered the other land uses and opted for underground pipeline system that will be used to transport extracted brine to the storage ponds and/or plant. The project design will consider the existence of wildlife corridors and hunting blocks and where necessary negations deemed can be started between the Government, key Ministries and stakeholders to find the better means of the issues especially the possibility of revoking the hunting block license. When the project is about to start the collaborative programme with various stakeholders will be initiated for good health of wildlife and livestock.

#### *7.4.2 Soils and Geology disturbance*

Since the construction phase will involve use of heavy machinery and excavations, soil disturbance is bound to happen. Therefore, the Contractor should put in place mitigation measures to aim at minimum soil disturbance and soil erosion. These measures will include clearing the project site of excavated materials or protect excavated sections from storm water, avoid excavation through flood plains or into stream banks, creating proper channels for waste water and solid waste disposal, develop emergency measures and procedures for protection of soils.

**Mitigation**

The impact rating is low; however, the Proponent through the Contractor should ensure that excavations are undertaken safely in that shoring and good slope banking is put in place and by adhering to all safety rules.

### *7.4.3 Depletion of Water Resources during Construction phase*

Construction works demand high level of water utilization. This high-water demand will in turn impact to the water supply in the area. The impact will be reduced water supply to other adjacent areas that shares the same water infrastructure.

**Mitigation**

The Impact rating is low. The Contractor is advised to consult with Monduli Rural Water and Sewerage Authority and/or Internal Drainage Water Board as well as Engaruka water users committee to get permit for their share allocation of water. This consultation and collaboration with water supplier will be encouraged so that water demand conflict will not arise. The Contractor is also advised to find new water sources, harvest rain water and install two water storage tanks of 2,500 $m^3$ capacity each and other water saving technology at the site to save on water usage.

### *7.4.4 Soils and groundwater Contamination*

The Proponent and Contractor will prepare a hazardous substance control systems and emergency response plans that will include preparations for quick and safe clean-up of accidental spills. It will prescribe hazardous-materials handling procedures to reduce the potential for a spill during construction, and will include an emergency response programme to ensure quick and safe clean-up of accidental spills.

**Mitigation**

The following mitigation measures should be undertaken:

- Pave and shield the waste collection area from direct sunlight and rains;
- Place all oily and contaminated wastes on paved surfaces;
- Dispose offsite oily waste appropriately;
- Obtain spill kits for use in case of accidental spillages on site; and
- Obtain portable secondary spill containments for use on site.

### *7.4.5 Air pollution (Dust generation)*

The construction activities often result in increased dust and gas emission. These pollutants emanate from movement of construction machinery and trucks as well as wheel generated dust during construction.

**Mitigation**

- Practice prevention measures such as dampening dust by use of water (sprinkling water on surfaces that produce dust or covering them);
- Provide PPEs such as nose masks to the workers on the construction site;
- Control over areas generating dust particles. Such areas should be regularly cleaned;
- Construction workers should be encouraged to go for regular health check-ups to ascertain their health standards;
- Regular air quality tests to enhance air quality monitoring;
- Wet sweeping of the surfaces that produces a lot of dust particles; and
- Establishment of optimum green spaces in the compound particularly at the perimeter fence as the vegetation helps in extracting pollutants from the air.

### *7.4.6 Air pollution (Generation of exhaust emission)*

The following measures are recommended to mitigate impact of air pollution associated with exhaust emissions:

- Maintaining equipment appropriately;
- Speeding of 20 km per hour should be recommended and maintained;
- Keeping vehicle idling time to the very minimum; and
- Use of alternative fuelled construction equipment where feasible.

### *7.4.7 Noise and excessive Vibration generation*

Noise refers to unwanted sound that can affect job performance, safety and health. Physical impacts may include; loss of hearing, pain, nausea and interference with communications when the exposure is severe. Psychological effects could be disruption of concentration and cause of annoyance. Construction activities tend to cause noise which affects the immediate environment and even disrupt other nearby operations. The noise will affect nearby receptors i.e. people, small animals and birds which are sensitive to noise.

**Mitigation**

- Construction activities should be carried only during the day when most the students and/or neighbours are active or carrying on with their normal day chores. The appropriate time could be between 0800hrs to 1800hrs;
- Construction vehicle's drivers and machine operators should be sensitized to adopt a habit of switching off engines of their vehicles or machinery when they are not in use;
- Regular maintenance of the construction machinery is highly encouraged to reduce the noise resulting from friction;
- The Proponent should provide a well-marked billboard at the construction site gates. This is meant to notify the public of the construction activity and timings;
- Unnecessary hooting should be avoided at all costs by the construction vehicles and even during project occupation; and
- Personal protective equipment and /materials such as earmuffs and earplugs should be provided to the workers when operating noisy machinery and in a noisy environment. This measure ensures physical barrier that reduces inner noise levels and guard against hearing loss.

### *7.4.8 Construction solid/liquid wastes generation*

Construction operations will generate solid wastes within the site. The wastes may include; rods of metal, pieces of iron sheets, broken glasses, pieces of wood, empty containers and broken stones.

**Mitigation**

- The Proponent should liaise with private waste handlers and the Monduli District Council to have a sound waste handling and disposal;
- The wastes should be properly segregated and separated to facilitate recycling of some useful waste materials. For example; broken stones can be used for backfills. Integrated solid waste management system may also be adopted through hierarchy of options like source reduction, recycling, composting and reuse;
- The Proponent should ensure that measures are put in place to ensure that construction materials required for the project are carefully budgeted to ensure the amount of construction materials left are kept to the minimal level possible;
- All the solid wastes should be collected by licensed waste collectors and dumped in the recognized dumpsite; and
- Human waste will be discharged into toilets and disposed appropriately by the toilet handler.

### *7.4.9 Health and safety Impacts*

Construction activities such as excavation and concreting can pose occupational hazards and risks to construction workers and the general public living and working in the neighbourhood of the construction site. They can cause respiratory infections and injuries to limbs and body due to exposure to, dust and combustion gases, operation of equipment and handling of construction materials. Accidents may occur during construction as a result of workers falling from heights or being hit by falling construction materials or tools. Dust and combustion gases can irritate the eyes causing trachoma and respiratory problems. While the operation of construction equipment and handling of materials can result in injuries to the workers especially in the absence of appropriate protective devices. The health of the site workers may be further compromised by the food which is often supplied by mobile individuals with no licenses to handle food and some of the foodstuffs may be prepared in unhygienic manner.

**Mitigation**

- Depending on the occupational safety and health hazards encountered while performing assigned tasks, workers may require using properly fitting personal protective equipment (PPE) to avoid injuries and illness. They (workers) must be provided with full protective gear. These include working/safety boots, overalls, helmets, goggles, earmuffs, masks, gloves etc.;
- Adapt effective emergency response plans. A good start of learning how to respond to an emergency is through certification in Basic First Aid. Regular drills and emergency situations should be followed to impart the anticipated insight and awareness to the workers;

- A first aid kit should be provided within the site. This should be fully equipped always and should be managed by qualified persons;
- Safety awareness may be gained through regular safety training or personal interest in safety and health;
- Local individuals preparing food for the workers at the site must be controlled to ensure that food is hygienically prepared. Allow only authorized food vendors to supply food for the workers in the site;
- The Contractor should have workmen's compensation cover; and
- Workers should always be sensitized on social issues such as drugs, alcohol, diseases etc.

#### *7.4.10 Increased surface runoffs*

Increase in the runoffs emanating from expansive rooftops and paved grounds shall be mitigated. These runoffs often lead to flooding and overflow of the drainage system.

**Mitigation**

- Construct gutters along the roofs for rainwater harvesting and provide tanks for water storage;
- Construct efficient drainage systems within the area.

#### *7.4.11 Landscape and Visual destruction*

At the initial stages of construction, excavators and landscape distortion can be an eye sore to the passer-by.

**Mitigation**

- The Contractor shall put up a perimeter fence using non-transparent material to prevent people from accessing the site; and
- The Proponent shall beautify the building and the site after its completion by painting it and planting aesthetic plant and flowers round it.

#### *7.4.12 Food poisoning*

Construction workers may contract food poisoning by buying food from food vendors. This may lead to reduces work personnel and may lead to delay of works and increased expenses for training new workers.

**Mitigation**

- Allow only authorized food vendors to supply food for the workers in the site; and
- Sensitize workers on the possibility of food poisoning from the vendors.

#### 7.4.13 *Poor sanitation*

Poor sanitation may be realized during construction when construction workers do not have access to toilets and water for washing hands thereafter.

**Mitigation**

- Provide suitable, efficient, clean, well-lit and adequate gender specific sanitary conveniences for construction workers; and
- Provide water and soap for washing hands after visiting the toilets.

### *7.4.14 Traffic snarl up and accidents*

Activities related to construction works and operation will undoubtedly induce uncharacteristic levels of additional vehicular traffic at the site and roads leading to construction site. Related issues of vehicle congestion and reckless driving by truck drivers delivering construction materials and supplies to the site will be sources of potential accidents to road users and pedestrians. Disturbance of normal living conditions to the local population and students due to the increased traffic in the area will also be expected especially during the construction period.

**Mitigation measures during construction**

The Proponent shall implement the following measures to minimise inconvenience and danger to proximate residents through increased road traffic and dust, and reduced access to worksites:

- Determine the main access and egress points for the site throughout the project duration, along with scheduled changes in these access and egress points, if applicable. These points need to be shown on the site layout (i.e., site setup) drawings;
- Proper traffic control signage should be installed. This includes road signage to be erected near all the entrances and junctions to control construction traffic;
- Delivery of materials should be planned at night when there is minimal traffic;
- Any excavated materials should be hauled at night or timed during traffic off-peak periods;
- Prepare a plan for communication with residents and/or students surrounding the construction site. Effective communication with local stakeholders is essential to minimise the inconvenience to the surrounding community;
- The Contractor shall prepare a traffic management plan;
- The Contractor’s vehicles and equipment must be in proper working condition and have registration plates, and numbering;
- The Contractor shall ensure proper driving discipline by its employees, and sanctions those in breach;
- Excavated sites and dangerous locations are protected with proper safety barriers, tape and warning signs;
- Maintain a log detailing every violation and accident on site or associated with the project work activities, including the nature and circumstances, location, date, time, precise vehicles and persons involved, and follow-up actions with the police, insurance, families, community leaders, etc; and
- Implement grievance resolution mechanism.

**Mitigation measures during Operation**

- Make the necessary arrangements for coordinating and controlling delivery vehicles;
- Make arrangements with the traffic police and personnel to manage traffic in the area to mitigate against traffic accidents and traffic jam built up at the entry and exit points of the area; and
- Delivery of supplies should be limited to off-peak hours when the market is not operational to minimize traffic jams in the area.

### *7.4.15 Housekeeping*

During construction, organization of the construction area is important to ensure prevention of accidents and incidences within the site. Clear gangways and pathways enable faster movements even during normal working time and during response to emergencies.

**Mitigation**

Ensure that there is a well-organized housekeeping plan in place at the construction site.

### *7.4.16 Crime Management, Child protection and Gender equity*

The laws of Tanzania prohibit Contractors from "employing children in a manner that is economically exploitative, hazardous, and detrimental to the child's education, harmful to the child's health or physical, mental, spiritual, moral, or social development. It is also important to be vigilant towards potential sexual exploitation of children, especially young girls. The Contractor should adopt a 'Child Protection Code of Conduct'; that all staff of the Contractor must sign, committing themselves towards protecting children, which clearly defines what is and is not acceptable behaviour.

Crimes might occur in the project area during the construction and operation such as stealing of construction materials or individual property, fighting, petty crimes such as drug abuse and alcoholism among others.

There is also potential that gender inequality might occur during project construction through unequal distribution of work, discrimination against women, and unequal pay for women, lack of provision of separate facilities for women, among others. Sexual harassment against women might also happen because of mixing of women and men at the construction site.

**Mitigation Measures during design phase**

- Proper design incorporating lighting to enhance security for the proposed project; and
- Provision for fencing along the property boundary should be part of the design to control entry and exit points.

**Mitigation measures during construction phase**

- Ensure no children are employed on site in accordance with national labour laws;
- Ensure that any child sexual relations offenses among Contractors' workers are promptly reported to the police;

- The client and the Contractor shall adopt a 'Child Protection Code of Conduct' which sets stringent standards for personal behaviour to avoid child exploitation and abuse;
- The Contractor shall require his employees, sub-Contractors, sub-Consultants, and any personnel thereof engaged in construction works to individually sign and comply with this Code of Conduct;
- Removing any employee who persists in any misconduct or lack of care, carries out duties incompetently or negligently, fails to conform to any provisions of the contract, or persists in any conduct which is prejudicial to safety, health, or the protection of the environment;
- Taking all reasonable precautions to prevent unlawful, riotous or disorderly conduct by or amongst the Contractor's personnel, and to preserve peace and protection of persons and property on and near the site;
- Prohibiting alcohol, drugs, arms, and ammunition on the worksite among personnel;
- The Contractor and Supervision Consultant should register in a log all events of a criminal nature that occur at the worksite or are associated with the civil works activities;
- The Contractor and Supervision Consultant should report all activities of a criminal nature on the worksite or by the Contractor's employees (whether on or off the worksite) to the police and undertake the necessary follow-up. Crime reports should include nature of the offense, location, date, time, and all other pertinent details; and
- Sensitize the construction workers, locals, and security to be on the lookout on suspicious activities near the site.

The Contractor's responsibility for workers' conduct within the worksite should include but not limited to:

- Contractor to prepare and enforce a "No Sexual Harassment Policy" in accordance with national law where applicable;
- Contractor and implementing agency to prepare and implement a Gender Action plan to include at minimum, in conformance with local laws and customs, equal opportunity employment, gender sensitization;
- Provision of gender disaggregated bathing, changing, sanitation facilities;
- Grievance redress mechanisms including non-retaliation should be set up for the workers;
- Liaise with the administration units (Regional, District and Councils and Wards governments, Police, etc.) to provide regular surveillance and patrols to protect workers and students during operation especially when there is an event; and
- The NDC/Contractor/Investor management should hire a security firm to manage security during social and/or academic events.

#### *7.4.17 Complaints and Grievances/Social Conflict*

During construction, the neighbouring community and/or students may have complaints and grievances regarding the ongoing activities. There is also potential for social unrest among the local population if they are not considered for employment. This can bring negative publicity during construction including stoppage of work and can delay the projects progress.

The development of the proposed project has been discussed through public consultation, and there are many expectations on renting cost for locals when the development is completed. Against the background of this knowledge and expectation, there is a risk of dissatisfaction if consideration of low renting charges for local people particularly neighbouring communities are not adequately applied, or if they are seen to be applied in an inequitable manner.

**Mitigation**

- Provide grievance redress mechanism for the public and workers;
- Advice the public, project staff and contractors on where to report grievances;
- Consider prioritizing the local manpower for both skilled and unskilled labour; and
- Implement proposed grievance resolution mechanism.

#### *7.4.18 Increased HIV/AIDs prevalence and other diseases*

Construction sites in developing countries are potentially primary centres of HIVAIDS because construction sectors provide entry-level local jobs, which may be crucial to the survival of youth-headed households and extended families.

**Mitigation**

- HIV-AIDS awareness methods used in campaign to increase understanding about the disease;
- Raising awareness about HIV/AIDS;
- Promote the benefits of abstinence / avoidance;
- Distribute condoms to construction workers;
- Encourage workers to go for HIV voluntary counselling, testing and referral services; and
- Monitoring of outcomes, in collaboration with National HIV/AIDS Authorities.

## 7.5 Operation Phase Impacts

### *7.5.1 Poor Solid and liquid waste*

The operation of the proposed project after completion will generate large quantity is the bittern (mother liquor), used process water, and mud sludge. From material balance calculations it is estimated that a total of 2,500,000m$^3$ of mother liquor and 250,000 m$^3$ of process water will be discharged per year (*Volume III –Technological Assessment Report*). The efficient management of the solid waste generated by the project during the operation phase rests on the hands of the investor's management.

**Mitigation**

- Wastes should be disposed-off in a regular and an appropriate manner. It is recommended that the Proponent should put measures in place to ensure that the wastes are disposed of efficiently through reuse, recycling and proper disposal procedures;
- The Proponent should provide waste handling facilities such as waste bins for holding wastes temporarily before disposal by appropriate waste handlers;

- The spent mother liquor (bittern) and process water will be returned back to the underground at a suitable location, to further dissolve the crust; and
- The Proponent should ensure that the sanitary facilities of the plant and township are connected to the septic tank to ensure proper discharge of liquid waste.

### *7.5.2 Increased Energy consumption and demand*

The project will be connected to the electric line which is already available in the area. However; increase in energy consumption will be experienced in the existing electric supply infrastructure.

**Mitigation**

- The Proponent shall install energy-efficient system within the plant building for instance the use of energy saving bulbs and/or tube lights. This will promote energy conservation during the operational phase of the project;
- The user of the project facilities will be sensitized to ensure energy efficiency during events;
- The above measures will be complemented by monitoring energy use during the operation of the project and set targets for efficient energy use;
- Maintenance of regular checks of the electrical systems and appliances; and
- Switching off security and internal lights during the day when natural lighting can be used.

### *7.5.3 Occupational Health and Safety Concerns*

The project premise should be maintained at its optimum useful state and high standards of hygiene maintained to avoid any disease outbreak. All electrical installations should be properly fixed and maintained to avoid any risk of fire outbreak.

**Mitigation**

- Local individuals preparing food for at the construction workers and operation staff must be controlled to ensure that food is hygienically prepared and served;
- Adapt effective emergency response plans. A good start of learning how to respond to an emergency is through certification in Basic First Aid. Regular drills and emergency situations should follow to impart the anticipated insight and awareness to the workers/staff;
- A first aid kit should be provided. This should be fully equipped always and should be managed by qualified persons;
- Safety awareness may be gained through regular safety training or personal interest in safety and health; and
- Users of the hall should be sensitized on social issues such as drugs, diseases etc.

### **7.5.4** ***Fire Outbreak***

The anticipated users are likely to use electricity as their source of power. Therefore, the risk of fire outbreak is likely and should be prevented as much as possible.

**Mitigation**

- Installation of firefighting equipment, which must be strategically placed;
- All electrical systems must undergo regular checks; and
- Highly inflammable paints should be avoided in the walls.

### *7.5.5 Blockage of drainage systems*

The plumbing system and drainage might be blocked if proper use and maintenance is not exercised.

**Mitigation**

- The Proponent should ensure that unwanted materials such as sticks and cloths/pads are not allowed into the drainages. Special bins for handling sanitary materials or clothes should be provided in the toilets; and
- Regular maintenance of the drainage should be done to avoid blockages.

### *7.5.6 Water Pollution*

During the operation phase, water pollution may occur when the users of the plant litter the drainages, channelling contaminated water to the drainage systems and disposal of liquid waste inappropriately.

**Mitigation**

- Avoid channelling contaminated water onto the drainage systems;
- Do not channel unrecyclable water into water bodies before treatment and/or without doing water quality analysis.
- Dispose generated waste appropriately.

### *7.5.7 Depletion of Water Resources during Operation phase*

Operation of the proposed project will lead to a higher demand of water by the hall users. This demand may lead to depletion of the water from the water service provider and at times water rationing will be required.

**Mitigation**

- Install water tanks and other water saving technology at the site to save on water usage;
- Train the hall users on water saving techniques;
- Find new water sources; and
- Carry out rainwater harvesting to supplement tapped water.

### *7.5.8 Air pollution (Dust; Source emissions; odour/foul smells)*

Air pollution may occur due to operation activities at the area. These include piling of solid waste for a long time, industrial wastes, rotting food stuffs especially vegetables and meats, use of sanitary facilities without proper cleaning, burning waste on site, and source emissions from vehicles.

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**Mitigation**

- Recycle industrial waste;
- Clean and dust away all project areas regularly;
- Solid waste should be regularly removed from the collection points;
- Carry out proper maintenance of vehicles engines used on site;
- Frequently (Hourly) clean the sanitary facilities by use of detergents; and
- Unnecessary combustion of materials within the compound should be avoided.

#### *7.5.9 Accidents and incidence occurrence*

Accidents and incidences may occur during operations of the project. Occurrence of such incidences may include falling, being knocked down by vehicles, damage to goods and property.

**Mitigation**

- Ensure that provisions for reporting incidents, accidents and dangerous occurrences during operations using prescribed forms obtainable from the local Occupational Safety and Health Authority (OSHA) Office are in place; and
- Train employees on how to respond to incident and accident occurrences.

#### *7.5.10 HIV/AIDS prevalence*

HIV-AIDS prevalence is likely to increase among project staff and nearby community. Without proper campaign on prevention, the spread of HIV can be rampant within Engaruka community.

**Mitigation**

- Awareness methods used in campaign to increase understanding about the disease;
- Raising awareness about HIV/AIDS;
- Promote the benefits of abstinence / avoidance;
- Availing condoms to Engaruka community;
- Encourage Engaruka community to go for HIV voluntary counselling, testing and referral services; and
- Monitoring of outcomes, in collaboration with National HIV/AIDS Authorities.

## 7.6 Decommissioning Phase Impacts

#### *7.6.1 Solid wastes (Scraps and other Debris Onsite)*

Demolition works generates a lot of solid wastes. These wastes range from; wood, tiles, waste metals and stones amongst others.

**Mitigation**

- The Proponent should liaise with private waste handlers and the Monduli District Council to have a sound waste handling and disposal;
- The wastes should be properly segregated and separated to facilitate recycling of some useful waste materials. For example; broken stones can be used for backfills.

Integrated solid waste management system may also be adopted through hierarchy of options like source reduction, recycling, composting and reuse; and

- All the solid wastes should be collected by licensed waste handlers and dumped in recognized dumpsite.

### *7.6.2 Air, Water and Soil Pollution*

Demolitions also generate a lot of waste that can contaminate water, air or soil. These wastes may include liquids, dust or waste water.

**Mitigation**

Solid waste, air pollutants and liquid waste resulting from demolition or dismantling works will be managed as described in the construction phase.

### *7.6.3 Occupational Health and Safety Concerns*

The decommissioning phase may cause accidents; inhalation of dust; generation of noise and occupational incidences like fall.

**Mitigation**

- Depending on the occupational safety and health hazards encountered while performing assigned tasks, workers will use properly fitting personal protective equipment (PPE) to avoid injuries and illness. Workers must be provided with full protective gear. These include working/safety boots, overalls, helmets, goggles, earmuffs, masks, gloves etc;
- A first aid kit should be provided within the site. This should be fully equipped at all times and should be managed by qualified persons;
- Local individuals preparing food for the workers at the site must be controlled to ensure that food is hygienically prepared;
- The Contractor should have workmen's compensation cover. It should comply with Workmen's Compensation Act, as well as other Ordinances, Regulations and Union Agreements;
- Workers should always be sensitized on social issues such as drugs, alcohol, diseases etc; and
- Grievance redress mechanisms including non-retaliation should be set up for the workers.

Table 7.1a-c below show the ranking of significance impact which are likely to occur during the project life cycles. The impacts are rated as negligible, low, moderate high or permanent.

**Table 7.1a Summary of Physical/Chemical Impacts and their Rankings**

| S/N. | Component | Specific Activity and Aspect | Impact | Rank |
|---|---|---|---|---|
| 1. | Soils and Geology disturbance | Drilling of boreholes, construction of storage ponds, pipeline systems, drainage systems, roads, plant, township etc | Soil and rocks loosening | Negative and short term impact of low significance |
| 2. | Depletion of Water Resources | Water abstraction for plant and township | Increased pressure on existing water resources | Negative and long term impact of medium significance |
| 3. | Soils, surface and groundwater contamination | Plant operation will use freshwater and generate waste water | Impact of generated wastes on soil, surface and ground waters. | Negative and long term impact of low significance |
| 4. | Air pollution (Dust generation) | Dust emissions from plant operations ie., Dust from wheel generated dust and wind impact from loose soil | Dust ($PM_{10}$ and $PM_{2.5}$) generation will impair the air quality status of the area | Negative and long term impact of low significance |
| 5. | Air pollution (Generation of exhaust emission) | Emissions from trucks, boilers, generators' exhaust | CO, $CO_2$, NO, $NO_X$, $SO_2$ will impair the ambient air quality status of the area | Negative and long term impact of low significance |
| 6. | Noise and excessive Vibration generation | Increased noise levels associated with plant, boiler and generator operations | Increased noise and vibration levels will reduce wildness value of the area and disturbances to biota. | Negative and long term impact of low significance |
| 7. | solid/liquid wastes generation | Plant and township operations | Impact of generated solid/liquid wastes to environment, water bodies and human health | Negative and long term impact of low significance |
| | | | Threat to visibility of biota | |
| 8. | Increased surface runoffs | Establishment of infrastructures i.e., plant and township roofs | Increased soil erosion/ surface runoffs | Negative and long term impact of low significance |
| 9. | Change of water quality of Lake Engaruka and underground resources | Pumping of wastewater back to underground aquifers via borehole and to Lake Engaruka | Composition of underground resources and lake | Negative and long term impact of low significance |
| 10. | Change of | Plant, Township, rail, | Reduced livestock | Negative and long |

| | | | | |
|---|---|---|---|---|
| | landscape and visual destruction | roads, water systems, drainage systems, storage ponds and boreholes | production due to loss of grazing land.<br>Loss of tourism value.<br>Loss of settlement land.<br>Blocking wildlife corridor.<br>Loss of hunting blocks. | term impact of low significance |
| 11. | Change in light | High levels of light pollution from plant, township and security systems | Reduce night time wilderness value of the area | Negative and long term impact of medium significance |
| 12. | Closure of plant operation | Abandoned structure | Loss of aesthetic value due to abandonment of structure | Negative and short term impact of low significance |

**Table 7.1b Summary of Biological/Ecological Impacts and their Rankings**

| S/N. | Component | Specific Activity and Aspect | Potential Direct Impact | Rank/Significance value |
|---|---|---|---|---|
| 1. | Change of land use | Land take during site selection for the establishment of plant, township and associated facilities | Loss of grazing land, farming land and GCA (hunting blocks an animal corridors) | Negative and long term impact of medium significance |
| | | | Loss of tourism value of the area | Negative and long term impact of medium significance |
| | | | Reduced wildness and conservation values of the area | Negative and long term impact of medium significance |
| | | | Clash with GCA's conservators, owner of hunting blocks and wildlife. | Negative and long term impact of medium significance |
| | | | Proposed soda ash project development may threaten the GCA/wildlife status of the area, or bring an extensive pressure which will undermine the conservation efforts of the GCA and development of tourism industry | Negative and long term impact of medium significance |
| 2. | Change in | Site clearance and | Loss of biodiversity | Negative and long |

| | | | | |
|---|---|---|---|---|
| | Biodiversity | destruction of endemic tree species during construction of plant and township facilities as well as plant operations | (destruction of wildlife habitat and vegetation) including endemic tree species around the boreholes, inner road network, plant site and township area. | term impact of medium to low significance |
| | | | Destruction of natural woody vegetation i.e., *Acacia tortilis* and *Acacia commiphora* open woodland as source of energy (charcoal) and building materials (poles) | Negative and long term impact of medium significance |
| | | | Threat to wildlife, visiting Lesser flamingos and avifauna populations | Negative and long term impact of medium significance |
| | | | High possibility of introducing an invasive and alien species | Negative and long term impact of low significance |
| 3. | Change in diseases and vector populations | Domestic and industrial wastes attracts pests and/or vectors | Possible introduction of pest and pathogen to domesticated animals, wildlife and human being. | Negative and long term impact of low significance. |
| 4. | Project development | Land take | Loss of Settlement | Negative and short term impact of medium to low significance |
| 5. | Change in wildlife, domestic animals and birds populations | Mobilization, site clearance, construction and operation activities will cause disturbances to biota | High disturbances or change to habitat will reduce the value or status of the area to accommodate wildlife, domestic animals and birds | Negative and long term impact of high to medium significance |
| 6. | Changes to GCA ecological status | Plant and township development | Changing the Game Controlled Area (GCA) status to Wildlife Management Area (WMA). | Negative and long term impact of medium significance |
| | | | Collapse of the existing ecosystem process and loss of suitable conditions for wildlife and birds. | |

| | | | | |
|---|---|---|---|---|
| 7. | Impaired air quality | Dust from wheel generated dust and exhaust gaseous emission from tailpiece emission. | Dust and pollutant gases may smother plant leaves/stomata/chlorophyll and interfere with photosynthesis. | Negative and long term impact of medium significance |
| 8. | Change in aquatic biota | Abstraction of water from Engaruka river | Loss of aquatic habitats along Engaruka river due to excessive water abstraction | Negative and long term impact of medium significance |
| 9. | | | | |

**Table 7.1c Summary of Social, Economic and Cultural Impacts and their Rankings**

| S/N. | Component | Specific Activity and Aspect | Impact | Rank |
|---|---|---|---|---|
| 1. | Changes in access to social services | Good road networking, hospitals/health centres, schools, water supply | Improved access to social services | Positive and long term impact of medium to high significance |
| 2. | Changes to Livelihood | Employments and employability | Increased income and labour wages to individuals, groups, and community. | Positive and long term impact of medium to high significance |
| 3. | Changes to social stability and/or cohesion | Communal land take | Social instability and/or incoherent related to traditional use of grazing land, local soda ash extraction, watering of livestock, settlements and fuel wood collection | Negative and long term impact of medium significance |
| | | Uncontrolled immigration and settlements | Possible development of unplanned settlements with lack of resources and poor waste management and high social impacts. | |
| 4. | Change in local administrative responsibility | Capacity in terms of skills and legal mandate at a local level to manage the operation of soda ash project | Local Authorities and personnel unable to identify, predict, manage or mitigate impacts associated with the project operations | Negative and long term impact of medium significance |
| 5. | Conflicts between involved parties | The propose project falls into a GCA, grazing land, settlement, farmland, hunting blocks and wildlife corridor | Clash with existing users | Negative and short term impact of low significance |

| | | | | |
|---|---|---|---|---|
| | Change involving loss of settlements and grazing land | Establishment of plant, township and associated infrastructures i.e., tar access roads | Evacuation, reallocations and compensations | Negative and short term impact of medium to low significance |
| | Changes involving loss of cultural and archaeological heritage | Cultural and archaeological artefacts' remains | Potential loss of archaeological and palaeontological remains i.e., burials within the project site | Negative and short term impact of low significance |
| | Change to settlement patterns and mobility | Development of access roads and tarmac roads | Improved roads may result in an influx of people into the area, behavioural change and conflict with existing community | Negative and long term impact of medium significance |
| | Loss of access natural resources | Sell of soda ash is an income generating activity to local community particularly women | Potential loss of right of access and use of soda ash by traditional users/locals | Negative and long term impact of high significance |
| | Change in health and diseases status | Immigration contract workers; and the limited HIV/AIDS knowledge to Maasai community | Increase in HIV/AIDS in existing Maasai Community residing the area | Negative and long term impact of medium significance |
| | Change to aesthetic landscape | Development of plant, roads, township and associated facilities will change the wilderness value of the area | Loss of tourism value of the GCA | Negative and long term impact of medium significance |
| | Change to conservation status of the GCA | Soda Ash project development and impact on ecosystem processes | Loss of wilderness value and reduced conservation efforts | Negative and long term impact of medium significance |
| | Food poisoning | Food supply from food vendors to plant workers | Stomach based food poisoning diseases i.e., Diarrheal, Typhoid, amoeba etc. | Negative and long term impact of low significance |
| | Poor sanitation/ Hygiene | Inadequate and/or Improper use of sanitary facilities | Health and safety Impacts | Negative and long term impact of low significance |
| | High demand of food | Food supply during operation phase. | Possible land use conflicts between pastoralist, conservators and agriculturalists during the | Negative and long term impact of low significance |

| | | | | |
|---|---|---|---|---|
| | | | operation as some people might establish commercial agricultural activities due to increase of population into the surrounding areas which leads to high demand of food. | |
| | Change in crop/livestock generated incomes | Grazing and farming land take | Reduced livestock and crop production | Negative and long term impact of low significance |
| | Resettlement plan | Reallocation of affected people residing within the project site | Loss of community stability and cohesiveness | Negative and long term impact of low significance |
| | Compensation | Valuation process to compensate physical structures | Replacement of land and physical structures compatible to what taken | Positive and short term impact of low significance |
| | Quality of life and security | Risk of uncontrolled influx of immigrants and competition for arable agriculture and grazing resources | Reduced quality of life for farmers and pastoralists | Negative and long term impact of low significance |

## 7.7 Assessment of Cumulative Impacts

The ESIA assessment looked at the likelihood of an impact having a residual impact that can build up or interact with other impacts from other nearby development/projects after the implementation of the mitigation measures proposed in this report. The impact was then rated likely or unlikely (sub-section 7.7.1). Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity. For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognized as important based on scientific concerns and/or concerns of affected communities. Cumulative impacts can only occur where, following the implementation of mitigation, significant residual impacts are predicted by the ESIA process. The cumulative impacts considered in this project include the following:

- Air quality;
- Water quality;
- Waste management;
- Noise impacts;
- Traffic; and
- Social economics.

### *7.7.1 Residual cumulative impact of air quality*

No significant local air quality effects are predicted following the good construction practice, which incorporates the implementation of the identified mitigation measures in the ESMP. Ranking of significance cumulative impact which are likely to occur during the project life cycles are shown in tables below. The residual cumulative impacts are rated as negligible, minor, moderate or high.

| Phase | Significance (Pre-mitigation) | Residual Significance (Post-mitigation) |
|---|---|---|
| Construction | Minor | negligible |
| Operation | Minor | negligible |

**Residual cumulative impact of water quality**

No significant impacts on the local water environment are predicted with the implementation of proposed mitigation measures. Therefore, in reference to the nearby developments, interaction of the impacts to produce cumulative impact is negligible.

| Phase | Significance (Pre-mitigation) | Residual Significance (Post-mitigation) |
|---|---|---|
| Construction | moderate | negligible |
| Operation | moderate | negligible |

**Residual cumulative impact of Waste management**

In waste management, cumulative impact to the waste services could be impacted if mitigation measures are not implemented and the impact significance could be minor. Therefore, following the implementation of mitigation measures cumulative impact are localised and impossible to spread and combine to produce any significant cumulative impact.

| Phase | Significance (Pre-mitigation) | Residual Significance (Post-mitigation) |
|---|---|---|
| Construction | moderate | negligible |
| Operation | moderate | negligible |

**Residual cumulative impact of Noise quality**

For the proposed project, the noise generation is predicted to be localized. In addition, it is impossible for the generated noise level to produce significant cumulative impact.

| Phase | Significance (Pre-mitigation) | Residual Significance (Post-mitigation) |
|---|---|---|
| Construction | minor | negligible |
| Operation | minor | negligible |

**Residual cumulative impact of traffic congestion/interruption**

Due to the geographical location of the project and the fact that there is no any industrial operation nearby the area or at the same time; it's unlikely to have any significant cumulative traffic impacts arising from the project. In addition, no anticipated significant impact following the implementation of the localized mitigation measures.

| Phase | Significance (Pre-mitigation) | Residual Significance (Post-mitigation) |
|---|---|---|
| Construction | moderate | negligible |
| Operation | moderate | negligible |

### *7.7.2 Cumulative impact on socio economic*

Cumulative impacts on socio economic as a result of the project is likely to have positive impacts to the socio economic of the area. Some of the benefits include the following:

- Increased population as casual/permanent during the construction or assistants during operation phase;
- The revenue tax will increase if neighbouring communities from peripheral business;
- The quality of associated infrastructure and aesthetic value of the area will be improved.

### *7.7.3 Conclusion*

The possibility of the interaction of the anticipated impact is unlikely to produce any cumulative impact due to the distance of the project area and existing Engaruka and Mto wa Mbu centres; and their geographic location.

# CHAPTER EIGHT

# 8 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

Environmental and Social Management Plan (ESMP) is a detailed summary of the impacts and the proposed mitigation measures (Table 8.1). The purpose of the ESMP is to initiate a mechanism for implementing mitigation measures for the potential negative environmental impacts and monitor the efficiency of these mitigation measures based on relevant environmental indicators. It further specifies who is responsible for implementation of the proposed actions and the cost involved in the action. The ESMP assigns responsibilities of actions to various actors and provides a timeframe within which mitigation measures can be implemented, supervised and monitored. Further, it provides a checklist for project monitoring and evaluation. The objectives of the ESMP are:

(i) To provide evidence of practical and achievable plans for the management of the proposed project.

(ii) To provide the Proponent and the relevant lead Agencies with a framework to confirm compliance with relevant laws and regulations.

(iii) To provide community with evidence of the management of the project in an environmentally acceptable manner. The ESMP outlined below will address the identified potential negative impacts and mitigation measures on the following project stages:

- Pre-construction and Construction Phases ESMP;
- Operation Phase ESMP; and
- Decommissioning Phase ESMP.

Once all the operational activities have ceased, it is necessary to highlight the basic mitigation measures that will be required during the decommissioning phase of the project. Thus, the crucial objectives, mitigation measures, allocation of responsibilities, time frames and costs pertaining to prevention, minimization all potential impacts associated with the decommissioning and closure phase of the project.

**Table 8.1: Environmental and Social Management Plan**

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| Preparation/Mobilization Phase | Loss of /disturbance of biodiversity (flora, fauna and ecosystem) | The proponent will ensure proper demarcation of the project area to be affected by the construction works. The proponent has committed itself to re-vegetation of some of the disturbed areas through implementation of a well designed landscaping programme. Part of the topsoil excavated from the construction site will be re-spread in areas to be landscaped to enhance plant health. | As minimum as possible | Contractor, Project proponent | Included in the BoQ under excavation.<br><br>Approximatel 5,000,000 |
| | Land acquisition/ Loss of Property/farmland and natural habitat | Development and Implementation of RAP | Before construction phase | Project proponent | Valuation is in process |
| | Depletion /degradation at points of source of construction materials | The proponent will source building materials such as sand, ballast and hard core from registered quarry and sand mining firms. The proponent will only order for what will be required through accurate budgeting and estimation of actual construction requirements. The proponent will ensure that wastage, damage or loss (through run-off, wind, etc) of materials at the construction site is kept minimal, as these would lead to additional demand for and extraction or purchase materials. The proponent shall consider reuse of building materials and use of recycled building materials. This will lead to reduction in the amount of raw materials extracted from natural resources as well as reducing impacts at the extraction sites. | No degradation | Contractor, Project proponent | 5,000,000 |
| | Noise pollution | ➢ Install portable barriers to shield compressors and other small stationary equipment where necessary.<br>➢ Use quiet equipment and the proponent will ensure all vehicles have | As minimum noise as possible | Contractor, Project proponent | 1,000,000 |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | | properly functioning mufflers,<br>➢ Limit pick up trucks and other small equipment to a minimum idling time and observe a common-sense approach to vehicle use, and encourage workers to shut off vehicle engines whenever possible.<br>➢ Construction works shall be done during the day when people are away and also the outside environment is also noisy.<br>➢ Workers operating equipment that generates noise will be equipped with the appropriate noise protection gear. | | | |
| | Impaired air quality | ➢ All personnel working on the project will be trained prior to starting construction on methods for minimizing air quality impacts during construction.<br>➢ Construction vehicles drivers will be under strict instructions to minimize unnecessary trips, refill petrol fuel tanks in the afternoon, and minimize idling of engines.<br>➢ Equipment shall be properly tuned and maintained<br>➢ Maintain equipment in good running condition - no vehicles to be used that generate excessive black smoke.<br>➢ Construction activities that will generate disturbing conditions will be restricted to normal working hours.<br>➢ Enforce vehicle load restrictions to avoid excess emissions from engine overloading.<br>➢ Where practical, switch off engines when not in use. | As minimum emission as possible | Contractor, Project proponent | 2,500,000 |
| Construction | Loss of vegetation | ➢ Minimize clearing of unnecessary areas at the construction site.<br>➢ Replant vegetation through landscaping upon completion. | Check and follow specifications in the drawings | Contractor, Project proponent | Included in the BoQ under excavation. |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | | | and plans. Minimal clearance of vegetation and soil stripping. | | Approximately 1,000,000 |
| | Dust pollution | ➢ Watering all active construction areas as and when necessary to lay dust.<br>➢ Cover all trucks hauling soil, sand and other loose materials or require all trucks to maintain at least two feet of freeboard.<br>➢ Pave, apply water when necessary, or apply (non-toxic) soil stabilizers on all unpaved access roads, parking areas and staging areas at construction sites.<br>➢ Sweep daily (with physical sweepers) all paved access roads, parking areas and staging areas at construction sites.<br>➢ Fast growing trees will be planted around the project area to act as a wind breaks to reduce the uplift of particulate matter that lead to respiratory diseases. | As minimum as possible | Contractor, Project proponent | 3,000,000 |
| | Environmental pollution from poor management of waste (i.e. both liquid and solid) | ➢ Stripping and clearance operations shall be undertaken on an as-required basis, so that at any time, only the minimum quantity of topsoil is in storage and stripped areas remain exposed for the minimum period of time.<br>➢ Demolition and construction waste will be recycled or reused to ensure that materials that would otherwise be disposed of as waste are diverted for productive uses.<br>➢ The proponent shall put in place measures to ensure that construction materials requirements are carefully budgeted and to ensure that the | No overburden left on construction site<br><br>No hazardous materials remain on site | Contractor, Project proponent | 5,000,000 |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | | amount of construction materials left on site after construction is kept minimal.<br>➢ The proponent shall consider the use of recycled or refurbished construction materials. Purchasing and using once-used or recovered construction materials will lead to financial savings and reduction of the amount of construction debris disposed of as waste.<br>➢ Use of durable, long- lasting materials that will not need to be replaced as often, thereby reducing the amount of construction waste generated over time<br>➢ Provision of facilities for proper handling and storage of construction materials to reduce the amount of waste caused by damage or exposure to the elements<br>➢ Purchase of perishable construction materials such as paints incrementally to ensure reduced spoilage of unused materials<br>➢ During construction phase small pit latrines (three) will be established at the temporary campsite for the construction workers at site. These will be easily decommissioned after the finalization of the phase. | after construction | | |
| | Increased soil erosion | The proponent will put in place some measures aimed at minimizing soil erosion and associated sediment release from the project site during construction. These measures will include terracing and levelling the project site to reduce run-off velocity and increase infiltration of rain water into the soil. Deliberately the proponent will re-cover exposed soils with grass and other appropriate species as soon as possible and temporarily will bind exposed soil and redirect flows from heavy runoff areas that threaten to erode or result in substantial surface runoff to adjacent water courses. In addition, construction vehicles will be restricted to designated areas to avoid | As minimum as possible | Contractor, Project proponent | 3,000,000 |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | | soil compaction within the project site, while any compacted areas will be ripped to reduce run-off. The proponent will monitor areas of exposed soil during periods of heavy rainfall throughout the remaining construction phase. | | | |
| | Increased construction accients | ➢ Capacity building of district polices (traffic) offices and District Game Officers<br>➢ Installation of proper safety signs and regular inspections for their presence<br>➢ Installation of speed control devices like humps in spur roads (from trunk road to the factory)<br>➢ Installation of pedestrian lanes at human settlement crossings | Zero incidents | Project proponent, OSHA, Traffic police, TAWA, TANROADS | 15,000,000 |
| | Surface and ground water hydrology and water quality degradation | ➢ The proponent will prepare a hazardous substance control and emergency response plan that will include preparations for quick and safe clean-up of accidental spills.<br>➢ Appropriate personal protective equipment will be used and waste management will be performed in accordance with applicable regulations. Oil absorbent material, tarps and storage drums will be used to contain and control any minor releases of engine and other equipment oil. | No degradation | Project proponent | 3,000,000 |
| | Risk of oil spills | The proponent will control the dangers of oil, grease and fuel spills during construction by maintaining the machinery in specific areas designed for this purpose. Machinery site repair will be discouraged and repair work restricted to only approve garages to avoid pollution from oil, grease and fuel. | As minimum as possible | Contractor, Project proponent | 1,000,000 |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | Water Resources Usage (Increased water demand) | Develop water abstraction plan to minimize conflict with nearby communities and/or residents.<br>Abstraction licenses should be obtained from water authorities.<br>The proponent shall ensure that water is used efficiently at the site by sensitizing construction staff to avoid irresponsible water use. The proponent will install water-conserving automatic taps and toilets. Moreover, any water leaks through damaged pipes and faulty taps will be fixed promptly by qualified staff. | As minimum as possible | Project proponent | 2,000,000 |
| | Increased energy consumption | The proponent shall ensure reasonable electricity use at the construction site through sensitization of staff to conserve electricity by switching off electrical equipment or appliances when they are not being used. In addition, proper planning of transportation of materials will ensure that fossil fuels (diesel, petrol) are not consumed in excessive amounts. Complementary to these measures, the proponent shall monitor energy use during construction and set targets for reduction of energy use. | As minimum as possible | Project proponent | 2,500,000 |
| | Health hazards associated with construction work | ➢ The contractor shall provide a small section of the construction site with a shed and a water stand where the food can be served to the construction workers to promote hygiene and health of the employees.<br>➢ A fully equipped first aid kit shall be provided at the site.<br>➢ The contractor must have workmen's compensation cover as required by law (The Workmen‟s Compensation Act, 2008).<br>➢ The workers, immediate neighbour and other stakeholders shall be sensitized on the dangers and risk associated with the construction works for enhanced self responsibility on personal safety.<br>➢ The proponent shall ensure that the completed buildings are fitted with safety facilities including fire detectors, fire fighting equipments, fire | Low risk to workers<br>No exposure | Project proponent | 10,000,000 |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | | exits, adequate access and buffer between the residential premises.<br>➢ Appropriate sanitation conveniences shall be provided at the site as required in the OSHA, 2003 and echoed in the Public Health Act, of 2008. | | | |
| | Working at heights | ➢ Implement a fall protection program that includes trainning in climbing techniques and use of scaffolds and harnesses to avoid fall.<br>➢ Fix barrier tapes to isolate site (working area) to bar intruders from safety reasons.<br>➢ Use of helmets and other protective devices will mitigate aainst injuries from various activities.<br>➢ Provide first aid facilities at the site. | Zero number of construction activities related accidents | Contractor, Project proponent | Costs build in the planning and administration costs of the Contractor |
| | Creation of informal settlement | ➢ In order to alleviate the impact of informal settlement/mushrooming of kiosks, on-site kiosk services with adequate sanitation during construction shall be provided. In addition, commercial facilities have been provided for in the master plan. | As minimum as possible | Contractor, Project proponent | 5,000,000 |
| | Security and Crime | Proper design incorporating lighting to enhance security at the site.<br>Sensitize the construction workers, Engaruka community and workers and security providers to be on the lookout for any suspicious activities near the site.<br>➢ Liaise with the administrative units to provide regular surveillance and patrols to protect workers. | Number of crimes reported (target =0) | Contractor, Police, Project proponent | No direct costs to ESMP, costs build in the planning and administration costs of the Contractor |
| | Child protection | The Contractor to have and enforce "Child Protection Code of Conduct".<br>Ensure no children employed on site in accordance with national labour | Number of incidences | Contractor, Project | No Direct costs |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | | laws.<br>➢ Ensure that any child sexual relations offenses among Contractors' workers are promptly reported to the police. | (target =0) | proponent | |
| Operation | Water Resources Usage (Increased water use) | Develop water abstraction plan to minimize conflict with nearby communities and/or residents.<br>Abstraction licenses should be obtained from water authorities.<br>The proponent will install water-conserving automatic taps and toilets. Moreover, any water leaks through damaged pipes and faulty taps will be fixed promptly by qualified staff. In addition, the occupants of the facilities will be sensitized to use water efficiently. Additionally, the pipes, as well as the other services, will be located in an underground duct constructed of block-wall and reinforced concrete, of sufficient height and width to allow inspection and maintenance purposes. The pipe material will be very carefully chosen taking into account strength, durability, flexibility under loading, joints designs, corrosion resistance etc. to minimize burst hazards. | As minimum as possible | Project Proponent | 5,000,000 |
| | Increased soil erosion | Exposed soil shall be seeded with grass or other appropriate cover as soon as possible to minimise soil erosion. Monitoring and maintaining proper storm water drainage systems, use of central valley areas and redirecting flows during periods of heavy rain are steps that can minimize erosion and surface runoff into the rivers. Also the proponent shall stabilize the slopes on the banks of the central valley by planting and/or maintaining erosion resistant shrubs. Maintaining or planting erosion resistant riparian vegetation along the valley to maintain natural drainage and minimize soil erosion. Preventing blockage of waterways (through rubbish dumping) must be strictly prohibited both during the construction and post-construction phases | No erosion tendencies | Project proponent | 3,000,000 |
| | Increased | Increased runoff from paved grounds and expansive roofs causing extreme | As minimum | Project | 5,000,000 |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | runoff from new impervious areas | flooding and overflows of drainage systems shall be mitigated. Surface runoff and roof water shall be harvested and stored in underground reservoir for reuse. A storm water management plan that minimizes impervious area infiltration by use of recharge areas and use of detention and/or retention with graduated outlet control structures will be designed. | as possible | proponent | |
| | Pollution of land and water resources due to mismanagement of waste (i.e. both liquid and solid) | A lot of solid wastes will be generated from the projects. An integrated solid waste management system is recommendable. First, the proponent will give priority to reduction at source of the materials. This option will demand a solid waste management awareness programme in the management and the workers. Secondly, recycling, reuse and compositing of the waste will be the second alternative in priority. This will call for a source separation programme to be put in place. The recyclables will be sold to waste buyers within Arusha and/or to Dar es Salaam City. Finally, sanitary landfilling will be the last option for the proponent to consider. The proponent will puts in place measures to ensure that the occupants manage their waste efficiently through recycling, reuse and proper disposal procedures. | No haphazard disposal of waste | Project proponent | 5,000,000 |
| | Noise and Air pollution | Critical environmental impact associated with any generating set is the noise generation and air pollution. To reduce such noise generation to within acceptable levels, sound attenuating enclosures will be provided, which will reduce sound levels to a threshold that is lower than that regulated by the Tanzania environmental norms. The enclosures will incorporate internally mounted exhaust silencers and will be of extremely rugged construction in order to withstand any rough handling. | As minimum emission as possible | Project proponent | 5,000,000 |
| | Increased electricity | ➢ In order to ensure a proper use of electrical equipment, an automatic load limiting system will be installed. | As minimum consumption | Project proponent | 5,000,000 |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | consumption | ➢ In order to identify major power consuming points or areas, sub-metering of major usage points will be considered e.g. heaters etc.<br>➢ The emergency generator will be designed to operate under major disaster conditions i.e. when all services to the project e.g. electrical, gas, heater, are likely to be simultaneously interrupted.<br>➢ The lighting system will thus be designed to be compatible with the acoustical, thermal, spatial and aesthetic requirements of the Institute buildings.<br>➢ Other energy sources i.e., solar and wind will be considered. | as possible | | |
| | Increased storm water flow | ➢ The storm water management system shall explore sustainable reuse of storm water for irrigation and other tangible uses without interference to the ecological balance and biodiversity of the site.<br>➢ The roof run-off from the buildings will fall freely over the sloping structure and roofing to the ground and either percolate into the soil or be made to discharge into ground tanks for re-use.<br>➢ Run-off from impermeable areas will be channeled to similar soak-away or similar ground tanks. | As minimum as possible | Project proponent | 5,000,000 |
| Socio – Economic | Health Hazards due to social interaction among workers and users | ➢ Safety, Health and Environment (SHE) induction course. NDC/Monduli DC/Engaruka will devote time in raising awareness of the dangers of the HIV/AIDS within the project premises.<br>➢ Support HIV/AIDS campaigns<br>➢ NDC/Monduli DC/Engaruka will encourage tenants' workers who know they are infected and receive care to break through the denial about HIV by talking with their fellow workers, friends and neighbours and reducing the discomfort associated with the subject.<br>➢ The proponent will encourage tenants to provide diagnosis and treatment | No or minimum HIV/AIDS victims | Project proponent, Contractor/NGOs/CBOs/local communities /local communities / District councils | 10,000,000 |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | | for tuberculosis and sexually transmitted infectious diseases that are common among people with HIV.<br>➢ NDC/Monduli DC/Engaruka will encourage tenants to support voluntary HIV counselling and testing to their workers.<br>➢ When the need arises, the proponent will seek for professional assistance from organizations working in the field of public health and control of HIV/AIDS for instituting a health education and disease control programmes at the workplace. | | | |
| | **Increased Crime including poaching** | ➢ The cooperation of local people together with the community policing (Ulinzi shirikishi) will help to lessen criminal incidents and maintain security of wild animals, people and their properties | Zero crime or poaching incidents | Project proponent, District Council/ Village leaders, Wildlife wardens | 2,000,000 |
| | **Increased natural resources exploitation rates** | ➢ Increase forest and wildlife personnel so as to ensure proper management of the forests and wildlife areas.<br>➢ Increased capacity building of the land and natural resources departments in Monduli DC.<br>➢ Increased control and enforcement on forest and game products.<br>➢ Promote alternative energy sources such as natural gas, electricity solar power, Biogas etc<br>o Promote forestation activities through existing NGOs and CBOs | Operation phase | Project proponent, Ministry of Natural Resources and Tourism and Monduli District Council | 10,000,000 |
| | Increased | ➢ The factory design shall take account of safety concerns especially in the | Zero incidents | Project | 10,000,000 |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | accidents during operations | factory site and at human habitation and wild animal crossing corridors e.g. installation of signs at the spur roads connecting the factory and trunk roads.<br>➢ Traffic management plan shall be incorporated in the designs to include for example details of signs, markings, intersection layouts, access restrictions, animal crossings, footpaths etc.<br>➢ The traffic management plans shall be presented both in English and Swahili. | | proponent, Contractor/Game wardens | |
| Decommissioning | Loss of Jobs | ➢ Ensuring that all employees are members of the pension fund and the employer should ensure that the workers' contributions are made.<br>➢ Preparing the workers for forced retirement by providing skills for self-employment, wise investment.<br>➢ Provision of condoms<br>➢ Providing relevant skills to workers through on job training to make them marketable after decommission. | All affected people | Project proponent | 10,000,000 |
| | Environmental contaminations from solid waste generation | ➢ The debris resulting from the demolition will either be transported by a licensed waste transporter for dumping at an approved site or used as base material for new construction work.<br>➢ All the necessary health and safety measures will be implemented including provision of personal protective equipment such as, safety harnesses, helmets, gloves, respirators, safety shoes, coveralls, goggles and ear protectors.<br>➢ Restoration of the affected land will involve the filling in of any open pits and grading the land to its natural contours, then planting appropriate tree species and under cover vegetation to hold the soil in place and to prevent flooding. | No overburden left on site<br><br>No hazardous materials remain on site after decommissioning | Project proponent | 5,000,000 |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | Noise pollution | ➢ During decommissioning the contractor will coordinate activities that produce the most noise levels and portable barriers will be installed to shield compressors.<br>➢ Use of equipment designed with noise control elements will be adopted where necessary.<br>➢ Trucks used during demolition exercise on site shall be routed away from noise sensitive areas in the neighbourhood, where feasible.<br>➢ Idling time for pick up trucks and other small equipment will be minimized to limited time.<br>➢ Use of very noisy equipment will be limited to daytime only.<br>➢ All workers operating in noisy areas or operating noisy equipment will be provided with earpieces to protect against extreme noise.<br>➢ The demolition exercise will be limited at day time only | As minimum noise as possible | Project proponent | 2,500,000 |
| | Dust and exhaust emissions | ➢ The demolition exercise will be limited at day time only<br>➢ All personnel working on the project will be trained prior to commencing the demolition exercise on methods for minimizing negative impacts on air quality.<br>➢ All active demolition areas will be watered at least twice a day to reduce dust.<br>➢ All trucks hauling demolition debris/wastes shall be covered.<br>➢ Careful screening to contain and arrest demolition related dust will be adopted<br>➢ Exposed demolition debris of e.g. dust and sand, will be enclosed, covered, and watered daily before transported to disposal site.<br>➢ All workers on the site will be required to wear protective clothing while on duty | As minimum emissions as possible | Project proponent | 5,000,000 |

| Phase | Potential Impacts | Management Measure | Target Level/ standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|
| | Occupational hazards | ➢ All workers will be sensitized before the exercise begins, on how to control accidents related to the demolition exercise<br>➢ A comprehensive contingency plan will be prepared before demolition begins, on accident response.<br>➢ Adherence to safety procedures will be enforced at all stages of the exercise<br>➢ All workers, pursuant to labour laws, shall be accordingly insured against accidents.<br>➢ Demolition work will be limited to daytime only avoid workers accidents due to poor visibility<br>➢ Appropriate working gear (such as nose, ear mask and clothing) and good camp management shall be provided and all workers should be instructed to wear protective clothing during demolition, including helmets.<br>➢ A well-stocked First Aid kit (administered by medical personnel) shall be maintained at each camp, quarry sites and each active work section in construction sites. | Low risk to workers<br>No exposure | Project proponent, Contractor | 10,000,000 |

# CHAPTER NINE

# 9 ENVIRONMENTAL & SOCIAL MONITORING PLAN (ESMoP)

## 9.1 Introduction

The Environmental and Social Monitoring Plan (ESMoP) is a vehicle for the effective implementation of the mitigation measures to ensure successful execution of the Project in an environmentally sound manner. The ESMoP provides mechanism to address the adverse environmental as well as social impacts of the proposed project during its execution, to enhance project benefits and to introduce standards of good practice to be adopted for all project works. For each expected impact, the ESMoP provides the following information:

- A specific description and technical details of monitoring measures that include the parameters to be measured, the methods to be used, sampling locations, frequency of measurements, detection limits (where appropriate), and definition of thresholds that will signal the need for corrective actions, e.g. the need for onsite construction supervision.
- Monitoring and reporting procedures to ensure early detection of conditions that necessitate particular mitigation measures and to furnish information on the progress and results of mitigation, e.g. by annual audits and surveys to monitor overall effectiveness of the ESMoP.
- The ESMoP also provides a specific description of institutional arrangements, i.e. who is responsible for carrying out the mitigating and monitoring measures. Additionally, the ESMoP includes an estimate of the costs of the measures and activities recommended so that the project proponent can budget the necessary funds.

## 9.2 Objectives of ESMoP

The objectives of project's ESMoP are:

- To design the monitoring mechanism and define the responsibilities of project components;
- To identify the monitoring parameters;
- To facilitate the implementation of mitigation as well as enhancement measures;
- To take timely action in case of an unexpected situation;
- To support smooth implementation of project with minimum losses or impact to environment; and
- To ensue compliance with national and international obligations.

The details of environmental issues, environmental impacts, proposed parameter to be monitored and timing agencies responsible for execution of proposed actions during mobilisation, construction, operation and decommissioning stages are presented in Tables 9.1 below.

**Table 9.1: Environmental and Social Monitoring Plan**

| Phase | Potential Impacts | Parameter to be Monitored | Monitoring Frequency | Monitoring Area | Measurement Unit | Target Level/ Standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|---|---|---|
| Preparation/Mobilization Phase | Loss of /disturbance of biodiversity (flora, fauna and ecosystem) | Area cleared<br>Trees cut down<br>Size of footpaths | continuously during mobilization phase | Project area | Area in $m^2$ | All affected areas are replanted | Contractor, project proponent | 3,000,000 |
| | Depletion /degradation at points of source of construction materials | Source of materials | continuously during mobilization phase | Source of materials site | Area in $m^2$ | No degradation | Contractor, project proponent | 1,000,000 |
| | Noise pollution | Noise level | continuously during mobilization phase | Project area | Noise level in decibel (dBA) | TBS, WHO | Contractor, project proponent | 2,500,000 |
| | Impaired air quality | $NO_X$, $SO_X$, CO | continuously during mobilization phase | Air quality monitoring stations at Project area | Emission levels in ppm, $mg/m^3$ | TBS, WHO | Contractor, project proponent | 5,000,000 |
| Construction | Dust pollution | Dust level (PM10 & PM2.5) | continuously during construction | Air quality monitoring stations at Project area | $PM_{10}$ and $PM_{2.5}$ levels in ppm or $mg/m^3$ | No dust contamination | Contractor, project proponent | 5,000,000 |
| | Environmental pollution from poor management of waste | Accumulation of debris, Solid waste collection system | Once before commissioning | Construction site | Area in $m^2$ | No debris | Contractor, project proponent | 2,000,000 |
| | Increased soil erosion | Soil erosion | Once every | Project area | None | No erosion | Contractor, | 1,000,000 |

| Phase | Potential Impacts | Parameter to be Monitored | Monitoring Frequency | Monitoring Area | Measurement Unit | Target Level/ Standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|---|---|---|
| | | tendencies | year | | | tendencies | project proponent | |
| | Surface and ground water hydrology and water quality degradation | Levels of oil and grease, pH, COD, TSS, Heavy metals | continuously during construction | Project area | mg/l | No oil contamination | Contractor, project proponent | 3,000,000 |
| | Risk of oil spills | Levels of oil and grease | continuously during construction | Project area | mg/l | No oil contamination | Contractor, project proponent | 10,000,000 |
| | Increased water demand | water needs report, type of water conservation gadgets, monitoring leakages reports | Before construction and once every year | Project area | $M^3$ | As minimum as possible | Contractor, project proponent | 3,000,000 |
| | Increased energy consumption | Energy conservation measures in place; Alternative energy sources level of exploitation | Once every three months | Resources use records | Numbers | As much uninterrupted power supply as possible | Contractor, project proponent | 5,000,000 |
| | Health hazards associated with construction work | Number of accidents | Once every year | Project area | Incidence | No or minimum accidents | Contractor, project proponent | 5,000,000 |
| | Frequency of illness of construction workers | Illness of construction workers | Once in a month for the | Project site | Number of cases | Health records | Contractor, Project proponent | 2,000,000 |

| Phase | Potential Impacts | Parameter to be Monitored | Monitoring Frequency | Monitoring Area | Measurement Unit | Target Level/ Standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|---|---|---|
| | | | construction period | | | | | |
| | Creation of informal settlement | Number of people moved in and structures established | During construction /Once every year | Project site | Number of incidences | As minimum as possible | Contractor, project proponent | 2,000,000 |
| | Compensation | compensation for land and properties | Once before the construction starts | All affected people | Numbers | Resettlement Action Plan (RAP). | Project proponent, Consultant | 5% of compensation budget |
| Operation | Increased water use | Performance of water conservation measures in place | Once every three months | Resources use records | Numbers | As much uninterrupted water supply as possible | Project proponent | 1,000,000 |
| | Reduced water quality | Water quality (of the receiving water bodies) | continuously during operation | Project area | mg/l | No oil contamination | Project proponent | 3,000,000 |
| | Increased soil erosion | Soil erosion tendencies, Monitoring schedule in place | Once every year | Project area | None | No erosion tendencies | Project proponent | 2,000,000 |
| | Increased runoff from new impervious areas | Floor covered with rough concrete in | Once every year | Project area | None | No flooding | Project proponent | 5,000,000 |

| Phase | Potential Impacts | Parameter to be Monitored | Monitoring Frequency | Monitoring Area | Measurement Unit | Target Level/ Standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|---|---|---|
| | | place | | | | | | |
| | Pollution of land and water resources due to mismanagement of waste | Systems for disposal of solid waste | Once every week | Water quality sampling stations at project area | Visual | No haphazard disposal of solid waste | Project proponent | 5,000,000 |
| | Noise and Air pollution | $PM_{10}$, $PM_{2.5}$, $NO_X$, $SO_X$, CO, Noise level | Once every 3 months | Air quality monitoring stations at Project area, Exhaust | ppm, $mg/m^3$, dBA | As minimum pollution as possible | Project proponent | 10,000,000 |
| | Increased electricity consumption | Water conservation strategies in place | Once every six months | Project area | Number of incidences | As minimum consumption as possible | Project proponent | 1,000,000 |
| | Increased storm water flow | Flood tendencies | Once every six months | Project area | Number of incidences | None | Project proponent | 2,000,000 |
| Socio – Economic | Health Hazards due to social interaction among workers and users | New cases of HIV/AIDS Number of complaints | Once every six months | Workers medical records | Numbers | Infections of HIV/AIDS are kept as low as possible | Project proponent | 10,000,000 |
| | Safety of human beings in villages and in the Soda ash project | Factory operational accidents and safety signs | Three times a year for the project life span | Project area | Safety signs and number of accidents; Records, | Zero accident and sufficient no of safety | Project proponent | 15,000,000 |

| Phase | Potential Impacts | Parameter to be Monitored | Monitoring Frequency | Monitoring Area | Measurement Unit | Target Level/ Standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|---|---|---|
| | | | | | inquiries and illness statistics | signs | | |
| Decommissioning | Loss of Jobs | Pension fund remittance | Once during decommissioning | Project area | Number of employees registered with Pension fund | All workers | Project proponent | 10,000,000 |
| | Environmental contaminations from solid waste generation | Aesthetics of the area | Six months after decommissioning | Project site | NA | As original as possible | Project proponent | 5,000,000 |
| | Noise pollution | Noise level | continuously during decommissioning | Project area, | dB | As minimum pollution as possible | Project proponent | 3,000,000 |
| | Dust and exhaust emissions | dust, NOX, SOX, CO | continuously during decommissioning | Project area, Exhaust | ppm, mg/m3, | As minimum pollution as possible | Project proponent | 10,000,000 |
| | Occupational hazards | Availability Protective gear; Type of people employed with their training | continuously during decommissioning | Project area | Incidence | No or minimum accidents | Project proponent | 5,000,000 |

| Phase | Potential Impacts | Parameter to be Monitored | Monitoring Frequency | Monitoring Area | Measurement Unit | Target Level/ Standard | Responsibility | Estimated Costs (TZS) |
|---|---|---|---|---|---|---|---|---|
| | | background; Working conditions | | | | | | |
| Enhancement of positive socio-economic impacts | Employment/Income generation | Number of local people employed | continuously during construction and operations | Project records | Number | As maximum as possible | URT/project proponent/ District council/ Contractor/ | Project running costs |
| | Improving growth of the economy | Procurement records | First year of operation | Project records | Amount provided | As maximum as possible | URT/project proponent/ District council | 5,000,000 |
| | Increased revenue to the nation through taxes, both direct and indirect | Timely remittance of revenue | First year of operation | Project records | Amount | As maximum as possible | URT/project proponent/ District council | 5,000,000 |
| | Support to local social services | Support provided | First year of operation | Project records | Amount provided | As maximum as possible | URT/project proponent/ District council | 20,000,000 |

## CHAPTER TEN

# 10 RESETTLEMENT ACTION PLAN FRAMEWORK

## 10.1 Introduction

Resettlement Action Plan (RAP) indicates the types of properties affected by the Soda ash project, the consultation process employed, recommended RAP implementation strategies and activities. It also describes the grievance redress mechanism, the legal and administrative framework within which the process is anchored and monitoring and evaluation activities.

The primary objective was to identify and prepare inventory of all properties, which will be affected as a result of construction of the soda ash project and provides an indication of the costs involved. It will be conducted so as to fulfil the requirements of the National and Village Land Act (1995). The Assessment will be carried out using desk reviews, a field visit and interviews with communities living within the project area and Government officers in charge of the area of influence of the project area i.e., Monduli DC, Wards of Engaruka, Selela and Mfereji as well as all villages within project area.

RAP is conducted according to the National Land Policy (1996) of Tanzania which provides guidance and directives on land ownership and tenure rights and taking of land and other land-based assets. The policy stipulates organization and procedures for valuing assets and delivery of compensation. The overall aim of the policy is to promote and ensure a secure land tenure system in Tanzania that protects the rights in land and resources for its entire citizen. The following principles are the basis of the land policy:

- All land in Tanzania is public land vested in the President as trustee on behalf of all citizens;
- Land has value;
- Rights and interest of citizens in land shall not be taken without due process of law; and
- Full, fair and prompt compensation shall be paid (in cash) when land is acquired.

## 10.2 RAP Justification

The identified project site will lead to physical displacement of people, loss of shelter, assets, income sources and livelihood, and restriction of access to economic resources. World Bank OP 4.12 - Involuntary Resettlement is triggered by this project and therefore requires the preparation of a Resettlement Action Plan. The Resettlement Action Plan helps to define the resettlement and compensation necessary as a result of implementing the Engaruka Soda ash project, in accordance with relevant sections of the Operations Manual together with the Laws and policies of Tanzania and World Bank's Involuntary Resettlement Policy.

## 10.3 Scope of RAP

### 10.3.1 RAP Objectives

Any project which envisages acquisition of land either of a temporary or permanent nature requires the development of a RAP in order to meet the following objectives:

- Provide a clear definition of the PAP by socio-economic and gender category; household or family; the cut-off dates for eligibility for compensation; the assets to be compensated at market value.

- Provide a detailed socio-economic survey in order to identify entitlement, key issues faced in terms of land acquisition and compensation, as well as options and strategies for minimizing impacts on current land use activities or cultural heritage.

- Provide specific rates for compensation of loss of assets at fair market and equitable value and the methodology of how these values are derived.

- Establish the land acquisition and compensation processes, options available, eligibility and entitlement and consultation and grievance referral and redress mechanisms.

- Take into account the requirements of the applicable laws of Tanzania as well as requirements of the World Bank policies and procedures.

### 10.3.2 RAP Study Team

The study team comprised of the following professionals:

- Environmentalists (Registered and experiesed with 10 year experience in the field, convesant with World Bank OP 4.12);

- Sociologists (with 10 year exoerience in the field);

- Socio-Economist (with 10 year exoerience in the field);

- Surveyor /Land Planner (with 10 year exoerience in the field);;

- Valuers (with 10 year exoerience in the field);;

- Ecologist/Natural Resource Expert (with 10 year exoerience in the field); and

- Enumerators.

## 10.4 Legislative Framework

There is no one direct law or legal provision on resettlement in Tanzania. It is generally guided by the Constitution of the United Republic of Tanzania 1977, National Land Policy 1995, Land Act No. 4 of 1999 and its Regulations, Village Land Act No.5 of 1999 and its Regulations, and the Land Acquisition Act of 1967. Land ownership in Tanzania is characterized by a dual system of tenure identifying both customary and statutory right of occupancy as being equal in law. According to the Land Act No. 4 of 1999, all Land in Tanzania is public/state land and is vested in the President as trustee on behalf of all. The Land Acquisition Act 1967 gives power to the President to acquire "Land" from private occupants for public purpose when it is in the public interest to do so. The Ministry of Lands, Housing and Human Settlements Development is responsible for land use planning, surveying and demarcating land/parcel/farms, and the provision of land ownership and tenancy.

It is a constitutional right in Tanzania that if one's property is either acquired or nationalized, the individual affected must be fully, fairly and promptly provided with compensation. The procedures for valuation are set out in the Land Act No.4 and Village Land Act No.5 of 1999. Compensation in Tanzania includes the market value of the real property less depreciation, disturbance and transport allowance, loss of profits or accommodation. Tanzanian practice usually entails cash compensation. The Land (Compensation Claims) Regulations, 2001 (Made under Section 179 of the Land Act No. 4 of 1999) states, that compensation shall take the form of monetary compensation. Section 2 however makes the amendment, that "compensation may, at the option of the government, take the form of all or a combination of the following:

a) A plot of land of comparable quality, extent and productive potential to the land lost;

b) Buildings of comparable quality extent and use comparable to the building or building lost

c) Plants and seedlings

d) Regular supplies of grain and other basic foodstuffs for a specified time.

This is further confirmed in the Land Act Section 12, which says that the person entitled to compensation can be given a grant on public land of equal value "in lieu or in addition to any compensation payable." Importantly, this enables compensation In-Kind within Tanzanian Law. WB's Involuntary Resettlement Policy, the World Bank's Operational Policy 4.12 and the IFC's Performance Standard 5 (2012) generally provide guidance on how to treat people who have been displaced or suffered other losses as a result of various projects. Whereas there is synergy between Tanzanian Law and World Bank's Involuntary Resettlement Policy, there are some key differences.

WB's Involuntary Resettlement Policy states that persons are eligible for compensation whether or not they have legal rights over the land but the GoT only recognizes those deemed to be legal residents or users of the land eligible for compensation for land. With regards to compensation, WB states that it should be based on replacement value rather than market value less depreciation. WB places emphasis on the improvement of PAPs' lives following displacement and prefers 'in-kind' forms of compensation rather than in cash, including special assistance to vulnerable peoples and gender sensitivity. There are specific guidelines with regards to the consultation process which should be participatory, culturally appropriate and ensure informed consent. Further sections of WB's Involuntary Resettlement Policy relate to the host communities, support to relive stress from public services and efforts to ensure benefits for the Host community to reduce conflict. WB also insists on continual monitoring and evaluation of the resettlement process. The RAP design and implementation modalities have integrated these critical focus areas and concerns to ensure that the physical and economic displacement to be experienced by the PAPs will not lead to a worsening of their economic and social welfares.

## 10.5 Community Participation and Public Involvement

The Project Proponent, National Development Cooperation (NDC) is committed to comply with international standards as well as national laws for resettlement. The project will develop a hybrid approach in handling public consultation in a culturally appropriate and gender sensitive manner. The public consultation will be conducted in a near future. The consultation process will involved visiting the areas. In general all household within the project area will be conducted.

**The specific objectives of the consultation process are:**

- To create awareness on the proposed project;
- To ask the local residents especially the Interested and Affected Parties about the problems they anticipate with the project and how these can be overcome;
- To consult and gather recommendations from the local administration e.g. DC, DED, Head of departments, Councilors, Village Elders and communities that have a stake in the project;
- To provide an opportunity to all the communities in the areas where the proposed project is expected to built to raise issues and concerns pertaining to the project, and allow the identification of alternatives and recommendations.

These engagements are also aimed to foster a two-way dialogue, in an open, honest and structured manner and maintain consistent messages regarding the Project activities and managing expectations. Care will be taken to assure that the groups being consulted are representative, with adequate participation of women, vulnerable groups, and ethnic or religious minorities. Separate meetings for various groups will be held when necessary. Clear mechanisms to respond to people's concerns, suggestions and grievances will be developed to provide timely feedback and all formal meetings are documented. A stakeholder mapping process will capture relevant government officials, community leadership and potentially interested NGOs. Appropriate protocols will be followed and relationships developed to have a productive working environment engendering transparency and flow of information between the parties.

The PAPs in the project area are very disparate, requiring a range of different approaches and dialogues with each whilst maintaining the same message to various groups of importance - the communities living on customary land, whose members have expanded into the project area for livelihood purposes are equally considered. All initial contacts with the villagers will commence with NDC sensitization in one form or another.

## 10.6 Project Impact on Human Settlements

The major impacts of the resettlement resulting from the construction of the Engaruka Soda Ash Project include:

**Loss of Land:** The impacts cover the loss of grazing pastures, agricultural land, settlement plots, GCA (hunting blocks and wildlife corridors) and denied access to the land.

**Demolition of building structures:** the impact includes the demolition of houses as well as other physical structures.

**Loss of income:** the resettlement will result into the loss of income from cattle, petty business and crops.

**Environmental effects:** The resettlement will deny access to natural resources resulting from land acquisition or from the project itself

## 10.7 Resettlement Mitigation Measures

The following interventions will be taken to minimize land acquisition and resettlement within the project area:

### 10.7.1 Compensation

In order to avoid the negative impacts to the people who will be affected by the project implementation, they will be compensated. The properties valuation has to be undertaken to all properties to be affected. The consultant in collaboration with local governments, and the people who will be affected made consultative meetings and agreed on the form of compensation.

### 10.7.2 Forms of compensation

During the Socio-Economic Survey, special attention will be paid in understanding the type of compensation preferred by every Project-Affected Person (PAP). It was whether to decide on cash or in-kind compensation options. About 98.4% of the PAPs preferred cash compensation options. This option is more appropriate as many village governments as well as individuals claimed that they have enough land for those who will be relocated. Also, this type of compensation is applicable where there is active market of labour.

### 10.7.3 Valuations

Tanzanian law states that compensation is due when land is acquired for a development purpose. The key difference between valuations of the Government of Tanzania (GoT) and WB is that the value should be assessed at the ‘open market rate’ with depreciation, unlike the WB states that compensation should have a ‘replacement value’ and where possible there should be a demonstrable improvement in people’s lives.

Apart from the core compensation for immovable assets, the PAPs will also receive compensation for their land and crops as well as disturbance, transport and accommodation allowances. Physically impacted PAPs are further entitled to transport and accommodation allowance. Transport allowances shall be actual cost of transporting 12 tons of luggage rail or road (whichever is cheaper) within 20 Kilometers from the point of displacement. Accommodation allowance is calculated by the number of rooms in a house times the average rent of the area times 36 months. Crop’s valuations are based on market prices of current year according to maturity rates.

## 10.8 RAP cost estimates

The estimate cost will be provided by the valuer. The good point to note is that, most villages within and around the project area have temporary houses and semi parmanent houses. The RAP estimate cost will be relatively less expensive due to nature of structures, land value and other development on the land which are not significant.

## 10.9 Implementation Schedule

The cost for the implementation of the actual resettlement will be included in full costs of the project activities. Most of the resettlement activities (up to the physical relocation stage) will be implemented and completed before the start-up of the construction works. Therefore, a realistic detailed activity implementation schedule will be prepared in a participatory setting, at a time when the intensity of the assignment in comparison to the physical, financial and human resources made available are known.

Displaced households and pastoralists and farmers will receive timely notice respectively to harvest the fields and salvage the frames, iron sheets or glasses from the buildings. As discussed before the Village Chairmen and Executive Officers will be involved in allocation of new plots to the isolated building owners inside the same villages, offering equal chance to exploit factory related business.

## 10.10 Grievance Redress Mechanisms

The sub-project RAP team will establish an independent grievance mechanism. This may be set up through Local Authorities, including a Resettlement or Land Committee and through community leaders. All PAPs will be informed about how to register grievances or complaints, including specific concerns about compensation and relocation. The PAPs should also be informed about the dispute resolution process, specifically about how the disputes will be resolved in an impartial and timely manner. The RAP Team will produce a Report containing a summary of all grievances. If needed, the dispute resolution process should include Tanzanian Courts of Law, but traditional institutions can be an effective first step in both receiving and resolving grievances.

## 10.11 Monitoring and Evaluation

For impact monitoring it is planned that an evaluation commissioned by NDC shall be conducted from an independent third party to determine the overall impact of the RAP. The key objective of the external evaluation will be to determine whether efforts to restore the living standards of the affected population have been properly executed. The evaluation will also verify the results of performance monitoring and identify adjustments to the RAP packages, if required. The evaluation will assess, inter alia: -

- The appropriateness of the relocation sites;
- The appropriateness of the implementation schedule;
- The appropriateness of the grievance mechanism;
- The appropriateness for assisting vulnerable groups;

The Project Affected Persons (PAPs) will be actively involved and informed in impact monitoring through participatory meetings. The cooperation of the Village Executive Officer and Ward Executive Officer is also crucial during these evaluations. It is anticipated that impact monitoring will first be carried out approximately 3 months after the PAPs have been relocated, and thereafter annually for a period of at least 2 years. At the end of each evaluation, a report will be submitted to NDC giving details of the evaluation and its findings.

# CHAPTER ELEVEN

## 11 COST BENEFIT ANALYSIS

## 11.1 Financial Cost Benefit Analysis To The Project

Cost benefit analysis is normally done in the framework of feasibility study. The aim of cost-benefit analysis is to inform decisions on:

- the costs of alternative ways of delivering a service;
- estimates of the size of a project; and/or
- whether a project should be undertaken

The costs may include:

- capital expenditures;
- operating and maintenance costs;
- staff costs;
- materials;
- research and development;
- opportunity costs; and
- Environmental health and other social costs.

Benefits may include:

- better, more cost-effective service delivery;
- the avoided costs-being the costs of the existing or conventional service delivery option;
- additional revenues generated;
- productivity savings; and
- Environmental, health and other social benefits.

Before the project is approved by the URT/NDC it has to pass the net present value test. The costs and benefits were used to calculate the net present value of the project. According to the *Volume IX – Project Appraisal Report*, the net present value of this project is positive.

### 11.1.1 Strengths

- Commitments of Central and Local Government
- Availability of local, regional and international markets
- Quality of soda ash products to be produces
- Sustainability and life span of brine resources
- Use of cost effective and Environmentally friendly technology
- Availability of plenty and untapped brine resources
- Geographical location in advantage sparsely vegetated area
- Proximity to Engaruka and Mto wa Mbu Centres on benefits of commercial and social economic facilities.

- Proximity to Engaruka centre in advantage of labour force, social economic facilities and interactions.
- Topographical advantage and natural drains i.e., Engaruka River, Engaruka basin, Burko river, Selela river.

### 11.1.2 Opportunities
- Capture local, regional and international markets
- Creation of employment opportunities and employability
- Emergency of Infrastructure and social services
- Provisions of water supply
- Better use of land for industry establishment and supportive facilities
- Better use of local building materials
- Establishment of plant centre for national sustainable development

### 11.1.3 Weakness
- The project design and construction will be cost-full to meet internal fund and/or investor/donor requirement,
- Clearance require clear cut of existing vegetation
- Blockage of wildlife corridors
- Impact on hunting blocks/GCA

### 11.1.4 Threats
- Vegetation clearance will change of natural setting;
- Containment of surface and ground water,
- Soil erosion and floods
- Effects to ecological balance of flora and fauna
- Destruction of the existing grazing land
- Disruption of existing GCA, wildlife corridors and surrounding areas
- High cost of construction and conservation of biodiversity ecosystem

## 11.2 Quantifiable and Non-Quantifiable Benefits to Communities
The benefit to the communities may be looked into different perspectives. The successful construction of the proposed project will make money for local contractors and services provider who will be involved in the project e.g., Techno-Economic studies' Consultants etc who in turn will pay taxes which will be used by the Government to provide social services to the community. The project activities will also generate employment during construction and operation of the projects and facilities. The activities that will be accommodated by the project will provide direct employment to Tanzanians from all businesses and services.

A wide array of non-quantifiable benefits will also result from the investment as the project will attract different businesses and services including shops, food vendors, ancillary (dispensary, bank, post office, supermarket) etc. For example, the banks will enhance business transaction and extend loan services to the community. Generally, since the project has a positive net present value it will contribute to Tanzania's economic growth and development.

## 11.3 Possible Costs to Government

As already mentioned, the Government will directly and indirectly benefit from taxes from the project. Apart from tax generation, the investment will also enhance the economic growth and ancillary private sector development spurred by the operations and activities associated with the proposed project. The image of the government in investment sector will also be enhanced nationally and internationally that will increase attractions from other local and foreign investors and ensure continued education growth.

## 11.4 Environmental Cost Benefit Analysis

Environmental cost benefit analysis is assessed in terms of the negative versus positive analysis. Furthermore, the analysis is considering whether the impacts are mitigatable and the costs of mitigating the impacts are reasonable. The negative impacts associated with the soda ash project development include: destruction of natural resources causing ecological imbalance, increase of disasters and occupational hazards; waste production and management, noise pollution, dust emission, noise emission, soil erosion, increased water demand, increased energy consumption among others. As it has been mentioned in Chapters 6 and 7 as well as *Volume IX – Project Appraisal Report*, the benefits of the project, in terms of financial and social benefit are substantial, the environmental impacts are mitigatable and the financial resources needed to mitigate the impacts are relatively small compared with the actual capital investment. This project shall have a significant impact on the Tanzania Government especially in the education sector.

## 11.5 Social Economic Cost Benefit Analysis

The project will directly enhance investment in various peripheral business and services and will indirectly enhance the image of Tanzania as preferred investment destination. All these will enhance employment opportunities to the Tanzanians, contributing towards poverty eradication activities. Positive impacts arising from the proposed project include: job creation; promotion of the business enterprises in the community; improvement of the people's social and economic wellbeing leading to better livelihoods; better planning and provision of infrastructural services; increase in the value of properties in the project vicinity; improvement and expansion of investment opportunities, optimum use of land, increase in rural development, improved security, improved social serves of the community among others. As it can be seen in the impact analysis, there are no serious negative social economic impacts. It can therefore be deduced that the social benefit outweighs the social costs that are anticipated.

# CHAPTER TWELVE

## 12 PRELIMINARY DECOMMISSIONING PLAN

This is a preliminary decommissioning plan. This plan establishes feasible decommissioning scheme that can be accomplished without undue risk to the health and safety of the public and decommissioning personnel, without adverse effects on the environment, and within established guides and limits of the appropriate regulatory agencies. While not a detailed document, this preliminary plan will serve to ensure that the decommissioning and ultimate disposition of the project is considered during the initial design and construction phase. The preliminary plan will remain a “living document,” and revisions will be made throughout the operating life of the project. It must be reviewed periodically and revised to reflect any changes during construction or operation phase of the project that might affect decommissioning. Prior to the initiation of actual decommissioning activities for the project, a detailed final disposition plan will be prepared.

The final plan should be based on the preliminary plan and revisions, and will define specific work activities and include safety evaluations of planned decommissioning methods, new technology, and the status of project facilities that will result from the decommissioning program. In addition, the final shall contain sufficient information to obtain any approvals needed from the appropriate regulatory agencies to proceed with decommissioning activities.

### 12.1 Aim of the Preliminary Plan

The preliminary plan serves to establish decommissioning as an important consideration from the inception of the project, during design and throughout the operation of the proposed project. The plan has the following purposes:

a) The primary purpose of the preliminary plan is to ensure that the proposed project designers are cognizant of decommissioning during the initial design of the project. Thus, where design choices that would enhance decommissioning are available for types of materials and system components, and location of components, these choices shall be made.
b) Another purpose of the preliminary plan is to identity the ultimate decommissioning options and final project status. These options would be evaluated and narrowed to the decommissioning method of choice as the end of the project life is approached.
c) The final purpose of the preliminary plan is to demonstrate to regulatory agencies that important aspects of decommissioning are considered as early as possible during the initial design of the project. The plan serves as the starting point to demonstrate that areas such as decommissioning methods, costs, schedules, and operating impact on

decommissioning will be reviewed and refined throughout the operating life of the proposed project.

## 12.2 Content of the Decommissioning Plan

The preliminary plan provides a general description of decommissioning methods considered feasible for the project. The description is intended to demonstrate that the methods considered are practical and that they protect the health and safety of the public and decommissioning personnel.

Design personnel should study the proposed decommissioning methods and take steps to ensure that the design incorporates features that will facilitate decommissioning. Considerations include:

a) An estimate of manpower, materials, and costs anticipated to support decommissioning.
b) A description of the anticipated final disposition and status of the project equipment and site.
c) A discussion demonstrating that adequate financing will be programmed for decommissioning.
d) Identification of records that should be maintained during construction and operation which might facilitate decommissioning, including a set of "as built" drawings.

## 12.3 Project Decommissioning Methodology And Schedule

The project proponent shall fund and implement all aspects of Project decommissioning, including but not limited to, all engineering, environmental assessment, permitting, construction, and mitigation activities associated with the removal of the structures, in accordance with this plan and mitigation of Project removal impacts on site. Project proponent shall monitor environmental impacts during and after Project removal to respond to defined events during the monitoring phase.

*12.3.1 Decommissioning will involve, but not limited to the specified list, because some issues or problems may surface during subsequent monitoring and audits:*

a) The project buildings will continuously be rehabilitated and renovated. While doing that there will be solid wastes which will be disposed of according to the ESMP.
b) Moreover, during decommissioning the buildings will be demolished accordingly to suit the new activity while doing that the rubble will be disposed of according to the directions of the Monduli District Council's directives.

12.3.2 Employees will be terminated from their employments and to them the future will look blunt. Three things will be observed: their contributions to the pension fund will be made monthly as required by law; a training programme will be made to continuously advance them into apt skills and professions; and the termination benefits including transport and disturbance allowances will be made.

12.3.3 On decommissioning the soda ash project, the proponent will search for experts' opinions in order to convert the entire premises into another or other uses. According to the current priorities the possible uses will be:

12.3.4 Making the premise a storage facility for hardware and spare parts for vehicles or heavy equipment and second-hand materials;

12.3.5 Using it as technical training unit (vocational centre) of mechanics who can be used to repair vehicles, machinery and other related setups.

12.3.6 Converting it into facility like a garage or vehicle assembling unit; or store

12.3.7 The restoration plan for the entire premises will be made by proponent (with expertise from environmentalists and economists) and then forwarded to NEMC for approval.

12.3.8 Also, the proponent shall obtain all permits required to undertake decommissioning of the Project. This basically will include Pension Fund, Monduli District Council etc.

Project removal will begin six months after closure and continue for twelve months. Within the six months from closure, the proponent will inventory all components that need to be removed and or disposed of. This inventory will include building structures, equipment etc. to be demolished/dismantled. Also, mode of disposal will have to be finalized. This information will assist in the preparation of the final decommissioning plan, for approval by NEMC.

After the approval of the decommissioning plan the metal parts will be removed first within the first three months (this is important to ensure that they are not vandalized). The second three months of the decommissioning will be used to remove concrete structures and foundations. Debris will be used as road fills for rural roads. All disturbed areas will be landscaped and revegetated using indigenous trees.

Project decommissioning has five phases: (1) pre-removal monitoring; (2) permitting; (3) interim protective measures; (4) Project removal and associated protective actions; and (5) post-removal activities, including monitoring of environment and socio-economic activities.

The first three phases will occur prior to removal of the Project (i.e., within the first six months). The fourth phase - project removal and associated protective actions — will take place twelve months after closing business. The fifth phase will begin after total removal and due to nature of the project (medium scale, with relatively moderate impacts) removal and continue for at least one year.

The description that follows outlines the activities that will occur in each phase:

**(1) Pre-removal monitoring:** Pre-removal monitoring includes environmental and socio-economic status of the project site and the surrounding. This monitoring is essential to identify if there is any environmental or social liability which need to be settled before the permit for closure is given. This period will also be used to inventories all assets and facilities that need to be disposed of and to prepare a final decommissioning plan for approval by NEMC.

**(2) Permitting:** The proponent shall obtain all permits required to undertake removal of the Project. This basically will include NEMC, Investor/NDC, Pension Fund, Monduli District Council etc.

**(3) Interim Protective Actions:** This will take care of any interim protective measure that needs to be implemented to protect human health and environment, if any.

**(4) Project Removal:** As noted above, the removal of the project will be completed within six months.

**(5) Post-Removal Activities:** Post-Project removal monitoring will continue for three months.

URT through NDC must ensure that shifting the operations of soda ash project located at Engaruka basin will not have a negative impact to the environment and societies, hence a good decommission plan should be in place.

# CHAPTER THIRTEEN

## 13 SUMMARY AND CONCLUSIONS

The EIS report establishes the baseline condition of the site and assesses the impact of the proposed project on area resources. Issues pertaining to the proposed project considered are as follows: physical presence of the proposed soda ash project in relation to the existing environment; natural resources destruction, materials sourcing and transportation; management of liquid discharges and solid wastes management, noise pollution, dust emission, noise emission, soil erosion, increased water demand, increased energy consumption and socio-economic impacts of the proposed project. The positive impacts of the project included: job creation; promotion of the business enterprises in the community; improvement of the people's social and economic wellbeing leading to better livelihoods; better planning and provision of infrastructural services; increase in the value of properties in the project vicinity; improvement and expansion of investment opportunities, optimum use of land, increase in rural development, improved security, and improved social services particularly road networks and health status of the community among others.

The negative impacts identified however can be adequately mitigated to minimize or eliminate their effects on physical and biological environment. The proposed mitigation measures are included in an environmental and social management plan (ESMP). The ESMP consists of the set of mitigation, monitoring, and institutional measures to be taken during site selection to decommissioning of the planned project to eliminate, offset, or reduce adverse environmental and social impacts. The plan also includes the actions needed to implement these measures. Moreover, the EIA outlines specific environmental management and monitoring plans and identifies any necessary reporting requirements and schedules.

Given the nature and location of the development, the conclusion is that the potential impacts associated with the proposed construction of soda ash extraction and processing plant are of a nature and extent that can be reduced, limited and eliminated by the application of appropriate mitigation measures. The proposed environmental management plan and environmental monitoring plan if implemented will safeguard the tranquillity of the environment. There is necessity of close monitoring to ensure compliance with the proposed environmental management plans and if successfully implemented, this project will have significant impact to improvement of education sector in the country and will strengthen the existing good relationship between the Tanzanian Government and International partners (funders/donors).

# CHAPTER FOURTEEN

## 14 ESIA TEAM QUALIFICATIONS

### 14.1 Dr. Julius Elias Daud (ESIA Team Leader - Environmentalist)

Dr. Julius is a Principal Researcher in the Environmental Technology and Occupational Safety Division at Tanzania Industrial Research and Development Organization (TIRDO). He is a registered and certified EIA and EA expert by NEMC since 2010. Dr. Julius has 10 years' experience working with government and private firms on issues pertaining Environmental and Social Impact Assessment (ESIA), Environmental Audit (EA), Environmental Due Diligence, Preliminary Environmental Analysis (PEA), Strategic Environmental Assessment (SEA), Risk assessment, Occupational Health and Safety, Environmental monitoring and needs assessment.

### 14.2 Dr. Benaiah Beno (Zoologist/ Fauna Expert)

Dr Beno has sufficient background in terms of environmental and social impact assessments, environmental Audit, environmental monitoring and an extensive knowledge on biodiversity especially fauna and avifauna. Dr. Beno has done several consultancies on, environmental impact assessment (EIA), environmental audit (EA), and training bachelor, masters and PhD students' environmental management and conservation issues in biodiversity. Dr. Beno has over 13 years' experience in the field and has been involved in a number of assignments related to government, private firms and NGOs.

### 14.3 Mr. Frank Mbago (Botanist/Flora Expert)

Mr. Mbago has sufficient background in terms of environmental and social impact assessments, environmental Audit, environmental monitoring and an extensive knowledge on plant (flora) ecology. Mr. Mbago has done several consultancies on, environmental impact assessment (EIA), environmental audit (EA), and training bachelor, masters and PhD students' environmental conservation issues in biodiversity/plant ecology. Mr. Mbago has over 15 years' experience in the field and has been involved in a number of assignments related to government, private firms and NGOs.

### 14.4 Dr. Charles Saanane (Archaeologist)

Dr Saanane has sufficient background in terms of environmental and social impact assessments, environmental Audit, environmental monitoring and an extensive knowledge on natural heritage especially archaeology and palaeontology. Dr. Saanane has done several consultancies on, environmental impact assessment (EIA), environmental audit (EA), and training bachelor, masters and PhD students on archaeology and palaeontology issues. Dr. Saanane has over 20 years' experience in the field and has been involved in a number of assignments related to government, private firms and NGOs.

**14.5 Mr. Huruma Kisaka (Sociologist)**

Mr. Kisaka has sufficient background in terms of environmental and social impact assessments, environmental Audit, environmental monitoring and an extensive knowledge of social studies. Mr. Kisaka has done several consultancies on social studies for over 18 years with a number of assignments related to government, private firms and NGOs.

# CHAPTER FIFTEEN

## 15 REFERENCES


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Volume IV – Project Engineering Design Report
Volume V – Assessment of Availability of the Plant Utilities Report
Volume VI – Plant and Township Site Selection and Infrastructures Report
Voulume VII – Transport Logistics
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# APPENDICES

APPENDIX 1: PROSPECTIN LICENSE (PLs) EVIDENCE

*Licence PL 11227/2018*

**THE UNITED REPUBLIC OF TANZANIA**
**MINISTRY OF MINERALS**
**MINING COMMISSION**

**PROSPECTING LICENCE NO. PL 11227/2018**

**GRANTED PURSUANT TO SECTION 32 OF THE MINING ACT, CAP. 123**

WHEREAS M/S **National Development Corporation of P.O.Box 2669, Dar es Salaam-Tanzania** has fulfilled the conditions for grant of Prospecting Licence pursuant to Section 31 of ***The Mining Act, Cap. 123***;

I, Prof. Shukrani E. Manya, **EXECUTIVE SECRETARY,** subject to the provisions of ***The Mining Act, Cap. 123,*** and of the regulations made thereunder or which may come into force during the continuance of this Licence, or any renewal thereof and pursuant to the powers conferred upon me under Section 32 of ***The Mining Act, Cap. 123,*** hereby grant to M/S **National Development Corporation** (hereinafter called the Licensee) a **Prospecting Licence - Industrial Minerals,** to prospect for **Soda Ash,** at **Engaruka** in **Monduli** District, over an area described in Annex A (hereinafter called the Licence Area), conferring on the Licensee the right to carry on such prospecting operations, abide to Annex B, Annex C and Annex D and execute such other works as are necessary for that purpose.

This Licence, unless sooner cancelled, suspended or surrendered pursuant to the provisions of ***The Mining Act, Cap. 123,*** shall be valid for a period of **forty eight (48)** months, effective from the date of grant.

Granted this 18th day of OCTOBER 2018

Prof. Shukrani E. Manya
**EXECUTIVE SECRETARY**

**ANNEX A**

## DESCRIPTION OF THE LICENCE AREA

Subject to Section 95 of the Mining Act, Cap. 123 the Licence is at **Engaruka** area in **Monduli** District, QDS **54/1** defined by lines of latitude and longitude having the following corner coordinates (Arc 1960):

| Corner | Latitude | Longitude |
|---|---|---|
| 1 | - 03 deg. 07 min. 55.00 sec. | 36 deg. 07 min. 0.00 sec. |
| 2 | - 03 deg. 07 min. 55.00 sec. | 36 deg. 13 min. 0.00 sec. |
| 3 | - 03 deg. 10 min. 0.00 sec. | 36 deg. 13 min. 0.00 sec. |
| 4 | - 03 deg. 10 min. 0.00 sec. | 36 deg. 07 min. 0.00 sec. |


| Legend | |
|---|---|
| Licensed boundary | |
| Licence Code | PL 11227/2018 |
| District | Monduli |
| Direction | N |

An area of approximately **42.75** Square Kilometres.

# THE UNITED REPUBLIC OF TANZANIA
## MINISTRY OF MINERALS
## MINING COMMISSION

### PROSPECTING LICENCE NO. PL 11226/2018

### GRANTED PURSUANT TO SECTION 32 OF THE MINING ACT, CAP. 123

WHEREAS **M/S National Development Corporation** of **P.O.Box 2669, Dar es Salaam-Tanzania** has fulfilled the conditions for grant of Prospecting Licence pursuant to Section 31 of ***The Mining Act, Cap. 123***;

I, Prof. Shukrani E. Manya, **EXECUTIVE SECRETARY**, subject to the provisions of ***The Mining Act, Cap. 123,*** and of the regulations made thereunder or which may come into force during the continuance of this Licence, or any renewal thereof and pursuant to the powers conferred upon me under Section 32 of ***The Mining Act, Cap. 123,*** hereby grant to M/S **National Development Corporation** (hereinafter called the Licensee) a **Prospecting Licence - Industrial Minerals,** to prospect for **Soda Ash,** at **Engaruka,** in **Longido** and **Monduli** Districts, over an area described in Annex A (hereinafter called the Licence Area), conferring on the Licensee the right to carry on such prospecting operations, abide to Annex B, Annex C and Annex D and execute such other works as are necessary for that purpose.

This Licence, unless sooner cancelled, suspended or surrendered pursuant to the provisions of ***The Mining Act, Cap. 123,*** shall be valid for a period of **forty eight (48)** months, effective from the date of grant.

Granted this ....18th.... day of ....OCTOBER.... 2018

..........................................

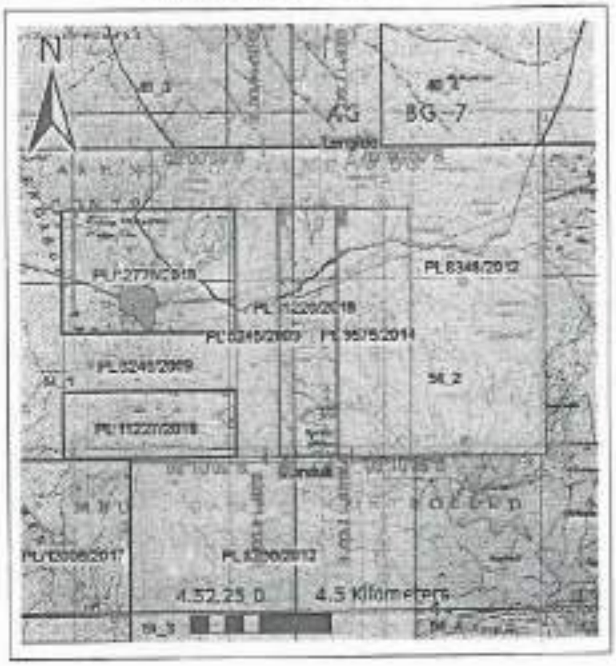
Prof. Shukrani E. Manya
**EXECUTIVE SECRETARY**

**ANNEX A**

## DESCRIPTION OF THE LICENCE AREA

Subject to Section 95 of the Mining Act, Cap. 123 the Licence is at **Engaruka** area in **Longido** and **Monduli** Districts, QDS **54/1, 54/2** defined by lines of latitude and longitude having the following corner coordinates (Arc 1960):

| Corner | Latitude | Longitude |
|---|---|---|
| 1 | - 03 deg. 02 min. 0.00 sec. | 36 deg. 14 min. 30.00 sec. |
| 2 | - 03 deg. 02 min. 0.00 sec. | 36 deg. 16 min. 30.00 sec. |
| 3 | - 03 deg. 10 min. 0.00 sec. | 36 deg. 16 min. 30.00 sec. |
| 4 | - 03 deg. 10 min. 0.00 sec. | 36 deg. 14 min. 30.00 sec. |




| Legend | |
|---|---|
| Licensed boundary | |
| Licence Code | PL 11226/2018 |
| District | Longido, Monduli |
| Direction | N |

An area of approximately **54.71** Square Kilometres.

APPENDIX 2: VILAGE LAND RIGHT

**JAMHURI YA MUUNGANO WA TANZANIA**

**WIZARA YA ARDHI, NYUMBA NA MAENDELEO YA MAKAZI**

Telegram: ARDHI"

Namba ya simu: 2753210

Ofisi ya Kamishna wa Ardhi Msaidizi
Kanda ya Kaskazini
S.L.P.1186,
MOSHI.

04/02/2020

**Kumb. Na.**LD/NZ/43040/4

Mkurugenzi Mtendaji,
Halmashauri ya Wilaya **Monduli**
S.L.P 1,
Monduli

**YAH: CHETI CHA ARDHI YA KIJIJI CHA ENAGARUKA CHINI WILAYA YA MONDULI**

Tafadhali rejea Cheti cha Ardhi ya Kijiji tajwa hapo juu kilichowasilishwa kwa hatua ya kusainiwa na Kamishna wa Ardhi Msaidizi Kanda ya Kaskazini na kugongwa Lakiri ya Serikali.

Tafadhali baada ya kusajili wasilisha nakala ya Cheti cha Ardhi ya Kijiji kwa Afisa Mtendaji wa Kijiji **ENAGARUKA CHINI WILAYA YA MONDULI** kwa kumbukumbu.

Moloimet O. Olemoko
Kny: **KAMISHINA WA ARDHI MSAIDIZI**
**KANDA YA KASKAZINI**

**Nakala:**
Afisa Mtendaji
Kijiji cha **Enagaruka Chini**
Wilaya ya **Monduli**

Fomu ya Ardhi ya Vijiji Na.16

HATINA 1/MOND/84
IMESAJILIWA LEO TAREHE 05.02.2020
MUDA 8:16 Mchana
AFISA ARDHI WILAYA

JAMHURI YA MUUNGANO WA TANZANIA

**SHERIA YA ARDHI YA VIJIJI, 1999**

**(Na.5 ya 1999)**

**CHETI CHA ARDHI YA KIJIJI**

(Chini ya fungu la 7)

Namba ya Cheti **1/MOND/84**
L.O.NO **385506**
Kumb.Na **AR/KIJ/400**

Leo tarehe 30 ya mwezi Januari mwaka 2020

Hii ni kuthibitisha kuwa Halmashauri ya kijiji (humu ikirejewa kama "Halmashauri")
Cha **ENGARUKA CHINI** Katika Wilaya ya **MONDULI** inakabidhiwa kama mdhamini usimamizi wa ardhi yote iliyoelezwa katika Jedwali lililoambatishwa (humu ikirejewa kama "ardhi ya kijiji" )kadri ya nia na maana halisi ya sheria ya ardhi ya vijiji na kwa masharti yafuatayo:-

i) Halmashauri itasimamia ardhi ya kijiji kadri ya sheria za mila zinazohusu ardhi kwenye eneo husika;

ii) Halmashauri italinda mazingira kwa kuhifadhi rutuba ya ardhi na kuzuia mmomonyoko wa udongo;

iii) Halmashauri italinda haki za njia;

iv) Halmashauri italinda na kutunza mipaka ya kijiji;

v) Halmashauri itatunza na kukihifadhi kwa usalama cheti hiki;

vi) Endapo mipaka ya kijiji imebadilishwa au kurekebishwa,Halmashauri itatuma cheti kwa Kamishna ili kuidhinisha mabadiliko au marekebisho ya mipaka kwenye cheti;

vii) Halmashauri itatoa hati ya hakimiliki ya kimila na kutunza daftari la Ardhi la kijiji.

**JEDWALI**

Eneo lote lijulikanalo kama kijiji cha **ENGARUKA CHINI** katika wilaya ya **MONDULI** lenye ukubwa wa **KILOMITA ZA MRABA 212.24 (MIA MBILI KUMI NA MBILI DESIMALI MBILI NNE)** kama mipaka inavyoonyeshwa kwa wino katika ramani/mchoro uliambatanishwa hapa.

IMETOLEWA na Rais na imekabidhiwa kwa mkono wangu na LAKIRI rasmi kuwekwa siku na mwaka vilivyoandikwa hapo juu.

..............................

KAIMU *Kamishna Msaidizi wa Ardhi*

IMEWEKEWA LAKIRI halisi ya Halmashauri ya kijiji
Cha **ENGARUKA CHINI** mbele yetu:

1. Jina LEMBOSE LADAANGAIA Mollel
   Saini..............................
   Cheo:Mwenyekiti wa Halmashauri ya Kijiji
   Anuani:**S.L.P 1,MONDULI**

2. Jina ROBINSON H. NATAI
   Saini..............................
   Cheo: Mtendaji wa Halmashauri ya Kijiji
   Anuani:**S.L.P 1,MONDULI**

LAKIRI/MHURI

Nakala:Msajili

APPENDIX 4: NAMES AND SIGNATURE OF CONSULTED STAKEHOLDERS

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE

TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)

NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED FOR SODA ASH PROJECT AT ENGARUKA, MONDULI DC IN ARUSHA

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1. | 13/8/2020 | Gaitani F. Mrimi | WIZARA YA VIWANDA MCHIMI | 0683805[illegible] | |
| 2. | 14/8/20 | Yustina A. Kiwango | CONSERVATOR TANAPA HQ | 0784711338 | |
| 3 | 14/8/2020 | Mahmu Mbijima | CONSERVATION OFFICER TANAPA HQ | 0754[illegible] | |
| 4 | 14/08/20 | MUSSA SHAMANGI | Ag RMO TUME YA MADINI MKOA WA ARUSHA | 0767583296 | |
| 5 | 14/8/20 | TEKLA AMINAT MPANDA | MINING ENGINEER TUME YA MADINI MKOA WA ARUSHA | 0742-775[illegible] | |
| 6 | 15/8/20 | HAMZA KAJA | TAWIRI | 0768-6[illegible] | |

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE

TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)

NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED FOR SODA ASH PROJECT AT ENGARUKA, MONDULI DC IN ARUSHA

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1 | 30/7/2020 | EDWARD PORGKAN | PINGOS Forum | Box 14437 ARS | |
| 2 | 30/7/20 | EMANUEL SAKINOE | PINGOS FORUM | Box 14437 ARUSHA | |
| 3 | 30/7/20 | Laya Naimi | Pingos Forum | ARUSHA Box 14437 | |
| 4 | 30/7/2020 | Emmanuel I. Munla | Pingos Forum | Box 14437 ARUSHA | |
| 5 | 30/7/20 | Nankya Ndoskoi | PINGO'S FORUM | P.O Box 14437 Arusha | |

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE

TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)

NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED FOR SODA ASH PROJECT AT ENGARUKA, MONDULI DC IN ARUSHA

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1. | 12/08/2020 | Monica Augustino | Principal Environmental Scientist - 0754 763014 | Mining Commission | [signature] |
| 2. | -"- | Eng. Azizi Suedi | Ag. MEX - 0755731070 | Mining Commission | [signature] |
| 3. | -"- | Jackson Biroe | Ag. ACEM - 0769[illegible] | Ministry of Minerals | [signature] |
| 4. | -"- | JAJI. H. LIGALWIKE | GEOLOGIST - 0716467[illegible] | Ministry of Minerals | [signature] |
| 5 | -"- | TRYPHON M. LUHANGULA | ENV. OFFICER - 076610[illegible] | MINING COMMISSION | [signature] |

NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED DURING THE SUBMISSION OF SCOPING REPORT FOR SODA ASH PROJECT LOCATED AT ENGARUKA BASIN IN MONDULI DISTRICT, ARUSHA REGION

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| | 11/8/2020 | AFRICO SIMON MATTEGRO | WIZARA YA MALIASILI NA UTALII, IDARA YA WANYAMAPORI - AFISA WANYAMAPORI MKUU | MJI WA SERIKALI MTUMBA MTAA WA UTAWALA [illegible] S.L.P 857 DODOMA 0767274774 | [signature] |
| | 11/8/2020 | ENG. DORISIA MULASHANI | WIZARA YA MAJI MKURUGENZI WA UANDAAJI WA MIRADI NA URATIBU WA PROGRAMU YA SEKTA YA MAJI | 0784299207 | [signature] |
| | 11/8/2020 | Mzamilu KAITO | MNRT - WILDLIFE DIVISION | Govt. CITY - MTUMBA P.O.Box 1351 DODOMA | [signature] |

NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED FOR SODA ASH PROJECT AT ENGARUKA, MONDULI DC IN ARUSHA

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1 | 17/08/2020 | REGINALD TESHA | TOWN PLANNER MONDULI DC | 0680-155797 | [signature] |

THE UNITED REPUBLIC OF TANZANIA

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NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED FOR SODA ASH PROJECT AT ENGARUKA, MONDULI DC IN ARUSHA

| S/N. | DATES/ TAREHE | NAME/ JINA | TITLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1 | 12/08/2020 | BERTHA H. LUZABIKO | Ministry of Minerals Ag. AC - MBVA | bertha.luzabiko@madini.go.tz 0754514282 | |
| 2 | 12/08/2020 | Sundi K. Matowu | MEV - Mining Commission | [illegible] 0767258055 | |
| 3 | 12/08/2020 | [illegible] S. [illegible] | Engineer - M.M | [illegible] 0714502273 | |
| 4 | 12-08-2020 | Eng. Asia Mwakilembe | Value addition officer | asia.mwakilembe@madini.go.tz 0753640230 | |
| 5 | 12-08-2020 | EMORENCIUS MASERO | EMORENCIUS MASERO Tume ya Madini | 0766560308 | |

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|---|---|---|---|---|---|
| 1. | 11/08/020 | PRAXEDA PAUL KALUGENDO | WIZARA YA MAJI P/HYDROGEOLOGIST | 0784 864 144 | Paul. |
| 2 | —11— | ENG. KISSINA SIMLIZY | WIZARA YA MAJI P/ENGINEER | 0716240888 | |
| 3 | —11— | YUSUF A. SELENGE | HEAD, ENVIRONMENTAL MANAGEMENT UNIT (ENV) MINISTRY OF LIVESTOCK & FISHERIES | 0754586095 | |
| 4. | -11- | MARIAM K MABOHU | FISHERIES OFFICER II MINISTRY OF LIVESTOCK & FISHERIES | 0768963311 | |
| 5. | -11- | OLLARY B. MBAFTAH | ENVIRONMENTAL OFFICER II MINISTRY OF LIVESTOCK AND FISHERIES | 0714 [illegible] | |
| 6 | -11- | Dwini M Kibona | P/ Fisheries Officer Ministry of Livestock & Fisheries | [illegible] | |
| 7. | -11- | Fredrick Frumbe | Wizara ya Mifugo na Uvuvi [illegible] Maji | 0655 637026 | |

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|---|---|---|---|---|---|
| 1. | 08/08/2020 | [illegible] | Executive Secretary, National Commission for UNESCO | [illegible] | [illegible] |
| 2 | 09/08/2020 | George L. Makhoya | TANAPA NORTHERN ZONE Senior Wardens Office – Research Mgt Area & Infrastructure | Box 2658, Moshi [illegible] | [illegible] |
| 3 | 10/08/2020 | Gloria Bideberi | SAC – CRCO TAWA NGORONGORO | 0786794611 | [illegible] |
| 4 | 10/08/2020 | Hamisi Mpunda | TAWA – AFISA WANYAMAPORI | 0744074779 | [illegible] |
| 5 | 10/08/2020 | DR. SIIMA BAKENGESA | TAFORI – DIRECTOR OF FOREST PRODUCTION RESEARCH | 0754 784545 | [illegible] |

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|---|---|---|---|---|---|
| . | 12/08/2020 | NEEMA L. MASINDE | MINISTRY OF MINERALS GEOLOGIST – MINES AND MINERAL DEVELOPMENT SECTION | 0718822399 P.O. BOX 422 DODOMA | [illegible] |
| | 12/08/2020 | MARIETHA FRANCIS | MINISTRY OF MINERALS GEOLOGIST – [illegible] | 0764270008 | [illegible] |
| | 13/08/2020 | Prof. W. Magigi | Ministry of Lands, Housing and Human Settlement Development | 0762322277 | [illegible] |
| | 13/08/2020 | NYACHERI MTAMBA | Internal Drainage Basin Water Board Env. Engineer | 0742528992 | [illegible] |
| | 13/08/2020 | Erasmus M. Parimu | Internal Drainage Basin Water Board Hydrologist | 0787277930 | [illegible] |

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|---|---|---|---|---|---|
| 1 | 24/7/20 | MELITA - KUIETEI | MZEE - WA - BOMA | 0678062528 | M/K/ |
| 2 | 24/7/20 | LEIYO - MELITA | KIJANA MKUBWA | 0754662110 | L/K/ |
| 3 | 24/7/20 | LUKAS - MELITA | KIJANA MDOGO | 0786751210 | L/M/ |
| 4. | 24/7/20 | KOILE - MELITA | KIJANA MKUBWA | 0871033789 | K/M/ |
| 5. | 24/7/20 | NARAMATISHO - KOILE | MAMA - MKUBWA | | N/K/ |

NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED FOR SODA ASH PROJECT AT ENGARUKA, MONDULI DC IN ARUSHA

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|---|---|---|---|---|---|
| | 24/7/2020 | PASHET SENGERUAN | MWENYEKITI NYANDA ZA MALISHO KATA YA ENGARUKA | 0747450722 | |
| | 29/7/2020 | LILIAN LOOLOITAI | COMMUNITY RESEARCH AND DEVELOPMENT SERVICES (CORDS) | 0784999823 | |

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|---|---|---|---|---|---|
| 1 | 24/7/20 | RUNDA - ZAKAYTU | KATIBU WA KITONGOJI | 0688651779 | |
| 2. | 24/7/20 | SANING'A - NGIPANI | MZEE WA BOMA | | S/N/ |
| 3 | 24/7/20 | NAKILA - LEMOTONKEI | KIJANA MDOGO | | N/L/ |
| 4 | 24/7/20 | NATISIPA NGAPONI | MAMA MKUBWA | | N/N/ |
| 5 | 24/7/20 | NGURUME MELITA | KIJANA MDOGO | | N/M/ |

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|---|---|---|---|---|---|
| | 24/07/2020 | PAULO EMANUEL MEIYAN | MWALIMU MKUU SHULE YA MSINGI ENGARUKA CHINI | S.L.P 59 MTO WA MBU 0758517930 | |
| | 24/7/2020 | KARONO-LANJAKIE-MLLE | CHM MW KITI SHULE ENSA | S.L.P. 59 M 0658145819 | |
| | 24/7/2020 | ELISHA LILANGA | MGANGA MFAWIDHI ZAHANATI YA ENGARUKA | 0753800742 P.O. BOX 12 MONDULI | |
| | 24/7/2020 | MATHAYO JONATHAN | MKUNGA ZAHANATI YA ENGARUKA | 0769-838584 | |
| | 24/7/20 | IRIMINA NTIKIANGA | MUHUDUMU ZAHANATI YA ENGARUKA | 0767 121812 | |

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|---|---|---|---|---|---|
| 1 | 27/7/2020 | LOMINA - KISITEI | MWENYEKITI-KIJIJI IBOMBO MAKAO | 0623934292 | |
| 2 | 27/7/2020 | JOSEPH MAILENYA | VEO IBOMBO MAKAO | 0620139873 | |
| 3 | -"- | SEREMON-LEPOSO | MJUMBE | 0625357400 | |
| 4 | -"- | NGOBITHU LENGONGO | MJUMBE | 0627044466 | |
| 5 | -"- | NGORONJOI-NENGONGO | MJUMBE | 0629103224 | |
| 6 | 27/7/2020 | LOBULO - MORINGE | MJUMBE | — | |
| 7 | -"- | SAIRUNI - MASINYA | MJUMBE | 0625472284 | |
| | -"- | LUCAS Kanitika | MJUMBE | 0624310571 | |

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|---|---|---|---|---|---|
| | | NENGONGU NONGOSI | MJUMBE DONYONABO | DONYONABO | Nu |
| | | MARIAS LEPOSO | MJUMBE DONYONABO | | |
| | | TIKOYAN TAIKO | MJUMBE DONYONABO | 0627529444 | Tiko |
| | | YALOYO MORINGE | MJUMBE DONYONABO | 0628405936 | Yapoto |
| | | MOSES MORINGE | MJUMBE DONYONABO | 0624836610 | |
| | | LENGAI KINGI | — MFERETI | MFERETI | |
| | | MANINAI NGAANI | MJUMBE DONYONABO | — | |
| | | IKONET LERUI | | | |

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|---|---|---|---|---|---|
| | 27/7/2020 | ZEPHANIA L. MBELEL | Mwenyekiti Donyonabo | 0629103357 DONYONABO | Mbelel |
| | 27/7/2020 | SITEYO TAIKO | MJUMBE DONYONABO | — | |
| | " | LEIYO MORINGE | MJUMBE DONYONABO | — | |
| | " | CHICHO KOPATO | MJUMBE DONYONABO | — | |
| | | NAPOKIE LATEUNGWA | MJUMBE DONYONABO | — | |

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|---|---|---|---|---|---|
| | 20.7.2020 | Dr. RAPHAEL MWAMBAIBI | ZONAL VETERINARY CENTRE (ZVC – ARUSHA) | 0713819394 | [signature] |
| | 20.7.2020 | Lilian Looloitai | COMMUNITY RESEARCH & DEVELOPMENT SERVICES (CORDS) ARUSHA | 0784 999823 cords2016@gmail.com | [signature] |
| | 29.7.2020 | ENG. TUAHA.B. KISAKA | PLANNING ENGINEER TANESCO ARUSHA | 0713066080 [illegible] | [signature] |
| | 29.07.20 | ENG JOHNNY DE KALUPALE | REGIONAL MANAGER TANROADS – ARUSHA | 0754295337 | [signature] |
| | 30.07.20 | ROSE S. SEMPINDU | I.H Inspector OSHA – NZ ARUSHA | 0754827158 | [signature] |

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|---|---|---|---|---|---|
| 1 | 23/07/2020 | NOVATUS MAGOMA | NGORONGORO CONSERVATION AREA AUTHORITY (NCAA) SENIOR ECOLOGIST | 0782761765 | [signature] |
| 2 | 23/07/2020 | LINUS GTIOTEM | NCAA CONSERVATION OFFICER | 0763156727 | [signature] |
| 3 | 23.7.2020 | Binson P. Mhagame | DEMO- NGORONGORO | 0767562580 | [signature] |

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| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1 | 01.07.2020 | PETER JUMA LEMHET | Ag. DED NGORONGORO | S.L.P 1 LOLIONDO 0755741738 | [signature] |
| 2 | 01.07.2020 | JULIUS KILUA NONDO | Ag. DESO | 0692478244 | [signature] |

APPENDIX 5: CONSULTATION MINUTES AT MFEREJI WARD

MHUTASARI WA KIKAO CHA PAMOJA NA WATAALAMU WA TOKA NBC NA WANANCHI WA KIJIJI CHA IDONYONAADO NA WATAALAMU WA MAZINGIRA

AGENDA NO 1 KUFUNGUA KIKAO

Mwenyekiti amefungua kikao mnamo wa saa 11:37 Asubuhi pamoja na kuwapongeza wananchi

AGENDA NO 2 UTAMBULISHO

Mwenyekiti amefanya utambulisho kwa wote watalaamu wa mazingira na wananchi kwa ujumla

AFISA MTENDAJI ... CHA IDONYO NAADO ... MONDULI

MAELEZO YA MJUMBE

Ameeleza kuwa wao kama wafugaji na wakulima walikuwa na wasiwasi kuwa wanajiuliza mifugo zao watakwenda wapi pamoja na mashamba yao kwani ziwa hilo ndilo tunalotumia kunywesha mifugo

OMBI

Ameeleza kuwa tunaomba serikali itusaidie kama watakapoanza kazi watujali kwenye kama vile miundo mbinu ya maendeleo kama vile barabara na shule majengo mbalimbali kwa vijana wetu wapate elimu na ujuzi mbalimbali

MAELEZO YA MTAALAMU WA MAZINGIRA

Mtaalamu ameleza kuwa tayari wameshauri serikali kupunguza eneo hilo libaki hekta 25. Na wameomba serikali wasiwazuie watu kama wafugaji waendelee kulisha mifugo zao ndani ya eneo hilo

Kwani Kiwanda hiyo haita chukua eneo kubwa na wasiweke uzio ili mifugo waendelee kupata maji na majani kwani yale maji yaopo pungua majani yanaendelea kuota

Anaendelea kufafanua kuwa Kiwanda kitatumia Eneo dogo na

Nawana Nchi wanaendelea kuomba Eneo hilo lipunguzwe tena kama kuna uwezekano kwani wananchi hawa wameendelea kuomba kama kiwanda kikianza Nijana wa eneo hilo watapata kazi

Pia wataalamu wameendelea kuwauliza wananchi kuna jeh Eneo hilo chukuliwa na mgodi kuna makaburi ama makaburi pamoja na maeneo ya kuabudia

Nawananchi wamesema kuwa hakuna maeneo ya kuabudia pale bali kuna eneo la kuchimba maji ndani ya muchanga



HASARA ZA MRADI

1 Kuchukuliwa kwa eneo ambayo wamezoea
2 Na kuchukuliwa kwa eneo la malisho ya mifugo
Na kunywea maji mifugo

Madhara mengine - Moshi utakaotoka ndani ya kiwanda
pamoja na taka itakayo zalishwa na kiwanda
kuepusha hayo maji ambao mifugo wetu wanatumia

MAJIBU YA WATAALAMU

wameeleza kuwa wao wana endelea kushauri Serikali watumie teknolojia ya kisasa ili kuepusha mtawanyiko wa moshi pamoja na ~~kwa~~ kudhibiti mtawanyiko wa takataka pamoja na mitetemeko itakayo sababishwa na kiwanda

pia wageni wakiwa wengi hasa wanawake wata endelea watakaa kwa muda na kwa kwa bambele Hatimae na kuondoka kwa

~~Hw~~ ONYO NA TAHADHARI

wataalamu ame endelea kuwakumbusha wana nchi wakae kwa tahadhari sana ili waepukane na magonjwa mengi sana ikiwepo UKIMWI na magonjwa mengine

pia wame ambiwa waendelee kujenga nyumba zao za kupangisha ili wapate faida pamoja na wageni watakaokuja watu wengi kusi jenge maeneo yenu kwani watakuja watu wengi wanao taka maeneo yenu

AGENDA NO: KUFUNGA KIKAO

Mwenyekiti alifunga kikao hicho wa saa 7:49 mchana pamoja na kuwashukuru wajumbe wote na kuwatakia kila la heri

MTHIBITISHO

MWENYEKITI
LOMINA KISITEY
SAINI _______

VEO
JOSEPH NAILENYA
SAIN

AFISA MTENDAJI
KIJIJI CHA IDONYO NAADO
S.L.P. 1 MONDULI

## APPENDIX 6: CONSULTATION MINUTE AT ENGARUKA WARD

HALMASHAURI YA WILAYA YA MONDULI.
MUHTASARI WA KIKAO MAALUMU CHA ENGARUKA CHINI NA TRDO, KIKAO KILIKETI TAREHE 22/01/2020.

AGENDA ZA KIKAO.

1. UTAMBULISHO + KUFUNGUA KIKAO.
2. FAIDA ZITOKANAZO NA KIWANDA PAMOJA NA ATHARI ZA MAZINGIRA.
3. KUFUNGA KIKAO.

AGENDA NO. 1: UTAMBULISHO + KUFUNGUA KIKAO.

Katibu/VEO alisimama na kusalimia kikao na kuwaeleza wajumbe/Wanaengaruka chini yakuwa Tunepata wageni kutoka shirika la Utafiti na Maendeleo ya Viwanda Tanzania (TIRDO). Katibu aliwaeleza wageni wa TIRDO yakuwa kikao hichi kimeudhuriwa na Wenyeviti wa Vitongoji, Wawakilishi wawili kwa kila kitongoji pamoja na wajumbe wa kamati ya mazingira ya Serikali ya kijiji. Mwisho Mnamo Saa 7:42 Mwenyekiti aliwakaribisha wageni wa shirika la TIRDO waweze kujitambulisha na baada ya utambulisho alifungua kikao rasmi.

AGENDA NO. 2: FAIDA ZITOKANAZO NA KIWANDA PAMOJA NA ATHARI ZA MAZINGIRA.

Wageni kutoka shirika la Utafiti na Maendeleo ya Viwanda Tanzania waliweza kukaribishwa ili kuendelea na agenda Ambapo waliweza kuwauliza wajumbe wa Engaruka Chini Je mnafahamu fursa au faida zitakazo tokana na kiwanda cha Magadi Soda kitakachojengwa Engaruka?

Wajumbe mbalimbali waliweza kunyoosha vidole ili kuchangia kujibu swali hilo, ambapo majibu tuliyoyapata katika swali hilo ni kama haya yafuatayo:-

- Wana Engaruka Chini wanategemea fursa za ajira baada ya ujio wa Kiwanda cha Magadi Engaruka.
- Wana Engaruka Chini wanategemea fursa biashara mbalimbali baada ya Ujio wa kiwanda.
- Wana Engaruka Chini wanategemea kupokea wadau mbalimbali wa maendeleo watao kuja kutokana na kiwanda hicho.
- Wana Engaruka Chini wanategemea Maendeleo ya Mji kutokana na kiwanda.
- Wana Engaruka Chini wanategemea baada ya ujio wa kiwanda miundombinu kama vile barabara, Maji na Umeme vitaboreshwa zaidi
- Pia wanategemea ongezeko kubwa la huduma za jamii kama vile Hospitali, Vituo vya Afya, Zahanati, Shule, Makanisa, Taasisi mbalimbali n.k.

Baada ya Wataalamu wa Shirika la Utafiti na Maendeleo ya Viwanda Tanzania kusikia fursa wanazozitegemea kutokana na kiwanda na pia je wanajiandaaje na fursa hizo.

Basi wataalamu waliweza pia kuwauliza Je mnafahamu athari ambazo zitakuja kutokana na Ujio wa kiwanda? Athari zilizoweza kutajwa na kujadiliwa ni hizi zifuatazo:

- <u>Magonjwa</u>:- Wajumbe waliweza kujadili yakuwa baada ya ujio wa kiwanda kutakuwa na magonjwa mbalimbali kutokana maingiliano pamoja na wingi wa watu watakao kuja kwenye shughuli mbalimbali hasa kwenye kiwanda. Mfano wa magonjwa ambayo yataongezeka ni magonjwa ya zinaa. Hivyo wataalamu pia waliweza kutoa ushauri kwa maana ya Watu wawe waaminifu kwenye ndoa zao au kutumia kinga kwenye mahusiano.

- Kupotea kwa Mila na desturi: Pia jamii ya Engaruka inategemea baada ya kuanza kwa kiwanda kutakuwa na watu kutoka maeneo ~~mbalimb~~ mbalimbali wakija kufanya kazi au kutafuta fursa mbalimbali hivyo mila na desturi ya Kimasai itapotea kutokana na Muingiliano huo wa watu wa mikoa mbalimbali.

- Mmomonyoko wa Maadili na kuvunjika kwa Ndoa: Wana Engaruka baada ya Ujio wa watu mbalimbali watategemea kila mtu anaye kuja kuwa ana tabia yake na hulka yake (tabia) hivyo lazima yale maadili ya eneo husika yatapungua kwa sehemu kubwa au kuisha kabisa. Pia kutokana na Muingiliano wa wageni mbalimbali ndoa nyingi zitakuwa zikivunjika. Japokuwa pia kuna wana Engaruka watapata fursa za kuolewa na wageni hao. Pia wageni hao wanaweza kujikuta wakitembea hata na wanafunzi wa shule au kuwapatia mimba.

- Uwindaji Haramu: Wana Engaruka Chini wakaweza kusema yakuwa eneo ambalo kiwanda kinaenda kuwekeza pia kuna baadhi ya wanyama wakubwa, wakati na wadogo. Ambao wanyama hao ni kama wafuatao fisi, pundamilia, mbweha, Twiga, pofu, swala na baadhi ya Ndege kama Kanga, Mbuni na wengine. Jamii ya sasa wameweza kuishi na wanyama hawa bila kuwawinda hii ni kutokana wa wanyama hawa kuwa sehemu ya pato la kijiji kutoka kwa wamiliki wa bloku hizo za wawindaji. Pia wamiliki wa bloku/vitalu hivyo wanakuwa wakitoa msaada wa kusomesha wanafunzi hapa kijijini, ambayo ndio inafanya kila mwana kijiji kuwa mlinzi wa wanyama hao.

USHAURI- Serikali itumie sheria za mazingira ili kuwalinda wanyama hawa ili wasipotee na pia dhidi ya ujangili baada ya ujio wa kiwanda.

- <u>Hewa chafu Angani</u> ÷ Wana Engaruka chini wanajua yakuwa baada kiwanda kuanza kitakuwa kinatoa moshi mchafu hewani Carbondioxide Wana Engaruka walitolea mfano Kiwanda cha Magadi cha Kenya yakuwa kinatoa moshi mwingi angani (Carbondioxide hewani) ambao moshi huo unatetea athari mbalimbali kama vile ukame mmomonyoko wa udongo. Kuangamia kwa jamii ya mimea, ongezeko la joto duniani.

<u>USHAURI</u> ÷ Wana Engaruka Chini wanamshauri muwekezaji wa kiwanda kutumia Teknolojia rafiki wa mazingira katika utekelezaji wa ujenzi wa kiwanda hicho ambayo haitaweza kuathiri mimea binadamu, mifugo pamoja na wanyama pori.

- <u>Upungufu wa Maji ya Mto Engaruka</u> ÷ Pia wana Engaruka Chini waliongelea yakuwa kutokana na Ujio wa Ujenzi wa kiwanda idadi ya matumizi ya maji itaongezeka hivyo wananaengaruka kutokana na shughuli za kilimo na ufugaji wanazofanya kwa sasa na kutumia maji ya Mto Engaruka kwa binadamu pamoja na mifugo yao hivyo wamewezа kutoa ushauri ufuatao.

<u>USHAURI</u> ÷ Wana Engaruka Chini wanashauri muwekezaji wa mradi wa kiwanda atafute vyanzo mbadala vya maji ili asihasiri jamii na kuepusha migogoro na kiwanda.

- <u>Upungufu wa Nyanda za Malisho</u> ÷ Hii pia ni mojawapo ya athari ambayo wana Engaruka chini waliweza kuitaja. Eneo ambalo kiwanda kinaenda kujengwa awali lilikuwa linatambulika kama eneo la nyanda za malisho na kunyweshea mifugo maji ya madini hayo mifugo. Hivyo baadhi ya maeneo ambayo hayo baada ya kuchukuliwa jamii itakuwa imepungukiwa na eneo la malisho, hivyo jamii wameweza kutoa ombi au ushauri kama ufuatayo kwa muwekezaji wa kiwanda ÷

USHAURI :- Wana Engaruka Chini wanashauri kwa muwekezaji wa kiwanda eneo ambalo litafunwa kiwanda wawajowefa majengo au litakalohuwa wazi warukusiwe kulishia mifugo yao.
:- Pia wana Engaruka Chini wanashauri kwa muwekezaji wa kiwanda kwenye eneo la kiwanda aweke barabara / pario ili kurukusu mifugo ipite iende kunywa maji ya zimo

MAPENDEKEZO YA WANANCHI :-

- Kwa kuwa kiwanda kinachukua eneo kubwa la uwekezaji Engaruka Chini wanaomba wapatiwe vipaumbele kwenye suala la ajira katika kiwanda hicho.
- Pia wanapendekeza Muwekezaji wa kiwanda ajenge Vituo vya Polisi kwa ajili ya suala zima la Ulinzi na Usalama wa raia na mali zake na hii pia ni kutokana na Engaruka mpaka sasa hakuna kituo cha Polisi
- Pia wana Engaruka wanamshauri na kuomba muwekezaji aweze kulipa fidia kwa wale watu ambao wa maeneo yao yamechukuliwa na kiwanda ili waweze kujiandaa na mapokezi ya kiwanda hicho.

AGENDA NO. 3 : KUFUNGA KIKAO.

Mnamo saa 11 : 30 jioni, Mwenyekiti aliweza kuwashukuru wageni wa shirika la utafiti wa maendeleo ya viwanda Tanzania kwa kikao na mafundisho yote ya mapokezi ya kiwanda na Mwisho aliwashukuru wajumbe wote walioudhuria na kuairisha kikao hicho.

Muhtasari huu umethibitishwa na :-

LEMBOSE LADANGATA
MWENYEKITI.

ROBINSON H. NDOTOI.
VEO / KATIBU.

AFISA MTENDAJI
KIJIJI CHA ENGARUKA CHINI

HALMASHAURI YA KH WILAYA YA MONDULI.
MAUDHURIO YA KIKAO CHA WANAENGARUKA CHINI NA WAGENI WA TIEPO, KIKAO CHA TAREHE 22/01/2020

| S/N | JINA KAMILI | CHEO | SAINI. |
|---|---|---|---|
| 1 | LEMBOSE LOBANGOTA | MWENYEKITI WA KIJIJI | [illegible] |
| 2 | SAMUSHI MGEAU | (MJUMBE) | [illegible] |
| 3 | ALAIS LEMAINA | " | ALAIS |
| 4 | KOHINGO HAMUKO | " | [illegible] |
| 5 | MANGARAI MULOYA | " | [illegible] |
| 6 | KUMERGI ESATO | " | [illegible] |
| 7 | ALAIS KOHOU | " | [illegible] |
| 8 | ISRAEL PALALTA | — | ALAIS |
| 9 | PIUS LENTAKE | MWIKITI KITONGOJI | [illegible] |
| 10 | MAAMA SANDETUA | MWIKITI KITONGOJI | [illegible] |
| 11 | KELE OLEMETENDEI | (MJUMBE) | M.S. [illegible] |
| 12 | SASTIAN MELAU | (MJUMBE) | [illegible] |
| 13 | MISIKO LEMUSHANAI | MJUMBE MJUMBE | [illegible] |
| 14 | PEIRO PURIOO | (LAIGWANANI) | [illegible] |
| 15 | TATA LEMTASO | MWENYEKITI KITONGOJI | [illegible] |
| 16 | NAHA PANAK | (MJUMBE) | N. [illegible] |
| 17 | SIMYATI ARBAWO | " | |
| 18 | SIRUA SITATI | " | |
| 19 | LOMBE-OLOMO | | |
| 20 | EMMANUEL OLEHOILENYA | MWIKITI KITONGOJI | |
| 21 | MEMBURS. LAIZA | (MJUMBE) | [illegible] |
| 22 | MACHUNGWA SEKINO | MJUMBE | [illegible] |
| 23 | ATMTAEI OLEAD [illegible] | " | [illegible] |
| 24 | OXISSIMO ALFAYO | VC JS | [illegible] |
| 25 | PASHETI SENGERWANI | MJUMBE | [illegible] |
| 26 | ROBINSON NATAI | DEO/KATIBU | [illegible] |
| 27 | YAMATI - MUSUYAN | MWIKITIONGOJI | [illegible] |

APPENDIX 7: CONSULTATION MINUTE AT SELELA WARD

MUHTASARI WA KIKAO CHA PAMOJA NA WADAU WA KIWANDA CHA MAGADI SODA KILICHOKETI SIKU YA TAREHE 23/01/2020 KATIKA SHULE YA MSINGI MBAASH.

AGENDA.

1. KUFUNGUA KIKAO
2. UTAMBULISHO
3. UFAFANUZI KUHUSU ADHARI ZA MAZINGIRA YATOKANAYO NA KIWANDA PAMOJA NA FAIDA ZA KIWANDA KATIKA ENEO LA MRADI.
4. MENGINEYO
5. KUFUNGA KIKAO

AFISA MTENDAJI KIJIJI CHA MBAASHI TAREHE

MUHT: 01/2020 KUFUNGUA KIKAO

Mwenyekiti wa kijiji cha mbaash alianza kwa kufungua kikao na kuwakaribisha wajumbe wote, Viongozi wa kata, Viongozi wa kijiji cha selela, pamoja na wageni [illegible] kutoka katika kiwanda cha magadi soda wenye eneo katika kijiji chetu.

MUHT: 02/2020 UTAMBULISHO.

Mwenyekiti wa kijiji alianza kwa kuwatambulisha wenyeji wa kijiji cha mbaash, na baada ya hapo alimkaribisha mtendaji wa kata ili aweze kuwatambulisha viongozi wa kata na baada ya hapo aliwakaribisha wageni ili kuweza kujitambulisha nao walijitambulisha kwa maja Si zao.

MUHT: 03/2020 UFAFANUZI KUHUSU ADHARI ZA MAZINGIRA YATOKANAYO NA KIWANDA PAMOJA NA FAIDA ZA KIWANDA:

Wataalam walianza kwa kuoma kuwa lengo kuu ni kujua adhari za mazingira zatokanazo na kiwanda pamoja na faida za kiwanda katika …

wajumbe wote walitwapokea walaalam hawa kwa kuona hilo na kuwasilisha hilo kwao.

Mtaalam wa mazingira alianza kwa kuuliza faida za kiwanda katika sehemu husika nao wajumbe walitaja faida hizo kama ifuatavyo:

⇒ Ajira kwa vijana pamoja na mama lishe:

⇒ Kuwepo kwa huduma za jamii kama, maji; umeme pamoja na barabara kuboreshwa.

⇒ Ongezeko la kipato kwa wananchi.

Mtaalam naye aliendelea kueleza faida za kiwanda pamoja madhara ya kiwanda katika eneo husika eneo la kiwanda kama ifuatavyo

⇒ Magonjwa kuongezeka kama magonjwa ya zinaa.

⇒ Kuvunjika kwa ndoa (wanandoa kupeana talaka)

⇒ Ongezeko la watu katika eneo husika.

Pia aliendelea kwa kutoa/~~njia~~ kueleza njia ya kuondokana na madhara yatokanayo na uwepo wa kiwanda katika eneo husika.

Baada ya hapo kiongozi wa msafara alimkaribisha — mtaalam wa mambo ya kale ili aweze kufafanua umuhimu ya kuwa na vitu/kumbukumbu ya mambo ya kale na kuwakaribisha wajumbe kama wanafahamu sehemu ilipo ~~vitu~~ vitu vya kale ili waweze kujua ni namna gani watafanya ~~namna~~ ili kuweza kuhamisha vitu, hivyo kwa ajili ya utalii kuendelea.

Mjumbe mmoja <Tata Lokino> alisema kuwa ipo njia ya wanyama wanaokatiza katikati ya eneo la mradi kutoka katika maeneo ya bonde/kiongozi kuelekea Bolati:

Mtaalam alisema kuwa Kikubwa ni kufahamu vitu vya mambo ya kale lakini zaidio la wanyama haiadhiri zana eneo la kiwanda

Mh: Diwani alisema kuwa katika kijiji cha lolela yupo mtu aliyegundua kuwepo kwa mianda iliyochongwa naye mtaalam akasema kuwa tunashukuru kwa taarifa hiyo na tutaifanyia kazi.

Mtaalam wa mambo ya kale alisema kuwa Kikubwa zaidi ni uwepo wa mradi usiharibu mambo ya kale ili uweze kuwa kumbukumbu hata kwa watoto na wajukuu wetu.

Wajumbe walisema kuwa vitu ambavyo vinaweza kuwa vikwazo ni Sehemu ya makaburi yaliyofanyiwa matambiko kimila pamoja na sehemu za kuabudia kimila.
Pia waliendelea kwa kusema kuwa yapo makaburi ambayo yaliingizwa kwenye sidia ya zingine kadi hayajaingizwa

Wataalam pamoja na wajumbe waliridhia kuyalelea hoja hiyo kwa wananchi kama yapo makaburi zaidi masharti yatambuliwe kikao kijacho litajwa la kupanga ili kuweka maamuzi



SUALA LA MAZINGIRA
Mtaalam aliomba kwa kuwakaribisha wajumbe wajaweze kueleza madhara ya mazingira yanayoweza kusababishwa na kiwanda
Mjumbe mmoja alisema kuwa tatizo kubwa litakuja kwenye eneo la malisho. Kwani eneo kubwa la malisho limechukuliwa na kiwanda.
Mtaalam alisema kuwa tutamshauri mtaalam mwekezaji asiweke fensi/uzio kwenye eneo lote la mradi ili kuweza kupata eneo la malisho uzio awoke eneo la kujenga kiwanda tu.

Pia wananchi wana wasiwasi na moshi utakaotoka na kiwanda kuwa itakuwa na madhara kwa afya zao, Afya za mifugo yao pamoja na athari za hali ya hewa kubadilika hivyo wanashauri wataalam kutumia muindombinu ya kisasa ili kuepukana na madhara yatokanayo na kiwanda.

Maendeleo ya wajumbe wote (wawakilishi wa wananchi) wamefurahia sana uwepo wa mradi lakini tunaomba tuwezo kupewa kuingiza mifugo yetu kutokana na kupoteza eneo kubwa la malisho. Lakini tunafahamu ni eneo la ~~mapy~~ kiwanda hatutaingilia kujenga mbali na kuchungia mifugo yetu

Wataalam walisema kuwa tutaenda kuwashauri wawekezaji suala hili ili wasiweze kupiga uzio sehemu yote ya mradi

Mjumbe mwingine aliuliza swali kuhusu faida ya kijiji unaotokana na mradi

Wananchi pamoja na viongozi wanapendekeza wazawa wa eneo husika wapewe kipaumbele katika ajira ndani ya kiwanda.

Wataalam waliwashauri wananchi pamoja na viongozi kuwashauri vijana wao wachangamkie fursa kwa kuomba kazi kulingana na ujuzi walionao.

AFISA MTENDAJI
KIJIJI CHA MRAASHI
TAREHE

Mh. Diwani alishukuru kwa elimu waliotoa na alikiri kuwa ni mradi huu ni mradi shirikishi kwani wananchi wamefurahi sana kwa maelezo yao. na aliuliza maswali yatokayo wapo wananchi ambao walikuwa hawapo wakati wa tathmini ya awali ya fidia. Je serikali ipo tayari sasa kuja kuja kufanya tathmini ya maeneo yao maana maeneo yao yaliyachukua kwenye eneo la kijiji

Kwa kuwa sasa wananchi wamekubali kuachia maeneo ya mradi je serikali sasa ipo tayari kuwatafutia wananchi hawa maeneo ya kuhamia?

fia uekelewekwaji wa kulipa fidia unasababisha wananchi kuendeleza maeneo yao je serikali sasa ipo tayari kuwaongezea wananchi huwa fidia.

→ Kijiji cha mbaashi kwenye fidia ina zaidi ya bilioni sita je ~~serikali~~ ~~sasa~~ kijiji chetu sasa italipwa kiasi gani.

MUHT. 04/2020 MENGINEYO:

Wajumbe wote walishukuru kwa jambo zuri ambalo waliletewa na wataalamu kuwa walimi wa mradi huo.

mjumbe mmoja alisema kuwa fidia imecheleweshwa sana ni mwaka wa tatu sasa hatujaona kinachoendelea mpaka wengine walifungua akaunti na wengine wameshafungiwa kwani hawajaendeleza.

MUHT: 05/2020 KUFUNGA KIKAO:

Mwenyekiti wa kijiji alifunga kikao saa 7:30 kwa kuwashukuru wajumbe pamoja na wageni wote waliofika katika kijiji chetu na kuwahakikishia ushirikiano mkubwa kwa suala la mradi huu wa magadi.

Muhtasari huu umeandaliwa na kusainiwa na

LAIYOLAI KINENA

MWENYEKITI WA KIJIJI

MWENYEKITI WA SERIKALI KIJIJI CHA MBAASHI AR/KIJ/636

EMANUEL-NJALANJ

MTENDAJI WA KIJIJI

AFISA MTENDAJI KIJIJI CHA MBAASHI TAREHE 23/01/2019

MAHUDHURIO YA KIKAO CHA PAMOJA NA WADAU WA KIWANDA CHA MAGADI KILICHOKETI TAREHE 23/01/202[illegible]

| | JINA KAMILI | CHEO | SAHIHI |
|---|---|---|---|
| 1. | CATHBERT MEENA | DIWANI KATA | |
| 2. | LEIYOLAI K. MOKO | M/KITI MBAASH | |
| 3. | LONGIDONG RUNDA | M/KITI SELELA | |
| 4. | AMINA SINGAILE | | |
| 5 | WILIAM MARTIN | WEO - SELELA | |
| 6 | MARIOUS LAZER | KIONGOZI MRADI | |
| 7 | Nadutari Leiyo Laizer | Muj. mkuu - Mbaash | |
| 8 | Noreki ngayok | Mjumbe K/mazingira | |
| 9 | Losingira Lengere | Mjumbe HLM | Mkina |
| 10 | Tha TA LEKINE | MWENYEKITI Wa Tonga / MJUMBE | |
| 4 | ~~LETENGES~~ | | |
| 11 | PATIMO - TENGES | | |
| 12 | Malulu - Taiko | MJUMBE | |
| 13 | MALULU KOROS | M/KITI wa kitongoji | Malulu |
| 14 | HEEMA DAUDI | MJUMBE KAMATI | |
| 15 | KAYEAI LEKIMARE | VEO - SELELA | |
| 16 | LEMOMO MASANGUS | Mjumbe | |
| 16 | LEMALI SAKUME | Mjumbe K/mazingira | |
| 17 | LETITA LOMAYANI | " | |
| 18 | MOONDOMON LETITA | mjumbe | Lemali |
| 19 | NGOIJO LAANDARE | " | |
| | MWENYEKITI WA KITONGOJI | mjumbe | |
| 20 | SITELU TALALAI | M/KITONGOJI | |
| 21 | NEMAYAN - NGOPUTO | | |
| 22 | WILLIAM .L. LAIZER | MJUMBE | |
| 23 | KIPARA KEKEKU | MJUMBE / MJUMBE | |
| 24 | EMMANUEL - NTALAM | VEO - MBAASH | |

AFISA MTENDAJI KIJIJI CHA MBAASHI TAREHE

APPENDIX 8: EVIDENCE POF SERVICES

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE

TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)

NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED DURING THE SUBMISSION OF SCOPING REPORT FOR SODA ASH PROJECT LOCATED AT ENGARUKA BASIN IN MONDULI DISTRICT, ARUSHA REGION

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| | 11/8/2020 | AFRICO SIMON [illegible] | WIZARA YA MALIASILI NA UTALII, IDARA YA WANYAMAPORI – AFISA [illegible] | [illegible] S.L.P 1351 DODOMA 0767274174 | [signature] |
| | 11/8/2020 | ENG. DORISIA MULASHANI | WIZARA YA MAJI MKURUGENZI WA UANDAAJI WA MIRADI NA URATIBU WA PROGRAMU YA SEKTA YA MAJI | 0784299707 | [signature] |
| | 11/8/2020 | Mzamilu KAITA | MNRT – WILDLIFE DIVISION | Govt CITY – MTUMBA P.O.BOX 1351 DODOMA | [signature] |
| | | | | | |

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE

TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)

NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED DURING THE SUBMISSION OF SCOPING REPORT FOR SODA ASH PROJECT LOCATED AT ENGARUKA BASIN IN MONDULI DISTRICT, ARUSHA REGION

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1 | 29/07/20 | MWAJUMA J RUBIBI | TANESCO – ARUSHA | 0658-600061 | [signature] |
| 2. | 29/07/2020 | ENG JOHNNY DE KALUBALE | TANROADS – ARUSHA | 0754295337 | [signature] |
| | | | | | |

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE

TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)

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| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| | 20/07/20 | Ross Stephen Sempindu | IN. HYGIENE INSPECTOR OSHA NORTHERN ZONE | 0754 327158 0713547790 | [signature] |
| | 20/7/2020 | Lilian Looloitai | COMMUNITY RESEARCH & DEVELOPMENT SERVICES (CORDS ARUSHA) | 0784 999823 | [signature] |
| | 20/7 | Edward Porokwa | PINGOS Forum EXECUTIVE DIRECTOR | 0754479815 | [signature] |
| | 20/07/2020 | Winnyida Fabian | TANZANIA NATIONAL PARKS | 0765637469 | [signature] |
| | 22.07.20 | SACF. SEMTANA, Y.Y | FIRE & RESCUE FORCE - ARUSHA | 0785-810057 | [signature] |

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE

TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)

NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED DURING THE SUBMISSION OF SCOPING REPORT FOR SODA ASH PROJECT LOCATED AT ENGARUKA BASIN IN MONDULI DISTRICT, ARUSHA REGION

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1 | 29/6/2020 | DANIEL LOIRUCK | AFISA KILIMO MKOA | TEL- 0767606059 BOX 3050-ARUSHA | [signature] |
| | -"- | STEPHEN A ULAYA | DED - MONDULI | BOX 4, MONDULI 0755-757910 | [signature] |
| | | ROSE J. MHINA | DCDO - MONDULI | BOX 1 MONDULI 0754 895486 | [signature] |
| | | FELLY C MPWAGE | WEO - ENGARUKA | BOX 59 MONDULI 0755409402 | [signature] |
| | | LINUS G. TIOTEM | CONSERVATION OFFICER | 0763256777 | [signature] |
| | | NOVATUS MAGOMA | SENIOR GEOLOGIST | 0782761765 | [signature] |

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE

TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)

**NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED DURING THE SUBMISSION OF SCOPING REPORT FOR SODA ASH PROJECT LOCATED AT ENGARUKA BASIN IN MONDULI DISTRICT, ARUSHA REGION**

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1. | 03/07/2020 | YUSUF H. SELENGE | KAIMU MKUU KITENGO CHA MAZINGIRA (EMU) WIZARA YA MIFUGO NA UVUVI (MIFUGO) | P.O. Box 2870 DODOMA 0754586095 | |
| 02 | 03/07/2020 | OWEN M. KIBONA | AFISA UVUVI MKUU WIZARA YA MIFUGO NA UVUVI IDARA YA UVUVI | P. O. Box 2870 DODOMA 0655 579325 | |
| 03 | 03/07/2020 | Prof. Shukrani Manya | Kaimu Mkurugenzi Tume ya Madini | P.O. Box 2292 Dodoma 0711 029113 | |
| 04 | 3/7/2020 | PS. Ministry of Industry & TRADE. Leo A. Lyayuka (for) | MINISTRY OF INDUSTRY & TRADE | P.O. Box 2889 DOM 0784 218155 | |
| 05 | 3/7/2020 | PS. Min. of Natural Resources & Tourism M. Marunga (Secretary) | Min. of Natural Resources & Tourism | 026-2321514 0754-230814 | |

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE

TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)

**NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED DURING THE SUBMISSION OF SCOPING REPORT FOR SODA ASH PROJECT LOCATED AT ENGARUKA BASIN IN MONDULI DISTRICT, ARUSHA REGION**

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1. | 8th July, 2020 | PETER JUMA LEHHET | Ag. DED NGORONGORO | S.L.P 1 LOLIONDO 0755741738 | |
| | | EMMANUEL - NITALAMI | WEO - SELELA VEO - MBAASH | 0716829168 0679972401 | |

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF INDUSTRY AND TRADE

TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)

**NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED DURING THE SUBMISSION OF SCOPING REPORT FOR SODA ASH PROJECT LOCATED AT ENGARUKA BASIN IN MONDULI DISTRICT, ARUSHA REGION**

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1 | 02/07/2020 | ERASMUS M. TARIMO | Ag: BWO | 0787277930 P.O.Box 1673 SINGIDA | |

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|---|---|---|---|---|---|
| 1. | 8/7/2020 | EDIFH JACOB | PAKIA | 0766187323 | [signature] |
| 2. | 16/7/2020 | HAMISI M. MAREBO | UNESCO – NATCOM | 0762377307 | [signature] |

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|---|---|---|---|---|---|
| 1. | 8/7/2020 | EDIFH JACOB. | PAKIA | 0766187323 | [signature] |

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| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| | 9/7/20 | SAADA S. MASANJA | WIZARA YA ARDHI | BOX 9132 DSM | |

APPENDIX 9: NAMES AND SIGNATURES OF STAKEHOLDERS CONSULTED DURING SCOPING STUDY

SHIRIKA LA UTAFITI NA MAENDELEO YA VIWANDA TANZANIA

Tanzania Industrial Research and Development Organization


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**NAMES AND SIGNATURES OF CONSULTED STAKEHOLDERS**

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 1. | 21/1/2020 | IDDI H. KIMANTA | DISTRICT COMMISSIONER | 0762 880580 | SmK |
| 2 | 24/1/2020 | Julius N. Azitula | REGIONAL NATURAL RESOURCE OFFICER | 0784 831144 | [illegible] |
| 3. | 24/1/2020 | HARGENEY R. CHITUKURO | ASSISTANT ADMINISTRATIVE SECRETARY-ECONOMIC & PRODUCTIVE SECTORS | 0767 263523 kchituk@yahoo.com | [illegible] |
| | | | | | |

| S/N. | DATES/ TAREHE | NAME/ JINA | TITTLE/ ORGANIZATION NYADHIFA/ TAASISI | ADDRESS/CONTACT ANUANI/MAWASILIANO | SIGNATURE/ SAHIHI |
|---|---|---|---|---|---|
| 01 | 21/01/2020 | ROSE MHINA | AG DED- MONDULI DC | 0754-895485 | [illegible] |
| 02 | -11- | ADIL MWANGA | AFISA ARDHI NA MALIASILI (W) | 0784-300444 | [illegible] |
| 3 | -11- | JOSEPH RUTABINGWA | Ag. DPLO - MONDULI | 0719 955 280 | [illegible] |
| | | | | | |

HALMASHAURI YA ~~KIJIJI~~ WILAYA YA MONDULI.

MAUDHURIO YA KIKAO CHA WANAENGARUKA CHINI NA WAGENI WA TIRDO, KIKAO CHA TAREHE 22/01/2020

| S/N | JINA KAMILI | CHEO | SAINI. |
|---|---|---|---|
| 1 | LEMBOSE LADANGOTA | MWENYEKITI WA KIJIJI | [signature] |
| 2 | SAMUSEL MELAU | (MJUMBE) | [signature] |
| 3 | ALAIS LEMAINA | " | ALAIS |
| 4 | KOHINGO HAMUKU | " | [signature] |
| 5 | MANGALAI MULOYA | " | [signature] |
| 6 | KUBERET ESATO | " | [signature] |
| 7 | ALAIS KOHARU | — | ALAIS |
| 8 | ISRAEL PALALTA | | |
| 9 | PIUS LENIAKE | MW/KITI KITONGOJI | [signature] |
| 10 | MUMMO SANDEIMA | MW/KITI KITONGOJI | [signature] |
| 11 | KELE OLEMETEMBE | (MJUMBE) | M.S. mollel |
| 12 | JASTINI MELAU | (MJUMBE) | K. L. ZARA |
| 13 | MISIKO LEMUSHARI | MJUMBE | [signature] |
| 14 | PEIRO PURIOO | MJUMBE | [signature] |
| | | (LAIGWANANI) | [signature] |
| 15 | TATA LENGASO | MWENYEKITI KITONGOJI | [signature] |
| 16 | NAHA PANAK | (MJUMBE) | N. [illegible] |
| 17 | SIMYOTI ARBAIOO | " | |
| 18 | SIRUET SITATI | " | |
| 19 | LANDE-OLOMO | " | |
| 20 | EMMANUEL-OLEMOILENYA | MW/KITI KITONGOJI | |
| 21 | MEMBURS LAIZA | (MJUMBE) | [signature] |
| 22 | MACHAUNGWA SEKINE | MJUMBE | [signature] |
| 23 | AMMANI OLENASEKU | " | [signature] |

AFISA MTENDAJI KIJIJI CHA ENGARUKA

HALMASHAURI YA WILAYA YA MONDULI.
MAHUDHURIO YA WAJUMBE VIJIJI VYA ENG. JUU, OLDONYO LENGAI, NA IRERENDENI KWENYE KIKAO MAALUM NA WAGENI KUTOKA TIRDO LEO 22/01/2020

| | JINA | NO YA SIMU | KIJIJI | SAHIHI |
|---|---|---|---|---|
| 1 | Mhe Onesmo L. Nakeyo | 0763731442 | Engaruka | [illegible] |
| 2 | MATHAYO OLE MUSIKO | 0768465320 | M/Kiti Kijiji | [illegible] |
| 3 | MATHAYO KAKUYU LAIZER | 0676459565 | Mw/Kitongoji | [illegible] |
| 4 | ELISHA MELAU LAIZAR | 0766038114 | Mw/Kitongoji | [illegible] |
| 5 | PIKIEI - OLEMASAI | 0767842132 | " " " | [illegible] |
| 6 | AMBENI KILEO | 0763091664 | IRERENDENI | [illegible] |
| 7 | LEMBURIS L. ABRAHAM | 0717232145 | IRERENDENI | [illegible] |
| 8 | OLEKILENA LOLTIW | 0652262393 | DONYOLENGAI | Hmollel |
| 9 | MALAIKA L LAIZA | 0746535823 | IRERENDENI | [illegible] |
| 10 | RAHABU SIMON | 0753343501 | ENG/JUU | [illegible] |
| 11 | REHEMA SANINGO | 0742138563 | EMG/JUU | [illegible] |
| 12 | KIJIHUPA OLOJU | 0686389444 | Oldonyo Lengai | [illegible] |
| 13 | LEA . MAKAA | 0712631110 | ENG/JUU | [illegible] |
| 14 | RASHID OMARI | 0784592056 | E/JUU | [illegible] |
| 15 | ATHANASIO BAYO | | ENG-JUU NO | [illegible] |
| 16 | LALAMAL PAAHI | 0677995324 | ENG [illegible] | [illegible] |

AFISA MTENDAJI
KIJIJI CHA ENGARUKA JUU

AFISA MTENDAJI
KIJIJI CHA IRERENDENI

AFISA [illegible]
KATA YA ENGARUKA
Nimethibitisha.

| | JINA | NAMBA YA SIMU | KIJIJI | SAHIHI |
|---|---|---|---|---|
| 1 | BASHIRI ALLY SANDY | 0745938003 | ENG/JUU | [signature] |
| 2 | AGNESS SIMON MOLLEL | | | |
| 3 | William ISMAEL Mollel | 0754740237 | EN-JUU | [signature] |
| 4 | YASSIN ALLY mollel | 0752117965 | ENG/JUU | [signature] |
| 5 | NEEMA LUCA MOLLEL | 0758041818 | ENG JUU | [signature] |
| | | | ENG/JUU | [signature] |
| 6 | THEODORA LEMBURIS | 0622454401 | ERERENDEN | [signature] |
| 7 | Maserian Muamedi | 067 | ERERENDEN | [signature] |
| 8 | NGOIYO SAREMU | 0746725116 | ERERIDEN | M.S |
| 9 | AMINA SIKERIGE | | | |
| 10 | DINNA ISMAIL | 0612162928 | IRERENDEN | [signature] |
| | | 0766046609 | ENGARUKA JUU | [signature] |
| 11 | ABRAHAM LOGOLIE | 0744966662 | MKTI SAS JUU | [signature] |
| 12 | SARAH ZAKARIA | 0746206789 | ODO-LEMBOIS | [signature] |
| 13 | ISRAEL O. MOLLEL | | | |
| 14 | SAINGURAN. LESAPUR | 0748961929 | Eng JUU | [signature] |
| 15 | KAIYE MEPUKORI | 065713704 | IRERENDEN | [signature] |
| 16 | RAHABU SIMON | 0679105276 | IRENDEN | K.M. |
| 17 | REHEMA SAMINGO | 0753343850 | ENG/JUU | [signature] |
| 18 | LEA MARAA | | ENG/JUU | [signature] |
| 19 | VICKY JANABAN | 0712631110 | ENG/JUU | [signature] |
| 26 | VIOLA SHADRACK | 0747072273 | ENG/JUU | [signature] |
| 27 | JOSEPHINE SHIRIMA | 0757593777 | OLDO-JOGAN | [signature] |
| 29 | Papekinyi Lobarukejin | 0754658409 | VEO-ENG/JUU | [signature] |
| 30 | Ngomma Masara | — | Oldlengai | [signature] |
| | | | Irerendem | [signature] |

AFISA MTENDAJI KIJIJI CHA IRERENDENI

AFISA MTENDAJI KATA YA ENGARUKA

Nimethibitisha

| | JINA | NO. YA SIMU | KIJIJI | SAHIHI |
|---|---|---|---|---|
| | LEMBURIS L. ABRAHAM | 0717282145 | IRERENDENI | |
| 2 | SOLOMON SIMON MOLLEL | 0763845088 | ENG: Juu | |
| 3. | L. KIMAISHA - LOLOHU | 0744989071 | ENGARUKA JUU | L. Lu[illegible] |
| 4 | JACKSON - NAIKUMOKI | 0711676857 | ENGARUKA JUU | |
| 5 | SAMSON LEMBOROKA | 0752963828 | ENGARUKA JUU | |
| 6 | ISRAEL J. OSUJAKI | 0756714657 | E/JUU | |
| 7. | PARMET - SAPURO | 0623493424 | [illegible] | |
| 8 | NDOROS LEKUMOK | 0678941611 | IRERENDENI | |
| 9 | LENKITEU - NGINASI | 0678053031 | IRERENDENI | NP |
| 10 | KALANGA NDIAPURU | - | IRERENDENI | |
| 11 | SPIRIANO SEREZI | 0656266[illegible] | IRERENDENI | S. S[illegible] |
| 12 | NDELAE ORMUNDERE | 0673153807 | IRERENDENI | |
| 13 | TAIKO - NDIAPURRU | 0713898[illegible] | IRERENDENI | T. ND |
| 14 | LENGIYA - KIONGI | 0711683742 | IRERENDENI | |
| 15 | FADHILI LUKATA | | AFO | Abdallah. |
| 16 | LENGAI LONYORIE | 0685826204 | MUS/KITOTO | |
| 17 | JOSEPH NAMUYO | 0745937[illegible] | IRERENDENI | |
| 18 | DANIEL PARTIMAT | 0745933430. | " | |
| 19 | NGOBELE LESAPURU | 0654489893 | " | |
| 20 | KIDEM NGULIYA | 0686629637 | " | |
| 21 | Paa Kidedia | - | Irerendeni | K. N. Kidedia |

AFISA MTENDAJI KIJIJI CHA IRERENDENI

AFISA MTENDAJI KATA YA ENGARUKA

| | JINA | | NO. YA SIMU | KIJIJI | SAHIHI |
|---|---|---|---|---|---|
| 1 | Simanga | Lobileli | 0656127266 | Oldonyolengai | |
| 2 | Paulo | Moikan | 0747790515 | Oldonyolengai | |
| 3 | Samwel | Sabore | 0715901296 | Oldonyolengai | |
| 4 | GRESI | | | | |
| 5 | Kushupa | DANIEL | — | Oldonyolengai | |
| 6 | Olekilena | Oloju | — | Oldonyolengai | |
| 7 | Shayo | Lothili | — | Oldonyolengai | |
| 8 | MORIJOY | Moolie | 0714510323 | Oldo | Anjaje |
| 9. | SHOKORE MOKOYO | NYIKIN | — | Oldonyolengai | |
| 10 | DANIEL LETINDOSI | | 0759338755 | Oldonyolengai | |
| 11. | BULI NGAKWA | | | | |
| 12. | KUSHUPA | - OLOIPOT | 0745278122 | Oldonyo | |
| 13 | PARMET | - OLOJU | 0686358440 | OLDONYOLENGAI | |
| 14 | SARAH | - SAPLIFO | 0623493426 | OLDONYOLENGAI | Omr |
| 15 | Elisha | ZAKARIA | 0746206759 | OLDONYO LENGAI | |
| 16 | Lalamal | Melau | 0766038111 | OLDONYOLENGAI | |
| 17 | Mayunga | Paa Dunga | 0714393372 | OLDONYOLENGAI | |
| 18 | FENNY | MPWAGE | | VEO Iverendeni | 22/ /2020 |
| 19 | ELIZABETH | LOMARGA | 0755409402 | | |
| 20 | BARAKA | PUACO | | WEO OLDONYO OLDOLENGAI | E. L Pendosa |

AFISA MTENDAJI KIJIJI CHA OLDONYOLENGAI

AFISA MTENDAJI KATA YA ENGARUKA

WEO

Nimethibitisha

AFISA MTENDAJI KIJIJI CHA IRERENDENI

MAHUDHURIO YA KIKAO CHA PAMOJA NA WADAU WA KIWANDA CHA MAGADI KILICHOKETI TAREHE 23/01/[illegible]

| | JINA KAMILI | CHEO | SAHIHI |
|---|---|---|---|
| 1. | CATHBERT MLEENA | DIWANI KATA | [signature] |
| 2. | LEIYOLAI K. MOKO | M/KITI MBAASH | [signature] |
| 3. | LONGIDONG' RUNDA | M/KITI SELELA | [signature] |
| 4. | AMINA SINGOILE | | [signature] |
| 5 | WILIAM MARTIN | WEO - SELELA | [signature] |
| 6 | MARIOUE LAIZER | KIONGOZI - MRADI | [signature] |
| 7 | Nadutari Leiyo Laizer | Muf. [illegible] - [illegible] | [signature] |
| 8 | Norekt ngayok | Mjumbe K/mazingira | [signature] |
| 9 | LOSINGAR. LENGIRE | Mjumbe HLM | [signature] |
| 10 | The TAF | MWENYEKITI WA KITONGOJI | [signature] |
| 11 | LETENGES LEBISINE | MJUMBE | OLKOLIKOL |
| 11 | PIATIMO - TIENGES | | |
| 12 | Malulu - TIENGES | MJUMBE | [signature] |
| 13 | MALULU Taiko | M/KITI wa Kitongoji | Malulu |
| 14 | HEETMA KOROS | | |
| 15 | KAYENI DAUDI | MJUMBE KAMATI | [signature] |
| 16 | LEMOMO LEKIMARE | VEO - SELELA | [signature] |
| 16 | LEMALI MABANERUS | MJUMBE | [signature] |
| 17 | LETITA SAKUME | MJUMBE K/MAZINGIRA | [signature] |
| 18 | MOONDORMON LOMAYANI | MJUMBE | Lemali |
| 19 | NGOIJS LETITA | " | [signature] |
| 2 | MWEKITI LAANDARE | MJUMBE | [signature] |
| 20 | SITELU WAKITOJI | | |
| 21 | HEMAYAN TALALA | M/KITONGOJI | [signature] |
| 22 | WILLIAM L. LAIZER MGOPURO | MJUMBE | [signature] |
| 23 | KIPARA KEKOKU | MJUMBE | [signature] |
| 24 | Emmanuel - Nitazani | MJUMBE / VEO - MBAASH | [signature] |

AFISA MTENDAJI KIJIJI CHA MBAASHI TAREHE

**APPENDIX 10: AIR QUALITY, NOISE AND VIBRATION BASELINE STUDY**

# REPORT
# ON
# AIR QUALITY, NOISE AND VIBRATION BASELINE SURVEY FOR ESTABLISHMENT OF SODA ASH PLANT AT ENGARUKA BASIN, MONDULI DISTICT IN ARUSHA REGION, TANZANIA

REPORT NO.

**Prepared by:**


*TANZANIA INDUSTRIAL RESEARCH AND DEVELOPMENT ORGANIZATION (TIRDO)*
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## 1.0 INTRODUCTION

This report provides the baseline data on air quality (particularly ambient gases), noise and vibration as sub-component of ESIA study for establishment of Engaruka Soda Ash project at Engaruka Basin, Monduli District in Arusha region, Tanzania. The study was conducted as sub-component of ESIA study to suffice the requisite of Environmental Management Act (EMA) of 2004 and EIA and EA regulations of 2004 and amendments of 2018. The purpose of the study was to establish the baseline status with respect to air quality around the proposed project area, surrounding villages and other centers of human activities for future monitoring purposes.

## 2.0 OBJECTIVES

### 2.1 Main Objective

To establish the baseline data on air quality, noise and vibration for the proposed project site (Soda Ash Project at Engaruka Basin) and the adjacent sensitive receptors.

### 2.2 Specific Objectives

The specific objectives of the air quality study were;

i. To assess the level of ambient gases ($NO_x$, SO2, CO, $H_2S$, $O_3$ and VOCs) at the proposed project site and adjacent receptors
ii. To assess the level of dust (particulate matter) at the proposed project site and adjacent receptors
iii. To assess the level of ground vibration at the proposed project site and adjacent receptors
iv. To assess noise levels at the proposed project site and to the adjacent receptors

## 3.0 METHODOLOGY

### 3.1 Sampling point's selection

A total of Seven (7) sampling points were selected within and outside of the proposed project area for measuring air quality parameters (i.e. dust (PM) and ambient pollutant gases, noise, vibration, Temperature and Relative Humidity. Some of the criteria used for selecting the sampling points include predominant wind direction (leeward and windward), project site, and availability of sensitive receptors. All environmental parameters were monitored during day and night time for each selected sampling point. The data were collected from 21$^{st}$ to 31$^{th}$ July, 2020.

Table 1: Coordinates for ambient air quality sampling points:

| Sampling point No. | Coordinates | |
|---|---|---|
| | **Latitude** | **Longitude** |
| **Air Quality Monitoring Stations (AQMS)** | | |
| **LOCATION 1** ( Near Melita Kutetei boma ) | -3.0410194 | 36.0689694 |
| **LOCATION 2** (Proposed Project area for Plant) | -3.0991 | 36.0889 |
| **LOCATION 3** (Near mama Kikama Boma) | -3.13486 | 36.05797 |
| **LOCATION 4** (Near Odokonyi Ngolonjoi Boma, Mbaashi village) | -3.2301 | 36.14516 |
| **LOCATION 5** (Near Lukas Boma, Idonyonaado village) | -3.12691 | 36.22392 |
| **LOCATION 6** (Near the lake Engaruka) | -3.0728722 | 36.15009722 |
| **LOCATION 7** ( Anglican Church ground, Irerendeni village) | -3.00055 | 36.04496 |

### 3.2 Data Collection

#### 3.2.2 Ambient Air Quality

Ambient pollutant gases (i.e. $NO_x$, $SO_2$, CO, $O_3$, VOC and $H_2S$) were measured using "Aeroqual series 500 monitor (S-500)", different sensor heads were used to measure different types of gases. The gases were monitored in accordance with manufacturer's procedure that meets ISO 9001:2008 protocol. The device was elevated at a height of 1.5 meters above the ground. Once the device is switched ON, it performs an automatic calibration for three minutes by pumping in fresh air into the sensors so as to set the toxic sensors to zero. Measurements were taken during the day and night and the mean value calculated to represent the value at each sampling station. The measured gas levels were then compared with TBS limits and World Health Organization (WHO) guidelines to check their compliance.

#### 3.2.1 Particulate Matter Emissions (in terms of $PM_{10}$ and $PM_{2.5}$)

Dust levels were measured by using Aeroqual series 500 monitor (S-500). Particulate matter ($PM_{10}$ and $PM_{2.5}$) were monitored in accordance with manufactured procedure that meets ISO 9835:1993 and ISO 9835:1993 Protocols for PM2.5 and PM10 respectively. During monitoring, the device was fixed at a breathing height of about 1.5 meters from the ground, which is assumed to be the breathing zone of people at their respective locality or working environment. Dust levels were monitored continuously for a maximum of twenty four (24) hours, and the average value was recorded at each sampling point. The recorded data were compared with National Environmental (TBS) and WHO/IFC guidelines to check for their compliance.

#### 3.2.3 Noise Levels

Noise levels were also monitored at seven selected points by using sound level meter type DT-8852, which was placed at 1.5 meters above the ground. Noise level monitoring was carried out in accordance to the international standards for sound level meter specifications IEC 61672:1999, IEC 61260:1995 and IEC 60651, as well as ISO 19961:2003 and ISO 3095:2001. During monitoring, the digital sound level meter was set to an A-weighting scale to enable the meter to respond in the same manner as the human ear. Noise levels were recorded for a minimum duration of eight (8) hours during day and night time at each sampling point and the recorded values were used to calculate the average value. The recorded averages were then compared to TBS Standards to check for the compliance.

### 3.2.4 Ground Vibration

Ground vibrations a term being used to describe mostly man-made vibrations of the ground (example human and animal movements on the ground, explosions, construction works, railways, industrial machinery and road transport etc.). Human comfort limits for ground vibration depends on various factors such as vibration levels, location and time of day. Some vibration sources give rise to audible effects such as structure-borne noise and secondary rattling of building elements or contents. During this study ground vibrations were monitored using vibrometer data logger, which is designed to measure ground vibrations according to European standard EN 14253:2003. The meter has an accuracy of ±5%, acceleration of 200 $m/s^2$, a wide frequency range of 10 Hz to 1 kHz for capturing almost all possible ground vibrations. At each sampling point, ground vibrations were recorded after every sixty (60) seconds for a maximum of twelve (12) hours, the mean value calculated and used to represent the vibration level at each particular sampling site.

## 4.0 Findings and Discussion

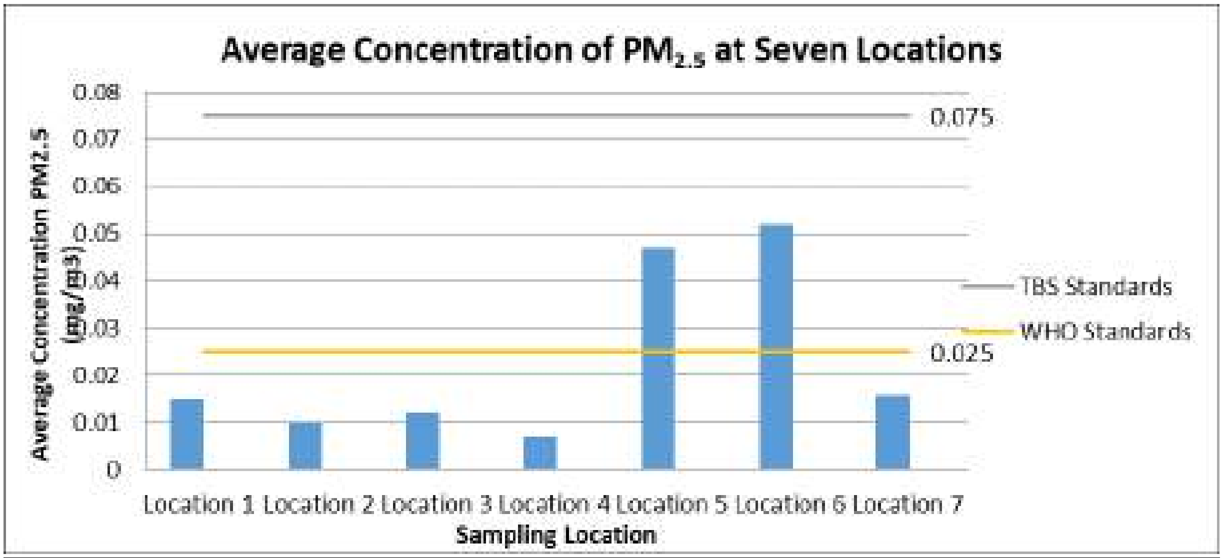
### 4.1. Particulate Matter Emissions (in terms of $PM_{10}$ and $PM_{2.5}$)

Levels of $PM_{10}$ and $PM_{2.5}$ in seven selected points are summarised in Table 2 and graphs 1 and 2. The daily average concentration ranged from 0.009 to 0.047 $mg/m^3$ for $PM_{2.5}$ and 0.009 to 0.083 $mg/m^3$ for $PM_{10}$. The recorded concentration levels of $PM_{2.5}$ and $PM_{10}$ at all monitored stations were within TBS limit of 0.075 and 0.1 $mg/m^3$ for $PM_{2.5}$ and $PM_{10}$ respectively. Compared to WHO standards, the concentration of location five ( ) and location six were above the limits for both $PM_{2.5}$ and $PM_{10}$.

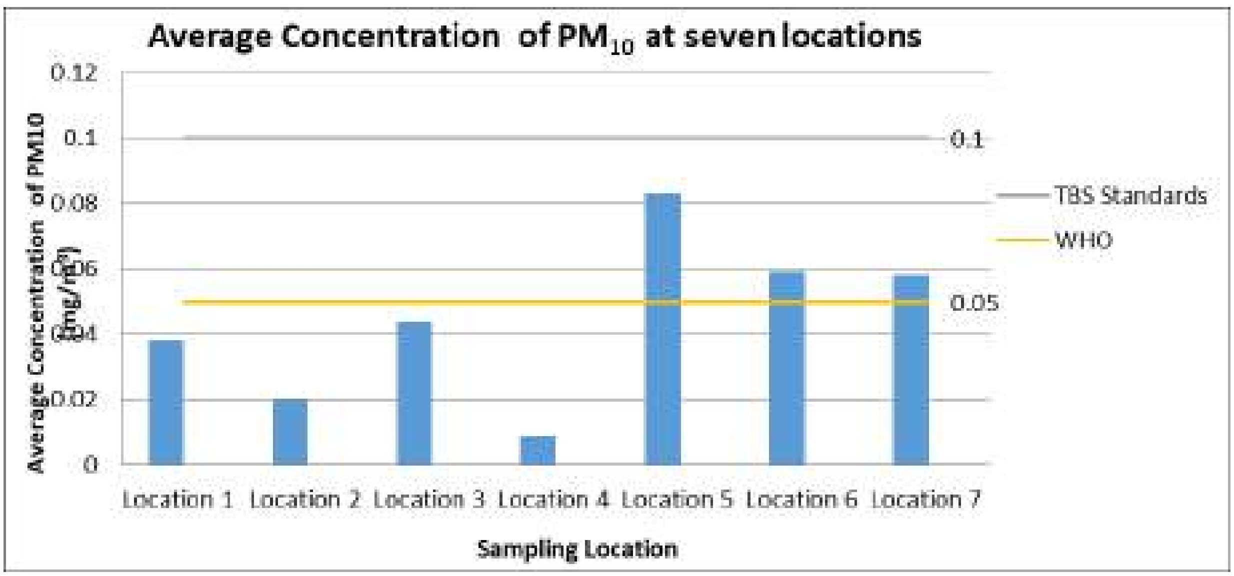
**Table 2: Average Results of Particulate Matter ($PM_{2.5}$ & $PM_{10}$)**

| S/N | Sampling Location | Daily Average Particulate Matter in $mg/m^3$ | |
|---|---|---|---|
| | | $PM_{2.5}$ | $PM_{10}$ |
| 1 | Location 1 | 0.015 | 0.038 |
| 2 | Location 2 | 0.01 | 0.02 |
| 3 | Location 3 | 0.012 | 0.044 |
| 4 | Location 4 | 0.007 | 0.009 |
| 5 | Location 5 | 0.047 | 0.083 |
| 6 | Location 6 | 0.052 | 0.059 |
| 7 | Location 7 | 0.016 | 0.058 |
| **TBS Limit [TZS845:2005]** | | **0.075** | **0.1** |
| **WHO Air Quality Guideline (2006)/IFC (2007)** | | **0.025** | **0.05** |

Sampling date: July, 2020




Graph 1: Average $PM_{2.5}$ values recorded from the sampled locations




Graph 2: Average $PM_{10}$ concentration recorded from seven sampling locations

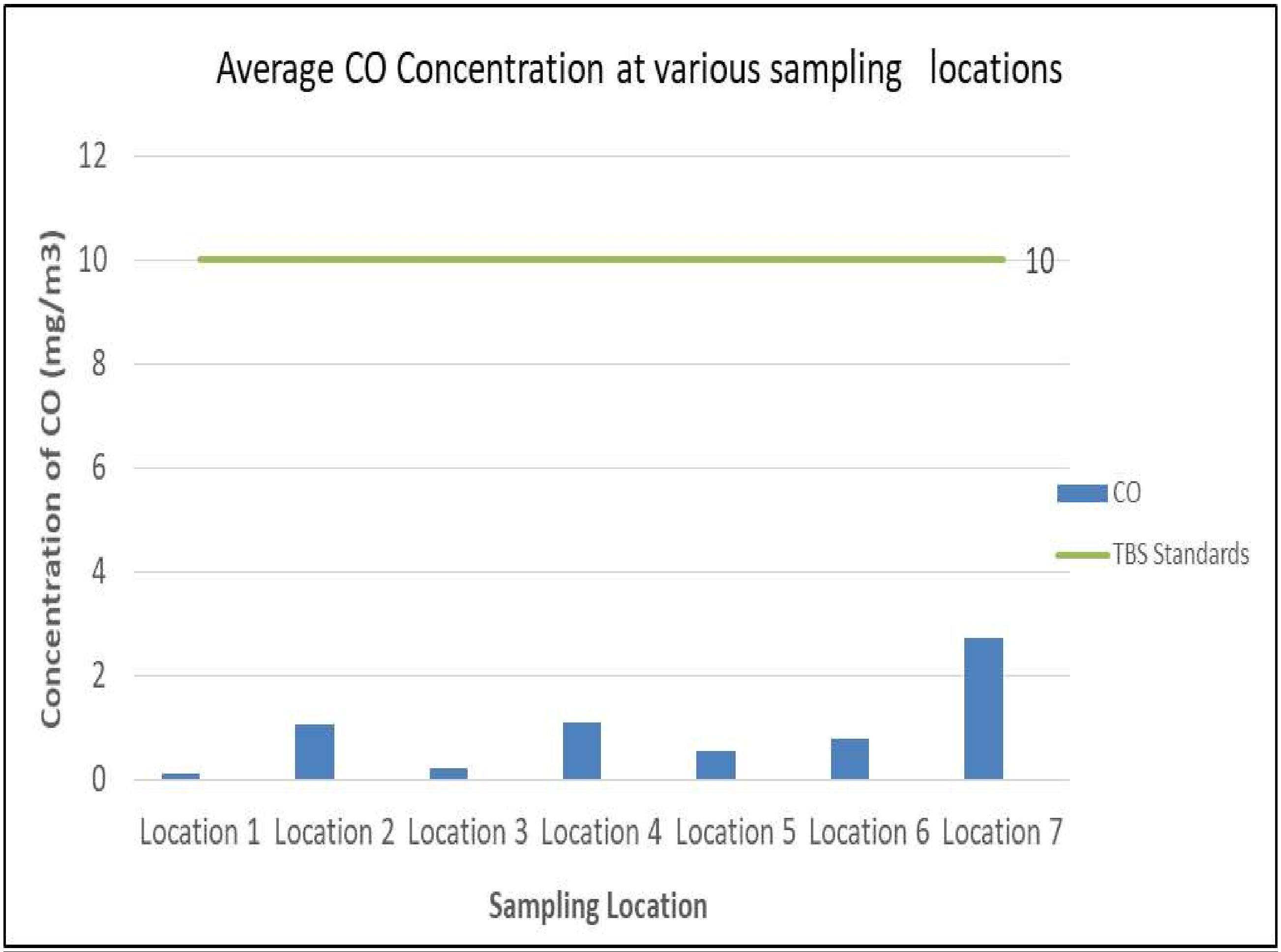
### 4.2 Ambient gases

Ambient gases were measured at the seven sampling locations as shown in table 3 below and graphs 3 - 8. The assessment covered the primary air pollutants (CO, $NO_X$, $SO_2$, $O_3$) as well as VOCs and $H_2S$. Results show that the ambient gaseous contents were within the acceptable TBS and WHO limits as presented in the table.

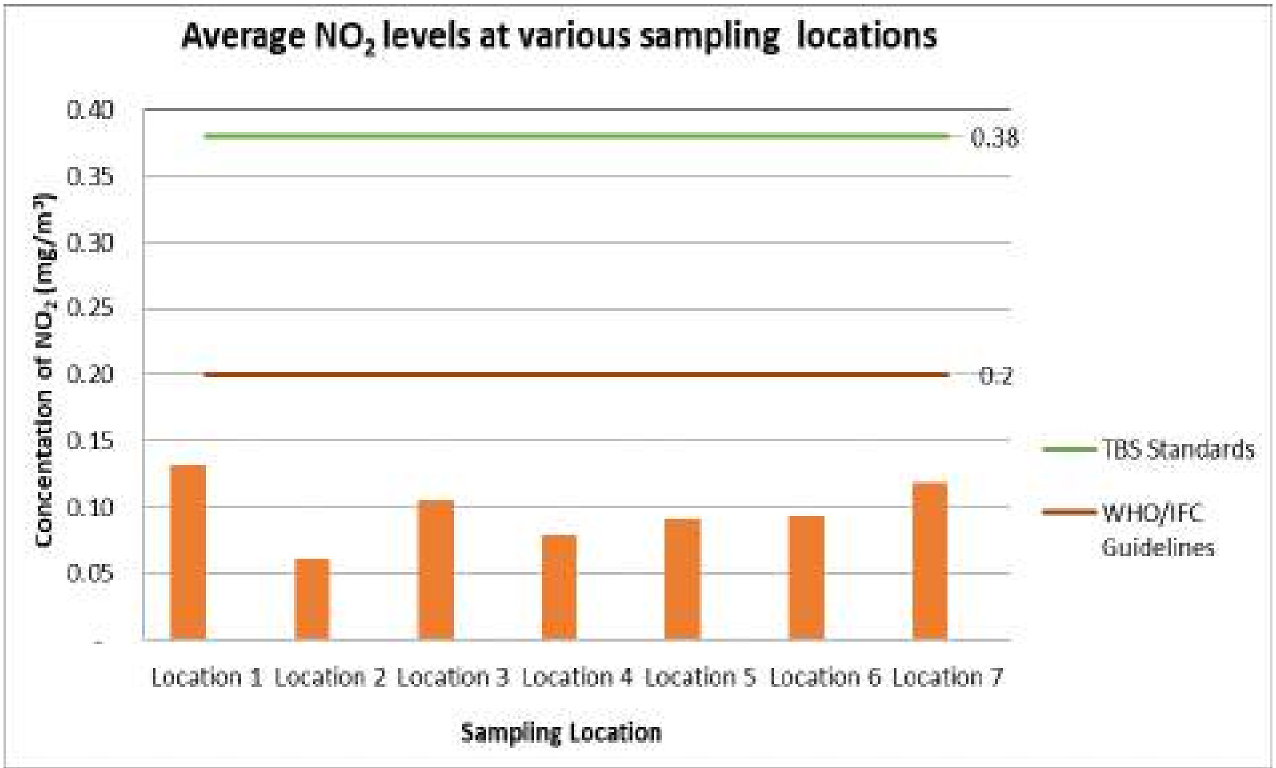
**Table 3: Average results of ambient Gases**

| Air Quality Sampling location | Concentration of ambient Gases | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $SO_2$ | CO | $NO_2$ | $O_3$ | VOC | $H_2S$ | RH% | Temp$^0$C |
| Location 1 | 0 | 0.106 | 0.132 | 0.077 | 0.03 | 0.03 | | |
| Location 2 | 0 | 1.043 | 0.061 | 0.065 | 0.083 | 0.025 | 47.49 | 28.04 |
| Location 3 | 0 | 0.202 | 0.106 | 0.056 | 0.085 | 0.013 | 43.5 | 29.78 |
| Location 4 | 0.005 | 1.088 | 0.08 | 0.102 | 0.078 | 0.073 | 40.11 | 31.32 |
| Location 5 | 0 | 0.542 | 0.091 | 0.059 | 0.093 | 0 | 40.21 | 31.25 |
| Location 6 | 0.003 | 0.773 | 0.094 | 0.040 | 0.093 | 0.048 | 42.35 | 29.12 |
| Location 7 | 0.001 | 2.722 | 0.118 | 0.086 | 0.055 | 0.028 | 36.54 | 30.27 |
| **TBS Limits** | **0.2** | **10** | **0.38** | **0.1** | 6 | | | |
| **WHO/IFC Guidelines** | **0.5** | | **0.2** | **0.1** | | | | |

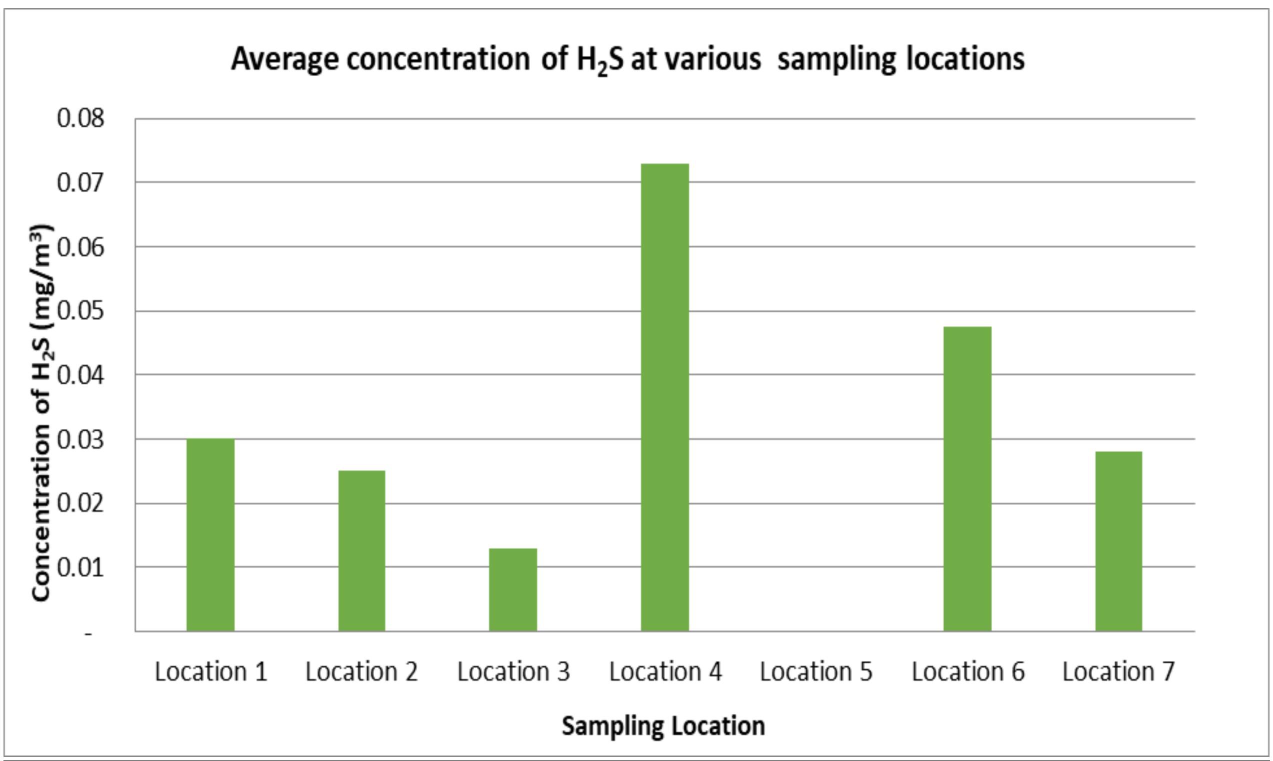
Sampling date: July, 2020



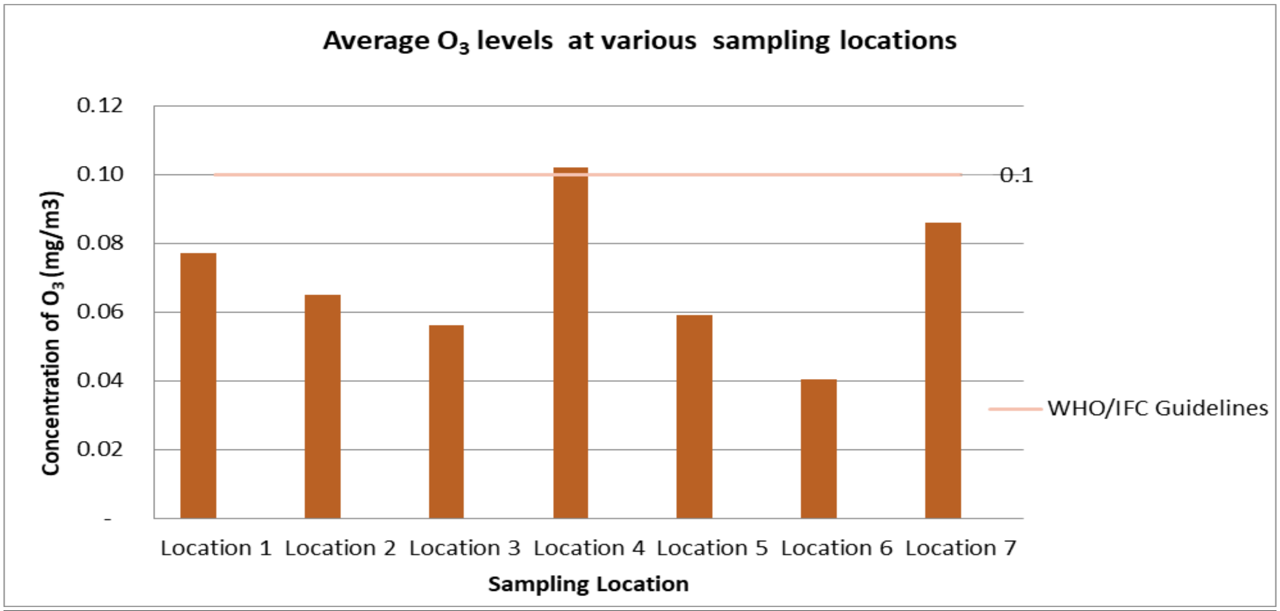

Graph 3: Average CO levels recorded at the seven locations



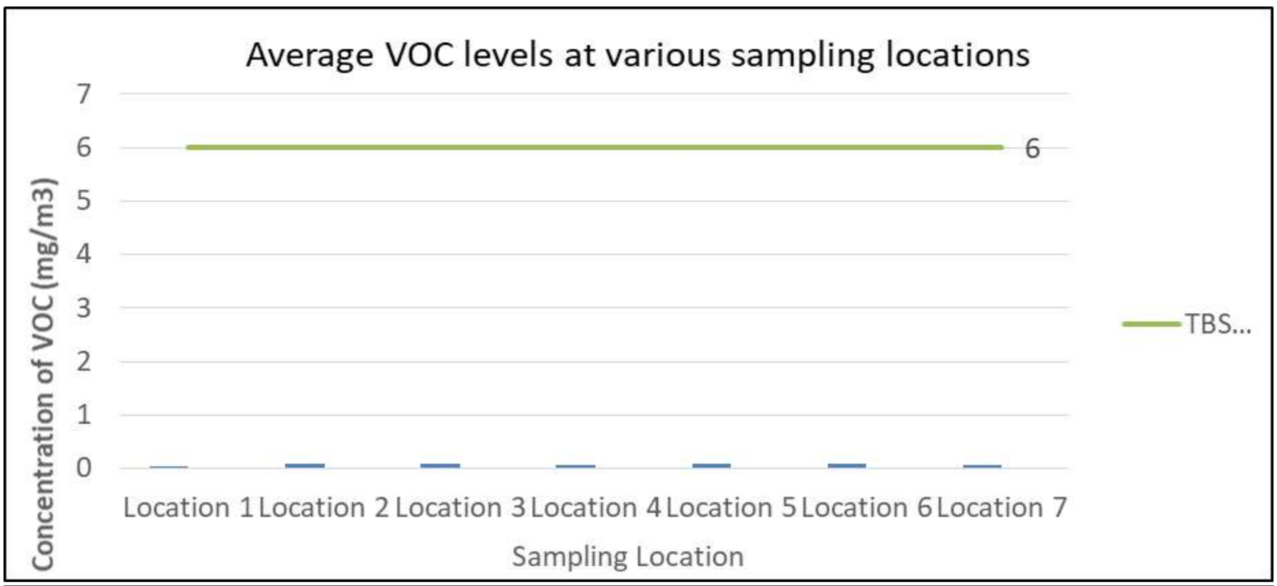

Graph 4: Average $NO_2$ levels at the seven sampling locations




Graph 5: Average $H_2S$ level at various sampling locations




Graph 6: Average $O_3$ levels (mg/m$^3$) from the seven sampling locations




Graph 7: Average VOC levels (mg/m$^3$) from the seven sampling locations

### 4.3 Noise levels

Noise levels were recorded at seven selected locations with a view to establish the baseline status with respect to noise levels existing around the proposed project area, surrounding villages/streets and other centers of human activities. The measurements were taken using sound level meter type DT-8852, which was placed at 1.5 meters above the ground. The noise levels at all measured stations were found to be slightly above the TBS standards for residential and Environment standards. This may be caused by wind blowing at high wind speed at the area (the lowest wind speed recorded was 2.4 m/s and the highest was 9.3 m/s). Other sources of noise are local people and livestock (for points taken near residence houses (Table 4).

Table 4: Average noise levels recorded at various locations within and near the project site

| S/N | Noise sampling Location | **Noise Levels** | **TBS limit for Residential areas** | **TBS limit for environment** |
|---|---|---|---|---|
| 1 | Location 1 (Near Maasai boma Residence) | 58.32 | 50 | 45 |
| 2 | Location 2 (Area proposed for project plant) | 62.4 | | |
| 3 | Location 3 (Near Maasai Boma Residence) | 61.95 | | |
| 4 | Location 4 (Near Maasai Boma Residence | 58.6 | | |
| 5 | Location 5 (Near Maasai Boma residence) | 57.92 | | |
| 6 | Location 6 (Near the lake Engaruka) | 62.75 | | |
| 7 | Location 7 (at the church ground) | 48.50 | | |

### 4.4 Ground Vibration Levels

Ground vibrations were monitored as part of ESIA study using vibrometer data logger, which is designed to measure ground vibrations according to European standard EN 14253:2003. The ground vibration as summarised in table 5 show that all the seven points selected received the ground vibration levels within TBS and British Standards**.**

Table 5: Summary of the ground vibration levels at different locations

| **Sampling Point No** | **Mean Vibration Levels, (mm/s)** | **TBS Standard (mm/s)** | **British Standard for ground vibration (mm/s)** |
|---|---|---|---|
| Location 1 | 0.01 | 5 | 0.3 |
| Location 2 | 0.01 | | |
| Location 3 | 0.02 | | |
| Location 4 | 0.00 | | |
| Location 5 | 0.01 | | |
| Location 6 | 0.02 | | |
| Location 7 | 0.01 | | |

## 5.0 Impact Assessment

### 5.1 Impact Assessment Rating of Potential Air Quality and Noise Impacts

Potential air quality and noise impacts were assessed using information gathered during the baseline assessment in combination with the detailed project plan and/or brief. This incorporated two aspects for assessing the potential significance i.e. occurrence and severity, which are further sub-divided as indicated. The significance of potential air quality and noise impacts were then ranked as high, moderate or low for both pre and post implementation of mitigation/management measures conditions (Tables 5.1, 5.2 and 5.3).

Table 5.1: Impact Classification for Impact Assessment

| Occurrence | | | Severity | | | | Environmental Consequence |
|---|---|---|---|---|---|---|---|
| Direction | Probability | Duration | Magnitude | Geographic Extent | Reversibility | Frequency | |

The impact assessment was done according to the following methodology based on sub-division of the two aspects of evaluating potential significance. This includes:

- Direction of an impact may be positive, neutral or negative with respect to the particular impact (e.g., a habitat gain for a key species would be classed as positive, whereas a habitat loss would be considered negative).
- Probability of occurrence is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40 % to 60 % chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur).
- Duration refers to the length of time over which an environmental impact may occur: i.e. transient (less than 1 year), short-term (0 to 5 years [construction]), medium term (5 to 15 years [operational]), long-term (greater than 15 years with impact ceasing after closure of the project) or permanent.
- Magnitude is a measure of the degree of change in a measurement or analysis and is classified as: negligible: no measurable effect (<1%) from current conditions; low :< 10% change from current conditions; moderate: 10 to 20% change from current conditions; and high:>20% change from current conditions. The categorization of the impact magnitude based on the set of criteria (e.g. health risk levels, impact concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analyzed.
- Scale/Geographic extent refers to the area that could be affected by the impact and is classified as site; local: effect restricted to the project footprint; regional: effect extends beyond local area or beyond regional: effect extends beyond the project site.
- Reversibility allows for the impact to be described as reversible or irreversible.
- Frequency may be low: occurs once; medium: occurs intermittently; or high: occurs continuously.
- Environmental Consequence: The overall residual consequence for each effect was classified as one of: negligible, low, moderate or high by evaluation of the rankings for magnitude, geographic extent and duration.

Table 5.2: Categories describing Environmental Consequence

| Category | Description |
|---|---|
| High | Of the highest order possible within the bounds of impacts that could occur. There is no possible mitigation that could offset the impact, or mitigation is difficult. |
| Moderate | Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. Mitigation is both feasible and fairly easily possible. |
| Low | Impact is of a low order and therefore likely to have little real effect. Mitigation is either easily achieved or little mitigation is required, or both. |
| No Impact | Zero Impact. |

Impact significance was also rated using the commonly known scoring system as shown in Table 5.3 below.

Table 5.3: Potential Air quality and Noise Scoring System Rates

| *Direction (Dir)* | *Probability (P)* | *Duration (D)* | *Magnitude (M)* | *Scale (S)* | *Reversibility (R)* | *Frequency (F)* | *Significance Point (SP)* |
|---|---|---|---|---|---|---|---|
| Negative (-ve) | 5: Definite/ don’t know (P>90%) | 5: Permanent (D=after closure) | 10: Very - high | 5: International | 3: High | 3: High | SP>75: High |
| Neutral (±ve) | 4: High probability (P=60-90%) | 4: Long- term D>15years | 8: High | 4: National | 2: Moderate | 2: Moderate | SP 30-75: Moderate |
| Positive (+ve) | 3: Medium probability (P=40-60%) | 3: Medium-term (D=5-15years) | 6: Moderate | 3: Regional | 1: Low | 1: Low | SP<30: Low |
| - | 2: Low probability (P=5-40%) | 2: Short- term (D=0-5years) | 4: Low | 2: Local | 0: Irreversible | - | - |
| - | 1: Improbable (P<5%) | 1: Transient (D<1year) | 2: Minor | 1: Site | - | - | - |
| - | 0: None (P=0%) | - | 1: None | - | - | - | - |

## 4.2 Identified Potential Impacts, Description and Assessment or Evaluation

This part assessed the relevant potential environmental impacts to ambient air quality, noise levels and vibrations that might resulted from the construction and operation phases of the proposed project. Decommissioning phase is unanticipated as the buildings are to be maintained and rehabilitated to exist into the future and no demolition is planned. The description and evaluation based on identified potential impacts through fieldwork, together with the measured air quality data, noise levels and vibrations as well as experience drawn from similar projects. The more complex issues are tabled and then discussed in detail while mitigation measures are also explained and/or listed.

### *4.2.1 Potential Construction Phase Impacts*

The potential impacts associated with the construction of proposed project include the deterioration of air quality through release of dust, fumes, noise and vibrations. Increased air pollution, noise and vibrations are expected during vegetation clearance, excavation, stockpiling of soil and rock materials as well as transportation and emplacement of soil and rocks. Table 5.4 below summarizes the potential impacts that are related to the construction phase of the proposed project while providing significance ratings for each impact prior to and after mitigation measures being implemented.

Table 5.4: Air quality, Noise and Vibrations Impact Assessment during the Construction phase

| Potential Air Quality, Noise and Vibrations Impacts | EVIRONMENTAL SIGNIFICANCE DURING CONSTRUCTION PHASE OF THE PROPOSE PROJECT | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Prior Mitigation | | | | | | | | | After Mitigation | | | | | | | | |
| | Occurrence | | | Severity | | | | | | Occurrence | | | Severity | | | | | |
| | *Dir* | *P* | *D* | *M* | *S* | *R* | *F* | *Total* | *SP* | *Dir* | *P* | *D* | *M* | *S* | *R* | *F* | *Total* | *SP* |
| *A: Dust (TSP, PM10 and PM2.5)* | | | | | | | | | | | | | | | | | | |
| 1. Dust generation as a result of site and/or vegetation clearing at the proposed project site. | (-ve) | 4 | 2 | 6 | 2 | 1 | 2 | 40 | M | (-ve) | 3 | 2 | 4 | 2 | 2 | 2 | 24 | L |
| 2.Dust generated as a result of vehicular movement on bare surface of unpaved roads | (-ve) | 4 | 2 | 4 | 2 | 3 | 2 | 32 | M | (-ve) | 2 | 2 | 4 | 2 | 3 | 2 | 16 | L |
| 3. Dust from wind impact on exposed stockpiles and/or bare top soil | (-ve) | 4 | 2 | 4 | 2 | 3 | 2 | 32 | M | (-ve) | 2 | 2 | 2 | 2 | 3 | 2 | 12 | L |
| 4. Dust resulting from site levelling and compaction of soil (floor preparation for building erection) | (-ve) | 4 | 2 | 4 | 2 | 2 | 2 | 32 | M | (-ve) | 2 | 2 | 2 | 2 | 2 | 2 | 12 | L |
| 5. Dust generated from hauling roads traffic during building materials and equipments transportation for construction | (-ve) | 6 | 2 | 6 | 2 | 2 | 2 | 60 | M | (-ve) | 4 | 2 | 4 | 2 | 2 | 2 | 32 | M |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | |
| *B: Pollutant gas emissions* | | | | | | | | | | | | | | | | | | |
| 1. Atmospheric emissions from engines of equipments and machinery used for construction activities | (-ve) | 4 | 2 | 4 | 3 | 3 | 2 | 36 | M | (-ve) | 3 | 2 | 4 | 2 | 3 | 2 | 24 | L |
| | | | | | | | | | | | | | | | | | | |
| *C: Noise Impact* | | | | | | | | | | | | | | | | | | |
| 1. Potential impact of noise generation due to traffic created during the delivery of construction materials. | (-ve) | 6 | 2 | 4 | 2 | 3 | 2 | 48 | M | (-ve) | 3 | 2 | 4 | 2 | 3 | 2 | 24 | L |
| 2. Noise generation due to the use of earth moving equipments and machinery for project construction works | (-ve) | 6 | 2 | 6 | 2 | 3 | 2 | 60 | M | (-ve) | 4 | 2 | 4 | 2 | 3 | 2 | 32 | M |
| | | | | | | | | | | | | | | | | | | |
| *D: Vibrations Impacts* | | | | | | | | | | | | | | | | | | |
| 1. Potential impact of vibrations associated with the use of heavy equipments, machinery and vehicles during site clearing and soil compaction and the delivery of construction materials. | (-ve) | 4 | 2 | 6 | 2 | 3 | 2 | 40 | M | (-ve) | 4 | 2 | 4 | 1 | 3 | 2 | 21 | L |

***Description and Evaluation of Possible Environmental Impacts on Dust Levels***

As summarized in Table 5.4 above, the generated dust during the construction phase can contribute to air pollution directly and indirectly as synergists or carriers of other pollutants. Dust can be generated at the project site as a result of vegetation clearance and soil excavations, vehicular movements, wind impact on exposed stockpiles and bare or eroded soil, hauling roads traffic on unpaved roads. Due to the proximity distance to nearby local communities and nearby unpaved roads, dust can affect the residential houses and crops of farmers within Engaruka basin. Generated dust might also land on vegetation and/or plants leaves and hinder their regular growth due to blockage of stomata or blocking light penetration for photosynthesis process. In addition dust or suspended solid particles can contaminate the nearby water bodies causing turbidity which can affect the aquatic creatures and limit its use for domestic and other purposes. The assessment results for impacts associated with dust generation are as follows:

- Dust generated as a result of site and vegetation clearance; vehicular movements on unpaved roads during the construction of the proposed project are considered to be of high probability (between 60 to 90%) and moderate magnitude (6). According to significance point scored, their impacts before mitigation are moderate (40) while 24 are significance points scored after mitigation. However, this is due to the fact that both probability and magnitude are expected to be reduced to medium (between 40 to 60%) and low (4) respectively after mitigation;
- Dust generated as a result of vehicular movement on bare surface of unpaved roads is considered to be of low magnitude (4) and medium (between 40 to 60%) probability with moderate significance point of 32. After mitigation measures, the significance point of 32 is reduced to low (16);
- Dust increased from wind impact on exposed stockpiles and hauling roads traffic are considered to be of high probability (between 60 to 90%) and low magnitude (4). However, their significance points for impacts before mitigation are moderate (32) but reduced to 12 after mitigation as probability and magnitude will be reduced to low (between 40 to 60%) and minor (2) during mitigation;
- Dust resulting from site levelling and compaction of soil (floor preparation for building erection) scored medium significance point of 32. This was attributed by a low magnitude (4) and high probability (between 60 to 90%). However, the significance point is reduced to low (12) after mitigation;
- Duration of all identified construction phase impacts is considered to be short term (between 0 to 5 years) as they will be restricted to the construction period;
- The scale (geographic extent) of all named impacts for dust during construction phase are expected to be localized;

All impacts are considered to have high reversibility as they will cease once the affecting activities ceased. Based on construction phase assessment, the overall significance of all dust impacts are considered to be low after implementing mitigation measures.

***Description and Evaluation of Possible Environmental Impacts on Pollutant Gases***

Likewise, there will be atmospheric emissions (i.e., CO, $NO_X$, $SO_2$, $H_2S$ and VOC and particulate matter to the atmosphere) from the use of construction equipments and vehicles which contribute to air pollution, greenhouse gas production and global warming. The assessment results for impacts associated with pollutant gases generation are as follows:

Increased atmospheric pollutant gases from vehicles and construction equipment were considered to be of low magnitude (4) as the measured ambient pollutant gases concentrations were well below both TBS limits and WHO/IFC Air Quality Guidelines. However, their significance points for impacts before mitigation are moderate (32) but reduced to low (24) after mitigation as probability reduced from high (between 60 to 90%) to medium (between 40 to 60%) during mitigation.

Nevertheless, these emissions will be minimal because they will not occur in low frequencies, for short periods of time within local area and will not expected to exceed local and/or international ambient air quality standards/guidelines. As there is no heavy car traffic in the area, the air quality (in terms of pollutant gases) in the area and its surroundings will continue be good.

***Description and Evaluation of Possible Environmental Impacts on Noise Levels***

Impacts associated with noises are expected to arise during the construction phase for the proposed project due to the presence of site workers, traffic created during the delivery of construction materials and the utilisation of heavy earth moving equipment for construction works. Elevated noise might be experienced in the immediate vicinity of the proposed site especially during working hours or during construction activities and localized. However, any produced noise as a result of the proposed project construction activities is expected to be intermittent and of relatively short-term duration and will be limited to those periods during which construction activities are occurring. The reversibility of all noise impacts is considered to be high as the impacts will be ceased as soon as the activity ceases. The frequency of noise impacts is also considered to be moderate as it is expected that the intensity of the activity in the project area will vary and that it will be slightly higher than that measured during the field work as baseline data. The overall significance point of noise impacts before and after mitigation measures is considered to be medium and low respectively during construction phase. However, noise generated by vehicles, equipment and workers at the site will cause disturbance to the wildlife, especially birds, but this will not create a problem to local communities as villages are located away from the construction site.

### *4.2.2 Potential Operation Phase Impacts*

Environmental impacts associated with the operation phase include dust generation from dry exposed bare soil, power generator, movement of vehicles within internal unpaved access roads that surrounding the project during importation of goods, inspections and monitoring as well as onsite and offsite unpaved roads and hauling roads traffic during goods and services transportation. Fumes, noise and pollutant atmospheric emissions will be associated with vehicle movements during inspections and transferring of goods. Table 5.5 below summarizes the potential impacts that are related to the operation phase of the proposed project while providing significance ratings for each impact prior to and after mitigation measures being implemented.

Table 5.5: Air quality and Noise Impact Assessment during Operation phase

| Potential Air Quality and Noise Impacts | EVIRONMENTAL SIGNIFICANCE DURING OPERATION PHASE FOR PROPOSED PROJECT | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Prior Mitigation | | | | | | | | | After Mitigation | | | | | | | | |
| | Occurrence | | | Severity | | | | | | Occurrence | | | Severity | | | | | |
| | *Dir* | *P* | *D* | *M* | *S* | *R* | *F* | *Total* | *SP* | *Dir* | *P* | *D* | *M* | *S* | *R* | *F* | *Total* | *SP* |
| *A: Dust (TSP and PM10)* | | | | | | | | | | | | | | | | | | |
| 1. Dust generation as a result of wind impact on dry exposed bare soil | (-ve) | 3 | 4 | 4 | 2 | 2 | 2 | 30 | M | (-ve) | 3 | 3 | 2 | 2 | 3 | 3 | 21 | L |
| 2.Dust generated as a result of vehicular movement within onsite and offsite unpaved roads during inspections and transfer of goods and services | (-ve) | 4 | 3 | 8 | 2 | 3 | 2 | 52 | M | (-ve) | 3 | 3 | 6 | 2 | 3 | 2 | 33 | M |
| | | | | | | | | | | | | | | | | | | |
| *B: Pollutant gas emissions* | | | | | | | | | | | | | | | | | | |
| 1. Emissions of pollutant gases and fumes from vehicle exhausts and machinery used for inspections and transfer of goods and services | (-ve) | 4 | 3 | 6 | 2 | 3 | 2 | 44 | M | (-ve) | 3 | 3 | 4 | 2 | 3 | 2 | 27 | L |
| | | | | | | | | | | | | | | | | | | |
| *C: Noise Impact* | | | | | | | | | | | | | | | | | | |
| 1. Potential impact of noise generation due to vehicles, power generator and workers | (-ve) | 4 | 3 | 6 | 2 | 3 | 2 | 44 | M | (-ve) | 3 | 2 | 4 | 2 | 3 | 2 | 24 | L |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| during inspections, handling, loading and unloading of goods and services. | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| *C: Vibrations Impact* | | | | | | | | | | | | | | | | | | |
| 1.Potential impact of vibrations from the use of heavy vehicles and loading and unloading equipments and machinery | (-ve) | 4 | 4 | 8 | 2 | 3 | 2 | 56 | M | (-ve) | 4 | 4 | 4 | 2 | 3 | 3 | 40 | M |

***Description and Evaluation of Possible Environmental Impacts on Dust Levels***

Generally, the generation of dust, fumes, vibrations and exhaust gases emitted from moving vehicles, and the use of heavy equipments will remain as the main source of continuous emission of air pollutants to be mitigated while the project facility is in use. Nearby water bodies will be contaminated and/or polluted by depositional dust from unpaved roads, bare soil and rocks disturbed during excavation. Deposited dust on vegetation will limit the function of chlorophyll during photosynthesis. Moreover, dust that landed on vegetation and/or nearby objects will have visual effect to fauna and local communities/workers. The assessment results for impacts associated with dust generation are as follows:

- Dust generation as a result of wind impact on dry exposed bare soil is considered to be of medium probability (between 40 to 60%) and low magnitude (4) before mitigation. Moderate significance point of 30 scored for each impact before mitigation which reduced to 21 significance point after mitigation. However, this significance deviation attributed by reduced magnitude minor (2) after mitigation;
- Dust generated as a result of vehicular movement within onsite and offsite unpaved roads during inspections and transfer of goods and services are considered to be of high probability (between 60 to 90%) and high magnitude (8) before mitigation. Moderate significance point of 52 scored for impact before mitigation which reduced to low significance point of 33 after mitigation. However, this significance deviation attributed by reduced probability to medium (between 40 to 60%) and moderate magnitude (6) after mitigation;
- All identified operation phase impacts are considered to be of medium term to long term (>15 years) in duration as the proposed project has no closure plan;
- The scale (geographic extent) of all named impacts for dust during operation phase is expected to be localized and;
- All impacts are considered to have high reversibility as they will cease once the affecting activities ceased.

Based on operation phase assessment, the overall significance of all dust impacts is considered to be low after implementing mitigation measures.

***Description and Evaluation of Possible Environmental Impacts on Pollutant Gases***

Emissions of pollutant gases and fumes from vehicle exhaust and machines used during inspections, maintenance, loading and unloading and goods transfers will contribute to air pollution, greenhouse gas production and global warming. The assessment results for impacts associated with pollutant gases emissions are as follows:

Emissions of ambient pollutant gases and fumes from vehicle exhausts and machinery used for inspections and transfer of goods and services are considered to be of moderate magnitude but high probability (between 60 to 90%). Significance points for impacts before mitigation is moderate (44) but reduced to low (27) after mitigation as both probability and magnitude reduced to medium (between 40 to 60%) and low (4) after mitigation.

These emissions will be minimal as expected to occur in moderate to high frequencies, for long periods of time and localized.

Based on the recorded baseline data for ambient pollutant gases that compared with the sited limits it is imperative to conclude that, the atmospheric air is not much degraded and can withstand an increase of ambient gases emission levels associated with new project.

***Description and Evaluation of Possible Environmental Impacts on Noise Levels***
During operation phase, vehicles movements, power generator, loading and unloading of goods, repair and maintenances and site workers will be the main sources of noise at proposed project.
Generated noise due to vehicular movements, site activities and workers during project execution are considered to be of high probability (between 60 to 90%) and moderate magnitude (6). Moderate significance points of 44 scored for impacts before mitigation and reduced to low (24) after mitigation as probability and magnitude reduced to medium (between 40 to 60%) and low respectively.

Produced noise as a result of project operations is expected to be of relatively long-term duration. The reversibility of all noise impacts is considered to be high as the impacts will be ceased as soon as the activity ceases. The frequency of noise impacts is also considered to be moderate and/or high.

Noise generated as a result of project operations will not create a problem to local communities given that the area is located within rural community of an undeveloped economy with surrounding noise levels representing typical African rural setting.

## 6.0 CONCLUSION AND RECOMMENDATIONS

### 6.1 Conclusion

This assessment report has been based upon information gathered during site visit and measured dust, ambient pollutant gases, noise levels and vibrations for the proposed project. Literature information has been used to compare the collected data and other acceptable standards (TBS, WHO).

Based on the site observation, and measured parameters, the proposed project could be manageable to an environmentally acceptable manner provided that the mitigation measures and/or recommendations made in this subcomponent of ESIA report on air quality, noise and vibrations are satisfactorily implemented including the fulfilment of the proposed Environmental and Social Management Plan (ESMP) and Policy.

**APPENDIX 11: WATER QUALITY BASELINE STUDY**

# REPORT
# ON
# WATER QUALITY BASELINE STUDY FOR THE PROPOSED ENGARUKA SODA ASH PROJECT IN MONDULI DISTRICT,ARUSHA, TANZANIA

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## 1.0 INTRODUCTION

This report provides the baseline data on water quality analysis for the proposed Engaruka Soda Ash project in Monduli District, Arusha, Tanzania. The study was conducted as sub-component of ESIA study to suffice the requisite EMA and EIA and EA regulations. The purpose of the study was to document the current data on water quality as a baseline for future monitoring purposes following implementation of the Engaruka Soda Ash project.

Also the study aims to examine all aspects and activities of the development of soda ash extraction project in terms of its impacts on the Environmental components and to provide better alternatives to preserve the environment and avoid potential negative impacts during the establishment and operation of the project.

## 2.0 OBJECTIVES

### 2.1 Main Objective

The study was carried out with the objective of collecting water quality baseline data from rivers which drain into the lake Engaruka (i.e. Engaruka River, Serela River and Buko River).

### 2.2 Specific Objectives

To assess physical, chemical and bacteriological parameters of water from rivers entering the proposed project site.

## 3.0 METHODOLOGY

### 3.1 Water sampling

Water sampling was done using a number of tools including sampling bottles (plastic and glass) of 1000ml, clean cool box , ice bags, Ethanol 70%,masking tape, marker pen, notebook, YSI professional pro multi probe system and Cotton wool. Plastic bottles were used for sampling of water for physical and chemical analyses, while sterile glass bottles were used to collect samples for microbiological analyses of water from three Rivers (Engaruka, Serela and Buko Rivers). Samples were collected from downstream, midstream and upstream. Sampling bottles were rinsed with river water three times before filling. After rinsing, the bottles were submerged below the water level and allowed to fill up to the neck of the bottles. The lids were screwed on tightly to prevent leakage. For microbiology sampling, the bottles and lid were kept close to avoid contamination during filling.


*WATER SAMPLING POINT 2 :( WSP2)*

Physical parameters i.e. pH; temperature, conductivity, Total Dissolved Solids (TDS), colour and turbidity were analysed onsite using a Multi probe system (YSI). Information such as the sample name (ID), date, time and location of the collected samples were recorded for each sample as required. The collected samples were placed in a cooler with wet ice to maintain their temperature at 4ºC during transportation and delivery to the laboratory for analysis of chemical and microbiology parameters.

The Chemical parameters analysed include heavy metals: Chromium(Cr) Manganese(Mn),Sodium(Na) ,Zinc(Zn),Potassium(k), Magnesium (Mg), Cadmium (Cd), Calcium (Ca), Copper (Cu), Lead (Pb), and Nickel (Ni), which were analysed by Atomic Absorption Spectrophotometer AAS model number AA 7000. Others were Iron (Fe), Aluminium (Al) ,Chloride($Cl_2$), Sulphate(S0, Hardness($CaCo_3$), Alkalinity, Chemical Oxygen Demand(COD), Biochemical Oxygen Demand(BOD), Ammonium($NH_4^-$), Nitrate($NO_3^-$), Nitrite($NO_2^-$), Fluoride($F_2$), and , were analysed by Photometer Wegtech 7100.
Microbiological parameters analysed include Faecal coliform and Total coliform which were analysed using the MPN Method.

**Table 1.Water sampling coordinates points**

| **Water Sampling Points (WSP)** | **Coordinates** | |
|---|---|---|
| | **Latitude** | **Longitude** |
| WSP1 (Downstream River Engaruka) | - 2.99768 | 36.00096 |
| WSP2 (Midstream River Engaruka) | -2.99823 | 35.99794 |
| WSP3 (Upstream River Engaruka) | -2.99768 | 35.95837 |
| WSP4 (River Serela Midstream ) | -3.16406 | 35.95994 |
| WSP5 River (Mbuko upstream ) | -3.09991 | 36.01599 |

### 3.2 Data Analysis

Each data collected from the laboratory analysis was compiled and analyzed with spreadsheet software, MS Excel. Interpretation of the data utilized various standards and norms and was compared to their respective specific threshold limits from the Natural portable water standards (TBS). The discharge from the project will not affect water bodies like rivers because all rivers come from highland, and the proposed project site is at low land and the discharge directed to Engaruka lake. Hence Natural portable water standards (TBS) were used to assess the current quality of Engaruka river, Serela River and Buko rivers.

### 3.3 Findings and Discussion

Table: 2 presents the results of water quality analysis i.e., physical, chemical and microbiological parameters from rivers draining into Lake Engaruka. As seen in the results, chemical oxygen Demand (COD) for WSP2, WSP3, WSP4, WSP5 were not detected except for WSP1. Na, Zn, Mg, Ca, Pb, and $SO_4$ were found to be within the limits but Cr, Mn, Cd, Ni, exceed limits of Natural portable water standards (TBS). Physical parameters measured onsite (pH, conductivity, Total Dissolved Solids (TDS) and turbidity, Colour) from all sampling locations were within the acceptable Natural portable water standards (TBS). High temperature of 43.7˚C was recorded at WSP4 because the water is taped from the source by using black plastic pipe which is exposed direct to sunlight. For microbiology analysis, Fecal coliforms and total coliforms for WSP3, WSP4, results were within the limits but WSP1, WSP2, and WSP5 the results exceed the limits.

Table 2: Results of Water Quality Analysis from Engaruka Rivers

| S/N | Parameter | Units | Downstream River Engaruka | Midstream River Engaruka | Upstream River Engaruka | Buko River | Serela River | Natural portable water standards(TBS) |
|---|---|---|---|---|---|---|---|---|
| 1. | pH | - | 7.300 | 8.700 | 7.000 | 7.400 | 7.400 | 5.5 – 9.5 |
| 2. | Temperature | °C | 28.100 | 20.200 | 19.200 | 43.700 | 28.400 | 20 - 35 |
| 3. | Conductivity | µs/cm | 550.000 | 544.800 | 413.800 | 543.000 | 482.700 | 2500 |
| 4. | Turbidity | NTU | 4.000 | 2.000 | 1.000 | ND | 6.000 | 300 |
| 5. | Total dissolved solids | mg/l | 558.000 | 353.000 | 296.000 | 266.000 | 294.000 | 1500 |
| 6. | Colour | TCU | 50.000 | 30.000 | 15.000 | 35.000 | 105.000 | 50 |
| | Chloride | mg/l | 4. 000 | 2.000 | 12.000 | 4.000 | 9.000 | 250 |
| 7. | Iron | mg/l | 0.206 | 0.141 | 0.326 | 0.404 | 0.893 | 0.3 |
| 8. | Aluminium | mg/l | 0.050 | 0.210 | 0.010 | 0.010 | 0.010 | 0.2 |
| 9. | Zinc | mg/l | 1.009 | 0.843 | 0.881 | 0.861 | 0.853 | 5 |
| | Potassium | mg/l | 13.107 | 12.547 | 7. 856 | 9.007 | 5.151 | - |
| 10. | Manganese | mg/l | ND | 9.642 | 8.483 | 9.062 | 9.411 | 0.1 |
| 11. | Total Chromium | mg/l | 1.994 | 1.994 | 2.012 | 2.004 | 1.995 | 0.05 |
| 12. | Cadmium | mg/l | 1.462 | 1.467 | 1.469 | 1.467 | 1.471 | 0.003 |
| | Sodium | mg/l | 9.623 | 4.929 | ND | 1.971 | ND | 200 |
| 14. | Lead | mg/l | ND | ND | ND | ND | ND | 0.01 |
| 15. | Nickel | mg/l | 3.049 | 2.983 | 3.086 | 3.093 | 2.946 | 0.02 |
| 16. | Copper | mg/l | 1.4167 | 1.395 | 1.401 | 1.399 | 1.386 | 1.000 |
| 17. | Calcium | mg/l | 9.865 | 10.584 | 14.404 | 4.539 | 4.898 | 150 |
| 18. | Magnesium | mg/l | 10.330 | 7.634 | 4.712 | 6.865 | 3.811 | 100 |
| 19. | Sulphate | mg/l | 5.000 | 3.000 | 5.000 | 4.000 | 9.000 | 400 |
| 20. | Hardness | mg/l | 60.000 | 50.000 | 40.000 | 30.000 | 40.000 | 600 |
| 21 | Alkalinity | mg/l | 100.000 | 90.000 | 95.000 | 50.000 | 70.000 | - |
| 22 | COD | mg/l | 11.000 | ND | ND | ND | ND | - |
| 23. | BOD | mg/l | 3.800 | 2.100 | 4.300 | 3.200 | 3.100 | - |
| 24. | Ammonium | mg/l | 0.150 | 0.020 | 0.010 | <0.010 | 0.120 | 0.5 |
| 25. | Nitrate ($NO_3^-$) | mg/l | 0.580 | 0.820 | 0.700 | 1.480 | 0.520 | 45 |
| 26. | Nitrote($NO_2^-$) | mg/l | ND | ND | ND | ND | ND | 0.003 |
| 27. | Fluoride | mg/l | 0.680 | 0.620 | 0.580 | 0.390 | 0.340 | 1.5 |
| 28 | Fecal coliforms | MPN/100ml | $>1.6\times10^3$ | $>1.6\times10^3$ | $>1.6\times10^3$ | $7.8\times10^0$ | $3.5\times10^2$ | - |
| 29. | Total coliforms | MPN/100ml | $>1.6\times10^3$ | $>1.6\times10^3$ | $>1.6\times10^3$ | $23\times10^0$ | $3.5\times10^2$ | - |

## 5.0 CONCLUSION AND RECOMMENDATION

### 5.1 Conclusion

Based on the physical chemical and microbiology parameters analysed the study found that the quality of Engaruka rivers suitable for irrigation scheme and livestock keeping and not suitable used as drinking water.

### 5.2 Recommendations

- Based on the results and site observations, the following is recommended:
- Water quality analysis should be done regularly
- Water quality should be assessed not only for human health but also for aquatic organisms both flora and fauna;
- River Engaruka, Mbuko and Serela, should be well protected as they serve as the prime source of water for Masai communities and proposed project site.

**APPENDIX 12: FLORA INVENTORY BASELINE STUDY**

# REPORT ON BASELINE VEGETATION SURVEY OF THE PROPOSED SITE FOR ESTABLISHMENT OF SODA ASH LANT AT ENGARUKA VILLAGE MONDULI, DISTRICT ARUSHA REGION TANZANIA

**Report for Tanzania Industrial Research and Development Organization (TIRDO)**

**(Environmental Impact Assessment-ESIA)**

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**August 2020**

# 1. INTRODUCTION

## 1.1. Background

The government of the United Republic of Tanzania through its parastatal organization the National Development Corporation, (NDC) plans to establish Soda Ash Plant. The proposed site for establishing the plant is located at Engaruka basin in the villages of Mferejini, Mbaashi and Engaruka chini in Monduli district, Arusha region. The Soda Ash Producing Project is 100% owned by the NDC which has commissioned Tanzania Industrial Research and Development Organization (TIRDO) to undertake the Environmental and Social Impact Assessment (ESIA ) studies.

Following the findings obtained from the scoping report conducted from the study area, Mbago(2020), the project developer has initiated the execution of this detailed botanical survey so as to identify individual plant species occurring from the vegetation types classified in the project area in both areas with direct and indirect impacts of the project activities.

Like any other development project which is based on mining activities, its implementation will include clearing of the vegetations and soil excavation being replaced with the construction of infrastructures. The expected infrastructures to be constructed includes, access roads, soda ash processing plant or factory, residential houses and pipelines which will transport row materials from the wells to the factory.

The implementation of the above activities will lead into direct and indirect impact on the existing vegetation and the plant species which supports the lives of both terrestrial and possible aquatic fauna occurring in Lake Engaruka and its tributaries.

## 1.2. Location of the project area

Engaruka Basin is located in Monduli District, Arusha Region, north-eastern Tanzania. It is 50 km northeast of Mto wa Mbu town and 58 km south-east of Lake Natron. The area can be accessed through the Arusha - Monduli road, and also through Arusha – Karatu Road where you branch of the main road at Mto wa Mbu and drive northwards for 50 km towards Lake Natron as shown on figure 1 below.


Figure 1: Location map of showing various parts surveyed within the project foot prints around lake Engaruka

### 1.3. Description of the study area

The proposed Soda Ash extraction plant is located at Engaruka basin which forms a seasonal lake known as Engaruka (lake Boloti called by Maasai).

Floristically, the vegetation of the study area falls under Phytocorion of Somali- Masai- *Acacia-Commiphora* bushland and thickets characterized by Edaphic grassland on volcanic soils, halophytic vegetation and thicket bushland.

According to floristic division of Tanzania which ranges T1-T8 Engaruka falls under floristic region T2 which is known to harbor 113 purely endemic plant species. Those endemic species include; 11 Trees, 32 shrub, 62 herbs and 8 climbers according to Least of East African Plants database LEAP (1996). Therefore, it is likely that some of these plant species might be occurs in the proposed project area of which they need to be identified for conservation concern.

### 1.4. Study objectives

The objective of the study is to assess the existing vegetation types and their species composition occurring within the project foot prints which will include: -

- Classification of the vegetation categories occurring in the project area both areas with direct and indirect impacts of the project activities;

- Identification of all plant species occurring in each classified vegetation type and establishing checklist of all plant species occurring in the project area;
- Identification of plant species with conservation concern including IUCN Red listed threatened categories or, CITES listed appendices, Endemic and Rare occurring in the project area;
- Identification of impacts of the project activities both direct and indirect onto the vegetation with their mitigation measures;
- Proposing a list of recommendations for the possible project impacts;
- Proposing long term vegetation monitoring based on seasonality wet and dry seasons; and
- Establishing a list of literature survey and stakeholders consulted.

## 2. 0. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

### *2.1 Policies and Legislation*

The challenge to manage Tanzania's forest resources as a national heritage on an integrated and sustainable basis to optimize their environmental, economic, social and cultural values remains as pressing as ever. In addition, as a result of the international forest related by 1992 UNCED conference in Rio and continued by the intergovernmental Panel on Forest, the contribution of the forests to the international conservation functions has become an important part of the national policy discussions. Development of sugar cane plantation for small scale farmers (out growers) and the construction of the factories and their associated infrastructures like any other development project requires that it is conducted in a sustainable way that takes into consideration the protection of both natural and introduced environment. This call for adherence to the policies and complementary legislation for issues pertaining to environmental protection as outlined in (i) National Forest Policy (1998), (ii) The Forest Act, 2002, (iii) National Land Policy Second Edition (1997), (iv) National Environmental Policy (NEP) 1997, (v) National Land Use Planning Commission Act 3/84, (vi) Land and Village Lands Act 1999, (vii) Environmental Impact Assessment Guidelines and Audit Regulations 2005, (viii) Environmental Management Act 2004. (ix) Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

### *2.2 Administrative framework*

#### 2.2.1 ESIA

Environmental aspects in Tanzania are regulated and controlled by the Minister for the Environment under the Vice Presidents Office through the Division of the Environment (DoE), which is the authority that issues all environmental certificates based on advice from the technical review committee. The National Environmental Management Council (NEMC) established Parliament act No.19 of 1983 performs advisory role to the government on all issues pertaining to the environment management such as to:

- Evaluate the existing and proposed policies and activities of government to control environmental pollution;

- Recommend measures to ensure policies for the development and conservation of natural resources are implemented; and
- Specify standards (Environmental Impact Assessment Guidelines and Audit Regulations, 2005), norms and criteria for quality of the environment.

For the proposed establishment of an irrigation scheme project, the proponent is responsible for the preparation of the ESIA and for implementation and monitoring of the environmental management plans.

Local governments are key stakeholders to the ESIA process; hence communication is important in order to ensure that the district, ward and village plans are in line with the intentions of the project.

### 2.2.2 National Environmental Policy (NEP) 1997

*The National Environmental Policy aims to ensure sustainability, security and equitable use of resources to meet the basic needs of the present and future generations without degrading the environment or risking health and safety. Any development is therefore not expected to cause: land degradation, environmental pollution, loss of habitats or biodiversity and deforestation during its operation. The Policy emphasizes the importance of sectoral legislation as an essential means for effective and comprehensive environmental management. The legislation should be meaningful and effective and should be clearly understood and respected by the communities and the individuals for whom they are intended.*

The execution of this vegetation survey initiated by the project developer (NDC) through (TIRDO) which aims on identification of possible negative impacts of the project activities and proposing their mitigation measures, indicate that the project proprietor comply with the above policy.

### 2.2.3 National Land Policy (1997)

*The Policy advocates equitable distribution and access to land by all citizens. It aims to ensure that existing rights in land especially customary rights of small holders (i.e. peasants and herdsmen who form the majority of the country's population) are recognized, clarified, and secured in law. Under this policy framework, land is to be put to its most productive use to promote rapid social and economic development of the country among other objectives.*

The proposed footprints of project fall within areas with natural vegetation including water bodies, settlements and pastoralist areas. The execution of this ESIA study promoted by the project developer indicates the compliance with the above policy.

### 2.2.4. Environmental Management Act, 2004

*The Environmental Management Act (2004) encompasses all matters pertaining to the environment. It sets out standards and procedures, duties and limits, with obligations for all stakeholders, to benefit human needs and govern resources sustainably. The act includes the* *composition and responsibilities of the environmental authorities i.e., The Minister, the Division of Environment and NEMC.*

This Act cuts across all sectors that in one way or the other affect or impact the environment and recommends parties to observe and take care of all sectoral legislations when planning any development project.

**2.2.5. Environmental Impact Assessment Guidelines and Audit Regulations, 2005**

*An important intervention for environmental management in Tanzania is the use of guidelines to carry out ESIAs. Guidelines have been developed by NEMC for the purpose of guiding project proponents on the requirements for ESIA for various project categories. The guidelines are printed as a single publication with three parts; the procedures of ESIA (obligations and responsibilities), the stages of the ESIA process (registration through to draft EIS) and annexure pre-requisites for ESIA, respectively. These Guidelines and Procedures hold particular importance as they have sought to incorporate issues of public participation and access to information in environmental decision-making processes in respect of projects with likely environmental impacts.*

The execution of this vegetation survey which initiated by the project developer, NDC reveal that the project developer comply with the above regulation.

**2.2.6. The Forest Act 2002**

*The Forest Act delineates the forest types and their management/ownership. For any development that would impact the forest such as extraction/exploitation of products, an assessment of impacts is necessary. This can be included in an overall ESIA depending on the nature and location of the development.*

The Ngorongoro Conservation area and Monduli Forest reserves are sources of all streams which flows into lake Engaruka. Therefore, the project developer should support the protection and conservation activities to those reserves.

**22.7 National Land Use Planning Commission Act 3/84**

*In addition to the Local Government Act, the National Land Use Planning Commission Act is also used to regulate land use. The Act creates the National Land Use Planning Commission with the main function to prepare regional physical land use plans, formulate land use policies for implementation by the government (central and local) and to specify standards, norms and criteria for the protection of beneficial use and maintenance of land.*

The project developer will need to take into consideration the legal requirements of land acquisition in all areas fall on the project foot prints whenever needed.

**2.2.8 Land and Village Lands Act, 1999**

*The Land Act No.4 (1999) and the Village Land Act (1999) consolidate all provisions enacted by earlier legislation. The Acts divide land into public land (Village land), reserved land (land set aside for conservation e.g. National Parks etc.) and hazardous land (land that poses danger if developed, e.g. on steep slopes, 60m from rivers, mangroves etc.). Project activities near river courses, on steep slopes or within village land require consideration of these legislations.*

The Project developer will need to take into consideration the conservation measures and appropriate technical mitigation measures to the land which falls on the project foot prints with respect to the above acts.

**2.2.9 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)**

The basic principles of the CITES is to control and monitor international trade on endangered and threatened species. The Convention establishes the international legal framework for co-operation between the producer and consumer and is essential for the conservation of wild species. The convention operates by means of a licensing system. No import permit is necessary for these species under CITES (although a permit is needed in some countries that have taken stricter measures than CITES requires). Permits or certificates should only be granted if the relevant authorities are satisfied that certain conditions are met, above all that trade will not be detrimental to the survival of the species in the wild. At the core of the Conventional, there are three appendices;

**Appendix I**

This includes species of plants and animals in which, with a few exceptions, trade in wild specimens is prohibited.

**Appendix II**

This list includes species whose survival is not yet threatened but projected to be so in a given time frame in the absence of conservation effort and/or regulation. International trade for such species is, in principal, allowed for both wild and artificially propagated or captive breed specimens subject to licensing.

**Appendix III**

Under this appendix is a list of species included at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation. This category acts as a support mechanism to domestic legislation, where countries ask other parties to monitor trade taxa not listed on appendix I or Appendix II. International trade in specimens of species listed in this Appendix is allowed only on presentation of the appropriate permits or certificates.

### 2.2.10 IUCN Red List

This is a widely recognized and most comprehensive objective global tool in evaluating conservation status, trends and threats of both plant and animal species in order to inform and catalyze action for biodiversity conservation. The IUCN Red List stratify species into 9 categories based on criteria such as rate of decline, population size, area of geographic distribution and degree of population and distribution fragmentation. The categories are as follows;

**Extinct (EX)** – No known individuals remaining.

**Extinct in the Wild (EW)** – Known only to survive in captivity, or as a naturalized population outside its historic range.

**Critically Endangered (CR)** – Extremely high risk of extinction in the wild.

**Endangered (EN) –** High risk of extinction in the wild.

**Vulnerable (VU)** – High risk of endangerment in the wild.

**Near Threatened (NT)** – Likely to become endangered in the near future.

**Least Concern (LC)** – Lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category.

**Data Deficient (DD) –** Not enough data to make an assessment of its risk of extinction.

**Not Evaluated (NE)** – Has not yet been evaluated against the criteria.

Under IUCN Red List “threatened species” refers to grouping of three categories namely **Critically Endangered, Endangered,** and **Vulnerable**.

### 2.2.11 Endemic Plant Species

Endemic plant species are plants which are native and confined to a particular region and not native to other areas.

## 3. METHODOLOGY

The survey was based on both qualitative methods where vegetation types were classified directly in the field basing on both physiognomic characterization (White 1983), and species based. Guide books on Flora of Tropical East Africa published series (FTEA) and a checklist of the Vegetation of Simanjiro by Kahurananga (1979) were used in the process. For those plants which couldn't easily be identified in the field, plant specimens were collected pressed and taken to the herbarium of the University of Dar es Salaam for further identification and preservation for future references. An existing two documents of CITES list (Convention on International Trade an Endangered Species of Wild Fauna and Flora) and the IUCN Red List of Threatened plant species categories, were used to identify those plant species which falls in any of its categories and appendices respectively. A data base of List of East African Plant species (LEAP Master-1996) were used to identify endemic and rare plant species possibly occurring in the project area. A map provided by the Project developer was used to locate various parts of the project foot prints where the construction activities will take place. A car used to reach various points in the project area, digital camera used to take photographs for further illustrations and a pair of GPSs used for marking various interesting points especially the ones where key plant species identified as well as positions of vegetation types classified.

## 4.0 SURVEY FINDINGS

### 4.1. Flora

From the survey findings a total number of 233 of vascular plant species from 8 life forms have been identified growing in the project area. The identified species are from 41 families. The family with the highest number of species includes; *Gramineae* 47, *Acanthaceae 22*,*Papilionoideae 19*, *Compositae* 10 and *Amaranthaceae*, *Labiatae* & *Malvaceae* 8 species each

The rest are represented with species ranges 1-7 respectively.

The 233 plant species represent 6 life forms includes; Herbs 98, trees 48, Grass 47, Shrubs 30, Climber 10 and sedges 2respectively. One endemic tree species have been identified as listed below.

### 4.2. Vegetation Categories classified into four main project impact areas

Vegetation is an integrator of environmental factors in that it reflects the climatic, physiographic, seraphic and biotic features pertaining to the land on which it grows. An understanding of the vegetation and plants of an area can therefore give good insights into the agricultural or biological potential of that area. Some land uses also depend directly on the vegetation resource and in this case an inventory of vegetation is obviously of great importance (Timberlake, Nobanda and Mapoure, 1993).

In the project area the survey has classified a total number of ten vegetation categories both main and intermediate which are: Edaphic grassland, Bushed grassland, Riverine thicket-woodland , *Acacia-Commiphora* open woodland, Thicket bushland, *Acacia tortilis* woodland, Swamp marshland, Settlements (bomas), Flood plain bushed grassland and Semi-desert grassland and bushes as shown on figure 2 below. Out of ten vegetation categories one is vulnerable Swamp marshland due to human activities especially overgrazing. During drought season domestic animals invade and feed on the plants of wetland especially goats and sheep. This vegetation is influenced by availability of water and it grows at the edges of the lake. Settlements (bomas) is a man-made category which affects the natural vegetation especially when the population increases plus other human activities which involves vegetation clearing and tree felling for domestic uses.

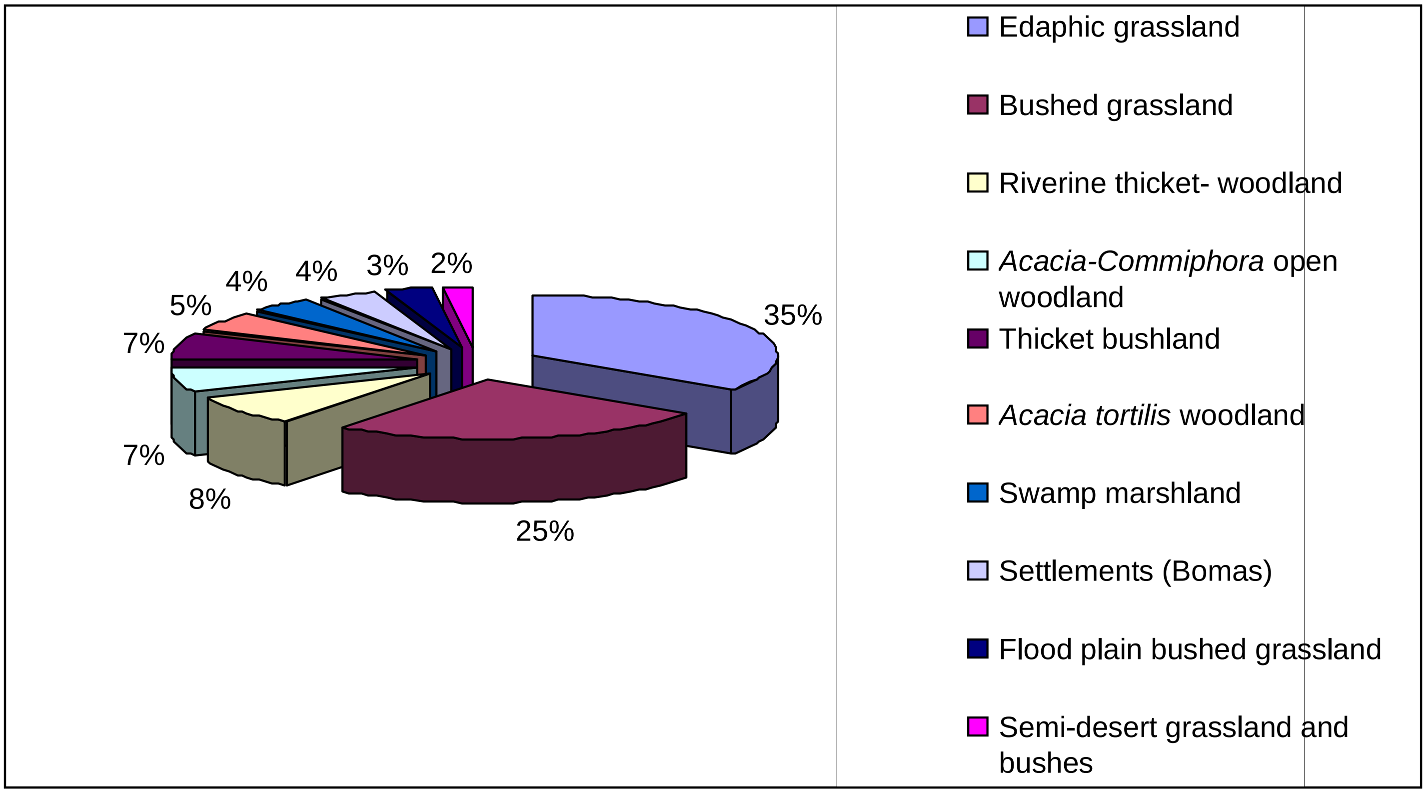



Figure 2: Vegetation categories classified in the project area and their estimated percentage cover to the total area of the project foot prints

**4.2.1. Edaphic grassland**

This vegetation category is characterized by a land which is covered with grass species with very few clumps of herbs and single tree. This vegetation type becomes barely during dry season due to animal grazing both domestic and wild. In the project area this vegetation category occupies the largest percentage cover 35% of the entire vegetations of the project area. Dominant grass species are: *Chloris pycnothrix, Chloris gayana, Digitaria velutina, Heteropogon contortus, Aristida babicolis, Cynodon dactylon, Sporobolus consimilis* and *Panicum infestum* Scattered few shrubs are *Boscia coriacea, Dobera Lorathifolia* and *Cadaba faricosa* as shown on plate 1 below.

This vegetation type is dominated by annual species; therefore, the project activity will have no impacts on it as it can easily regenerate. Also, this vegetation is locally and regional common and it supports no species of conservation concern. Therefore, any of the project activities which will cause vegetation clearing it will cause no possible loss of biodiversity.

Plate1:  Edaphic Grassland vegetation type during dry and wet season occurring at Engaruka chini. The dominant grass on the right side is *Chloris pycnothrix*

**4.2.2. Bushed grassland**

This vegetation characterized by an area covered by grass, dwarf bushes and woody herbs growing on rocky volcanic soils. The dominant grass species in this category includes: *Setaria homonyma*, *Chloris virgata* and *Cynodon nlemfuensis.* The dominant woody herbs and bushes includes: *Barleria grandicalyx* subsp. *Mucronata*, *B. acanthoides*, *Hermannia uhligii*, *Heliotropium stedneri Sericocomopsis hildebrandtii,* and *Justisia heterocarpa* as shown on plate 2 below. This category is the second largest in the project area with an estimated 25% cover of the entire vegetation of the project area which is currently used for cattle grazing. In the project area this category is the second largest occupies an estimated cover of 25% of the entire area. The proposed area for the construction of the plant is falling in this vegetation category. Therefore, part of it will be cleared for the construction activities. However, this vegetation category is locally and regional common with no species of conservation concern.

Plate 2: Bushed grassland vegetation type growing in the area proposed for the construction of the plant. The dominant woody herb on the right side is *Barleria grandicalyx* subsp. *mucronata* growing at Yaeda chini at Nengaleshi hamlet.

### 4.2.3. Riverine thicket- woodland

This vegetation type is characterized by an assemblage of woody species with small trees and shrubs forming a dense impenetrable thorn bushes underneath growing along the seasonal river. In the project area this category is found in patches growing along the valley dominated with the following shrubs; *Grewia tembensis, G. similis, Harrsisonia abyssinica, Cadaba faricosa, Dombeya shupangae, Lycium shawii,* and *Ziziphus mucronata.* Scattered small trees includes*; Dobera loranthifolia Cordia sinensis and Acacia tortilis.*

The ground *cover* is dominated with *Achyranthes aspera, Capparis tomentosa* and *Aerva lanata* as shown on plate 3 below. This vegetation category is a major source of building materials and fuel wood to the villagers of Engaruka chini near the lake. Although this vegetation category fall within the project foot prints but it is located away from the extraction wells. Besides the fact that this vegetation category harbors a diverse of woody species but it support no species of conservation concern. Therefore, the execution of the project activities will have no impacts onto this category as well as there are no possible risks of loss of biodiversity.

Plate 3: Riverine vegetation type growing at Engaruka chini village. The plant with white flowers is *Grewia tembensis*

### 4.2.4. *Acacia –Commiphora* Open woodland

This vegetation type is characterized by a stand of scattered trees with single layer dominated by two genera of tree species of *Acacia* and *Commiphora* and the ground layer is covered with grass and herbs on rocky soil. Dominant tree species includes; *Acacia torilis, Commiphora africana, C. campestres* and *Acacia nubica.* The ground layer is dominated by woody herb of

*Barleria grandicalyx* subsp. *mucronata* and *Aerva lanata.* The grass species are *Chloris pycnotrix* and *Aristida keniensis* as shown on plate 4 below. This vegetation category is located at the eastern boundary of the project area at Embaashi area. This vegetation type harbor an endemic tree species of *Commiphora campestres* which is restricted to T2 and T3 floristic regions in Tanzania. However, currently there is no project activity allocated to be executed in this vegetation category therefore there is no risks of extinction of this habitat as well as loss of biodiversity due to the project activities. It is highly recommended to protect this habitat as it hosts the key plant species as mentioned above.

Plate 3: *Acacia* –*Commiphora* open woodland vegetation growing at Mbaashi area.
The tree with whitish canopy is *Commiphora campestres* an endemic tree to Floristic region T2 & T3 in Tanzania

### 4.2.5. Thicket bushland

This vegetation category is characterized by an assemblage of woody species with canopy height less that 5m tall forming a dense impenetrable on the under storey. In the project area this vegetation type is growing in small patches at Engaruka chini near extraction well no U2. It is dominated by small trees includes: *Acacia tortilis, A. mellifera, A. nubica, Maerua edulis, Grewia tembensis, Balanites aegyptiaca,* and *Cordia ovalis* includes; *Barleria grandicalyx, Sida cordifolia, Duosperma crenatum* and *Cucumis dipsaceus* as shown on plate 5 below. This vegetation category is locally and regionally common and it supports no species of conservation concern. Therefore, the execution of the project activities will have caused no risks of loss of biodiversity.

Plate 5: Thicket bushland vegetation type growing at Engaruka chini near extraction well no U2 in the project area

### 4.2.6. *Acacia tortilis* woodland

This vegetation type is characterized by an assemblage of woody species dominated by a single species of tree layer which is *Acacia tortilis* as shown on plate 6 below. The ground layer is dominated with herbaceous and few shrubs of which mostly are the tree lets of the same canopy species. The height of this vegetation ranges from 3-6m tall and the growing layer is sometimes bare due to over grazed. In the project area this vegetation type is commonly found at Engaruka chini and it falls in an area where the residential and business are to be constructed. Part of this vegetation will be cleared during the project implementation. This vegetation is a good habitat which harbors various animals including birds. Also, it is a good source of building materials as it dominated with woody species. However, this vegetation category is locally and regionally common and it support no species of conservation concern. Therefore, the project activities will cause to possible loss of habitat and biodiversity. Also, similar vegetation category is available at Mbaashi area where it will not be cleared. In addition, the listed below recommendations should be implemented during the constriction time by the project developer.

Plate 6: *Acacia tortilis* woodland vegetation type occurring within the project foot prints in an area where residential houses and business will be constructed.

### 4.2.7. Swamp marshland

This vegetation category is characterized by a land which is dominated by water loving plants either in areas with permanent water body or areas with high water table. The dominant plant species includes sedges rushes and grass. In the project area this vegetation category is found permanent foung along the lake shores during dry season and in wet season is also found in areas with depression in the flood plain. Dominant grass species are *Soporobolus concimilis Echnochloa pyramidalis* and *Leersia hexandra.* The dominant reed is *Typha capensis* and the sedge species are *Cyperus exaltatus,* and *C. rondus* as shown on plate 7 below.  This vegetation category is very fragile hence it is totally depending on the availability of water. Also, this vegetation type is highly used by pastoralist for grazing cattle during dry season and it has catchments values. The project activities will have a slightly impacts on this vegetation as some of the extraction wells are near the lake shore on both sides. Hence the extracted soda ash will be pumped to the factory thorough big pipes it is expected that the excavation work for burring the pipes from the lake to the factory will only occupy a small corridor. Therefore, little vegetation will be cleared. Howerer, this vegetation type is locally and regional common and it supports no species of conservation concern therefore there is no risks of loss habitat loss and biodiversity due to execution of the project activities.

**Plate 7*:*** Swamp marshland vegetation type near lake shore at Engaruka chini and Donyonado villages. The clumps of grass on left is *Sporobolus consimilis* and the greenish sedges are *Cyperus exaltatus* associated with *Typha capensis*

### 4.2.8. Settlements (Bomas)

This vegetation category is characterized by a land which its natural vegetation has been cleared being replaced by houses and other human activities. In the project area this vegetation category is found in scattered patches common known as Maasai bomas where few houses surrounded by cattle's encloses are found as shown on plate 8 below. This vegetation type part will be affected by the project activities especially those ones which will fall within the project foot prints where project infrastructures will be constructed. However, resettlement action plan (RAP) will be negotiating with the victims and a reasonable compensation should be done to avoid land use conflicts as well as an alternative land should be allocated for new settlements.

Plate 8: Settlements (Bomas) at Mbaashi village in Serela ward. Cattle enclosure (Boma) constructed with *Acacia tortilis* & *A. nubica* can be seen surrounding the cattle and houses

### 4.2.9. Flood plain bushed grassland

This vegetation type is characterized by a land which is covered with grass and scattered bushes which is subjected to floods during wet season. During dry season the grass species has been over browsed by cattle only non palatable herbs becomes dominant. The most dominant herb is *Justicia scandens* followed by, *Aerva lanata*, *Abutilon longicuspe*, *Leonotis mollisima*, *Monechma debile*, *Solanum coagulans*, *xanthium strumarium*,*Melhania velutina* and *Heliotropium steudneri*. Remnants of grass species includes; *Eriochloa fatmensis, Setaria* *homonyma, Eragrostis aspera* and *Panicum trichocladum.* The dominant climber *is Cucumis dispsaceus.* Emergent trees species includes; *Dobera loranthifolia, Acacia tortilis* and *Boscia corieacea* and *Cadaba faricosa* ssp. *Adenotricha* as shown on plate 9 below. In the project area this vegetation category is commonly found at Endorokoko village in Mbaashi ward. Five soda ash extraction wells are located in this area such as well no 12, 13,14, 15 and 16 respectively. Therefore, the project activities will slightly disturb this vegetation type during the implementation period. However, this vegetation type is already highly disturbed due to grazing and also it supports no species of conservation concern. Either this vegetation category is locally and regionally common. Therefore, there are no risks of loss of biodiversity due to implementation of the project activities.

Plate 9. Degraded flood plain bushed grassland at Endorokoko village in Mbaashi. The hern on the fore ground is *Melhania velutina* and the bushy behind is *Justicia scandens* which is abundant in the habitat

**4.2.10. Semi-desert grassland and bushes**

This vegetation category is being characterised by a mixture of bare land with scattered clumps of dry bushes less than 2m tall, few grasses and herbs. In the project area, this vegetation type is commonly found near the lake where most of the extraction wells/ bore holes are located. Common species of bushes includes; *Grewia sp. Boscia coriacea* and *Dobera lorathifolia*. The dominant herbs on the ground are *Portulaca orelacea* and *Aerva lanata* Common grass species includes; *Sporobolus spicatus* and *Cynodon dactylon* as shown on plate 10 below.

This vegetation category is common in the raea found in small patches and it supports no species of conservation concern. Therefore, the project activites will have very minimum impacts on it. as there is no much plants to clear during the construction.

Plate 10: Semi-desert grassland and bushes vegetation type near the shore of Lake Engaruka. (Left)The herb with white inflorescences is *Aerva lanata* and the bushes (Right) side are *Boscia coriacea and Grewia similis.*

### 4.3. List of IUCN Threatened Plant species Categories (Version 2009)

The globally threaten plant species from the **IUCN** Red List falls under the following main categories: -

**Extinct (Ex)**

*A taxon is extinct when there is no reasonable doubt that the individual has died. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), and throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.*

In the project area, non-of the plant species in this category have been identified.

**Extinct in the Wild (EW)**

*A taxon is Extinct in the will when it is known only to survive in cultivation, in captivity or as a naturalised population (populations) well outside the past range. A taxon is presumed Extinct in the Wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.*

In the project area, non-of the plant species in this category have been identified.

**Critically Endangered (CR)**

*A taxon is critically endangered when the best available evidence indicates that it is facing an extremely high risk of extinction in the wild.*

In the project area, non-of the plant species in this category have been identified.

**Endangered (E)**

*A taxon is endangered when the best available evidence indicates that it meets any of the criteria for Endangered is therefore facing considered to be facing a very high risk of extinction in the wild.*

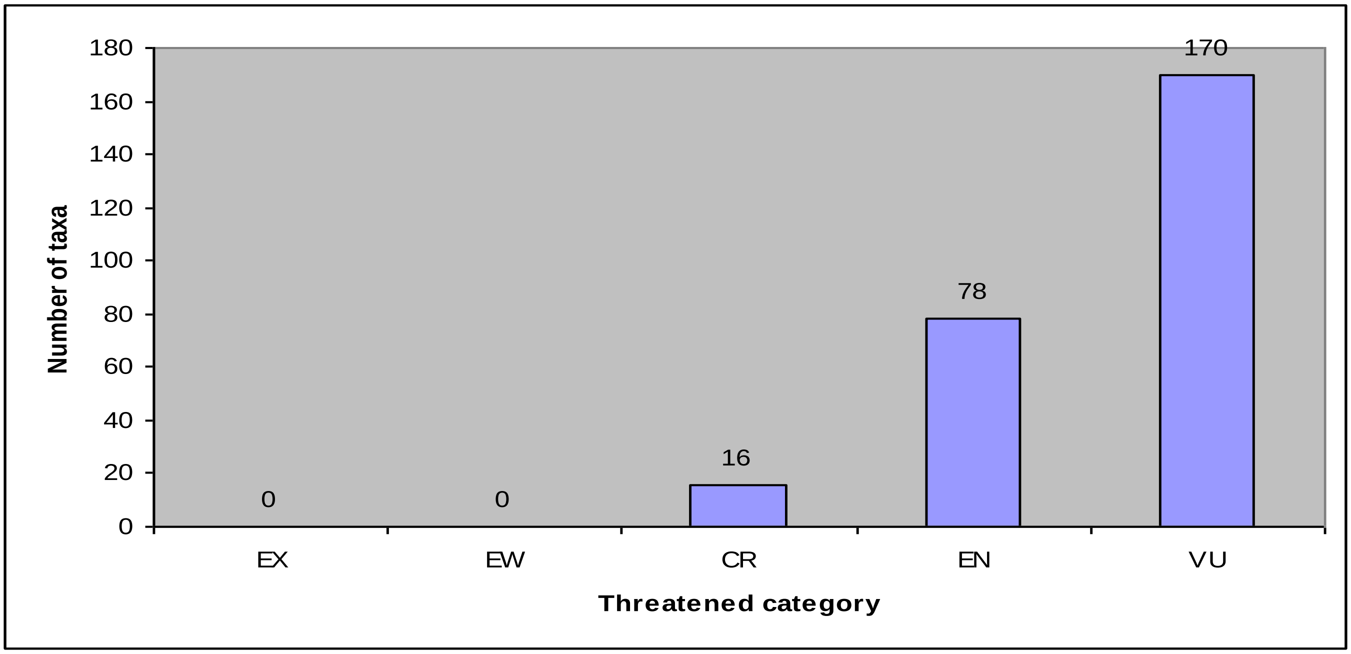
In the project area, non-of the plant species in this category have been identified.

**Vulnerable (VU)**

*A taxon is Vulnerable when the best available evidence indicates that it is facing a high risk of becoming endangered in the wild.*

In the project area, non-of the plant species in this category have been identified

**Figure 2: Current status of IUCN threatened plant species in Tanzania (Version 2016-2019)**




### 4.4 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The basic principals of the CITES is to control and monitor international trade in endangered and threatened species. The Convention establishes the international legal framework for co-operation of the producer and consumer is essential for the conservation of the species traded from the wild. The convention operates by means of a licensing system. At the core of the Convention are three appendices-in effect three species lists.

***Appendix 1***

*Appendix 1 includes those species of animals and plants in which, with a few exceptions trade in wild specimens is prohibited*

In the project area, non-of the plant species in this category have been identified.

***Appendix 11***

*Includes those species whose survival is not yet threatened but may become so. Here trade is allowed in both wild and artificially propagated or captive bread specimens-subject to licensing.*

In the project area, non-of the plant species in this category have been identified.

***Appendix 111.***

*This category acts as a support mechanism to domestic legislation, where countries ask other parties to monitor trade taxa not listed on appendix 11 or Appendix 1.*

In the project area, non-of the plant species in this category have been identified.

### 4.5. Endemic plant Species

*Endemic plant species are plants which are native and confined to a particular region and not native to other areas.*

In the project area, one tree species *Commiphora campestres* has been identified growing in the *Acacia-commiphora* open woodland vegetation category as shown below.

Plate 11: *Commiphora campestres* – (Burceraceae family) an Endemic tree species restricted to T2 and T3 floristic regions in Tanzania

## 5. POSSIBLE IMPACTS OF PROJECT ACTIVITIES ON THE VEGETATION IN THE PROJECT AREA

From the survey findings:

- It has been established that the proposed establishment of the Soda ash factory falls in areas with significant cover of natural vegetation with human settlements;
- The project area also falls in the vegetation types which supports the lives of key plant species such an endemic tree;
- Although the project foot prints falls in vegetation which supports the growth of an endemic tree species, but the endemic tree is well distributed in the areas outside the foot prints. Therefore, there will be slightly **negative direct impact** on the vegetation during the construction work;
- There is a high possibility of introducing an invasive and alien plant species in the area during construction and operating time due to high movements of vehicles too and from the factory to urban areas;
- There is a chance of creating land use conflicts between pastoralist and agriculturists during the operating time as some people might establish commercial agricultural activities due to increase of population into the surround areas which leads into high demand of food; and

- The existing natural woody vegetation such *Acacia tortilis* woodland and *Acacia-commiphora open* woodland in the project area and its surrounding will be vulnerable as a source of energy such as charcoal and building materials. The factory employers and influx of business man to the area will increase the demand of forest products especially charcoal which are limited.

## 5.2. SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS AND THEIR SIGNIFICANCE

The Table below presents some of the known and foreseeable impacts of the project. They range from potential impacts of site acquisition, mobilization of materials/ equipment, mining and mining operations and decommissioning.

**Table 5.1**: Impact summary

| Phase | Potential Direct Impacts | Significance Value |
|---|---|---|
| SITE SELECTION PHASE | Land use change of the project area | Negative, long-term, low significance |
| MOBILISATION PHASE | Destruction of riparian habitat along the roads and around the bore holes | negative, and short term medium significance |
| CONSTRUCTION PHASE | Clearing of vegetation including some endemic tree species aound the bore holes and along the inner road network | negative, short term and of moderate significance |
| | high possibility of introducing an invasive and alien plant species in the area | Negative, long term of moderate significance |
| OPERATION PHASE | Smoke and dust Pollution from mining equipment which may smother plant leaves and interfere with photosynthesis | negative, long term and of medium significance |
| | Possible land use conflicts between pastoralist and agriculturists during the operating time as some people might establish commercial agricultural activities due to increase of population into the surround areas which leads into high demand of food. | Negative, long term of high significance |

| Phase | Potential Direct Impacts | Significance Value |
|---|---|---|
| | Destruction of natural woody vegetation such *Acacia tortilis* and *Acacia-commiphora open* woodland in the project area and its surrounding as a source of energy such as charcoal and building materials. | Negative long term and of high significance |
| | Contamination of Environment by wastes from mining activities | Negative and Long term of high significance |
| | Loss of aesthetics due to haphazard disposal of mined waste material | negative, short/medium term and of medium significance |
| | Loss of aesthetic value due to abandonment of structures | negative, long-term, moderate significance |
| DECOMMISSIONING PHASE | Loss of aesthetics due to site rehabilitation process | negative, short/ term and of medium significance |

## 5. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN FOR FAUNA IN THE PROJECT AREA

| Phase | Impact | Management Measure | Target level/ Standard | Responsibility | Annual Costs [TZS] |
|---|---|---|---|---|---|
| Mobilization phase | Degradation of riparian vegetation along the road to the project site and around the bore holes | Replant trees in the neighbourhood | Leveled surface with trees planted | NDC | 2,000,000 |
| | Introduction of alien invasive species | Close monitoring of any growth of non native species<br><br>Weeding all newly grown plants around the construction sites | Absence of alien invasive plant species in the project area<br><br>Ornamental plants to be planted around the buildings should be native to the area | Contractor | |
| Construction phase | Clearing of vegetation including some endemic tree species around the bore holes and along the inner road network | Most of the infrastructures such as road and buildings should be located in areas which does not bear woody vegetation to avoid unnecessary tree cutting which are a rare life form in the project area | No cutting of any woody vegetation | Contractor | - |

| Phase | Impact | Management Measure | Target level/ Standard | Responsibility | Annual Costs [TZS] |
|---|---|---|---|---|---|
| | | Avoid unnecessary tree cutting and vegetation clearing | Minimum clearing of natural woody vegetation (trees) | contractor | - |
| Operation phase | Harvesting of woody vegetation for fuel wand construction poles | The-project developer should liaise with the forest department of Monduli district on managing and monitoring the business of charcoal to make sure that there is a protection of the woody vegetation | No sporadic exploitation of the trees from the natural vegetation within the project area | Contractor, Monduli DC (Forestry and Environmental officers) | 2,000,000 |
| Decommissioning phase | Loss of aesthetics due to site rehabilitation process | rehabilitation or vegetation restoration is to be conducted indigenous plant species should be planted instead of exotic species which can be invasive. | All cleared places should be replanted with trees to maintain a land cover | contractor | 5,000,000 |

## 6. VEGETATION MONITORING

Monitoring assesses the effect of the project on the natural and cultural environment. Inclusion of a frame work Mbago (1999). For monitoring of the vegetation, it will improve significantly the effectiveness of the project since it can provide a mechanism for ensuring that the proposed mitigation measures have been carried-out and determining whether predictions were accurate. Therefore, monitoring programme of the vegetation should be carried out during and after the implementation of the project especially the invasive species.

### 6.1 ENVIRONMENTAL AND SOCIAL MONITORING PLAN

| Phase | Impact | Parameter to be monitored | Monitoring Frequency | Monitoring Area | Measurement Unit | Target Level/ Standard | Responsibility | Annual Cost [TZS] |
|---|---|---|---|---|---|---|---|---|
| MOBILISATION PHASE | Degradation of riparian vegetation along the road to the project site and around the bore holes | Type of Woody plants | Once every month | Project area | Volume of woody plants | Initial amount of plants | Contractor | - |
| CONSTRUCTION PHASE | Introduction of alien invasive species | Plant species | Once every three months | Along the roads, around bore holes and house construction sites | Number of alien species and amount | No alien invasive species | Contractor | 2,000,000 |
| OPERATION PHASE | Clearing of vegetation including some endemic tree species around the bore holes and along the inner road network | Woody vegetation | Once every month | Project area | Types and Volume of woody vegetation | Minimum amound | contractor | - |
| DECOMISSIONING PHASE | Loss of aesthetics due to site rehabilitation process | Plants species replanted | Once every three months | Project area | number of plant species planted in all reclaimed areas | Only Native species to be used | Contractor | 10,000,000 |

## 7. MITIGATION MEASURES AND RECOMMENDATIONS

(i) During the construction time most of the infrastructures such as road and buildings should be placed in areas which does not bear woody vegetation to avoid unnecessary tree cutting which are rarely life form in the project area.

(ii) The use of fuel woody as a source of energy in the project area especially in camps and residential areas during the construction and operating time should be prohibited to discourage the demand of fuel wood.

(iii) Unnecessary tree cutting and vegetation clearing should be avoided during the construction time to avoid loss of biodiversity and habitat loss.

(iv) To avoid much destruction of the natural habitats within and surrounds of the project area, it is recommended that quarrying materials should be collected in the areas with scattered rocks lather than on the hills of kopjes which forms the natural beauty of the areas suitable for scenery tourism.

(v) The-project developer should liaise with the forest department of Monduli district on managing and monitoring the business of charcoal to make sure that there is no sporadic exploitation of the trees from the natural vegetation within the project area.

(vi) During digging soil pits and quarrying areas, the top soil should be pulled aside in one place, then after finishing the work the top soil should be recovered on top of the pits so as to allow the regeneration of the indigenous plants of which their seed bank always stays with the top soil.

(vii) In order to maximise the utilisation of the existing natural resources, some of the large quarrying and soil collecting pits can be modified onto dams and small lakes which can be used as a source of water for green house irrigation, animals, fish farming and recreation.

(viii) The project developer should liaise with the district land use office to make sure that land for agricultural activities are not allocated near the project area as it used to be currently. This is to avoiding land use conflicts between the pastoralists and agriculturist who they have been there for many years without cropland.

(ix) In areas where rehabilitation or vegetation restoration is to be conducted indigenous plant species should be planted instead of exotic species which can be invasive.

(x) After construction activities landscaping should be directed to use native plant species for decoration and gardening instead of exotic ones.

(xi) Finally it is strongly recommended that the project developers should try to recruit labourers from among the villages which falls on the project foot prints so that they can learn about various construction techniques used to avoid environmental degradation as well as conservation techniques.

## 8. CONCLUSIONS

From the survey findings it has been concluded that, the execution of the Soda Ash project has very little direct negative impact onto the vegetations. This is due to the fact that major part of the project foot prints falls on common vegetation categories such as the edaphic grassland and bushed grassland. These vegetation types can easily regenerate after clearance and they are locally and regionally common.

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# APPENDIX 1

**Tentative Checklist of the vascular plants recorded from the Project area.**

**Acanthaceae**
*Dombeya rotundifolia,*
*Achyranthes aspera* L.
*Aerva lanata* (L.) Schult.
*Barleria acanthoides* Vahl
*Barleria grandicalyx* subsp. *mucronata*
*Blepharis maderaspatensis* Heine
*Centemopsis kirkii*(Hook.f.)Schin
*Crabbea velutina* S. Moore
*Dyschoriste subquadrangularis* C.B.Clarke
*Duosperma clinopodioides* Mildbr.
*Duosperma crenata* L.
*Dyschoriste hildebrandtii* Lindau
*Ecbolium amplexcaulis* S. Moore
*E. subcordatum* C.B.Clarke
*Megalochlamylamys revoluta*(L.)Vollesen
*Hypoestes carnosula* Chiov.
*Justicia betonica* L..
*Monechna debile* (Forssk.) Nees
*Neuracanthus tephrophyllus* Bidgood & Brummit
*Ruellia megachlamys* S. Moore
*R. patula* Jacq.
*Thunbergia alata* Bojer ex Sims
*T. gurkeana* Lindau

**Agavaceae**
*Sansevieria volkensii* N.E.Brown
*S. kirkii* Baker

**Aloaceae**
*Aloe lateritia* Engl.
*A. volkensii* Engl.

**Amaranthaceae**
*Achyranthes aspera* L.
*Aerva lanata* (L.) Schult.
*Cyathula orthacantha* (Asch.) Schinz
*C. uncinulata* (Schrad.) Schinz
*Digera muricata* (L.) Mart.
*Justicia scandens* Vahl.
*Pandiaka lanuginosa* (Schinz) Schinz
*Psilotrichum sceleranthum* Thwaites

**Anacardiaceae**
*Lannea humilis* (Oliv.) Engl.
*L. schweinfurthii*( Engl.)Engl.var. *stuhlmannii*(Engl.)Kokwaro
*Rhus natalensis* Krauss

**Apocynaceae**
*Ococanthera oppositifolia* ( Lam.) Codd
*Periploca nigrescens* Afzel.
*Secamone africana* (Oliv.) Bullock

**Asparagaceae**
*Asparagus africanus* Lam.
*A. setaceus* (Kunth) Jessop

**Asclepiadaceae**
*Calotropis procera* (Aiton) W.T.Aiton
*Caralluma dicapuae*(Chiov.)Chiov.
*Caralluma priogonum* K.Schum.
*Orbea denboefii* (Lavranos)Bruyns

**Balanitaceae**
*Balanites aegyptiaca* (L.) Delile
*B. glabra* Mildbr. & Schltr.

**Bombacaceae**
*Adansonia digitata* L.

**Boraginaceae**
*Cordia monoica* Roxb.
*C. ovalis* S.R.Br.
*C. sinensis* Lam.
*Ehretia amoena* Klotzsch
*Heliotropium steudneri* Vatke

**Burceraceae**
*Boswellia neglecta* S. Moore
*Commiphora africana* (A.Rich.) Engl.
*C. campestris* Engl. ssp. *campestris*
*C. africana*(A.Rich.)Engl. var. *africana*
*C. edulis* Engl.
*C. kataf* (Forssk.) Engl.
*C. mekeri* Engl.
*C. mossambicensis* (Oliv.)Engl.
*C. samharensis* Schweinf

**Capparidaceae**
*Boscia angustifolia* A. Rich.
*B. angustifolia* A. Rich.
*B. coriacea* Pax
*Cadaba farinosa* Forssk.
*Capparis tomentosa* Lam.
*Maerua crassifolia* Forssk.
*M. edulis* Gilg-Ben. & Be

**Caesalpiniaceae**
*Cassia abbreviata* Oliv.

**Celastraceae**
*Maytenus senegalensis* (Lam.) Exell

**Chenopodiaceae**
*Suaeda monoica* Forssk. ex J.F.Gmel.

**Combretaceae**
*Terminalia brownii* Fresen.

**Commelinaceae**
*Commelina africana* L..

**Compositae**
*Aspilia mosambicensis* (Oliv.) Wild
*Berkeya spekeana* Oliv.
*Bidens leariloba* Oliv.
*Bothriocline argentea* (O.Hoffm.) Wild & G.V.Pope
*Conyza pyrrhopappa* Sch.Bip. ex A.Rich.
*Emilia coccinea*(Sims)G. Don
*E. discifolia*(Oliv.) C.Jeffrey
*Pluchia dioscorides* (L.) DC.
*Vernonia adoensis* Sch.Bip. ex Walp.
*V. cinerea*(L.)Less.

**Convolvulaceae**
*Astripomea hyoscyamoides*(Vatke)Verdc.
*Ipomoea bullata* Oliv.
*I. crassipes* Hook.
*I. hildebrandtii* Vatke
*I. kituiensis* Vatke
*I. malvacea* (Klotzsch) A.Meeuse

**Cucurbitaceae**
*Cucumis dipsaceus* Spach
*Cucumis figarei* Naudin
*Mormodica foetida* Schumach.

**Cyperaceae**
*Cyperus exaltatus* Retz.
*Cyperus rotundus* L.

**Euphorbiaceae**
*Acalypha ornata* A.Rich.
*Croton dichogamus* Pax
*Erythrococca menyharthii* (Pax) Prain
*Euphorbia candelabrum* Kotschy
*E. cuneata* Vahl

**Gramineae**
*Aristida adoensis* Hochst.
*A. babicolis* Trin. & Rupr.
*A. stenostachya* Clayton
*Brachiaria brizantha* (A.Rich)Stapf.
*Chloris pycnothrix* Trin.
*C. woodii* Renv.
*Ctenium concinnum* Nees
*Cynodon dactylon*(L.)Pers
*C. plectostachyus* (K. Schum) Pilg
*Dactyloctenium aegyptium* (L.) Willd.
*D. bogdanii* S.M.Phillips
*D. giganteum* Fisher & Schweick.
*Dicanthium annulatum* (Forsk)Staf
*Digitaria milanjiana* (Rendle) Stapf
*Eleusine multiflora* A.Rich.*Eragrostis aspera* (Jacq.) Nees

*E. congesta* Oliv.
*E. superba* Peyers
*Eriochloa fatmensis* (Hoschst.& Steud.)W.D. Clayton
*Harpachne schimperi* A. Rich.
*Hermathria natans* Stapf
*Heteropogon contortus* (L.) Room, Schults
*Hyparrhenia nyassae* (Rendle) Stapf
*H. filipendula* (Hochest) Stapf
*Oryza sativa* L.
*Panicum colorotum* L.
*P. infestum* Peters
*P. maximum* Jacq.
*Pennisetum mezianum* (Nees) Benth.
*P. trachyphyllum* Pilg.
*P. unisetum* (Nees) Benth.
*Phragmites mauritianus* Kunth.
*Polystachion polystachion* (L.) Schult.
*Senchurus ciliaris* L..
*Setaria homonyma*(shika nguo)
*S. verticillata*(L.)Beauv.
*S. incrassata* (Hochst) Hock.
*S. sphacelata* (Schumach) Moss
*Sorghum arundinaceum* (Desv.) Stapf
*Sporobolus consimilis* Fresen.
*S. iocladus*(Trin.)Nees
*S. panicoides* A.Rich.
*S. pyramydalis* P.Beauv.
*S. spicatus* (Vahl) Kunth.
*Thelepogon elegans* Roem. & Schult.
*Themeda triandra* Forssk.
*Tragus berteronianus* Schult.
*Urochloa mossambicensis*(Hack.)Dandy

**Labiatae**
*Becium obovatum (*E.Mey. ex Benth.) N.E.Br.
*Hoslundia opposita* Vahl
*Leonotis mollissima* Gurke
*Leucas martinensis* (Jacq.) R.Br.
*L. tomentosa* Gurke
*Ocimum bacilicum* L.
*O. kilimandcharicum* Gurke
*Ocimum suave* L.

**Malvaceae**
*Abutilon guineense* (Schumach. & Thonn.) Bak.f. & Exell
*A. hirtum* (Lam.) Sweet
*Azanza garckeana* (F.Hoffm.) Exell & Hillc.
*Hibiscus diversifolius* Jacq.
*H. micranthus* L.f.
*H. surattensis* L..
*Sida cordifolia* L..
*S. corymbosa* R.E.Fr.

**Mimosaceae**
*A. mellifera*(Vahl) Benth.
*A. brevispica* Harms
*A. hockii* De Wild.
*A. nigrescens* Oliv.
*A. nilotica* (L.) Willd.
*A. nubica* Benth.
*A. thomasii* Harms
*A. tortilis*(Forssk.)Hyne
*Dichrostachys sinerea* (L.) Wight & Arn.

**Moraceae**
*Ficus sur* Forssk.

**Ochnaceae**
*Ochna mossambicensis* Klotzsch

**Onagraceae**
*Jussiaea repens* L.

**Opiliaceae**
*Opilia campestris* Engl.
*O. celtidifolia* (Guill. & Perr.) Walp.

**Papilionaceae**
*Crotalaria .steudneri* Schweinf.
*C. incana* L..
*C. spinosa* Benth.
*Gylcine wightii* (Wight & Arn.) Verdc.
*Indigofera hirsuta* L..
*I. schimperi* Jaub. & Spach
*Macrotyloma axillare* (E.Mey.) Verdc.
*M. maranguense* (Taub.) Verdc.
*Ormocarpum kirkii* S.Moore
*O. trachycarpum* (Taub.) Harms
*O. trichocloa* (Taub.) Engl.
*Rhynchosia hirta* (Andr.) Meikle & Verdc.
*R. minima*(L.)DC.
*Sesbania macrantha* Phil. & Hutch.
*Sesbania sesban* (L.) Merr.
*Spathionema kilimandscharicum* Taub.
*Tephrosia pumila* (Lam.) Pers.
*T. villosa* (L.) Pers.
*Vigna unguiculata* (L.) Walp.

**Peddaliaceae**
*Sesamothamnus rivae* Engl.

**Polygonaceae**
*Oxygonum sinuatum* (Meisn.) Dammer

**Portulacaceae**
*Portulaca orelacea* L.

**Rhamnaceae**
*Ziziphus mucronata* Willd. ssp. *mucronata*

**Rubiaceae**
*Gardenia ternifolia Schumach*. & Thonn. ssp.*ternifolia*
*Psychotria riparia* Schum. & K. Krause) Petit
*Spemacoce dibrachiata* Oliv.

**Rutaceae**
*Teclea nobilis* Delile
*Vepris glomelata* (F.Hoffm.) Engl.

**Salvadoraceae**
*Dobera loranthifolia* (Warb.) Harms

**Sapindaceae**
*Allophyllus africanus* P.Beauv.

**Solanaceae**
*Lythium shawii Roem & shult,*
*Solanum indicum* L.

**Sterculiaceae**
*Dombeya burgessiae* Gerr. ex Harv. & Sond.
*Dombeya shupangae* K.Schum.
*Melhania velutina* Forsk.

**Tiliaceae**
*Grewia forbesii* Harv. ex Mast.
*G. mollis* Juss.
*G. tembensis* Fresen.
*G. villosa* Willd.
*Sperrmania ricinocarpa*(Eckl.&Zeyh.)Kuntze var. *ricinocarpa*

**Typhaceae**
*Typha capensis* (Rohrb.) N.E.Br.

**Verbenaceae**
*Clerodendrum glabrum* E. Mey
*C. jonhstonii* Oliv.
*Lantana virbunoides*(Forssk.) Vahl
*Lippia javanica* (Burm.f.) Spreng.
*Stachytapherta jamaicesis* (L.) Vahl

**Vitaceae**
*Cissus cornifolia* (Baker) Planch.
*C. quadrangularis* L..
*Cyphostemma adenocaule* (A.Rich.) Wild & R.B.Drumm.

**Zygophyllaceae**
*Tribulus terrestris* L.

## APPENDIX 13: FAUNA INVENTORY BASELINE STUDY

# REPORT ON BASELINE FAUNA SURVEY FOR THE PROPOSED OF SODA ASH DEVELOPMENT PROJECT IN ENGARUKA VALLEY, MONDULI DISTRICT, ARUSHA REGION

Report for Tanzania Industrial Research and Development Organization
(TIRDO)
(Environmental Impact Assessment-ESIA)
By BENAIAH BENNO
Fauna expert

**March 2021**

## 1.0 INTRODUCTION

### 1.1 The project setting

The Ministry of Industries and Trade through NDC is implementing a project titled “Mning and Processing of Soda ash in Engaruka valley, Monduli district, Arusha region. The Project Development objective is to produce soda ash for local use and export, leading to generation of foreign exchange and contributing to the livelihoods of the rural communities who could earn incomes through being employed at the mining and processing plant. The project will also stimulate development in the nearby four village communities namely Engaruka chini, Mbaashi, Irerendeni and Donyanado. In addition, there are other villages such as Engaruka juu and Selela. The project is also expected to bring the government some revenue through local sales and export of the soda.

The proposed project will be implemented in Engaruka valley in an area of 25,000 ha. Accessibility by vehicles to the mining site could only be possible during the dry season unless a bitumen road is constructed because the area is of mainly clayey soil and so unpassable during the rainy season. In addition, some of the proposed production boreholes are located in bushy areas which currently offer refuge to a number of animals. It is mkore likely that once these vegetation are cleared it will reduce the habitats for these animals.

It is envisaged that the construction and operation of the proposed Engaruka Soda ash mining and processing project will have both positive and negative environmental and social impacts. In compliance with the Tanzania Environmental Management Act, Cap 191 of 2004, the Ministry of Industries and Trade would wish to ensure that implementation of activities under this project are environmentally and socially acceptable.

The Tanzania EIA and Audit (Amendment) Regulations of 2018, First Schedule (Type A projects) provides a list of large-scale activities that falls under a mandatory list for full EIA study. Clause 1 (c) lists the development of soda ash mining and processing (command area ≥500 Ha) under this category. As such, in fulfilment of the EIA procedure as applies in Tanzania, this report presents the indepth baseline fauna study report as the second stage after having carried out a Scoping Study as an initial stage of the ESIA process to enable the National Environmental Council (NEMC) of Tanzania make decision in accordance to the Environmental Management Act (Environmental Impact Assessment and Audit) (Amendment) Regulations, 2018.

### 1.2 Nature of the Undertaking

The project is typically a mining. The total project area is estimated at 25,000Ha command area. Currently there is no Soda ash mining activities in the area. However, earlier prospecting was done which led to digging of 16 wells. The development therefore mean planning, design and construction of the soda mining plant in order to:

- Enable soda ash to be mined to the surface;
- Construct a soda ash processing plant in the area
- Provide a road system to the area for better access to project area;

- Mitigate any adverse environmental and social impacts resulting from soda ash mining and processing; and
- Establish the physical environment for the soda mining and processing plant to be constructed and operated in an environmentally sustainable manner;

### 1.3 The project Implementation Plan

The scope of the proposed Engaruka Soda ash mining and processing plant Project will involve two main activities, namely:

i. Mining of the crude soda ash; and
ii. Processing of the soda ash to produce brine concentrate

### 1.4 Objective of the assignment

The study aimed at conducting wet and dry seasons' fauna field survey for an environmental assessment of the proposed Engaruka valley soda ash development project

### 1.5 Specific tasks

Among other things as specified by the client in the RFP, the expected outputs from the assignment included Collection and analysis of the fauna baseline data in the project area.

Therefore, the anticipated overall deliverables of the service providers were but not limited to:

- A detailed summary report on fauna resources in the wetland, aquatic, riparian, wildlife corridor, and forested area habitats, as well as rare species in the study area.
- Identification of any animals of ecological conservation concern
- Identification of critical habitats in the area including the presence of an animal migratory corridor
- Identifying all possible impacts of the project activities on the fauna in the area and proposing some mitigation measures, environmental and social management and monitoring plans
- Submission of final report which shall incorporate comments from the Client and other

## METHODOLOGY

### 2.1. Project area description

The proposed soda ash project is located in Engaruka valley, Monduli district, Arusha Region. Administratively the project area falls within the boundaries of four villages including Engaruka chini, Irerendeni (Engaruka ward), Mbaashi and Donyonado (Selela ward). The village settlements are located far away about 20km or more from the project area because part of the project area gets flooded during rainy season forming a small lake.

Topographically, the project area is gentle land sloping in the west- east direction with intetmitent raised grounds. The project site is located within the rift valley that runs from the north including Lake Natron Ngorongoro, Conservation area (Fig 2) and Lake Manyara southwards towards Lake Malawi. According to the vegetation expert, the vegetation in the area can be divided into seven categories namely edaphic grassland, Bushed grassland, Riverine thickets,

Acacia- Commiphora, open woodland, Thicket bushland, Acacia tortilis woodland, and Seasonal swamp marshland. The scrub land dominating the central and western part is on the western side adjacent to the project area and is very utilized by the visiting wildlife.

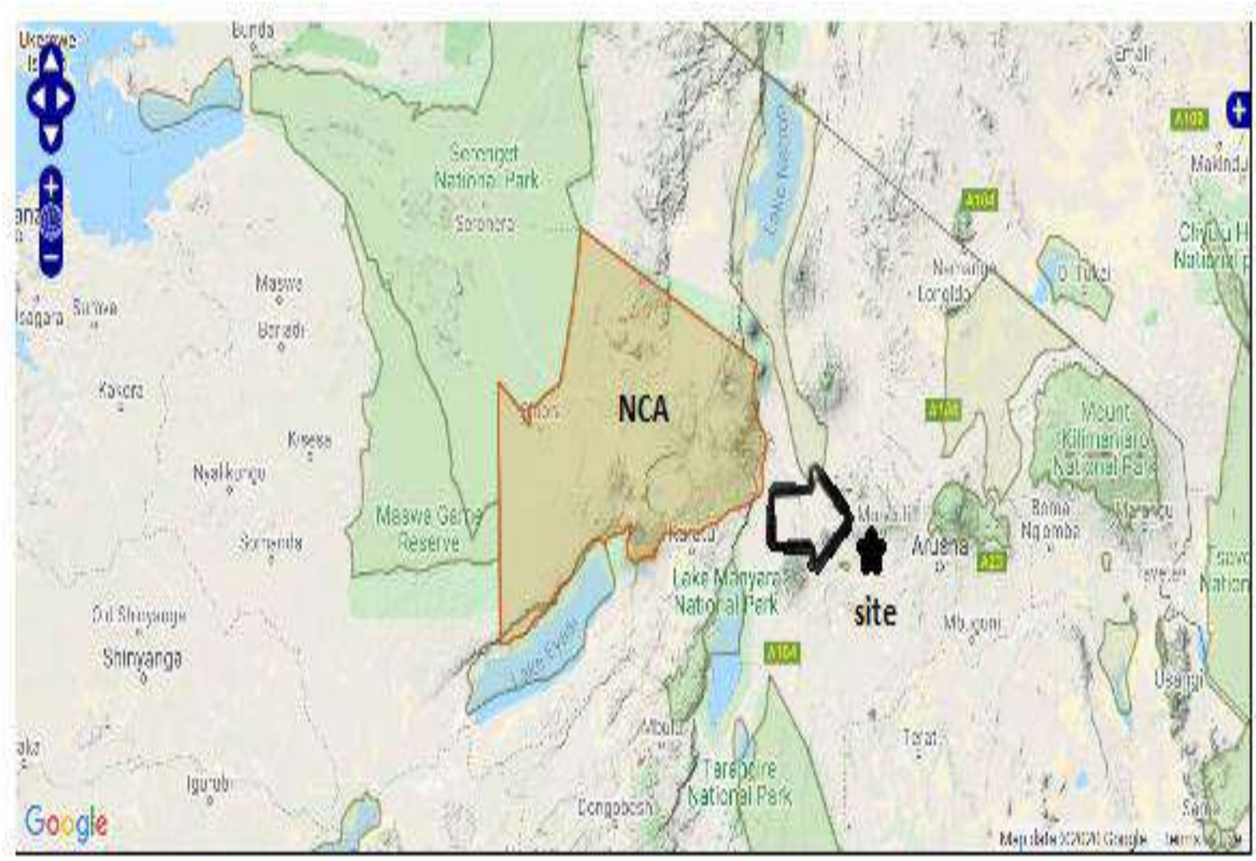


Figure 2; position of the Ngorongoro Conservation Area (NCA) in relation to the project site

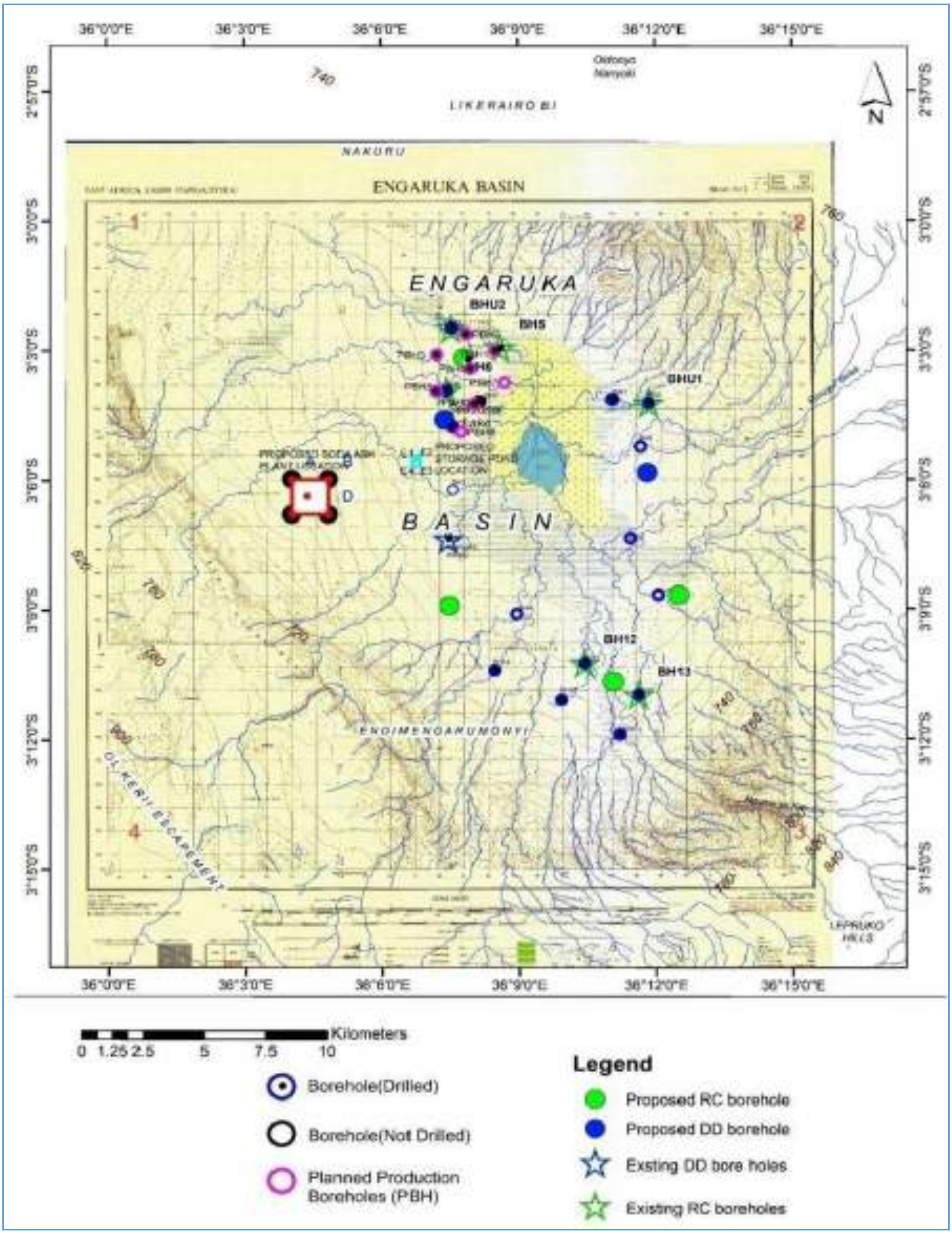

Figure 3: Map of the project area

Hydrologically, the core project area is located in a semi-arid area where drought dominates a large part of the year. Most of the rivers in the area are seasonal except Engaruka river that flows from the western rift valley wall. The other several streams appeared as big wide gorges (termed as makorongo) of sandy rivers that all end in a shallow depression that forms a seasonal lake Engaruka (plate 2), that had formed following heavy rains that fell in April and May. The lake had stretched about 20 km in the north south direction. Of the main seasonal rivers/streams, only Engaruka that flows from the North West highlands had some water. The rest on the rivers, including Kaikwat flowing from the north, Peleke and Obonai from the east, Losskene from the south, Serela and Buko from south west ere all dry.

Plate 1: Dry river valley and a temporary formed Engaruka lake, some acacia bushy trees and open dry grassland

During the baseline study wells number 3, 8 and 9 were submerged under the lake. The Engaruka valley experiences a unimodal rainfall pattern with long rains in March – May where an average of up to 130mm mm of Rainfall have been recorded to except last and this year where the rainfall has gone up 400mm while a temperature ranges from $15^{o}$ C to a maxmum of $30^{o}C$ (.1) In the neighbourhood of the proposed project area are the Northern Highland and Kitumbeine forest reserves on the north and the Ngorongoro Controlled Area about 40 km to the west.

## 2.2. Fauna study methodology

In order to establish the baseline conditions pertaining to the fauna in the proposed project area, various techniques were used as part of the proposed Project ecological study; to study animals in the study area and provide fauna checklists and relative abundance indices by main habitat types durin dry and wet seasons. Interviews with the locals were conducted to gather information on the sighting of wild animals in the project area, any seasonality of the sightings, and if there exists any migration corridor of wildlife in the project area. This was followed by a trial setting of traps during the scoping study. During the in-depth study more walk drive through surveys was done in order to identify and estimate animal densities noting animal signs such as animal dung, shaded skin, feathers, hair, bent branches, stripped trunks, grazed grass, mud ponds and food prints and sighting of animals Another survey was made to the northern and southern boundaries of the project site to check the conditions of the rivers and riparian vegetation. This was done on the western side (Engaruka chini and Irerendeni villages) side of the project area and other survey was done on the south eastern side of the project site towards Donyonado village approached from Salale village via Mbaashi village.

2.3 Sampling.

A sampling was using bucket fall traps with a drift fences that was set in the proximity of the wells at to capture some small sized animals that could be present in the project area (Plate 3).

Setting of the traps was carried out in several places close to the proposed production bore holes, near the proposed plant site, near the proposed workers residential area and also other places in the project area. Also, trial fishing using an cast net and a small (10m) beach seine and small beach seine was done on the so formed lake at two sites on the Engaruka chini side. The sampling sites were as shown in table 1.

| Sn | Geographic position | Project feature | characteristics |
|---|---|---|---|
| 1 | 03$^{o}$ 04’ 13’’S; 36$^{o}$07’14’’E | Near borehole no,4 | Grassland with bushes |
| 2 | 03$^{o}$ 04’ 04’’S; 36$^{o}$07’28’’E | Near borehole no6 | Open grassland |
| 3 | 03$^{o}$ 04’ 19.6’’S; 36 $^{o}$08’11.6’’E | Near Borehole no 7 | Open with scattered grass, about 50 m from the lake |
| 4 | 03$^{o}$ 02; 05.’’S, 36$^{o}$ 05’39.1’’E | Near borehole no 5 | Open grassland with thorny bushes |
| 5 | 03$^{o}$ 02’ 50.4’’S, 36$^{o}$ 08’43.’’E | Near borehole | Grassland with Bushes |
| 5 | 03$^{o}$ 02’13.9.’’S, 36$^{o}$ 04’20.’’E | Near proposed workers residential area | Wooded Grassland with sedges an d treess |
| 6 | 37m 1802672 S,9662112 E | | lake |
| 7 | 37m 182578S,9662191 E | | lake |

**Plate 2: Trapping animals in the proposed project area: Bucket fall trap with a leader fence and fishing by a small beach seine in Engaruka lake**

## 3. STUDY FINDINGS

### 3.1. Distance to Nearest Residential and/or Other Facilities

The Engaruka soda ash mining facility will be located a bit way from the nearest residence areas of the four villages of Irerendei, Engaruka chini, Mbaashi and Donyanado. Due to the clayey soil that makes the area difficult to track during rainy season the settlements are located very far away, for example the Engaruka chini village is about 20km away although there are two Masai bomas located less than 5km away from the project site.

### 3.2. Adjacent Land Uses (Existing & Proposed)

Adjacent land uses are two namely: pasture land and human settlement. In the immediate vicinity, there is a a pastureland used mainly for livestock keeping and a residential land, The residential houses include a few scattered (Maasai boma) with cattle pen around in which a mix of goat, sheep and cattle are kept. In the area of influence are resource village centres at Engaruka chini, Irerendeni, Engaruka juu, Mbaasi, Donyanado and Selela villages and Mtowa mbu town.

### 3.3. A Declaration That the Project Site is Not Within or Near the Sensitive Ecosystem/Areas

Ecologically, the closest sensitive biological ecosystem to the project area is the Ngorongoro Conservation Area located about 40 kms away North West of the project area. Another is The lake Natron about 60 km north which is an Important Bird area harbouring the lesser flamingos. Also the Engaruka ruins are located about 30km away from the project site Socio-economically/strategically, there is no sensitive public utilities such as schools and hospitals and military base in the project area.

### 3.4. The animal habitats

At the time of the baseline study some habitats had changed especially the grass had dried out rendering some areas bare (Plate 1). Only a few areas still had some habitat that could provide refugia to animals. The animal habitats in the proposed project area include the seven terrestrial vegetation categories as was described by the vegetation expert ie., Edaphic grassland, Bushed grassland, Riverine thickets, Acacia- Commiphora , open woodland, Thicket bushland, *Acacia tortilis* woodland, and Seasonal swamp marshland, the seasonal rivers/ streams for aquatic habitats. However, there also exists an extensive open scrubland adjacent to the project site which is also utilized by both domesticated and wildlife.

### 3.5 Animals found in the project area

Mammals

The wild big and small mammals that were observed and reported in and around the project area during dry and wet seasons are listed in Table 2 below:

Table 2: Wild animals identified in the project area

| S/N. | Common name | Scientific name | Dry season | Wet season | conservation status |
|---|---|---|---|---|---|
| 1 | Burchell's zebra | Equus bruchelli | | v | Lc |
| 2 | Thompson gazelle | Gazelle thompsonii | | v | Lc |
| 3 | Impalas | Aepyceros melamps | | v | Lc |
| 4 | Wildebeest | Connochaetes gnou | | v | Lc |
| 5 | Baboons | Papio cynocephalis | | v | Lc |
| 6 | Savanna Hare | Lepus victoriae | v | | Lc |
| 7 | Elephant shrew | Rhynchocyon chrysopygus | v | | Lc |
| 8 | Giraffe | Giraffe camelopadalis | | v | Lc |
| 9 | Leopard | Panther pardus | | v | Vu |
| 10 | Lion | Panthera leo | | v | Vu |
| 11 | Spectackled dormouse | Graphiurus ocularis | v | | Lc |

**Lc= Least concern, Vu= Vulnerable**

Plate 3: Some of the animal habitat types in the project area

Plate 4: Domesticated animals grazing in the project area

### 3.5.2 Reptiles

The arid conditions favour only a few species that can withstand prolonged dry conditions. The reported / observed reptiles included some snakes and skinks (Table 3).

**Table 3: Reptiles observed wet and dry season within the project site**

| sn | Common name | Scientific name | Dry season | Wet season | Concervation status |
|---|---|---|---|---|---|
| 1 | African rock python | Python sebae | v | | Lc |
| 2 | Tropical gecko | Hemidactylus mabouia | v | | Lc |
| 3 | African striped skink | Trachylepis striata | v | v | Lc |
| 4 | Leopard tortoise | Stigmochelys pardlis | v | | lc |

### 3.5.3 Amphibians

The arid conditions in the area do not favour colonisation of amphibians because they need freshwater always although they can survive on land for some time. The only amphibian types that were observed in the area include some guttural toad and the clawed frog (Xenopus sp).

**Birds**

A number of passerine birds were observed perching on the trees. Also, some ostriches and herons were seen in the proposed project area. A checklist of birds that were observed /reported (by Birdlife international. 1996) in the project area is given in Table 4.

**Table 4: List of birds observed /reported in the project area durin wet and dry seasons**

| S/N. | Common name | Scientific name | Dry season | Wet season | Ecological status |
|---|---|---|---|---|---|
| | Ostrich | *Struthio camelus* | v | v | Lc |
| | Namaqua Sand grouse | *Pterocles namaqua* | v | v | Lc |
| | Grey headed sparrow | *Passer griseus* | v | v | Lc |
| | Red winged starling | *Onychognathus morio* | | v | Lc |
| | Greater commorant | *Phalectocorax carbo* | | v | Lc |
| | Pink- banded pelican | *Pelecanus rufescens* | | v | Lc |
| | Squacao heron | *Ardeolle relloides* | | v | Lc |
| | Greta white egret | *egrettavalba* | | v | Lc |
| | Grey heron | *Ardea cinerea* | | v | Lc |
| | saddle billed stork | *Ephipprorhynchus senegalensis* | | v | Lc |
| | Marabou stork | *Leptoptilis cruneniferus* | | v | Lc |
| | Glossy ibis | *Plegadius falcinellus* | | v | Lc |

| S/N. | Common name | Scientific name | Dry season | Wet season | Ecological status |
|---|---|---|---|---|---|
| | African spoonbill | *Platalea alba* | | v | Lc |
| | Cape wigeon | *Anas capensis* | | v | Lc |
| | Crowned crane | *Balearica pavonina* | | v | Lc |
| | Avocet | *Recuvirostra avosetta* | | v | Lc |
| | Wood sandpiper | *Triangea glare* | v | v | Lc |
| | African black crow | *Corvus capensis* | v | v | Lc |
| | Pied crow | *Corvus albus* | v | | Lc |
| | White naked raven | *Corvus albicolis* | v | | Lc |
| | Superb starling | *Lamprotornimus superbus* | | v | Lc |
| | Burchells starling | *Lamprotornis australis* | | v | Lc |
| | Red-winged starling | *Onychognathus morio* | | | Lc |
| | Scarlet chested sunbird | *Nectarinia senegalensis* | | v | Lc |
| | Mariqua sunbird | *Nectarinia mariquensis* | | v | Lc |
| | Lesser masked weaver | *Ploceus intermedius* | | v | Lc |
| | African red-eyed bulbul | *Pycnonotus nigricans* | v | v | Lc |
| | Bearded woodpecker | *Thripias namaquus* | | | Lc |
| | Southern yellow billed hornbill | *Tockus leucomelas* | | v | Lc |
| | Speckled mousebird | *Colius striatus* | | v | Lc |
| | Secretary bird | *Sagittarius serpentarius* | | v | Lc |
| | Crested francolin | *Francolinus sephaena* | | v | Lc |
| | Helmented Guinefowl | *Numida meleagris* | v | | Lc |
| | Laughing dove | *Streptopelia senegalensis* | v | | Lc |
| | Greater flamingo | *Phoenicopterus ruber* | | v | Lc |
| | Lesser flamingo | *Phoeniconaias minor* | | v | NT |

**Fishes**

A trial fishing in the Lake Engaruka never yielded any fish. Even the rivers that flow into the project area are mainly seasonal and during the visit they were observed to be dry except Engaruka river. The Maasai tribe do not eat fish and therefore the locals could not give definitive answers on the existence of fishes in the rivers.

## 3.6 CONSERVATION STATUS OF THE ANIMALS IN THE PROPOSED PROJECT AREA

With the exception of the lesser flamingo which is considered nearly threatened other animal species found in the area are of least concern as far as the ecological conservation status is concern, Moreover the seasonal Engaruka Lake only exists during years of very heavy rains. It was reported that for the past three years the lake never formed and therefore the water loving birds including the flamingoes were not seen in the area. Because of the dominant drought conditions the visiting flamingos never use this lake as their breeding area. Lesser flamingos are known to build mud nests far out in inaccessible salt flats and mudflats to deter humans and carnivores (Alden *et al*., 2005), a condition that is not attained by this temporary shallow and narrow lake Engaruka.

Also, this study revealed that some animals such as the Leopard and lions that occasionally visit the project area are Vulnerable according to the IUCN conservation categories. These animals will not be affected by the project activities since they are big game animals and therefore will simply flee away from the project area because of the noises when mobilization construction and operation activities begin.

### 3.7 THE TARANGIRE LAKE NATRON WILDLIFE MIGRATION CORRIDOR

The proposed project area lies adjacent to the wildlife migration corridor between tarangire National Park and the Northern Gelai plains south of Lake Natron. The Tarangire Ecosystem is defined by the large migratory ranges of the eastern white-bearded wildebeest and Grant's zebra as they move in and out of Tarangire National Park in their age-old search for water and food. Research has shown that 30-50% of Tarangire wildebeest migrate northward to give birth in the Northern Plains, and thousands of Tarangire's zebra, eland, oryx, and gazelles also use the plains south of Lake Natron each wet season. Only 2 of the former 10 migration routes remain – one north to the Opirr Calving Grounds on the Gelai Plains (fig 2), and one east to the Simanjiro Plains. These populations migrated along 10 routes between their dry-season range in Tarangire and their wet-season ranges outside the park, with annual distances up to 250 km. The wet-season range is critical because it provides nutrient-rich grass necessary for reproduction.

Genetic evidence indicates that Tarangire population of wildebeests is unique, as it has not mixed with the population in Serengeti/Ngorongoro for thousands of years. Thus, the loss of these wildebeests could mean the extinction of an entire species. Because neither route is adequately protected, habitat within these migration corridors continues to be rapidly lost to farming and permanent human settlements, and illegal poaching of wild ungulates along the migration routes. Not surprisingly, the eastern white-bearded wildebeest declined from 40,000 animals in 1988 to just 7,000 in 2014. Therefore, the conserving the migration from Tarangire to the Northern Plains is very important as it will protect the notably the unique population of eastern white-bearded wildebeest. Conservation of the migration corridor will preserve the economy, ecology, and culture of the Tarangire Ecosystem and provide an engine for economic growth in the region for generations to come.

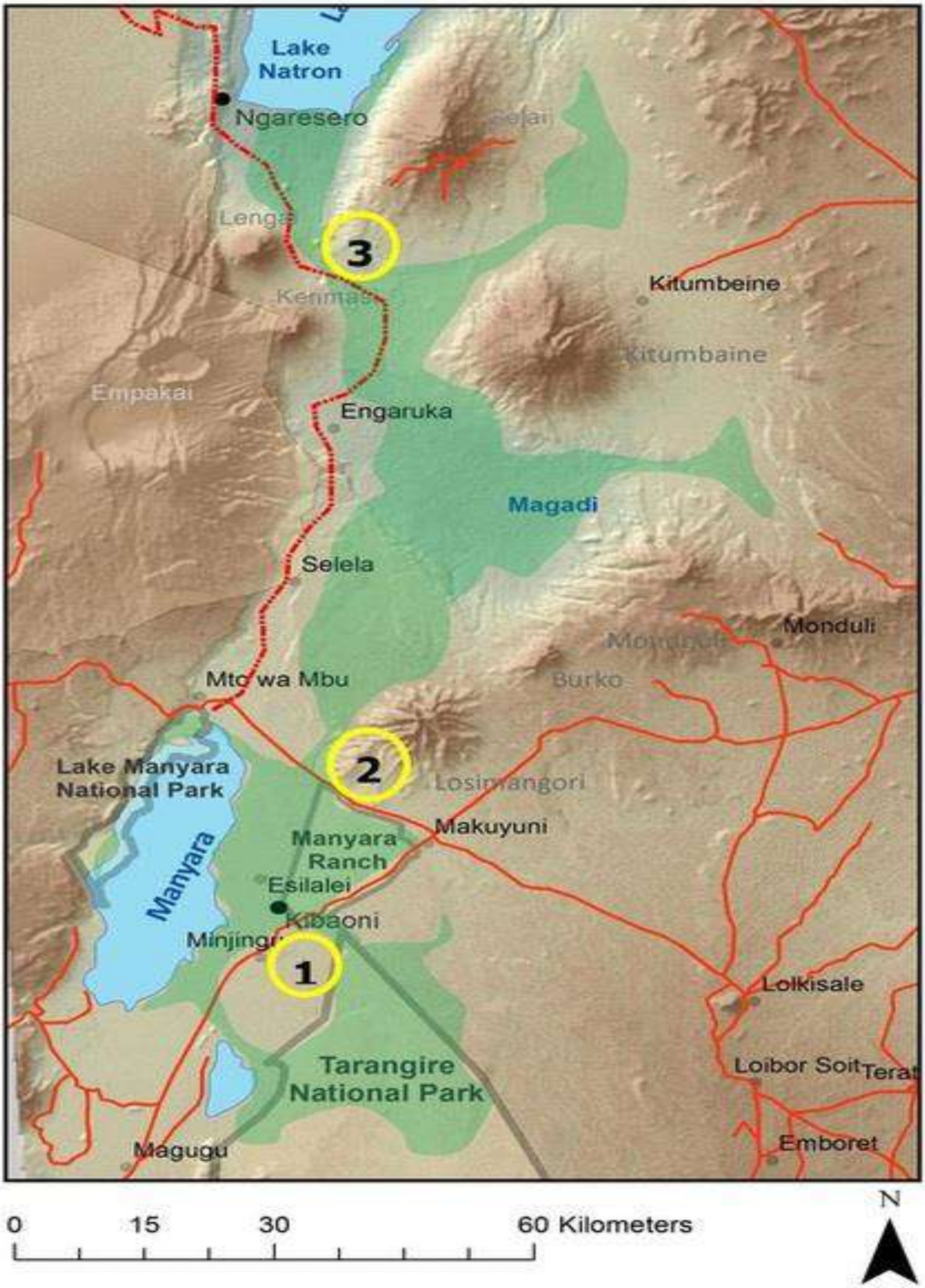


**Plate 6:** Adopted from: https://www.wildnatureinstitute.org/corridor-campaign.html


Plate 5: Some animals observed in the project area

**`Plate 7: Some of the fauna observed in the proposed project area**

## 4.0 LIKELY IMPACTS OF THE PROJECT ACTIVITIES AND MITIGATION MEASURES

### 4.1 Impact Assessment

Impact assessments were determined by superimposing project infrastructures onto the existing bio-physical environment of the project site. This involved analysis of data for identification, prediction and evaluation of foreseeable impacts, both beneficial and adverse, of the proposed project using checklists, simple matrices and expert judgment; and reference to standards and guidelines.

### 4.2 Impact Identification and Evaluation

The methodology used considered all the potential impacts using a standard matrix approach, which among other things considers impacts on the fauna.

### 4.3 Mitigation Measures and Management Controls

Identification of mitigation measures that aim at eliminating or minimizing the potential negative impacts and enhance positive ones using expert judgment and best practices was conducted. Plans for management and monitoring of identified mitigation and enhancement measures were also prepared.

## 4.4 LIKELY IMPACTS

The most likely negative impacts of the project activities include destruction of the habitat displacement of some organisms and these differ depending on the project phase

### 4.4.1 SITE SELECTION PHASE IMPACTS

IMPACT 1: **Loss of part of vegetation in riverine ecosystem due to land clearance for installation of mining rigs**

An appreciable area around the boreholes will be cleared for installation of drill rigs. Some of these sites are in wooded grass land areas and therefore the vegetation loss in an area where most of the land is open consisting of scrub. Otherwise most of the wells are located in the seasonal lake area where there exists less vegetation. Although no big mammals were seen in the woodland areas, footprints of gazelles also some guttural toad that were observed in the areas. The vegetation to be lost may be providing shade to the wildlife

IMPACT 2: D**isturbance of biodiversity due to field investigations and surveys**

Geotechnical investigations and land surveys may involve clearance/trampling of vegetation and small mammals and amphibians, while digging of pits cause soil disturbance, loss of vegetation and disturbance of fauna. A baseline study revealed the presence of wildebeests, zebras, giraffes, and toads in the area while interviews reported the presence of snakes, leopards, warthog and occasionally lions in the bushes. It was also reported that several bird species frequent the area including Ostriches, Guinea fowls, greater and lesser flamingos. On the other hand zebras, Thompson gazelles, zebras, wildebeests and hare were observed in the open scrubland west of the proposed project site

### 4.4.2. MOBILIZATION & CONSTRUCTION PHASE IMPACTS

IMPACT 3***:*** **Land degradation / resources depletion at points of source of construction materials**

Exploitation of input materials for construction purposes (sand, stones, aggregates, gravel, fill materials etc.) from onsite excavation works or offsite location may cause direct or additional land disturbances /soil erosion and/or depletion at the sources of construction materials. Aggregates could be readily available obtainable from in Mbaashi village where granite rocks exist which can enable a quarry to be established. However, if the quarry site is not well managed it could lead to land degradation manifested by disorderly vegetation clearance and eroded soils. The mining and processing plant infrastructure development is expected to contribute towards leading to further cumulative effects of resource depletion and / or degradation. However, since the aggregates may only be needed during the construction period and therefore the negative impacts will not last long.

IMPACT 4: **Loss/damage of biodiversity due to site clearance and civil works**

Vegetation clearing and trampling, during earth/excavation works and civil works are likely to cause direct damage or disturbance of local vegetation and associated fauna. The most likely fauna to be negatively impacted include small mammals, reptiles, amphibians and aquatic life if any in the seasonal rivers and swampy areas. Terrestrial parts of the project footprint may have some wildlife especially the big mammals that were observed in the open scrub land including zebras, Girrafes, Thompson gazelles, and warthogs. Also in the area other animals observed and reported include, hares, ostriches, reptiles (snakes and lizards) ampbibians (Guttural toads) and big flocks of birds. It was also reported that occasionally animals vist the area from Islalei and the Ngorongoro conservation area which is about less than 40 km away. In addition, the herdsmen from the neighbouring villages utilise the area as a pasture land for their cattle, sheep, goats and donkeys. Therefore, the clearance of vegetation that offers habitat and food will certainly disturb the animals during the time of construction

**Impact 5: Restricted access by fauna to natural habitats**

The main impact to fauna related to project activities include restriction of free access of the animals to the wooded grassland and watering points in the project area that will probably be fenced. The primary causes of intrusion could be physical presence of infrastructures construction works for the erection of drilling rigs and the processing plant.

IMPACT 6: **Flight/disturbance of sensitive fauna by noise and vibrations from equipment operations and movement of vehicles**

Materials and personnel's transportation by vehicles and operation of equipment and machinery will generate noise, vibrations that may exceed allowable level within the project zone and cause distraction and scare wildlife – especially avifauna. Various avifauna species including ostriches, herons, guinea fowls, lesser flamingo and many passerine species have been observed seasonally in the proposed project area and in the adjacent scrubland flat. Noises emanating from drilling activities, may initially scare away the animals although later they may not flee away after getting used to the noises. Besides the birds, others big animals that may flee because of the noise disturbances include the small mammals and reptiles

IMPACT 7: **Deterioration of ambient air quality by dust emissions from vehicles movements, and disturbed loose soils and exhaust emissions from equipment and vehicles operations**

Construction works are associated with smoke and dust emissions from land clearance, transportation of construction materials, stockpiling and offloading materials at the site, and vehicles running on loose earth village roads. Dust emissions (including fugitive (unavoidable, residual) impair local air quality and are nuisance to humans in settlement areas and can smother vegetation leaves impairing photosynthesis. Large mammals and birds will only avoid such places, the only problem will be with the small mammals. Also, upon settling, the dust can for silt in water and therefore affecting the aquatic organisms that use gills as their breathing organs.

Exhaust emissions containing carbon-dioxide ($CO_2$) plus small quantities of noxious Green House Gases such as nitrogen oxides (NOx), sulphur dioxides (SOx), hydrocarbons and particulate matters (PM) that cause deterioration of ambient air quality albeit to a very small degree. $CO_2$ is a greenhouse gas which is known to cause global warming and consequently climate change effects.

When the dust settles to the ground, it may be washed into the streams as silt, sediments and other debris in water may clog the breathing organs (gills) of aquatic organisms such as fishes and some macro-invertebrates found in the river. The contribution of these greenhouse gases in the air around the project area could be minor lasting especially during mobilisation and construction phases but will be reduced during operation as few machines will be used and these gases can be sequestered by the vegetation in the project area.

IMPACT 8: **Land disturbance / soil erosion due to earth, excavation and civil works**
Construction activities will involve site clearing; earth and excavation works (involving removal of silts and top soils, cutting/filling, trimming, levelling and compacting); civil works involving digging, trenching, excavation, draining, filling, placement of material and spreading, resurfacing, watering and compacting, piling of foundation; concrete works, block/brick works). These activities cumulatively and singly are likely to involve some degree of land disturbance and/or movement of soils causing damage of soil profile / structure leading soil erosion. Soil erosion lead to degradation of land and land-based resources – substantially reducing their quality (nutrients, water retention, physical properties etc.) below acceptable levels, as well as causing damage / disturbance to soil surface and sub-surface organisms.

IMPACT 9*:* **Impairment of soil quality and water quality by construction wastes discharges**
Mobilization and construction works involve collection, transportation, handling, storage and disposal of various types of materials some of them containing pollutants. Planned or accidental discharges will involve various types and quantities of solid and liquid wastes including:

(i) Discharge of disposed spoils (overburden, demolition rubble, spoil / excavated materials), sludge from excavated wetland, and soils eroded from disturbed areas caused by vegetation clearance and uncontrolled earth moving works.
(ii) Domestic solid waste and sanitary waste and littering by construction crew[1]. Assuming that per capita waste generation is about 0.35 kg per day, the expected 50 construction labour force will generate about 17.5 kg / day of solid waste.
(iii) Domestic wastewater - assuming that each person will use 30 litres of water per day, and 80% of this amount is discharged as waste.
(iv) Spillage / leakages i.e., discharge of fuel, oil and lubricants from equipment and vehicle repairs and re-fuelling; and
(v) Storm water loaded with wastes, oils, sediments etc.

Even small quantities if not properly managed, will discharge directly into or drain across and impair qualities of receiving medium including farm land, surface water bodies (local and downstream wetlands and rivers and underground water sources. Discharges in a water habitat may affect water quality (i.e. increasing water biological and /or chemical oxygen demands –Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), organic matter content (increase total dissolved and suspended solids), turbidity, pH). Effects tend to reach further due to dispersion. Pollution to watercourses and existing wetland areas in the locality is potentially detrimental to aquatic fauna such as fishes and other macroinvertebrates.

Discharge of solid wastes, leaking fuel, oil and lubricants on land may affect the soil quality (pH, chemistry) but tend to be concentrated and localized, not dispersed or diluted (unless by rain). Runoff water from construction site may be laden with soil eroded from clearance and piling of spoil materials. Increase in soil deposits from eroded soils will obstruct natural drainage systems and cause effects on the integrity of watercourses, drainage, and sedimentation regime. Linear soda ash canals and farm service road etc. may distort natural drainage systems exacerbating water management in the soda ash mining and processing area. Decrease in volumes of local rivers due to siltation, low storm water flow and increase water turbidity and change colour will be much evident during dry season.

**4.4.3. OPERATION & MAINTENANCE PHASE IMPACTS**

Impact emanating from wastes discharged during operation will depend on the nature of the wastes.

IMPACT 10: **Impairment of air quality, soil quality and water quality from emissions of dust and smoke from drilling equipment and vehicles transporting the soda ash from bore holes to the processing plant**

Project operation will entail drilling the ground to get the soda ash and transporting the raw material to the processing plant. These machineries will emit smoke and noise and some soda ash will spill into the environment. If these will not be properly managed, they will degrade the quality of the air and the surrounding land.

IMPACT 11: **Disturbance of sensitive fauna due to vibrations and noise emissions by from drilling activities and movement of vehicles**

Operation activities may cause of disturbances to fauna especially avifauna due to noise and vibrations generated by working equipment and machinery.

IMPACT 12: **Loss of environment aesthetics die to improper disposal of solid wastes**

It is expected that many solid wastes will be generated during operation both from the mining activities and from the offices and residential houses.

**4.4.4. DECOMMISSIONING PHASE IMPACTS**

IMPACT 13: **Impairment of air quality, soil quality and water quality from demolition wastes discharges**

Project decommissioning will entail demolishing all physical structures and hence production demolition wastes. If these will not be properly managed, they will degrade the quality of receiving bodies, though temporarily.

IMPACT 14: **Disturbance of sensitive fauna due to vibrations and noise emissions by from demolition activities**

Demolition activities may cause of disturbances to fauna especially avifauna due to noise and vibrations generated by working equipment and machinery.

## 4.5. SUMMARY OF POTENTIAL ENVIRONMENTAL IMPACTS AND THEIR SIGNIFICANCE

The Table below presents some of the known and foreseeable impacts of the project. They range from potential impacts of site acquisition, mobilization of materials/ equipment, mining and mining operations and decommissioning.

**Table 6.2: Impact summary**

| Phase | Potential Direct Impacts | Significance Value |
|---|---|---|
| SITE SELECTION PHASE | Land use change of the project area | Positive, long-term, low significance |
| MOBILISATION PHASE | Destruction of riparian habitat along the roads | negative, and short term medium significance |
| | Noise, dust and smoke pollution due to movement of drilling equipment | cumulative and short term, medium significance |
| CONSTRUCTION PHASE | Air pollution due to dust from earth vehicles movements and erection of drilling rigs | negative, short term and of moderate significance |
| | Degradation of pre-existing conditions | negative, cumulative, medium-term, moderate significance |
| OPERATION PHASE | Smoke and dust Pollution from mining operations equipment | negative, long term and of medium significance |
| | Noise from mining equipment and vehicle movements | negative, long term and of low significance |
| | Accumulation of solid wastes | negative, short-term, medium significance |
| | Increased traffic accidents due to the increase of vehicle movement in the area | Negative, long term and high significance |
| DECOMMISSIONING PHASE | Loss of aesthetics due to haphazard disposal of mined waste material | negative, short/medium term and of medium significance |
| | Contamination of Environment by wastes from mining activities | negative, short-term, medium significance |
| | Dust and noise Pollution from demolishing equipment | negative, short term and of low significance |
| | Loss of aesthetic value due to abandonment of structures | negative, long-term, moderate significance |

**5. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN FOR FAUNA IN THE PROJECT AREA**

| Phase | Impact | Management Measure | Target level/ Standard | Responsibility | Annual Costs [TZS] |
|---|---|---|---|---|---|
| Mobilization phase | Degradation of habitat for small mammals due to movement of trucks | • Replant trees in the neighbourhood | Leveled surface with trees planted | NDC | 2,000,000 |
| Operation phase | Pollution due to poor handling of lubricants spills or its disposal of liquid waste | • Installation of oil/water separation chambers<br>• Regular maintenance of drainage system<br>• Regular monitoring of liquid waste management systems | Oil and Grease (fatty maters and hydrocarbons) < $10mg/m^3$ | NDC | 500,000 per yea |
| | Solid waste from offices and food wastes may increase scavenger animals in the area | • Provide solid waste collection bins within the port area;<br>• Regular disposal of solid waste from the port area to dumpsite at Engaruka village<br>• Post warning sign on strategic areas to prevent" littering | As minimum as possible | NDC | 4,500,000 per year |
| | | • | | | |

## 6. ENVIRONMENTAL AND SOCIAL MONITORING PLAN

| Phase | Impact | Parameter to be monitored | Monitoring Frequency | Monitoring Area | Measurement Unit | Target Level/ Standard | Responsibility | Annual Cost [TZS] |
|---|---|---|---|---|---|---|---|---|
| MOBILISATION PHASE | Destruction of riparian habitat along roads | Noise level | Once every month | Project area | Volume of woody plants | Initial amount of plants | NDC | 3,500,000 |
| CONSTRUCTION PHASE | Accumulation of wastes | Volume of waste | Once every three months | Mining area | Volume of waste | No waste | NDC | 2,000,000 |
| OPERATION PHASE | Increased traffic accidents due to the increase of vehicle movement in the area | Number of accident involving wildlife | Once every month | Project records | Number of accidents | Zero accidents | NDC | 1,000,000 |

## 7.0 CONCLUSION AND RECOMMENDATIONS

The in-depth study has revealed that there are some animals both domestic and wildlife in the proposed project area. The Engaruka soda ash project activities, are likely to cause some negative impacts on the fauna found in the project area especially due clearing of vegetation and releasing of some materials. However, the magnitude of these impacts is likely to be small and short lived because most of the wildlife spend most of the time in the open scrub land and the area to be used as a foot print of project area is small while the construction activities are likely not to take a very long time. The products from the mining and processing activities are not foreign to the environment. It is recommended that the contactor carry out the construction activities with the best practices and precautions to safeguard the environment and its organisms. The impact on species of ecological concern such as the lesser flamingos may not be significant since these birds only come into the project area when the temporary lake forms and this happens once after every four to five years due to the drought conditions that normally prevail in the area. The birds usually spend most of their time at lake Natron and Lake Naivasha in Kenya which are permanent soda lakes preferred by the flamingos.

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**APPENDIX 14: ARCHEOLOGY AND PALAENTOLOGY BASELINE STUDY**

# BASELINE ARCHAEOLOGY AND PALAEONTOLOGY ESIA DETAILED REPORT FOR ENGARUKA SODA ASH PROJECT, MONDULI DISTRICT, ARUSHA REGION, JULY, 2020

By Dr. Charles Saanane (Dr. *phil. nat*.)

## 1.0 Introduction and Background Information

### 1.1 Archaeological and Palaeontological Resources in Engaruka and Engare Sero

Engaruka is a village situated 63 kilometres north of Mto wa Mbu in Monduli district, Arusha region along the road to Oldonyo Lengai as well as Lake Natron and it lies at the foot of the Rift Valley escarpment (Sassoon, 1978). Furthermore, at Engaruka Chini, there is an archaeological site renowned for its extensive dry-stone ruins of both villages and field-systems (*ibid*.). The site is important whereby it is interpreted that some 500 years ago, a farming community of several thousand people chose to develop an indigenous irrigation as well as cultivation system (Sassoon, 1978, 1971, 1967; Sutton, 1984, 1978). The irrigation ruins at Engaruka, are the most extensive in the interior of East Africa (Sassoon, 1978, 1971, 1967). Archaeologist, Hamo Sassoon (1978, 1971) argued that due to unknown reasons, the farmers left Engaruka around 1700 Anno Domino [(AD, Sassoon, 1978, 1971, 1967; Sutton, 1984, 1978]. Further extensive archaeological surveys conducted by Sutton (1984, 1978) led him to give an account of the abandoned agricultural system of Engaruka Chini that they covered some five thousand acres and described the manner the whole of the area was artificially irrigated. Based on comparative analysis to some related, though smaller, sites in the area, Sutton (1984) suggested the date for the whole Engaruka Juu irrigation complex to be to the middle or latter part of the past millennium. Furthermore, Sutton (1984) attempted to expound reasons for Engaruka's decline together with its eventual desertion, a process, which seemed to parallel roughly with the growing dominance of the Wamasaai.

Not very far from Engaruka village, on the southern shore of Lake Natron near the village of Engare Sero village, scientists reported over 400 human footprints including animal tracks representing zebra and bovid preserved in a series of volcaniclastic deposits (Liutkus-Pierce *et al*., 2016; Balashova *et al*., 2016). Through geochemical as well as grain-size analyses carried out by Liutkus-Pierce and colleagues (2016), it was suggested that the deposits originated as proximal volcanic material from the nearby active volcano, Oldoinyo Lengai that were then fluvially transported to the footprint site. Stable isotope (δ18O and δ13C) results led the team (Liutkus-Pierce *et al*., 2016) to suggest that the reported footprints at Engare Sero were originally emplaced on a mudflat saturated by a freshwater spring that were later inundated by rising alkaline waters of Lake Natron. The same views were held by Balashova and colleagues (2016). Based on radiosotopic dating of unstable isotopes ($^{40}Ar/^{39}Ar$ and $^{14}C$) the age of footprint level was determined to be older than 5,760 ± 30 years Before Present (BP) and younger than 19,1000 ± 3.1 BP. Presented radioisotopic ages are supported by stratigraphic correlations with previously documented debris landslide deposits together with stable isotope signatures associated with the most recent high stand of Lake Natron, further compelling the age to the latest Pleistocene (Liutkus-Pierce *et al*., 2016; Balashova *et al*., 2016). As long as modern humans (*Homo sapiens*) were present in Africa around 200,000 including important sites in northern Tanzania like those recovered at Laetoli nick named Ngaloba skull in Ngorongoro Conservation Area (Magori and Day, 1983a, 1983b), Engare Sero represents the most abundant as well as the best-preserved footprint site of anatomically modern *Homo sapiens* currently known in Africa. Liutkus-Pierce and colleagues (2016) argued that, "fossil footprints are a snapshot in time, recording behavior at a specific moment in history; but the actual duration of time captured by the snapshot is often not well defined. Through analog experiments, we constrain the depositional window in which the prints were made, buried, and ultimately preserved to within a few hours to days or months."

**1.2 Archaeological and Palaeontological Resources in Makuyuni and Contiguous Areas**

Sediments of ancient Lake Manyara area were first described by Jäger (1913), Reck (1921) as well as Reck and Kohl-Larsen (1936). According to Reck (1921), Pleistocene sequences in Makuyuni valley were discovered early on by Louis and Mary Leakey and later on, they were examined by Kent in 1935 (1942). In 1969 and 1970, archaeological, geological and sedimentological reconnaissance survey of Lake Manyara Basin as well as neighbouring Engaruka Basin was conducted by Charles Keller, Carl Hansen and Charles Alexander. Keller and colleagues (1975) collected Pleistocene fauna materials, Acheulian stone tool materials and Middle Stone Age stone tool materials whereby they published several stratigraphic sections. They dated a basalt flow at the base of the observable sedimentary sequence in Engaruka Basin to 1.66±0.17 million years ago (Ma) using the whole rock Potassium to Argon dating method (Keller *et al*., 1975). Keller and colleagues (1975) argued that there possibly exist additional sedimentary layers below that level.

Renewed investigation of geology, palaeontology and archaeology of Lake Manyara Beds was instituted in 1994 and 1995 as well as carried out to the early 2000 by a team led by Friedemann Schrenk and Tim Bromage with Tanzanian colleagues (Schrenk *et al*., 1995; Kaiser *et al*., 1995; Kaiser, 2000; Saanane, 2004; Ring *et al*., 2005). The most important fossil localities discovered by the expedition are located close to Makuyuni village, near the intersection of Mto wa Mbu and Arusha to Dodoma roads, northeast of modern Lake Manyara where intensive surveys and controlled excavations were undertaken. Two distinctive members were recognized in Manyara Beds. First, the Lower Member is a fine-grained, lacustrine sequence and second, the Upper Member is coarser-grained, reddish and consist of more terrestrial facies (see Ring *et al*., 2005; Figure 1). Most importantly, tephra layers lending themselves to geochronological analysis were found throughout both members (Ring *et al*., 2005).

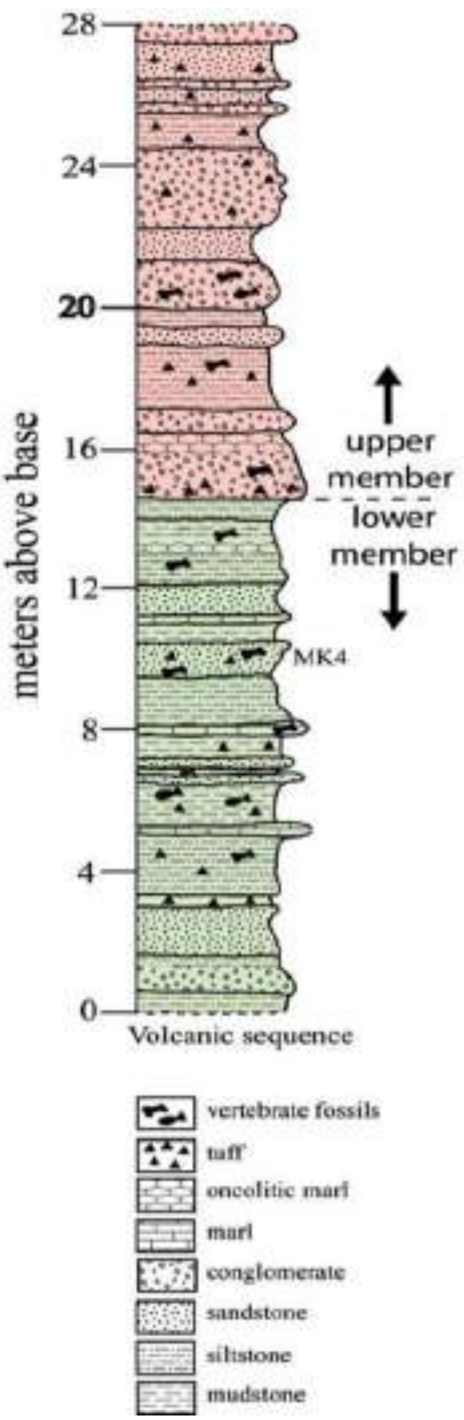


**Figure 1 Generalized Stratigraphic Column of the Manyara Beds**
**Source: Adapted from Kaiser and colleagues (1995) and Saanane (2004).**

During 1994 to 1995 expeditions, 12 fossil localities were recorded in the Lower Manyara Member with a total of 229 fossil specimens that were collected, representing a wide range of mammalian taxa including two hominin fragments assigned to *Homo erectus* (Saanane, 2004; Ring *et al*., 2005). Recovered specimens included an upper incisor and a right partial parietal (Saanane, 2004). One hundred sixty-six vertebrate fossils from nine localities were collected from the Upper Member (*ibid*.). Subsequent field works in 2000s, for example, Giemsch and colleagues (2018) resulted in discovery of 56 new sites that yielded Middle Stone Age (MSA)/Later Stone Age (LSA) artifacts and exclusive fossil sites, 45 sites yielded varying amounts of Acheulean artifacts. Based on technological as well as chronological classification, the discovered assemblage was attributed to Middle Acheulean with a few artifacts dated to early Late Acheulean (*ibid*.). Further analyses led the team (*ibid*.) to suggest that Chronometric dating places of Makuyuni finds to be between 630,000 and 270,000 years Before Present (BP) with majority of artifacts belonging to an earlier period between 630,000 and 400,000 years BP. In such research, key result is discovery of artifacts at the contact zone between the lacustrine (lower) and the terrestrial (upper) member of the Manyara Beds (see Figure 1), which allowed a stratigraphic attribution of artifacts for the first time, suggesting that hominins exploited the landscape along the shoreline of the paleolake Manyara during the early Middle Pleistocene (*ibid*.).

Besides recovery of hominin specimens belonging to *Homo erectus*, further research works in 2005 by Saanane led to discovery of a fossil non-human primate material from the Manyara Beds, which includes the first nearly complete female cranium of *Theropithecus oswaldi leakeyi* and a proximal tibia from the same taxon (Frost *et al*., 2017). The cranium is dated to between 633 and 780 hundred thousand years ago (Ka) and the tibia to Pleistocene (*ibid*.). It is known that *Theropithecus oswaldi leakeyi* lineage is one of the most important among Neogene mammals of Africa such that it is both widespread and abundant (*ibid*.). Analysis further revealed that size of the dentition, cranium and tibia all confirm the previously recognized trend of increasing body size in this lineage and make their taxonomic assignments secure (*ibid*.). In due regard, the morphology of the recovered specimen provides new insights into evolution of this lineage through time as well as its geographic variation and sexual dimorphism (*ibid*.). Furthermore, identification of specimen as representing *Theropithecus oswaldi leakeyi* agrees with Middle Pleistocene age estimates for Makuyuni Site 4 (MK4) locality, in particular, (that yielded the cranial material assigned to *Homo erectus*) and Manyara Beds, in general.

Biostratigraphically, the Lower Member correlates to Upper Bed II at Olduvai and thus, dates to approximately 1.7 to 1.3 million years ago (Ma), while the Upper Member correlates to Bed III, dating between 1.3 and 1.2 Ma (Tamrat *et al*., 1995; Ring *et al*., 2005). The lower age estimate for the Lower Member is consistent with the whole rock K/Ar age estimate for the basalt flow at the bottom of the sequence in Engaruka Basin that may be structurally related to Manyara Basin (see Keller *et al*., 1975). In addition, archaeological materials of what appears to be mainly of Mode II were found throughout Makuyuni area both in 1994 and 1995 research stints and during previous explorations of the area (Kent, 1942; Keller *et al*., 1975; Kaiser *et al*., 1995; Saanane, 2004).

Further dating (as refinement) was undertaken by an additional team (Shwartz *et al*., 2012) by using undecompacted sedimentation rates of 24e46 m/Ma led to estimate that the base of the Manyara Beds was deposited between 0.98 and 1.3 Ma and the top between 0.27 and 0.44 Ma. The team (*ibid*.) further argued that Beds III as well as IV and the Masek Beds at Olduvai were probably also deposited in the same early Middle Pleistocene interval, during which the Mid-Pleistocene Revolution climatic event and active rifting as well as volcanism in the southernmost Gregory Rift jointly contributed to landscape and ecosystem instability.

### 1.3 Archaeological and Palaeontological Resources in Areas at a Regional Scale

#### 1.3.1 General Overview

Ngorongoro Conservation Area (2°30'-3°30'S, 34°50'-35°55'E) is located in Ngorongoro District, Arusha Region in northern Tanzania (Hay, 1976; Manega, 1993). Ngorongoro Conservation Area includes Olduvai Gorge, Laetoli, Lake Ndutu, Nasera Rock Shelter and Ngorongoro burial mounds. In 1911, Prof. Katwinkel was the first to bring to attention the rich fossiliferous deposits at Olduvai Gorge (Reck, 1921; Reck and Kohl-Larsen, 1936; Leakey, 1965). Subsequent research works from 1950s to date, have brought to attention about Laetoli palaeontological site including other cultural heritage sites (Lake Ndutu, Nasera Rock Shelter and Ngorongoro burial mounds).

### 1.3.2 Physical Resources

The open plains of eastern Serengeti rise to crater highlands of volcanic massifs of Loolmalasin (about 3,587 metres above sea level) and Oldeani (about 3,168 metres above sea level) dating from late Mesozoic Era to early Tertiary period (Hay, 1976; Manega, 1993). Ngorongoro crater is one of the largest inactive unbroken calderas in the world, which is unflooded (*ibid*.). The crater has a mean diameter of 16 to 19 kilometres, a crater floor of 26,400 ha and a rim soaring between 400 and 610 metres above the crater floor (ibid.). Formation of the crater and other highlands are associated with the massive rifting that occurred to the west of the Gregory Rift Valley (*ibid*.). The Ngorongoro Conservation Area also includes Empakaai Crater, Olmoti Crater and Olduvai Gorge as well as Laetoli (*ibid*.). The latter two are famous for geology and associated palaeoanthropological findings (*ibid*.).

Olduvai Gorge is a valley in the Serengeti Plains at western margins of the Eastern Rift Valley in northern Tanzania (Hay, 1976; Leakey, L, S. B., 1965; Leakey, M. D., 1971. The gorge is generally 90 to 100 metres deep (*ibid*.). It bifurcates into two branches, a smaller southern branch or Side Gorge and a larger northern branch or Main Gorge (*ibid*.). The Side Gorge extends as far as Laetoli palaeoanthropological site (*ibid*.). The gorge cuts into Pleistocene beds, which overlie a trachyte-welded tuff known as the Naabi Ignimbrite and basement rocks of Precambrian age. Schist, gneiss and quartzite form the Precambrian basement exposed in the western part of the Gorge and in several inselbergs near the gorge (Hay, 1976; Manega, 1993). Pleistocene beds were deposited in a broad, shallow basin that lay on a surface of low relief to the east of Ngorongoro including other volcanoes of the Eastern Rift Valley (*ibid*.).

There are several faults exposed in the gorge and can be traced several kilometers northward across the Serengeti Plains (Hay, 1976). Olduvai Gorge drains into Ol'Balbal, a fault graben (*ibid*.). The exposed faults were active at various times during Pleistocene as evidenced by abrupt changes in thickness of stratigraphic units across faults (*ibid*.). On the other hand, the Ol'Balbal depression, a fault graben, was formed due to the latest episode of faulting such that it lowered the base level, resulting in erosion of the gorge to its present form depth (*ibid*.).

Due to great amplitude in terms of relief and dynamics of air masses, there is a great variation in climate in the area (*ibid*.). In the highlands, it is generally moist and misty, while temperatures in semi-arid plains can be as low as 2 degrees Celsius (°C), but can often go up to 35°C. Rainfall is seasonal and follows the altitudinal gradient (*ibid*.). Annual precipitation varies from under 500 millimetres (mm) on the arid plains in the west to 1,700 mm along forested slopes in the east (*ibid*.).

### 1.3.3 Cultural Resources (Ethnographic, Archaeological and Palaeontological)

Ngorongoro Conservation Area is a unique reserve area in that it is the only palaeoanthropological conservation area in the government gazette as a conservation area in Tanzania and it was inscribed in the World Heritage List of United Nations Educational, Scientific and Cultural Organization (UNESCO) under mixed criteria (natural and cultural) in 2008. At Olduvai Gorge on the western part of the Ngorngoro Crater, extensive palaeoanthropological finds have been made. For example, in 1959, the famous protohuman *Zinjanthropus boisei* (or *Australopithecus boisei* nicknamed "nut cracker man") was discovered (Leakey, 1971). To date, about 65 hominid remains representing various species genera as well as species have been recovered there. Also, it is the type-site for the oldest stone tools, Oldowan Stone tool techno-complex (Leakey, 1971). At Olduvai Gorge, relatively intelligent hominid specimens belonging to *Homo habilis* (nick named "handy man") were recovered (Leakey, 1965). The hominid species has been interpreted to have had been the maker and user of Oldowan stone tools (L. S.B. Leakey, 1965; M. D. Leakey, 1971). Further hominid specimens were recovered there that included *Homo erectus* with associated Acheulian stone tools and *Homo sapiens* associated with Middle and Later Stone Age assemblages at varying time spans in the fossil record (Leakey, 1971). Numerous fossils of other mammals, extinct and extant, were also found in the area. Fossils belonging to non-hominid species some first discovered at Olduvai Gorge as holotype specimens are also found.

They include the following: proboscidians (*Deinotherium bozasi* and *Elephas recki*); several archaic pigs (including *Mesochoerus* sp., *Notochoeurus* sp., *Potamochoerus* sp., *Stylochoerus nicoli*, *Mesochoerus olduvaiensis*, *Potamochoerus majus*, *Phacohoerus* and *Metridiochoerus* sp.); several bovid (including a giant bovid, *Pelorovis oldowayensis*); giraffids; rodents; carnivores; non-human primates; equids (such as *Equus oldowayensis; Stylohipparion albertense*); lagomorphs; small amphibians; reptiles (including crocodilians) and fish (Leakey, 1971). Included in the findings were extinct saber toothed cats (*ibid*.). In due regard, discoveries of hominid remains associated with mammal fossil fauna and stone tools led to scientific reconstructions pertaining to early hominid subsistence strategies and patterns (Leakey, 1971). On the other hand, discovery of mammalian fossil remains including rigorous geological interpretations paved the way for palaeoenvironmental and palaeobiogeographic reconstructions of the entire area during Plio-Pleistocene epochs (Hay, 1976).

Fossiliferous deposits cover the entire gorge for about 45 kilometres from East on the Western site of Crater highlands to West where the gorge terminates but at another palaeoanthropological site, Lake Ndutu (Hay, 1976; Leakey, 1971). Another extension is due south about 36 kilometres to another rich palaeoanthropological site, Laetoli (Hay, 1976; Leakey, 1971).

At Lake Ndutu, on the Northern part, hominid remains documenting evidence for "archaic" *Homo sapiens* were uncovered along deposits dating to around 200,000 years before present (Mturi, 1971). The findings give testimony for a transition from *Homo erectus* to Anatomically Modern Humans [(*Homo sapiens*) *ibid*.]. Middle Stone Age artifacts were recovered from the Western part of the lake (*ibid*.).

Laetoli palaeoanthropological site is extremely important because it yielded early hominids that include a holotype for *Australopithecus afarensis* recovered from volcanic tuffs dated at 3.59 million years ago (Leakey, 1987). Besides preserved animal trails, hominid footprints representing three individuals (two adults and a juvenile) were uncovered in the deposits dated at 3.59 million years ago (Leakey, 1987a, 1987b, 1987c; Leakey and Hay, 1976). They have been interpreted to document early hominid bipedal locomotion during that time already to have ensued for *Australopithecus afarensis* (*ibid.*). In addition, Laetoli yielded a big number of extinct and extant fossil specimens as follows: reptilian represented by tortoises of genus Geochelone and diverse samples of snakes representing four genera belonging to four families; and 32 bird fossils representing four families that include a vulture (Accipitridae), francolins of two different sizes (Phasianidae), guinea fowl, doves (Columbidae) and an eagle owl specimen [(Strigidae) Leakey, 1987a, 1987b, 1987c]. Furthermore, two specimens of fossil eggs representing Family Phasianidae were recovered (*ibid*.). Additional fossil specimens representing insectivores with a holotype Family Macroscelidae (*Rynchocyon pliocaenicus* sp. novo) and a paratype of this species were recovered at Laetoli (*ibid*.).

Laetoli yielded further specimens belonging to Sub-Order Prosimii, named after a volcanic Mountain East of Laetoli (Sadiman), *Galago sadimanensis* sp. novo were recovered at Laetoli (M. G. Leakey and Delson, 1987). Over 135 specimens for monkeys (Family Cercopithcidae) belonging to four species were recovered there (ibid.). They represent the largest and most complete ever collections of all African Pliocene monkey specimens recovered so far (ibid.). In addition, different lithological units yielded a total of twenty-seven hominid specimens that include Pleistocene remains (the Ngaloba skull) attributed to “archaic” *Homo sapiens* (Magori and Day, 1983a, 1983b; Leakey, 1987a). Also, the site has uncovered stone tools representing Middle Stone Age Leakey, 1987a).

About 500 rodent specimens (excluding springhares) were recovered from Laetoli (Leakey, 1987a). Also, specimens belonging to Family Pedetidae (springhares) including a type specimen, *Pedetes laetoliensis* sp. Novo (*ibid*.). Abundant fragmentary fossil remains belonging to Family Leporidae were recovered at Laetoli (*ibid*.). Besides, the site yielded small carnivore remains that included five species that differ markedly from extant species (*ibid*.). Furthermore, recovered large carnivore specimens included three Families: Canidae, Hyanidae and Felidae with three species identified for Canidae, between three and five for Hyanidae and nine species assigned for Felidae (*ibid*.).

At Laetoli, elephant specimens were represented by *Loxodonta exoptata* including extinct relatives of elephantoid proboscideans represented by Family Deinotherridae whereby fossil fauna representing eight individuals belonging to *Denotherium bozasi* were recovered from Laetoli (*ibid*.). Eleven fossil advaark specimens assigned to one genus Orycteropus were recovered from Laetoli (*ibid*.).

All three Perssodactyl groups, namely, equids, chalicotheres and rhinoceros were uncovered from the site (*ibid*.). Equid materials belong to genus *Hipparion* with an advanced form, *Hipparion libycum ethiopicus* (*ibid*.). Five specimens represented Family Chalicotherriidae all assigned to *Anclotherium hennigi* (*ibid*.). Fossil rhinoceratid materials include white rhinocerous, *Ceratotherium praecox* represented by 28 individuals, while a complete cranium interpreted to be more progressive of white rhinocerous (*Ceratotherium simum*) than the former (*ibid*.). Suid materials were recovered represented by the following: *Notochoerus euilus, Potamochoerus* and *Kolpochoerus* (*ibid*.). Three giraffid species were recognized from the site represented by *Giraffa stillei, Giraffa* cf. *jumae* and *Sivatherium*. Also, a camel assigned to genus *Camelus* was recovered at Laetoli (*ibid*.).

A lot of Family Bovidae fossil specimens were uncovered from Laetoli represented by the groups: Alcelaphine, Neotragini and Antilopini (*ibid*.). Although termite remains were not recovered at Laetoli, ichnofossil structures were found there giving testimony of termites (*ibid*.). Remains of cocoons and brood cells of Hymenoptera, the only common insect activity, were collected from Laetoli. In addition, several Mollusca specimens were recovered including a type species, *Edouardia laetoliensis* (*ibid*.).

Nasera Rock Shelter yielded over 200,000 fossil fauna specimens, over 300,000 stone artifacts and over 500 pottery artifacts (Leakey, 1971). The site has documented Middle Stone Age and Later Stone Age assemblages (*ibid*.).

Ngorongoro Crater is of archaeological significance in that it has yielded remains documenting burial and thus, settlement patterns of ancient humans around 2,000 (± 180) years ago (*ibid*.). The site also uncovered game boards known as *bao* in Kiswahili. Such discoveries document prehistoric people's care for the dead several hundreds of years ago (*ibid*.).

## 2.0 Description of the Study

### 2.1 Description of the Activity

The team carried out a field survey (using internationally accepted palaeoanthropological field survey methods) to ground-truth any surface remains and artifacts of archaeological, palaeontological, historical or cultural significance (including graves) and recorded their geographical location by using the Global Positioning System (GPS). The team was desirous to analyze any material that had to be found so as to establish significance of sites/materials and develop a register of sites as well as relevant materials. The team observed the Antiquities Act of 1964 and its Amendment Act of 1979 together with Antiquities Rules and Regulations of 1991 pertaining to Archaeological and Palaeontological research.

Furthermore, in compliance with professional ethics, maps and coordinates indicating location of culturally (archaeologically or palaeontologically) important sites as well as any other relevant information including maps (track logs) of areas covered and photographs of both the general study area were recorded. The team had the duty to identify sites/materials requiring excavation and/or preservation/conservation. Also, the team commented on possible occurrence and significance of sites in the wider concession area (such as traditional and sacred sites, graves, areas for medicinal plant use and the like).

The team was obliged to see to it that if sites of importance were to be found, the team has to advise on the process to preserve or remove them as required. In addition to reporting on results obtained from surveys as already detailed, the team presents a description of baseline cultural heritage components in the area and significance (international, national and local) of cultural heritage in the project area; and sought to identify sensitive or critical cultural heritage resources, which require protection or management.

**2.2 Study Terms of Reference**

The archaeological and palaeontological studies were undertaken so as to establish likelihood of existence of any archaeological and/or palaeontological findings within the Project area. Such investigations involved test pits at various locations so as to establish whether or not there were archaeological and/or palaeontological remains. Localities that were to yield archaeological/palaeontological materials had to be excavated by one to two metre squares to ascertain further abundances of the same. Excavations were envisaged to help determine extent of archaeological and/or palaeontological materials to either retrieve all or part thereby determine conservation if many or make pertinent mitigation decisions for project activities. Existence of archaeological and palaeontological materials had to be established in conjunction with observations. All were carried out by the study team through the following aspects:

- Conducted archaeological as well as palaeontological reconnaissance survey that had to lead to excavation of potential areas to discern their status for the proposed project;
- Supposed to map out all potential areas that had to yield archaeological and palaeontological materials/objects for either total recovery, as the case may be, to give way for desired project development or to preserve (*in situ*) as well as demarcate such objects for preservation including conservation, while at the same time suggest proper mitigation measures;
- Sought to identify as well as describe cultural heritage assets/resources likely to cause potential impacts if not conserved; and
- Recommended as well as compiled mitigation measures.

**2.3 Objectives of the Study**

The study had the following objectives of cultural, archaeological and palaeontological study for the project area:

- To obtain a good understanding of overall archaeological and palaeontological material conditions of the area through a desktop study;
- To locate, identify, record, photograph and describe sites of archaeological as well as palaeontological importance within the project area;
- To identify potential impacts as well as suggest pertinent measures to manage the potential impacts; and
- To ensure that local heritage requirements (Antiquities Act of 1964 and Antiquities Act, Amendment Act of 1979) as well as international the best practice including IFC Performance Standard 8, Cultural Heritage are met.

3.0 Summary of Applicable Legislations and Standards

Tanzanian laws, regulations and related international conventions into which Tanzania is signatory

The Antiquities Act of 1964 together with its amendment, Amendment Antiquities Act of 1979 repealed the Monument Preservation Ordinance of 1937 and 1949 and enlarged the scope of heritages that need to be conserved. The legislation offers general protection to objects or structures, which are of archaeological, palaentological, historic, architectural, artistic, ethnological or scientific interest (see Appendix I). In addition, Cultural Heritage Impact Assessments (in compliance with National Environmental Management Act of 2004 plus other national legislations, Appendix I) are carried out for IEA as part of fulfilling requirements of the Antiquities Act.

Furthermore, the Antiquities Division in the Ministry of Natural Resources and Tourism operates by using the Cultural Heritage Policy of 2008; UNESCO Convention on means of prohibiting and preventing illicit import, export and transfer of ownership of Cultural property; UNESCO Convention of 1972 concerning protection of the world cultural and natural heritage; and UNESCO Convention of 1954 on protection of cultural property in the event of armed conflict (together with other Conventions see Appendix II).

In addition, concerning graves or burial places, an Act to provide for the Removal of Graves from land required for public purposes Number 9 of 1969 shall apply. The Act refers to the Minister responsible for Lands for all matters in the said Act. Most likely, other laws like Mineral Act and Environment Act should be in consideration on execution of removal and re-inter of graves or burials in the project area.

**4.0 Employed Methodology**

The baseline study involved archaeological and palaeontological field surveys of the project area including consultation with members of the surrounding communities. Driving over areas facilitated to carry out on foot survey transects at exposed areas along the project area (Table 1; Figure 4). They involved inspection of exposed surface areas augmented with test pits of one metre squares and reached a maximum depth of 70 centimetres below surface except terminated such exercise at depth up to twenty centimetres below surface whereby as reported by Keller and colleagues (1975; also, documented in Sub-section 1.1 of this report), there is a sedimentary sequence (bedrock) in Engaruka Basin. Such sedimentary bedrock is exposed widely in the large geographical area in Engaruka past Mto wa Mbu areas. Also, the team checked gullies that provided a clear kind of profile so as to identify presence or absence of archaeological/palaeontological materials.
Artefacts (like pottery, slag, *tuyérés* and so on), stone tool finds, fossil fauna and other specimens were to be collected from localities desired to be established using the standardized 13-point protocol and further had to be documented following a standardized palaeoanthropological ten-point protocol. Besides, documentation included Global Positioning System [(GPS) Table 1] coordinates, photographic record as well as preliminary notes pertaining to identification (taxonomic affinity, for example), preservation and taphonomic features. Specimens to be collected were required to be identified and sorted to extent feasible in the field. Parallel hard copy as well as electronic records are maintained for results.

Furthermore, test pit excavations were carried out that involved documentation that included GPS coordinates (Table 1; Figure 5) including establishment of one by one metre square grids. They were deemed to recover/collect archaeological as well as palaeontological material remains. For example, pottery, slag, *tuyéré*, fossil bone as well as stone tool materials) within the grids, while for fossil fauna, the undertaking sought to note taphonomic signatures like surface of faunal stance such as facing up or otherwise. In addition, the team sought to collect baseline data (archaeological and palaeontological data) through excavation of pits in selected areas if the surface survey augmented with shovel test pits would have yielded archaeological/palaeontological remains. More importantly, the study team sought to develop an understanding on values of cultural heritage of the area together with identification as well as description of cultural heritage assets/resources likely to cause potential impacts if not conserved; and to recommend and compile mitigation measures. However, the team never recovered archaeological/palaeontological materials were recovered. In due regard, no analysis of materials was undertaken so as to determine about potential impacts in the project area except consent was sought from responsible people about graves/cemetery. Thus, traditional leaders through local authority leaders (Village Chairpersons of Engaruka Chini and Mbashi) were earmarked to provide information pertaining to ethnographic information of the area, particularly graves and/or ritual sites.

Conveyance of the study was to map out all potential areas that had to yield archaeological and palaeontological materials/objects and spiritual sites for either total recovery, as the case may be, so as to give way for desired project development or to preserve (*in situ*) as well as demarcate such objects for preservation including conservation, while provide pertinent suggestions for mitigation measures.

## 5.0 Results

### 5.1 Results from Scoping Exercise

**Cultural materials that will be negatively or positively impacted by the proposed project**

The palaeoanthropological scoping undertaking that sought for identification of cultural materials at exposed areas (Figure 2) never yielded any of such materials. Moreover, the survey spotted two small black obsidian stones that were examined (Figure 3). After thorough examination, they were not ascertained to be stone tools. Thus, they were never modified as well as used by ancient humans as expected for Later Stone Age (LSA) or Pastoral Neolithic (PN) cultural traditions. Their presence is most likely due to presence of volcanic mountains such as Essimingorr in the south, Monduli in the east and Kitumbeine in the north. All such volcanic mountains provided obsidian some of which are under study to determine artifacts that were used by ancient people, for example, during early domestication of plants and animals in Tanzania and East Africa, in general (Bushozi, personal communication). Such stone tools were used for various tasks and were recovered at such areas as Gol Kopjes, Simba Kopjes, Seronera Kopjes, Serengeti Wildlife Research Institute Kopjes and other areas in Serengeti National Park. Cultural materials that testify for early domestication of animals and plants in Serengeti National Park sites were dated to around 6,000 years before present and provided pottery, fossils of wild game as well as domestic animals including ostrich egg shell beads for personal adornment plus obsidian stone tools. The author is examining some obsidian stones he recovered in October, 2019 in vicinities of Makuyuni (almost 5 five kilometres south of Makuyuni village) and Essimingorr Mountain slopes.

**Figure 2:** Obsidian stones

The survey involved noticing geological formation in form of pillars (Figure 3). They stand in Engaruka Chini village outside the project area whereby during the meeting at Mbashi village, participants mentioned them as pyramids. They informed that they take tourists to such rock structures. They have to be closely examined by geologists so as to ascertain their formation. Are they volcanic rocks or sedimentary rocks? So far, literature has never led to determination of such pillars.

**Figure 3:** Stone pillars

The only protected, conserved and presented archaeological materials are the famous ancient irrigation channels at Engaruka Juu village in Engaruka ward interpreted at some 500 years ago by farming community of several thousand people (Sassoon, 1978, 1971, 1967; Sutton, 1984, 1978). They have been thoroughly documented and they are still being studied to quench scientific knowledge at diverse dimensions. The said cultural heritage resources are outside the project area by far.

Due to inaccessibility to the area after rains a few days before the visit, members in village meetings were probed (informally) to furnish information on cultural materials in the areas. It was informed that the etymology for the name Engaruka from Wamaasai name it *Ng'ara* for river. Others alluded to the origin that the area had previous Wasukuma inhabitants before Wamaasai pastoralists moved into the area, whose greetings in the morning have the word, *ngwa'ngaluka*, meaning good morning. It seems likely that all such names were Anglicised to the current name, Engaruka.

Moreover, participants to the village meetings informed that there are rock painting sites in forest area northwest of the project area. They depict animals, birds and other figurines. The party did not go because of inaccessibility after it had heavily rained. The next step is an independent party of experts who should carry out a thorough study and make pertinent recommendations to heritage resources authority of the country according to the country's laws and policies.

Furthermore, participants disclosed that there were no archaeological or palaeontological materials in the project area. Besides, they mentioned that in the project area, some former homesteads called by Wamaasai as *boma* had remains of their loved ones. Also, they had graves as clusters for the villages (Engaruka Chini and Mbashi) in the project area. Such information is important such that it has to be verified in the detailed ESIA undertaking by getting exact locations and extent for mitigation for the desired project.

**Stakeholders' main concerns on safeguard of cultural materials regarding the proposed project**

Participants to the meetings, especially those in Mbashi were critical of the manner buried loved ones would not be affected by project during construction and eventual project operations. They requested for the government and project proponent to take all necessary measures that such burials should be re-interred at safe designated places with all required human dignity. The project team assured of undertaking such mandatory measures before initial project infrastructural developments would take place.

**Main project alternatives in case cultural materials will be identified in project area**

The main project alternatives so far deemed to be discussed encompass mentioned burials/graves in the project area. They must be re-interred as required based on the country's laws as submitted in report.

**5.2 Results from Baseline Archaeology and Palaeontology ESIA Detailed Report**

**Survey Results**

The archaeological and palaeontological survey was carried out at twenty spots, some within Project Area and others outside Project Area (Table 1; Figure 4). Survey spots One, Two, Three and Five are within Project area, except Survey Spot Four is outside Project Area in Engaruka Chini village, Engaruka ward. They augmented scoping exercise carried out in February, 2020 (Table 1; Figure 4). Survey spots Eight, Ten, Twelve, Fourteen, Sixteen and Seventeen are in Project Area, while Survey Spots Seven, Eighteen, Nineteen and Twenty are outside Project Area out in in Mbashi village, Selela ward (Table 1; Figure 4). In all survey works, no archaeological or palaeontological materials were spotted/recovered (Table 1). Also, Figures 6 to 9 offer a glimpse of landforms as well as vegetation cover including status of the land surface like barren area, rock gravels, small rock boulders and the like along the surveyed and excavated spots (see Appendix III).

Table 1 GPS Coordinates for Archaeological and Palaeoanthropological Study

| CODE NAME | CORDINATES | Description |
|---|---|---|
| SS1 | ELEVATION<br>726 M<br>S 03$^0$ 02' 48.3"<br>E036 08' 07.6" | Engaruka Chini village<br>Almost 1 kilometre away from Engaruka Lake shore.<br>Open land with grass patches and closed bushes about 100 metres away<br>No archaeological or palaeontological specimens recovered |
| SS2 | ELEVATION<br>733 M<br>S 03$^0$ 02' 37.6"<br>E036$^0$ 07' 42.7" | Engaruka Chini village<br>About 2 kilometres from Engaruka Lake, along Engaruka river, part that flows on sedimentary bedrock<br>Some rock gravels and acacia trees around river edges<br>No archaeological or palaeontological specimens spotted |
| SS3 | ELEVATION<br>743 M<br>S 03$^0$ 02' 28.2"<br>E036$^0$ 06' 30.5" | Engaruka Chini village<br>In project area<br>Bedrock exposed all along<br>No archaeological or palaeontological specimens spotted |
| SS4 | ELEVATION<br>720 M<br>S 03$^0$ 04' 13.6"<br>E036$^0$ 03' 11.9" | Engaruka Chini village<br>Outside project area<br>Lake expanded due to flood water<br>No archaeological or palaeontological specimens spotted |
| SS5 | ELEVATION<br>724 M<br>S 03$^0$ 03' 05.6"<br>E036$^0$ 08' 39.1" | Engaruka Chini village<br>Close to Project Bore Hole 5<br>Soft sandy soils, barren<br>No archaeological or palaeontological specimens spotted |
| SS6 | ELEVATION<br>740 M<br>S 03$^0$ 10' 32.1"<br>E036$^0$ 10' 15.0" | Mbashi village<br>Southern end of project area<br>Some small rock (lava) gravels scattered on surface<br>Bushes with acacia trees<br>No archaeological or palaeontological specimens spotted |
| SS7 | ELEVATION<br>740 M<br>S 03$^0$ 19' 57.7"<br>E036$^0$ 10' 25.0" | Mbashi village<br>Flood plain, barren with rock gravels and scattered acacia trees along deep sols<br>No archaeological or palaeontological specimens spotted |
| SS8 | ELEVATION<br>743 M<br>S 03$^0$ 10' 52.1"<br>E036$^0$ 09' 20.7" | Mbashi village<br>Small lava gravels<br>Very short grasses<br>No archaeological or palaeontological specimens spotted |
| SS9 | ELEVATION<br>744 M<br>S 03$^0$ 10' 68.7"<br>E036$^0$ 09' 44.4" | Mbashi village<br>Area full of lava gravels and small boulders<br>Maasai homestead around<br>No archaeological or palaeontological specimens spotted |
| SS10 | ELEVATION<br>746 M<br>S 03$^0$ 10' 43.3"<br>E036$^0$ 09' 30.7" | Mbashi village<br>Area almost 200 metres radius<br>Some gullies and close to main river bank<br>Barren with rock gravels and small rock boulders<br>No archaeological or palaeontological specimens spotted |
| SS11 | ELEVATION<br>737 M<br>S 03$^0$ 10' 17.5"<br>E036$^0$ 09' 52.2" | Doruko hamlet in Mbashi village<br>Barren with scattered acacia thick trees<br>No archaeological or palaeontological specimens spotted |
| SS12 | ELEVATION | Mbashi village |

| | | |
|---|---|---|
| | 734 M<br>S $03^0$ 10' 19.2"<br>E$036^0$ 09' 47.3" | Very short grasses<br>Acacia trees almost 50 metres from main of survey spot<br>Many acacia trees<br>No archaeological or palaeontological specimens spotted |
| SS13 | ELEVATION<br>738 M<br>S $03^0$ 10' 18.8"<br>E$036^0$ 09' 43.9" | Mbashi village<br>Middle of river basin<br>Thick soils on river bank<br>No archaeological or palaeontological specimens spotted |
| SS14 | ELEVATION<br>738 M<br>S $03^0$ 10' 18.8"<br>E$036^0$ 09' 43.9" | Mbashi village<br>Barren area with rock gravels and rock boulders<br>No archaeological or palaeontological specimens spotted |
| SS15 | ELEVATION<br>746 M<br>S $03^0$ 10' 40.6"<br>E$036^0$ 09' 39.7" | Mbashi village<br>Barren area with rock gravels and rock boulders<br>No archaeological or palaeontological specimens spotted |
| SS16 | ELEVATION<br>773 M<br>S $03^0$ 11' 30.3"<br>E$036^0$ 09' 13.5" | Mbashi village<br>Degraded grassland that may lead to semi-arid condition<br>No archaeological or palaeontological specimens spotted |
| SS17 | ELEVATION<br>834 M<br>S $03^0$ 12' 52.8"<br>E$036^0$ 09' 00.0" | Mbashi village<br>Degraded grassland that may lead to semi-arid condition<br>Bedrock exposed<br>No archaeological or palaeontological specimens spotted |
| SS18 | ELEVATION<br>886 M<br>S $03^0$ 13' 47.7"<br>E$036^0$ 08' 40.1" | Mbashi village<br>Scrub land with bedrock<br>A lot of rock gravels<br>No archaeological or palaeontological specimens spotted |
| SS19 | ELEVATION<br>951 M<br>S $03^0$ 15' 22.9"<br>E$036^0$ 07' 52.1" | Mbashi village<br>Scrub land with bedrock<br>A lot of rock gravels<br>Few acacia trees<br>Ichnofossils (ancient termite mounds)<br>No archaeological or palaeontological specimens spotted |
| SS20 | ELEVATION<br>1004 M<br>S $03^0$ 15' 28.9"<br>E$036^0$ 07' 32.4" | Mbashi village<br>Barren with bedrock<br>No archaeological or palaeontological specimens spotted |
| TP1 | ELEVATION<br>745 M<br>S $03^0$ 02' 29.0"<br>E$036^0$ 06' 34.8" | Engaruka Chini village<br>Excavated one by one metre square pit to 70 centimetres below surface.<br>At 70 centimetres below surface encountered bedrock, terminated excavation.<br>From 0 to 20 centimetres below surface dry soft soils and from 20 to 70 centimetres below surface wet soft soils.<br>No archaeological or palaeontological specimens recovered |
| TP2 | ELEVATION<br>726 M<br>S $03^0$ 02' 48.3"<br>E$036^0$ 08' 07.6.9" | Engaruka Chini village<br>Place traversed with gullies. Excavated to 50 centimetres below surface due to very hard impenetrable sub-surface.<br>No archaeological or palaeontological specimens recovered |
| TP3 | ELEVATION<br>702 M<br>S $03^0$ 04' 04.6" | Engaruka Chini village<br>With scattered thick bushes<br>Terminated excavations after hitting bedrock at 44 centimetres below surface |

| | | |
|---|---|---|
| | E036$^0$ 07' 14.3" | No archaeological or palaeontological specimens recovered |
| TP4 | ELEVATION<br>726 M<br>S 03$^0$ 04' 34.9"<br>E036$^0$ 07' 28.7" | Engaruka Chini village<br>Excavated to 50 centimetres below surface<br>No archaeological or palaeontological specimens recovered |
| TP5 | ELEVATION<br>744 M<br>S 03$^0$ 10' 56.0"<br>E036$^0$ 10' 22.2" | Mbashi village<br>Floodplain area with very soft clay soils<br>Almost 100 metres away some acacia trees<br>There is riparian woodland along Simingor River<br>Excavated to 60 centimetres below surface<br>No archaeological or palaeontological specimens recovered |
| TP6 | ELEVATION<br>743 M<br>S 03$^0$ 10' 52.1"<br>E036$^0$ 09' 20.7" | Mbashi village<br>No archaeological or palaeontological specimens recovered |
| TP7 | ELEVATION<br>744 M<br>S 03$^0$ 10' 68.7"<br>E036$^0$ 09' 44.4" | Mbashi village<br>No archaeological or palaeontological specimens recovered |
| TP8 | ELEVATION<br>746 M<br>S 03$^0$ 10' 43.3"<br>E036$^0$ 09' 30.7" | Mbashi village<br><br>Floodplain area with small scattered bushes and very short grasses<br>No archaeological or palaeontological specimens recovered |
| TP9 | ELEVATION<br>737 M<br>S 03$^0$ 10' 17.5"<br>E036$^0$ 09' 52.2" | Mbashi village<br><br>Very short grasses with a lot of rock gravels<br>No archaeological or palaeontological specimens recovered |

KEY: SS – SURFACE SURVEYSPOT, TP – TEST PIT SPOT

**Test Pit Excavation Results**

All test excavation pits were carried out under arbitrary levels of 10 centimetres spits to mark level to the sub-surface. Soils were minimally inspected through very small sieves of 0.5 millimetres mesh to spot as well as recover small archaeological and palaeontological materials. A total of nine excavation Test Pits were carried out in Project Area (Table 1; Figure 5). Test Pits One to Four were carried out in Engaruka Chini village, Engaruka ward (Table 1; Figure 5). The rest of Test Pits Five to nine were carried out in Mbashi village, Selela Ward (Table 1; Figure 4). All test pits never yielded archaeological or palaeontological remains (Table 1).

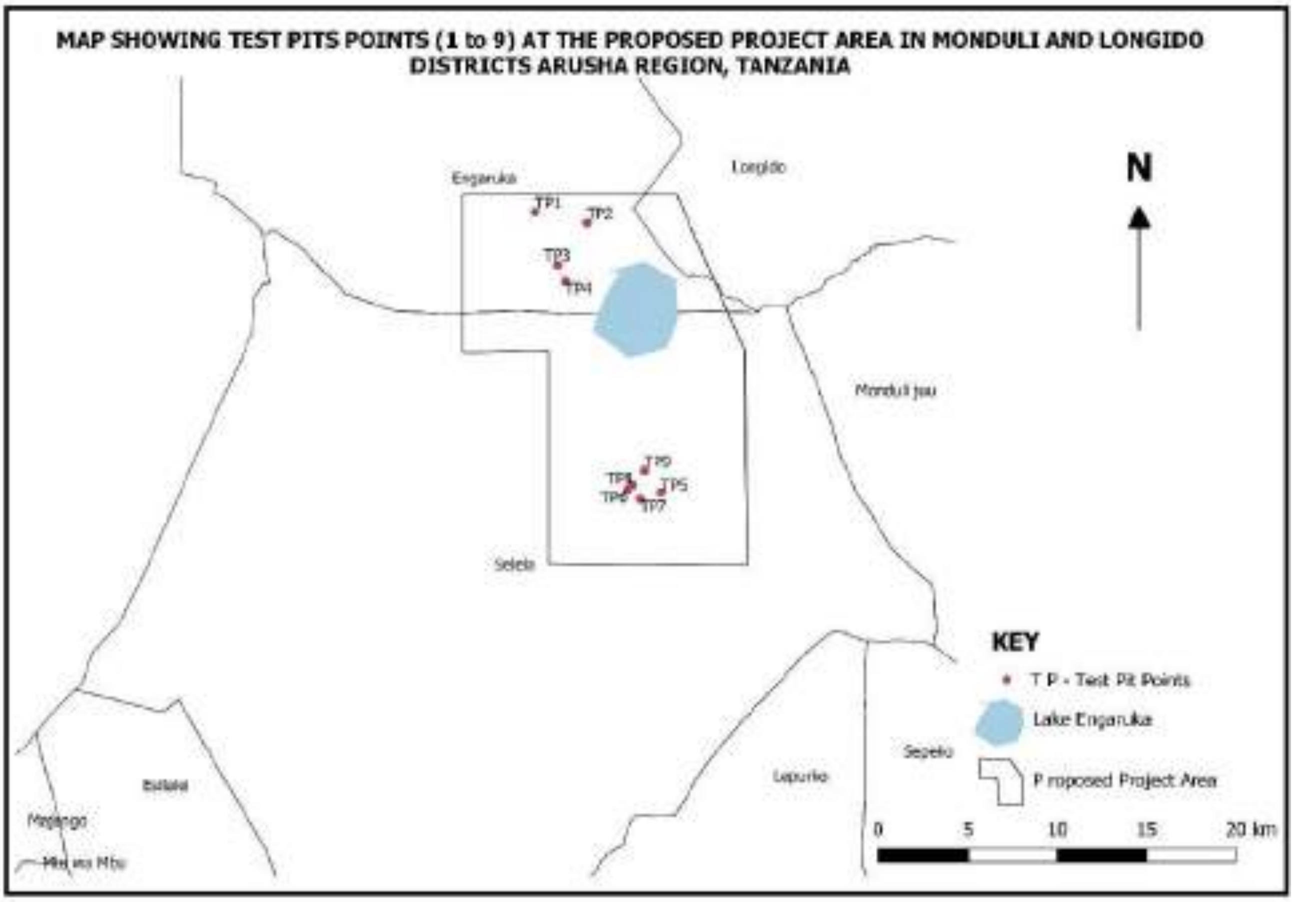


**Figure 4:** Archaeological and Palaeontological Test Pit Spots

**Key Informant Interview Results**

The team expected to interview local people living in Doruko hamlets in Mbashi Village. However, the few encountered Maasai people in their homesteads constructed within and outside project area were expected to furnish information concerning burials in their vicinities. They never disclosed any information for the desired aspect and relegated the team to consult their village chair who was away in Arusha. Recall, in February, 2020 during scoping, the team was informed of presence of burial places that may be within the project area in Mbashi village. Thus, the team sought to pinpoint exact spots and evaluate their coverage so as to advice for proper mitigation of removal and eventual re-inter the burials. To the dismay, the team was informed that it was a cultural taboo for none Maasai leaders to disclose information pertaining to burials in their areas. Only leaders are bestowed to provide such information.

**6.0 Discussion**

6.1 **Discussion**

**Ethnographic Interpretation Concerning Burials**

Through meetings conducted during scoping it was disclosed that Mbashi village has burials. This time of baseline data collection the team was desirous to carry out key informant interviews for pinpointing burial places. Against the team's expectations, there was no one to disclose such information after a few encountered Maasai people in Doruko hamlet, Mbashi village felt difficult to do so. Instead, they advised to get such information from their village chair who was away on a trip in Arusha. Thus, through evaluation for resettlement with the sociologist, such measures for identifying burial places including their coverage should be carried out.

**Archaeological and Palaeontological Resources in Areas at Close to Project Site**
Not very close to the project area, there the only protected, conserved and presented archaeological materials by the government through Antiquities Division, Ministry of Natural Resources and Tourism. Such materials encompass world famous ancient irrigation channels at Engaruka Juu village in Engaruka ward interpreted to be some 500 years ago by farming community of several thousand people (Sassoon, 1978, 1971, 1967; Sutton, 1984, 1978). They include iron age materials that are dated in the same time period (*ibid*.). Although they have been extensively documented, they are still being studied to quench scientific knowledge at diverse dimensions. However, it has to be noted that the said cultural heritage resources are outside the proposed project area by far.

**Verdict Pertaining to Archaeological and Palaeontological Resources**

The described world-famous ancient irrigation channels at Engaruka Juu village in Engaruka ward interpreted to be some 500 years ago by farming community of several thousand people including iron age materials in the same vicinity are outside the proposed project area by far. They will never be disturbed by any undertakings in the proposed project. Therefore, the desired Project should be carried out as planned because there will be no effect for archaeological or palaeontological materials.

## 6.2 Identified and Assessment of Potential Impacts

There are no archaeological or palaeontological materials recovered by the expert team. Thus, there are no threats to such missing materials once the Project gets started for its development and eventual operations.

In another vein, the team for collection of baseline archaeological and palaeontological resources together with ethnographic materials was informed of burials in Doruko hamlet, Mbashi village. In due regard, there could be conflicts that may lead to violent actions the Project would be carried out with burials in the area. The best option would be to remove and relocate the remains at costs outside the project area in amicable agreement with the concerned people Wamaasai. After all, through government legal framework, in particular, the Act to provide for the Removal of Graves from land required for public purposes Number 9 of 1969, the Project authority can relocate the said remains with amicable consent from Wamaasai and their leadership in all avenues.

In addition to the Act to provide for the Removal of Graves from land required for public purposes Number 9 of 1969, the Antiquities Act of 1964 and its amend Act of 1979 together with the Cultural Policy of 1997 and Antiquities Heritage Policy of 2008 as well as other applicable pieces of legislation, are pieces of articles that safeguard and lead to pertinent execution of proper handling of cultural (physical and non-physical) heritage assets that include removal of burials and re-inter them at an agreed place or agreed places elsewhere to pave the way for future Project developments. All these are in harmony with NEMC Act of 2004 together with the NEMC Rules and Regulations of 2005 in the EIA conduct.

## 6.3 Proposed Mitigation Measures

Based on field investigation, the proposed project area has no archaeological or palaeontological materials. Besides, Engaruka irrigation ruins and iron age materials already under protection, conservation and presentation by the government of Tanzania in Engaruka Juu village are safely outside the proposed project area. The only materials that may be hit by the proposed project are ethnographic materials in form of burials for Wamaasai ethnic group that are advised to be removed and relocated to places outside the proposed project area. Such measures will pay dividends for smooth project operations from start of infrastructure developments to its life time operations. In due regard, using the proper 1969 burial legislation would be the caveat for the mining authority to relocate them. All measures to relocate the said cultural heritage resources should be executed with amicably agreed/settled costs according to commensurate government legislations already mentioned in this report.

### 6.4 Vulnerability of the Resource

The identified graves would be vulnerable to destruction and/or possible loss/vanish if not removed. They may be prone to such dangers starting from works involving infrastructural development and actual project operations. The other consequence would be the intangible aspect of the said cultural resources once destroyed whereby concerned parties could feel harmed at various felt levels. In addition, such cultural materials are never replaceable. Therefore, the best option as mitigation measures to safeguard their values and integrity would be their removal from the proposed project area before it starts its developments to its eventual operations.

### 6.5 Monitoring Plan and Indicators

As long as, to date, no archaeological and palaeontological materials have not been identified from surface to subsurface, it does not mean that such resources are totally absent. There could be remains that were not spotted by the survey team due to factors like accessibility at time of baseline data collection together with others that that cannot be justified. Thus, it is proposed that before infrastructural development of the project operations, a dossier of archaeological and palaeontological materials should be prepared by experts who will produce in form of text with accompanied visual depictions in simple easy to understand languages, Kiswahili and English. Such printed materials could be used as guides to workers of various levels, professions and cadres for their smooth execution from development to mining operations. Such materials should show and spell out that caution is given if such workers may get across such remains they should inform their authority who will summon experts to visually inspect the suspected cultural heritage resources and undertake pertinent inspection for proper decision-making as to their retrieval, conservation and care.

## 7.0 Conclusions and Recommendations

So far the team did not identify any archaeological and palaeontological materials in the proposed project area. However, the team identified cultural heritage assets in form of graves that have special humanitarian consideration.

It is recommended that the project authority should commission publications on archaeological and palaeontological resources recovered from elsewhere in Tanzania that could be used as examples by workers when executing their duties. The works will need to consider that aspect from infrastructural development to eventual project operations. Thus, the client has to call upon experts once such materials would be spotted by their workers for pertinent evaluation so as to pave the way for project operations to proceed as planned. The team further recommends that the graves should convince concerned parties for removal and relocation by adhering to the country’s legislations of the said heritage assets.

## 8.0References


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## TANZANIAN LAWS AND POLICIES ON CULTURE

The Antiquities Act No. 10 of 1964 was amended in 1979 (Amended Act No. 22 of 1979).

Subsidiary Legislation on Protected Objects and Monuments Number 13 of 1981

Subsidiary Legislation on Conduct of Excavations and Access to Monuments Rules (1991).

National Constitution of 1984 (Para 9)

Culture Policy of 1997

National Museums Act Number 7 of 1980

National Environmental Management Act of 2004

Cultural Heritage Policy of 2008

An Act to provide for the Removal of Graves from land required for public purposes Number 9 of 1969

## APPENDIX II: RATIFIED CONVENTIONS BY UNITED REPUBLIC OF TANZANIA

| **Convention** | **Date of deposit** | **Type of deposit** |
|---|---|---|
| Agreement on the Importation of Educational, Scientific and Cultural Materials, with Annexes A to E and Protocol annexed. Florence, 17 June 1950. | 26/03/1963 | Accession |
| Convention for the Protection of Cultural Property in the Event of Armed Conflict with Regulations for the Execution of the Convention. The Hague, 14 May 1954. | 23/09/1971 | Accession |
| Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property. Paris, 14 November 1970. | 02/08/1977 | Ratification |
| Convention concerning the Protection of the World Cultural and Natural Heritage. Paris, 16 November 1972. | 02/08/1977 | Ratification |
| Convention against Discrimination in Education. Paris, 14 December 1960. | 03/01/1979 | Ratification |
| Regional Convention on the Recognition of Studies, Certificates, Diplomas, Degrees and other Academic Qualifications in Higher Education in the African States. Arusha, 5 December 1981. | 12/07/1983 | Ratification |
| Convention on Wetlands of International Importance especially as Waterfowl Habitat. Ramsar, 2 February 1971. | 13/04/2000 | Accession |
| Convention for the Safeguarding of the Intangible Cultural Heritage. Paris, 17 October 2003. | 18/10/2011 | Ratification |
| Convention on the Protection and Promotion of the Diversity of Cultural Expressions. Paris, 20 October 2005 | 18/10/2011 | Ratification |

## APPENDIX III: SOME SELECTED PHOTOGRAPHED AREAS

Figure 6 An Open Barren Area with Bushes and Scattered Acacia Trees

Figure 7 Barren Land with Rock Gravels

Figure 8 Gully with Riparian Acacia Trees

Figure 9 Small Rock Boulders/Lava Rock Boulders

## APPENDIX 15: NEMC's COMMUNICATIONS

NATIONAL ENVIRONMENT MANAGEMENT COUNCIL(NEMC)
*BARAZA LA TAIFA LA HIFADHI NA USIMAMIZI WA MAZINGIRA*

| | | |
|---|---|---|
| Telephone: | +255 22 2774889, | 35 Regent Street, |
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| Mobile: | 0713 608930 | 11404 Dar es Salaam |
| Fax: | +255 22 2774901 | **TANZANIA** |
| Email: | dg@nemc.or.tz | |
| Website: | www.nemc.or.tz | |

*In reply please quote:*
**Ref: CB.145/205/504/12** **Date: 05/08/2020**

Managing Director,
National Development Corporation (NDC),
P.O. Box 2669,
**Dar es Salaam**

**RE: APPROVAL OF TERMS OF REFERENCE (TOR) FOR THE PROPOSED ESTABLISHMENT OF SODA ASH PROJECT AT ENGARUKA BASIN IN MONDULI DISTRICT, ARUSHA REGION**

Reference is made to the above subject.

We acknowledge receipt of your letters dated 02nd April, 2020 and 16th July, 2020 attached with the evidence of services from relevant Authorities as per the Environmental Management (Environmental Impact Assessment (EIA) and Audit) (Amendment) Regulations 2018, particularly Regulation 10(2) and (3), Environmental Impact Assessment (EIA) registration forms and draft Terms of Reference (ToR) respectively for undertaking an EIA study of the aforementioned project.

We advise you to refer to our File Reference number **(CB. 145/205/504)** whenever you communicate with the Council concerning this project.

In regard to the above, the Terms of Reference were reviewed and found generally to be adequate and therefore can guide the Environmental Impact Assessment (EIA) study of the named project. In this regard, you will be required to submit to NEMC 15 copies of the Environmental Impact Statement (EIS) for review.
In addition, you will be required to ensure that:

i. All key Stakeholders' from National to Village level not limited to Ministry of Minerals, Ministry of Water and Irrigation, Ministry of Lands, Housing and Human Settlements Development, Ministry of Natural Resources and Tourism, Ministry of Livestock and Fisheries, Ministry of Industries and Trade, Mining Commission, Ngorongoro Conservation Authority, Internal Drainage Water Board, Local Government Authorities (LGAs) (Monduli and Ngorongoro District Councils Including all Villages which will be affected by the proposed projects) and **all other relevant Key stakeholders** should be consulted adequately and their views and

**All correspondence should be addressed to the Director General**

concerns addressed; records of meetings, communication and comments should be provided. Consultation forms should bear **date** and each consulted stakeholder should **sign** against his/her **name** as the law requires. Note that copies **Villages minutes/minutes of meetings** should be attached on the EIS. Submission of documents which do not observe this requirement will be sent back to the developer for corrections,

a) Also, views of the relevant authorities provided during scoping exercise should be incorporated in the EIS.

ii. The comprehensive **valuation report and Resettlement Action Plan (RAP)** should be prepared and the summary of Valuation Report and compensation status to the Project Affected Persons should also be documented in the EIA Report,

iii. The area covered by Prospecting Licenses and the intended area to be utilized by the proposed project should be documented in the EIA report,

iv. The data for air quality, soil quality, water quality, and noise level are provided as baseline data,

v. The complete mineral rights over the area (Prospecting Licenses-PLs) is appended to the EIA report,

vi. The proposed project should be detailed and include the life span of the proposed project and number of people to be employed in all phases of the proposed project;

vii. The project components should be detailed explained in the EIA report in terms of the nature of activities to be performed or operated and type of wastes to be generated by each of the component,

viii. The processed soda ash transportation routes from proposed project site to Tanga Port and access ways within the proposed project should be clearly explained,

ix. The designs of Soda Ash and processing Plant, brine's extraction wells, brine holding ponds, Effluent Treatment Plant (ETP), water storage dam, access road and railway with their engineering drawings should be appended and described in the EIS,

a) The designs of the proposed project should be based on the onsite conducted specialist studies on hydrology, hydrogeology, and geotechnical survey, geochemical characterization of the host rocks and ecology which should also be discussed in the EIS.

b) The specialist studies should inform the EIS how the proposed project will impact the hydrology, hydrogeology and ecology of the proposed project area and suggests the best available practicable mitigations measures for the identified impacts;

x. The detailed Cost Benefits Analysis (CBA) of the proposed project should be well explained in the EIS,

xi. Managements of by products such as mud slurry, depleted brine from processing plant and fly ash from boilers should be well explained in the report,

xii. Task 5 of the ToR, on waste management should include the management of all types of waste to be generated by the proposed project including hazardous waste.

xiii. The EIS, should clearly explain the technical differences between the previously proposed Soda Ash project of 2007 and the current envisaged project;

xiv. Experts relevant to the project should be involved in the EIA study e.g. Sociologist, geologists, mining engineers, Environmental scientists, **Ecologist** (wildlife expert for biodiversity studies) etc.

xv. All experts involved in the study should sign the EIA report with their original signature (not scanned signatures or forged signatures) and be indicated whether he/she is a registered or non-registered environmental expert. Failure to observe this requirement will constitute to an offense as per Environmental Management Act, 2004;

In this regard, 2 copies of the revised TOR should be submitted as separate documents to the Council within 7 days from the date of this letter for approval and endorsement prior to the EIA study.

Upon submission of 15 copies of EIA report for review will be required to pay Tshs. **5,000,000/=** to the Council charges for the review and approval processes as indicated in the attached **Proforma Invoice No. 05681** dated 04th August, 2020. You will also be required to **incur transportation costs** for the site verification team to and from the site. Note that, the funds can be paid through **Government electronic Payment Gateway system (GePG)** using control number obtained at NEMC office. . Once you are ready to pay, please contact us through cellphone **No. 0677 069 967** so that you can be issued an invoice with a **Control number** to effect your payments.

For further information or clarification on this matter please do not hesitate to contact us through Tel. No. +255 659615136 Monday – Friday around 8:00am to 16:00pm

Yours Sincerely,

Joram

Ndimbumi Joram
**For: Director General**

Cc: Dr. Julius Elias Daud - Tanzania Industrial Research and Development Organization
P.O. Box 23235,
Dar es Salaam.

All correspondence should be addressed to the Director General

**APPENDIX 16: NAMES OF ESIA TEAM AND THEIR SPECIALITIES**

| Project Proponent | ESIA Team Leader (Specialty) | Signature |
|---|---|---|
| National Development Cooperation ;(NDC)<br>Box 2669, Kivukon ront/Ohio Street,<br>Dar es Salaam, Tanzania<br>Tel: +255 22 2112893 or 2111460/3<br>E-mail: info@ndc.go.tz | 1. Dr. Julius Elias Daud (Environmental Scientist/Engineer) – Registered as EIA Expert | |

Also, the major contribution of the following key experts is highly acknowledged:

1. Dr. Beno Bennaiah (Biodiversity Expert- Wildlife/Fauna)
2. Dr. Charles Saanane (Archeologist and Paleontologist)
3. Huruma Kissaka (Sociologist)
4. Frank Mbago (Biodiversity expert - Flora)
5. Prof. Abdulkarim Mruma (Geologist)
6. Prof. Beatus Kundi (Economist)
7. Prof. Winiesta Anderson (Market study specialist)
8. Prof. Abraham Temu (Extraction and Processing Technology specialist)
9. Salum Lyimo (Hydrologist)
10. Eng. Liberatus Chizuzu (Chemical and Processing Engineer)
11. Athanas Ntawanga (Mining Engineer)
12. Anderson Babylon Ruvanduka (Land Use expert)
13. Transport Logistic team
14. Kunda Sikazwe (Waste Analyst/Environmental Engineer)
15. Maneno Ally (Chemical Processing Engineer)
16. Dr. Tobias Aloisi (Financial Analyst)
17. Augustino Mwenda (Financial Analyst)
18. Kennan Tarimo (GIS Expert/Environmentalist)
19. Rahel Elibariki (Soil Analyst/Environmental Scientist)
20. Erica Sawe (Environmentalist)
21. Aidan Ndomba (Processing Engineer)
22. Haikaema Mboya (Lab Technician – Environment)
23. Mariam Kasim (Lab Technician - Microbiology)
24. Innocent Barongo (Lab Technician-Chemistry)
25. Barnaba Mpwapwa (Field Assistant)

**APPENDIX 17: TERMS OF REFERENCE**

NATIONAL DEVELOPMENT CORPORATION

NDC

**TERMS OF REFERENCE**

**FOR**

**THE ESTABLISHMENT OF SODA ASH PROJECT AT ENGARUKA BASIN IN MONDULI DISTRICT, ARUSHA, TANZANIA**

**Submitted to:**

The National Environment Management Council
Regent Estate, Plot No. 29/30
P.O. Box 63154, Dar es Salaam, Tanzania
Tel: +255 (022)2134603 Fax: +255 (022)2111579
E-mail: nemc@nemctan.org

**Developer:**

National Development Corporation (NDC)
P.O. Box 2669, Kivukon ront/Ohio Street,
Dar es Salaam, Tanzania
Tel: +255 22 2112893 or 2111460/3
Email: info@ndc.go.tz
Website: www.ndc.go.tz

**Name of contact person**: Dr. Yohana E. Mtoni
Mobile No: +255 787 851562

**Consultant:**

Dr. Julius Elias Daud (Expert Registration No. NEMC/EIA/0160),
Tanzania Industrial Research and Develeopment Organization (TIRDO),
P.O. Box 23235, Dar es Salaam, Tanzania
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*August, 2020*

For DIRECTOR GENERAL
NATIONAL ENVIRONMENT
MANAGEMENT COUNCIL
24/8/2020

## TERMS OF REFERENCE

TERMS OF REFERENCE FOR ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF THE PROPOSED SODA ASH PROJECT AT ENGARUKA WARD IN MONDULI DISTRICT, ARUSHA REGION, TANZANIA

### Introduction

During scoping several key environmental and social issues of concern were identified after holding consultations with stakeholders of the project and also after reviewing various literature related to the project. Similarly, expert opinion was sought on various key issues identified as requiring specialized knowledge.

The purpose of the Terms of Reference (TOR) therefore, is to provide formal guidance to the Proponent /ESIA Consultant of the proposed Soda Ash extraction and processing project on the range of issues that must be addressed in the ESIA process. They form the basis for subsequent review process. In these Terms of Reference (ToR), strategies for addressing the issues identified during scoping have been in cooperated to make the ESIA focused.

### Project Description

The Government of United Republic of Tanzania (URT) through National Development Cooperation (NDC) is in the process of developing a Soda Ash plant (henceforth referred to as the project), with a capacity of producing one million tonnes per year. The proposed project is in line with the overall aim of the URT to revitalize and reinvigorate the industrial sector so as it can contribute more to the national economy.

The project set up is strategically located in an area of about 25,000 hectares at Engaruka basin in Monduli District, Arusha region, Tanzania. The basin was chosen due to its large brine resources enriched with high concentrations of Sodium Bicarbonate (43.5gm/lt) and Sodium Carbonate (141.5 gm/lt).

The proposed project covers the establishment of a soda ash extraction and processing plant and associated project components. The project components include: brine's extraction wells, pipelines (to transfer extracted brine from boreholes to the plant's storage ponds), administrative offices, brine holding ponds, power plant, ETP, solid waste collection facilities, water storage dam, wash rooms, car packing area, fence and living accommodations. The facility will also include construction of railway and access road to the plant and upgrading of Longido - Mto wa Mbu road for easy transfer of processed soda ash from the plant to Tanga port and/or neighbouring countries.

### Environmental Assessment Requirements

The Environmental Management Act of 2004 requires that ESIA be undertaken for all new projects that may cause adverse environmental and social impacts. Under the Environment Impact Assessment and Audit Regulations of 2005 and its amendment of 2018 the proposed project is categorized as an ESIA obligatory project for which a full EIA is required.

For: DIRECTOR GENERAL
NATIONAL ENVIRONMENT ... COUNCIL
21/08/2020

**Objectives of EIA**

The objectives of the EIA are:

- To establish baseline information on both natural and built environment including socio-economic conditions of the proposed project area;
- To identify the stakeholders that are likely to be affected by the project;
- To identify, predict and evaluate foreseeable impacts, both beneficial and adverse, of the proposed project;
- To develop mitigation measures that aim at eliminating or minimising the potential negative impacts and promote positive ones; and
- To develop management clauses and monitoring aspects to be observed during project implementation.

This requirement clearly presents a broad challenge on what type of activity that is environmentally friendly need to be dealt with the soda ash project.

**Study Area**

The proposed project site is specifically located within Engaruka basin at Monduli District in Arusha region, north-eastern part of Tanzania about 840km from Dar es Salaam. It is 20 km from Engaruka township, 50 km northeast of Mto wa Mbu Town and 58 km south-east of Lake Natron at Monduli District in Arusha region. The site is bordered by Mbaashi village on the south, Irerendeni and Noondoto villages on the north, Lepurko and Idonyonaado villages on the west and Engaruka chini village on the east.

**Environmental Impact Assessment Scope of Work**

Task 1: Description of the Proposed Project

The Consultant shall give details of:

- Location of the project site;
- General layout of facilities - diagrams of structures, design basis, size, sources and estimation of utilities demand;
- General distribution of facilities on the project area;
- Description of project components;
- Pre-construction activities, construction activities and post construction activities
- Sources and estimation of materials to be used during all project phases;
- Ownership, size, land use type of the project area;
- Adjacent developments to project area; and
- Organizational relationships, mandates and interactions among the different parties to be involved in the project.

Task 2: Description of the Environment

The Consultant shall:

i. Provide description of the project Physical Environment by giving detailed description of:
    - The climate of the project location and surrounding areas;
    - The project geology;
    - Quantity and quality of surface water;



For: DIRECTOR GENERAL
NATIONAL ENVIRONMENT
...CIL
21/08/202-

- ➢ Quantity and quality of ground water; and
- ➢ Freshwater systems (natural drainage patterns and stream flows).

ii. The Consultant shall provide description of the Biological Environment by giving detailed description of the Flora (rare or endangered species, vegetation community of conversational or scientific value, etc.,); and Fauna (rare or endangered species, diversity of animal community, migratory species, alien species, etc.

iii. The Consultant shall provide description of the Socio-economic Environment by providing detailed information on:
- ➢ Demographic aspects (location, distribution and density of local population, existing age or gender composition, etc.;
- ➢ Economic and employment status of the affected social groups (trends, pressure, economic base, etc.);
- ➢ Health and cultural profile; and
- ➢ Social services in the area.

Task 3: Legislative and Regulatory Considerations
The Consultant shall: Describe pertinent local, national and international regulations and standards governing environmental quality, health and safety, land use control etc. which the project developer (NDC) required to observe during the implementation of the project activities. Therefore, the description should show how the developer will adhere to the provisions during all project phases.

Task 4: Determination of Potential Impacts of the Proposed Project Component
Under this activity the consultant shall:
i. identify issues and concerns in order to find suitable remedies;
ii. identify linkages among project components and the issues;
iii. identify where project activities or elements interact with social and biophysical environment (direct impacts):
iv. identify indirect impacts of the project on the environment;
v. identify cumulative impacts that may be anticipated;
vi. identify residual impacts if any;
vii. predict probability, magnitude, distribution and timing of expected impacts.
viii. for certain project components, it might be necessary to carry out assessment at two or more sites (alternatives) in order to come out with the best option; and
ix. Forecast what will happen to the affected environmental components if the project is implemented as it is or if the alternatives (e.g. sites and routes) are chosen.

Task 5: Waste management
The management of all types of wastes to be generated by the proposed project including hazardous waste shall be addressed in EIS report.
Task 6: Estimation of the significance of the impacts



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The consultant shall:

i. determine which environmental components are mostly affected by the project or its alternatives;
ii. list issues raised by the public and classify them according the level and frequency of concern whenever possible;
iii. list regulatory standards, guidelines etc. that need to be met; and
iv. Rank predicted impacts in order of priority for avoidance, mitigation, compensation and monitoring.

Task 7: Development of Management Plan to mitigate negative impacts and develop environmental monitoring plan

The consultant shall:

i. determine appropriate measures to avoid or mitigate undesirable impacts;
ii. assess and describe the anticipated effectiveness of proposed measures;
iii. identification of responsible party/parties in the implementation of environmental management and monitoring plan;
iv. ascertain regulatory requirements and expected performance standards;
v. determine and assess methods to monitor impacts for prediction accuracy remedial measures for effectiveness;
vi. determine and assess methods to monitor for early warning of unexpected effects;
vii. re-assess project plans, design and project management structure;
viii. describe follow-up scheme and post-project action plan for achieving ESIA objectives, and
ix. Assess the level of financial commitment by the project proponent for the management and monitoring plan, and follow up activities.

The consultant shall be guided by the cost-effectiveness principles in proposing amelioration measures. Estimation of costs of those measures shall be made. The assessment will provide a detailed plan to monitor the implementation of the mitigation measures and impacts of the project during construction and operation.

Task 8: Institutional set-up

The Consultant shall review the institutional set-up at community, ward, District/ Regional and national levels - for implementation of the Management and Monitoring Plans recommended in the environmental assessment. The assessment shall identify who should be responsible for what and when.

Task 9: Drawing Recommendations

The consultant shall:

i. highlight key concerns and considerations associated with the acceptance and implementation of recommended actions;
ii. determine resources requirements for implementing recommendations;
iii. determine capacity and resourcefulness of the client to meeting such commitment;
iv. explain rationale for proposed development and benefits and costs vis-à-vis the no project option;



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v. Ascertain degree of public acceptance of or reaction to recommendations.

Task 10: Environmental Impact Statement (EIS)

The assessment shall result into an EIS focusing on findings of the assessment, conclusions and recommended actions, supported by summaries of data collected etc. This shall be a concise document limited to significant environmental issues. The report format will be as per EIA and EA regulations of 2005 and its amendments of 2018.

Task 11: Review

The review report from NEMC may require further input (data collection, consultation inputs etc.). The consultant shall undertake to provide extra information and inputs until the project review is satisfactorily concluded.

Task 12: Public involvement

Stakeholders consultations shall be done adequately and records of meetings, communications and comments raised be appended and addressed in the EIS. The assessment shall establish the level of consultation of the affected stakeholders before designing the project, level of involvement in the running and maintenance of the project facilities as this is an important aspect for both environmental and project sustainability. A people's participation report will be prepared as part of the EIS i.e. apart from the socio- economic and cultural impact report (which basically are dealing with consultants' perception and interpretation of issues). As consultation with various stakeholders have been conducted during the scoping and further consultation shall be conducted during the ESIA study. The lists of consulted stakeholders including the Ministry of Industry and Trade as well as the Ministry of Minerals and other key institutions shall be provided in the EIS report.

The assessment will provide a framework:

- for coordinating the environmental impact assessment with other government agencies, and
- For obtaining the views of affected groups, and in keeping records of meeting and other activities, communications, and comments and their disposition.

## Reporting and EIS Report Presentation

The content and structure of Environmental Impact Statement (EIS) report shall be concise and adhere to Regulations 18 and 19 respectively of the Environment Impact Assessment and Audit Regulations of 2005 and its amendments of 2018 for simplifying the review process. Moreover, the timeframe for which the ESIA study will be conducted shall be indicated in the ESI report starting clearly the time from project brief up to final submissions. The EIS shall also be attached with architectural drawings which has been done by the licenced architect.

## Record of Meetings

The consultants shall provide record of the names of organizations, government and departments and individuals whose views will obtain. The record will also provide description of views and information that will be obtained.



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## Outputs

The consultant shall submit to the Client, a original bound hard copy and electronic copies of the Environmental Impact Statement (EIS) report to client for review before submitting the approved report to NEMC.

## Reference

The consultant shall provide a list of all information sources used, including unpublished documents and sources.

## Consultant(s) Qualifications and Team Composition for detailed ESIA

The Consultant shall deploy a team of experts with the following qualifications:

(i) Proven experience in conducting ESIA studies for more than 7 years of the same scale and nature;

(ii) Understanding of Environmental Management Act and EIA guidelines and procedures of the United Republic of Tanzania;

(iii)Knowledge of World Bank safeguard policies;

(iv)Demonstrated experiences in Environmental assessment and review and approval procedures for development projects in Tanzania; and

(v) Ability to produce high quality reports and presentations.



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### 6.6. Ground and Surface Water Sampling

Water/brine sampling was carried by staffs from Arusha Water Quality Laboratory. In situ parameters on each borehole such as temperature, acidity and electrical conductivity were carried out using portable water quality test probes. Sampling was done at each borehole, at the lake and at Kitumbeine stream. Sample collections and in situ parameters measurements were done after draw-downs have stabilized during constant rate pumping test. In total, 30 samples were collected for chemical analysis in the laboratory. All samples collected were properly labelled and stored in a cool box before transported to the laboratory in Arusha.

### 6.7. Pumping Test Data Analysis

After field activities were completed, analysis of the data collected was carried out. The scope of this work aimed at the following:

- Assessment of borehole performance
- Assessment of effect of pumping well to other wells
- Determination of hydraulic parameters of the aquifers
- Estimation of safe yield of Engaruka brine basin

***Assessment of Boreholes Performance***

Borehole discharge capacity is interrelated to its drawdown at a given discharge rate during constant pumping test. Plots of drawdown against time with small drawdown and steady state attained indicates good productive borehole at that discharge rate. On other hand, longer drawdown curves without attaining steady state, indicates low borehole capacity at the given discharge. This is sometimes attributed to poor borehole design. Plots of drawdown vs. time for each borehole and descriptions of the curves are given below.

i. **Borehole BH5;**

**S**teady state not reached after continuous pumping for 43hours at constant discharge rate of 62,937l/hr. Draw down reached 54.9 meters by the time pumping stopped.

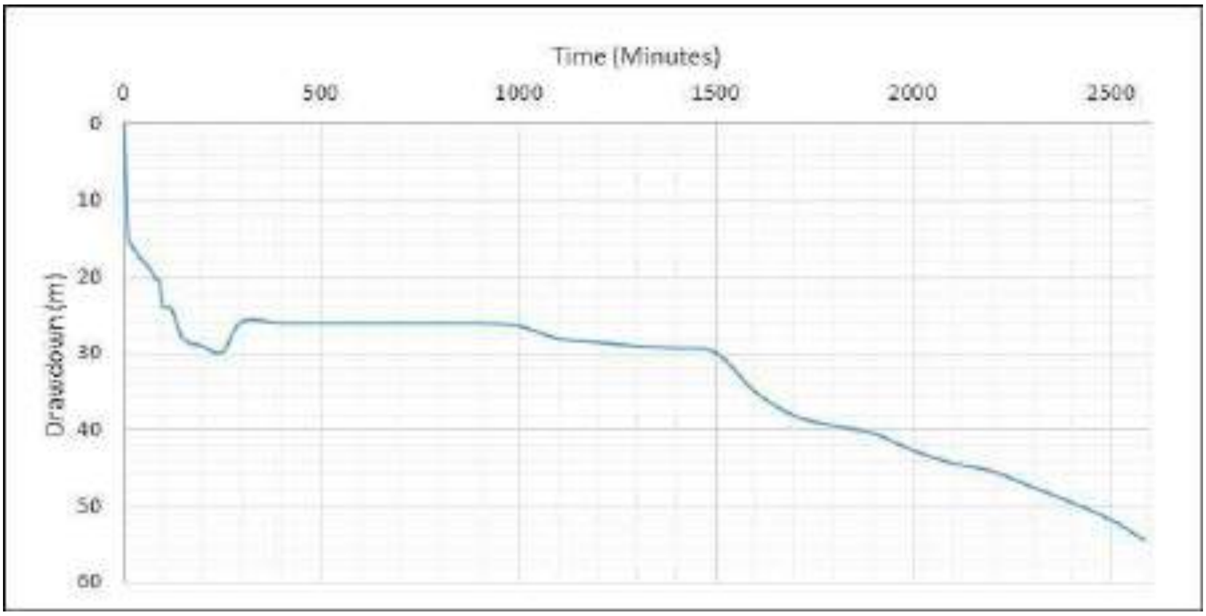


Figure 6.12. Drawdown Graph of Borehole BH5

ii. **Borehole BH U2;**

Steady state not completely reached but drawdown was very gradual; just 32cm in final 10hours of pumping which was done for 17hrs at constant discharge rate of 27,692l/hr. Total drawdown is 8.84meters only.

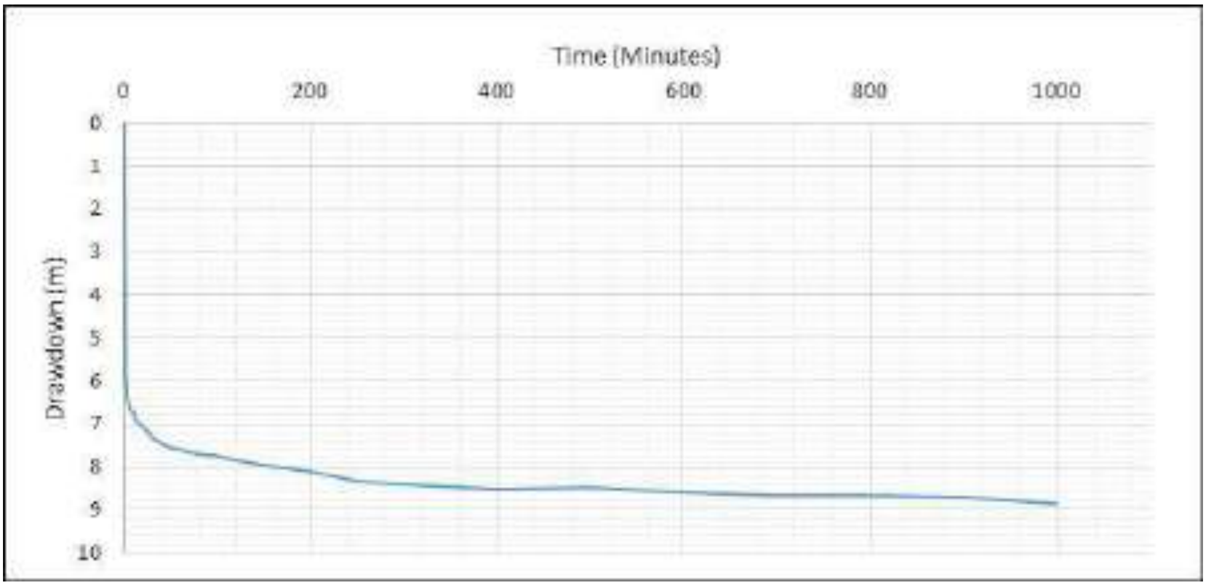


Figure 6.13. Drawdown Graph of Borehole BH-U2

iii. **Borehole BH U1;**

Steady state reached. Drawdown stabilized (no change) for five (5) final hours of pumping during pumping test of 12hours at a constant discharge rate of 20,000l/hr. Total drawdown is 36.68meters.

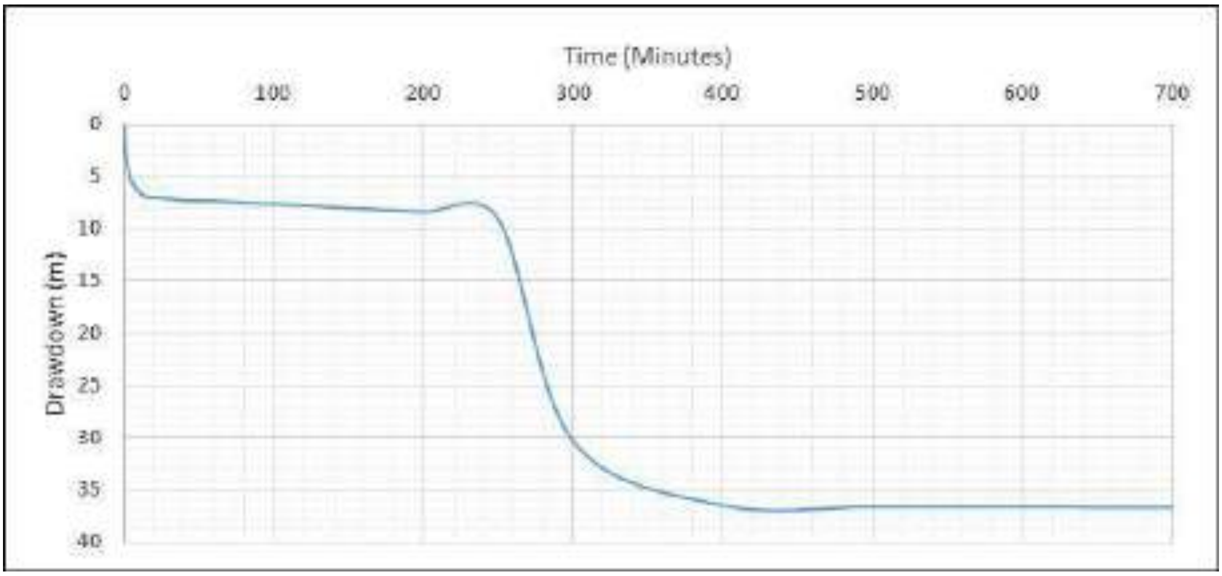


Figure 6.14. Drawdown Graph of Borehole BH-U1

iv. **Borehole BH6;**

Steady state not reached after pumping for 10hrs at constant discharge rate of 20,000l/hr. Drawdown reached at pumping test stoppage time is 18.50meters.

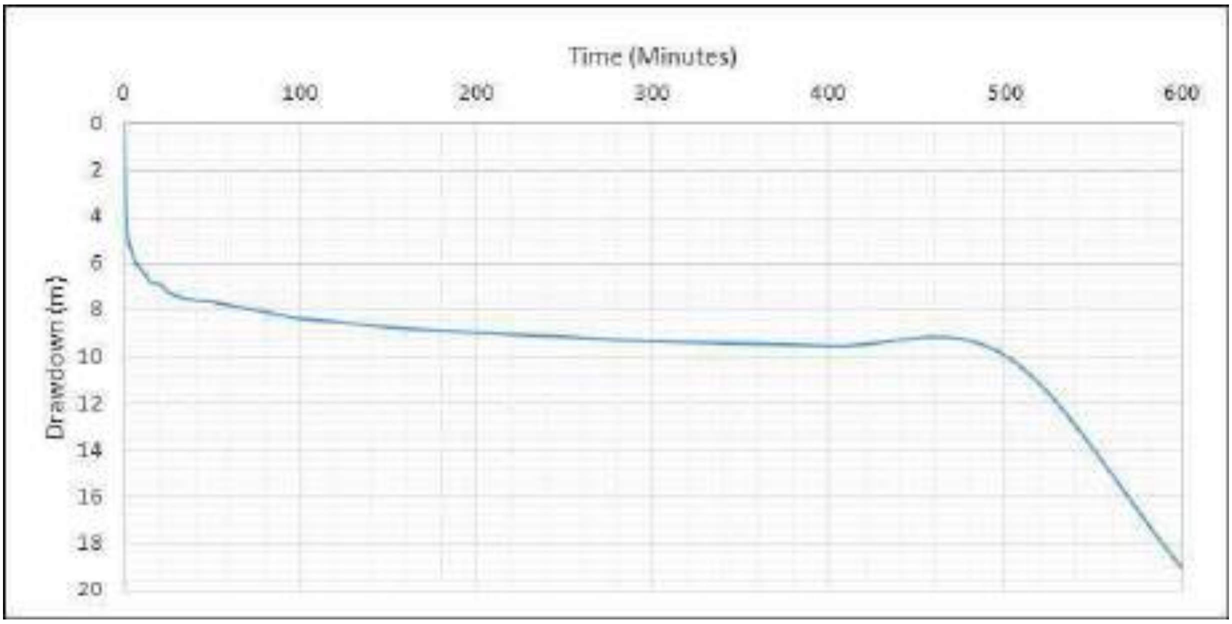


Figure 6.15. Drawdown Graph of Borehole BH6

v. **Borehole BH12;**

Steady state not reached after pumping for 10hrs at constant discharge rate of 20,000l/hr although drawdown had started to stabilize on the final three hours of pumping test. A very small drawdown of 6.20meters was observed during 10hours of pumping.

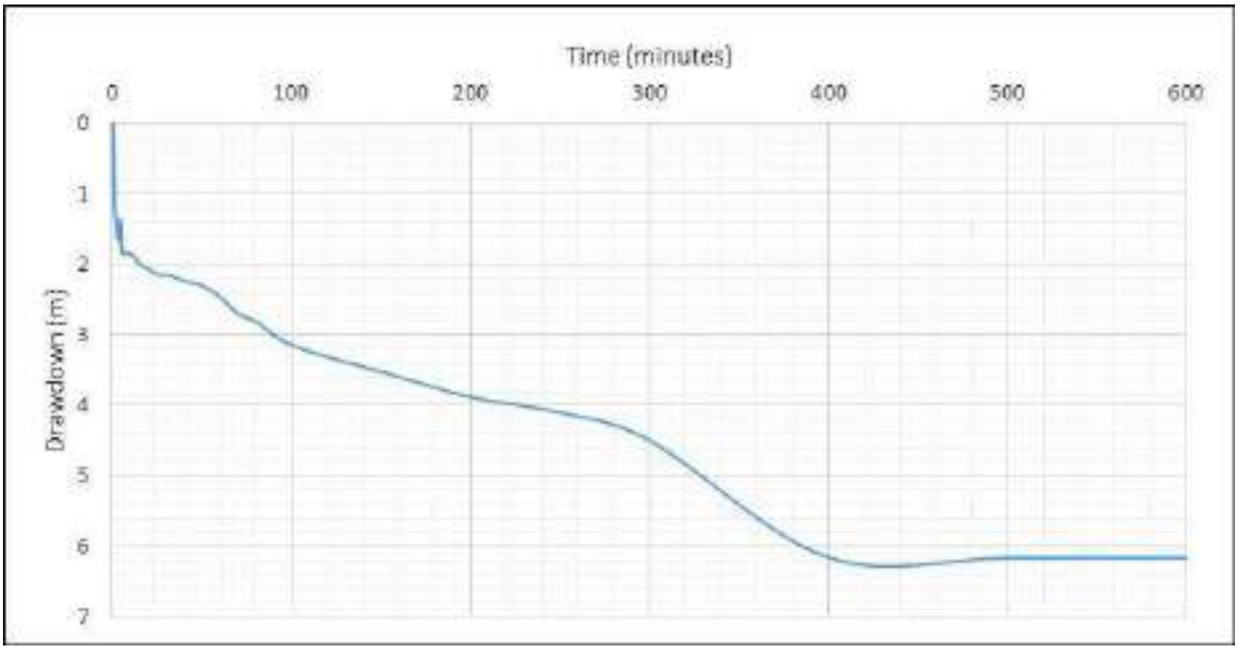


Figure 6.16. Drawdown Graph of Borehole BH12

vi. **Borehole BH13;**

Steady state not reached after pumping for 10hrs at constant discharge rate of 21.176l/hr. A drawdown of 3.6meters only was observed.

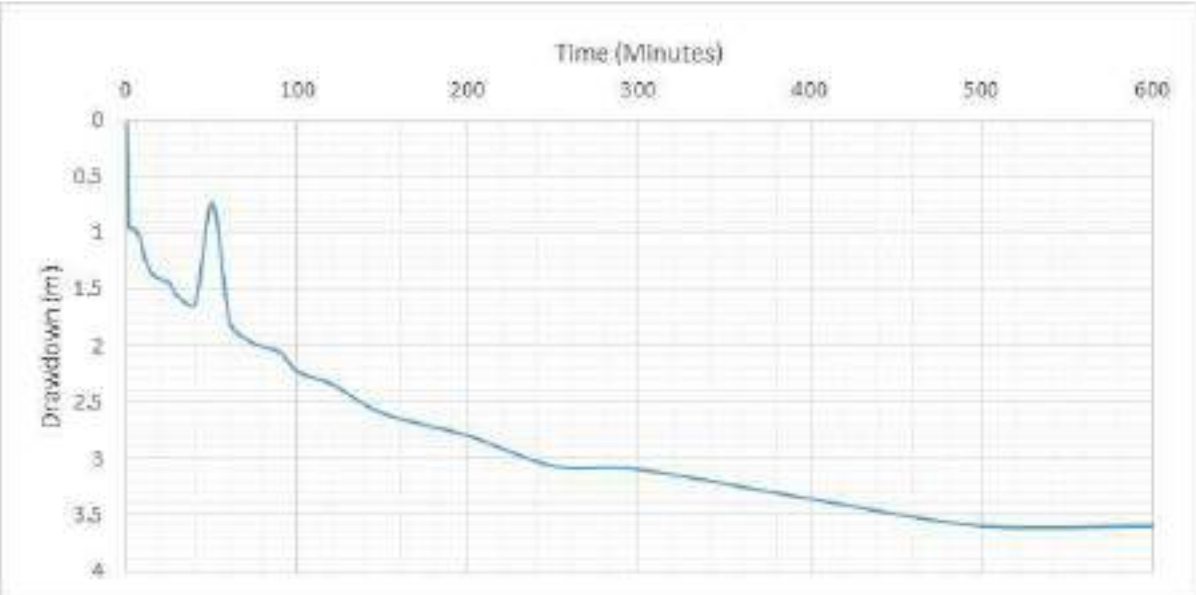


Figure 6.17. Drawdown Graph of Borehole BH13

Table 6.9: Borehole Performance Summary

| Borehole ID | Borehole Depth (m) | Pump Position (m) | Yield (L/Hr) | Drawdown (m) | Steady State Attained? | Recovery Time (Min) |
|---|---|---|---|---|---|---|
| BHU1 | 96.0 | 93 | 20,000 | 36.68 | YES | 200 (80%)* |
| BHU2 | 62.0 | 57 | 27,692 | 8.20 | NO | 300 (100%) |

| | | | | | | |
|---|---|---|---|---|---|---|
| BH5 | 100.0 | 93 | 62,937 | 54.90 | NO | 200 (100%) |
| BH6 | 65.0 | 57 | 20,000 | 11.06 | NO | 120 (82%) |
| BH 12 | 73.45 | 68 | 20,000 | 6.16 | NO | 60 (92%) |
| BH 13 | 92.0 | 90 | 21,176 | 3.60 | NO | 60 (87%) |

*Percent of water level recovered on indicated time

***Assessment of Effect of Pumping Well(s) to Other nearby Wells***

Effect of prolonged pumping was monitored during constant rate pumping test on two boreholes; BH5 and BH-U2. Selection of these boreholes for monitoring the effect of prolonged pumping was decided firstly because the borehole have wide diameter-that would allow use of larger pump hence maximum stress, and secondly because these were boreholes that would be pumped longer during constant rate pumping test.

During pumping at borehole BH5 which was pumped for 43 hours, water levels were monitored on boreholes BH-U1, BH-U2 and BH6. Water levels on these observation boreholes were measured (read) at the zero hour (beginning of) constant rate pumping test has started followed by an interval of 8hrs. Total of 7 readings (including stoppage time reading) were recorded in the process. All seven records showed no water level changes on any of the observation boreholes (Table 6.10) which could indicate lack of connectivity. However, the large distance ranging from 1.8 to 7 between production borehole and observation boreholes could affect the monitoring results.

Table 6.10: BH5 Piezometer Records

| BOREHOLE ID | S.W.L (m) | Water Level Reading Hours After Pumping Started (m) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | 8 | 16 | 24 | 32 | 40 | 43* |
| BHU1 | 9.98 | 9.98 | 9.98 | 9.98 | 9.98 | 9.98 | 9.98 | 9.98 |
| BHU2 | 18.90 | 18.90 | 18.90 | 18.90 | 18.90 | 18.90 | 18.90 | 18.90 |
| BH6 | 19.70 | 19.70 | 19.70 | 19.70 | 19.70 | 19.70 | 19.70 | 19.70 |

*Stoppage time reading

During pumping at borehole BH-U2 which was pumped for 26hours, water levels were monitored on boreholes BH-U1, BH5 and BH6. Water levels on these boreholes were ready at zero hour after constant rate pumping test has started followed by an interval of 8hrs. Total of 5 readings (including stoppage time reading) were recorded in the process. All five records showed no water level changes on any of the piezometer boreholes (Table 6.11).

Table 6.11: BH-U2 Piezometer Records

| BORE HOLE ID | S.W.L (m) | Water Level Reading Hours After Pumping Started (m) | | | | |
|---|---|---|---|---|---|---|
| | | 0 | 8 | 16 | 24 | 26* |
| BHU1 | 9.98 | 9.98 | 9.98 | 9.98 | 9.98 | 9.98 |
| BH5 | 9.50 | 9.50 | 9.50 | 9.50 | 9.50 | 9.50 |
| BH6 | 19.70 | 19.70 | 19.70 | 19.70 | 19.70 | 19.70 |

*Stoppage time reading

The information on Table 6.10 and Table 6.11 shows that, there is no effect and/or relation caused by prolonged pumping between boreholes BH-U1, BH-U2, BH5, BH6 and BH7. However, this finding does not exclusively deny presence of the effect of pumping boreholes to adjacent borehole. The cone of influence cannot reach the wide scattered boreholes hence cannot measure water level changes in piezometer wells. Longer pumping time during production phase should be monitored to continually assessing this factor.

***Determination of Hydraulic Parameters of the Aquifer***

Hydraulic properties of the aquifer are required for aquifer management issues like management of hazards associated with prolonged pumping (e.g., land subsidence), pollution control and monitoring degradation of groundwater quality. In this study, the main hydraulic property that this objective is supposed to estimate is transmissivity of the wellfield (to asses' extraction possibilities of brine from the Engaruka aquifers).

Using information generated from boreholes BH5 and BHU2 and their consequent observation boreholes (Table 6.10 and Table 6.11) storage coefficient (S) and transmissivity (T) were derived using Aquifer Test 10.1 software (Figure 6.18). Table 6.12 shows the information and assumptions that were fed to software. Engaruka soda ash aquifer **Storage Coefficient (S)** was found to be **0.0001** and **Transmissivity(T)** of **3.60m$^2$/h.**

Table 6.12: Information and assumptions fed to Aquifer Test 10.1 software

| **Required Information** | **Fed Information** | **Remarks** |
|---|---|---|
| Aquifer Thickness (m) | 80 | Quoted from drilling report by O.C. Holdings Ltd |
| Aquifer Type | Confined | Quoted from drilling report by O.C. Holdings Ltd |
| Aquifer Extent | Recharge barrier | Field observation |
| Anisotropy | Isotropic | |
| Well Orientation | Vertical | From physical observation and drilling reports |
| Borehole Penetration | Fully | Borehole penetration through aquifer |
| Screen Length (m) | 80 | Borehole completion report by O.C. Holdings Ltd |
| Gravel Pack Porosity (%) | 46 | Porosity for loose packing condition of sand (She Kaiming et al, 2006) |
| Pumping Test Discharge | Constant | Discharge during pumping test |
| Analysis Method | Theis | |

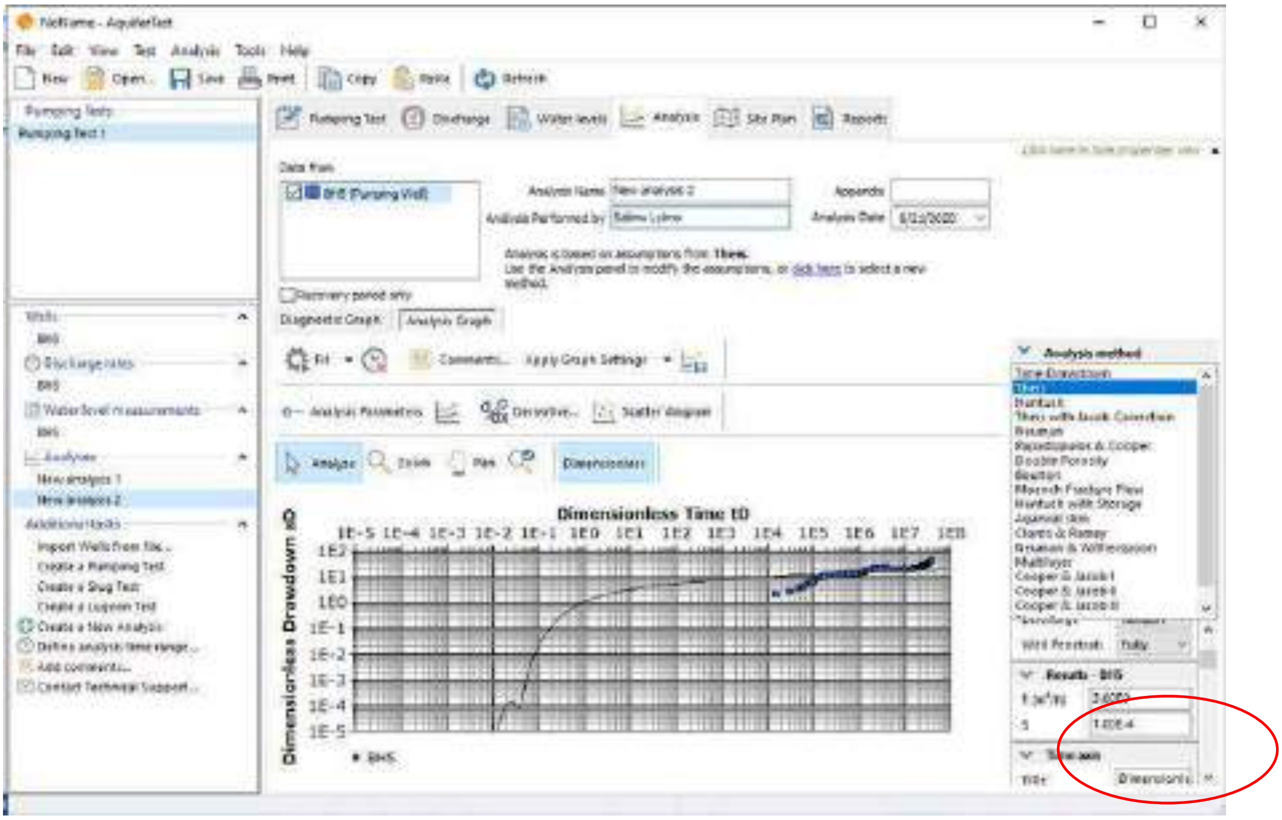


Figure 6.18: Analysis of aquifer propoerties using AquiferTest 10.1 software

***Estimate of Brine Recharge in the Engaruka Basin***

Groundwater recharge of a catchment is obtained through groundwater modelling or calculated by through catchment water balance method using equation **P = R+E+ΔS** (where P = Precipitation, R = Runoff/stream flow, E = Evapotranspiration and ΔS = Change in groundwater storage/recharge).

The study initially attempted to use catchment water balance method but the results were too high and unrealistic. This was in one hand due to limitations and shortcomings of the methodology while on other hand several key data necessary for calculating different variables of the equation were missing. Therefore, the study used the groundwater modelling tool; Soil and Water Analysis Tool (SWAT Model) to estimate recharge in the Engaruka basin. SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds. The tool was selected as it separates recharge to shallow aquifer and deep aquifer, a very important factor in deciding amount of groundwater recharged.

Input data for the model included land use map (generated by Arc SWAT tool which integrates remote sensing techniques), soil data obtained from Global Soil Data by FAO, a 30-m resolution DEM downloaded from USGS website and time series data (rainfall, relative humidity, temperature, solar radiation and wind speed). Time series data were obtained from Magugu Metrological Station (Table 6.13) which is operated by Internal Drainage Basin Water Board. This station is located 120km south-west of the Engaruka basin in Magugu

Village, Babati District, in Manyara Region. The station was selected for use in the study because the topographical settings of Magugu Village closely resemble that of Engaruka basin when compared to other available nearby stations such as Arusha Airport Meteorological Station and Monduli Rainfall Station on the windward side of Mount Meru and Kolomonike (Monduli) Mountain respectively while the Engaruka basin is on the leeward side of these mountains. Data used for the study span from 2006 to 2011 only. Poor data quality (longer data gaps and outliers) prevented the use of a longer data span.

Table 6.13. Magugu Metrological Station Evaporation Data (2006 to 2011)

| **Month** | **Rainfall (mm)** | **Max Temp. (°C)** | **Min Temp (°C)** | **Humidity (%)** | **Wind Speed (km/day)** | **Sunshine (hrs)** |
|---|---|---|---|---|---|---|
| January | 90 | 31 | 19 | 75 | 86 | 8 |
| February | 84 | 31 | 19 | 74 | 89 | 8 |
| March | 133 | 31 | 20 | 76 | 95 | 8 |
| April | 186 | 29 | 20 | 78 | 97 | 7 |
| May | 71 | 27 | 19 | 77 | 98 | 7 |
| June | 15 | 27 | 17 | 73 | 93 | 7 |
| July | 7 | 27 | 16 | 72 | 96 | 7 |
| August | 6 | 28 | 17 | 68 | 102 | 7 |
| September | 10 | 30 | 18 | 67 | 115 | 8 |
| October | 47 | 32 | 19 | 65 | 86 | 9 |
| November | 67 | 31 | 20 | 68 | 89 | 8 |
| December | 108 | 31 | 20 | 72 | 95 | 8 |

The model was calibrated and validated using the observed flow dataset from the Kirurumo River in Mto wa Mbu. The simulation period for the model was fifteen (15) years (1999-2013) and warm-up period was three (3) years (1999-2001). Model calibration was done by SWAT-CUP using two-third (2/3) of the dataset which is from 2002 – 2006 while one-third (1/3) of the dataset from 2006-2008 were used for data validation.

Assessment of the model performance was done by using hydrographical approach and statistical methods including Coefficient of Determination (R2) and Nash-Sutcliffe Efficiency (NSE). This helped in coming up with best fit scenario. The results of modelling are summarized on table 6.14.

Table 6.14. Summary of SWAT Model Results for Engaruka Basin

| **Parameter** | **Depth (mm)** |
|---|---|
| Precipitation | 460 |
| Evaporation | 381 |
| Potential Evapotranspiration | 1,638.5 |
| Evaporation from shallow aquifer | 30.93 |
| Percolation to shallow aquifer | 64.87 |
| Surface Runoff | 2.43 |

| | |
|---|---|
| Lateral Flow | 15.02 |
| Return Flow | 40.3 |
| **Recharge to deep aquifer** | **3.24** |
| Average Curve Number (CN Number) | 45.35 |

The result of the modelling shows that only 3.24mm out of 460mm of total precipitation in the Engaruka basin catchment goes into recharging deep aquifer. This amount of rainfall depth translates to volume recharged by using normal formula of calculating volume of an object; Volume = Area x. Depth. Area of Engaruka basin is 5,461$km^2$ as delineated by ArcGIS software (Figure 6.20). Then;

Volume Recharged = Area of the Engaruka Basin x. Rainfall Depth
= 5,461$km^2$ x. 3.24mm
= 5,461,000,000,000,000$mm^2$ x. 3.24mm
= 17,693,640,000,000,000$mm^3$
= **17,693,640$m^3$**

Therefore, the study concludes that amount of groundwater and hence brine recharged annually at Engaruka basin is **17,693,640$m^3$**

Results of SWAT Model (Table 6.14) indicate that precipitation (460mm) is higher than evaporation (361mm). Potential annual evapotranspiration parameter of 1,638.5mm is higher than annual precipitation. The fraction of precipitation that recharges Engaruka basin is apportioned during rainy season when precipitation is larger than evapotranspiration. Higher evapotranspiration in the catchment is probably attributed by evaporation from Lake Engaruka and vegetation cover on slopes of rift escarpment and mountains Kitumbeine and Kerimasi.


Figure 6.19: Catchment Area of Engaruka Basin (Google Earth image background)

***Estimate of Safe Yield of Engaruka Brine Basin***

Aquifer safe yield is (in simple language) a quantity of water (in our case, the brine) that can safely be removed from an aquifer system over time without causing undesirable effects such as depletion of the resource, degradation of brine quality and land subsidence. Safe yield of aquifer can be estimated by using several methods such as pumping test, catchment water balance and computer modelling.

Observations made from the whole exercise of pumping test, literature reviews and experience suggest that, estimating safe yield of Engaruka aquifer by using generated pumping test data will be misleading. Using these data would require that pumping test is done simultaneously in multiple boreholes in the aquifer, steady state is reached and recharge effect of nearby water body (Lake Engaruka) to the pumped boreholes is established. During this pumping test work, these factors were not dealt. For that reason, safe yield will be established via catchment water balance method.

Then, safe yield is calculated as a fraction of amount of recharge. However, there is ambiguity and lack of agreement on the safe yield fraction among many scholars (Alley and Leake, 2004; Maimone, 2004). Several references indicates that, in theory, a reasonably conservative estimate of safe yield would be about 10% while in practice, higher values of up to 20% have been considered. In this case, safe yield will be estimated at 20% to allow production maximization.

$$\begin{aligned} \text{Safe Yield} \quad &= (\Delta S * (20\%)) \\ &= (17{,}693{,}640\text{m}^3) * (20\%)) \\ &= \mathbf{3{,}538{,}728m^3} \end{aligned}$$

Therefore, safe yield and hence the maximum pumping rate at Engaruka brine field should be **3,538,728m$^3$**per year.

***Some Remarks on Pumping Tests***

a) Pumping test performed could not allow having nearby observation boreholes.

b) This pumping test work was not successful in evaluating the aquifer properties as steady state was not reached. This is one part caused by poor borehole design and inadequacies during execution of the pumping test work.

c) The study strongly recommends drilling of additional 4 exploratory cum production boreholes and 2 core/diamond drilling boreholes. These new boreholes will facilitate accurate assessment of aquifer properties before, during and after drilling.

d) The boreholes final casing diameter should not be less than 10 inches to allow usage of big and efficient pumps. Access roads should be improved such that are accessible throughout the year.

***Analysis of In-situ Parameters and Brine Sampling***

Water and brine sampling was carried on each pumped borehole, at the lake, at Engaruka and Kitumbeine streams.

In-situ parameter measurements on each borehole were conducted three times through the length of pumping test for the aim of testing the effect of brine dilution caused by continuous pumping. The first sample was taken at the beginning of the pumping, second sample at mid-way and the third one after drawdown has reached equilibrium. Analysis of these samples did not show any difference in the tested parameters. Results of in-situ testing are presented on Table 6.15.

Table 6.15: Results of Measurements of In-situ Parameter

| Borehole ID | Measured In-situ Parameters | | |
|---|---|---|---|
| | Acidity (pH) | Temperature (°C | EC (µS/cm) |
| BH-U1 | 10.17 | 33.3 | 117,400 |
| BH-U2 | 10.13 | 34.1 | 119,400 |
| BH5 | 9.93 | 35.0 | 121,200 |
| BH6 | 10.26 | 36.4 | 128,600 |
| BH12 | 11.03 | 33.1 | 120,600 |
| BH13 | 10.91 | 34.4 | 117,300 |
| Lake Engaruka | 9.55 | 37.0 | 3,590 |
| Engaruka Stream | 7.41 | 27.3 | 206 |

Brine samples for laboratory tests were collected, marked and preserved in cool box for up to 3days in the field then were sent to Arusha Water Quality Laboratory for temporary storage. After the pumping test exercise was completed, all samples (total of 32 samples) were transferred to Mwanza Water Quality Laboratory for analysis.

Control-Blank-Reagent (CBR) samples were collected as required by standard analysis procedures. Two samples CBR1 and CBR2 were collected and in situ parameters measured. The first sample CBR1 was collected from Kitumbeine Stream (coordinates UTM Zone 37, 9671766/188170, altitude 1619amsl). The second sample (CBR2) was collected at a borehole located in Engaruka Township (UTM Zone 37, 9668584/166561, altitude 840amsl).

***Chemical Analysis of the water samples***

Samples of water collected from the boreholes were analysed for various parameters at the Water Quality Laboratory of Ministry of Water and Irrigation in Mwanza City. This Laboratory is accredited by the Southern African Development community Accreditation Services (SADCAS) with Accreditation Number Test-50011.

Results of these analysis have revealed the presence of high concentrations of sodium bicarbonate whereby most of them ranging from 12.33g/l to 25.49g/l (Average 17.90 g/l). On the other hand, most of samples showed sodium carbonate ranging from 125.93g/l to 245.92 g/l (Average 201.61g/l). Compositions of the brines are presented in Table 6.16 and Appendix 9.3.

.

Table 6.16. Chemical analysis results of water samples

| ***Sample*** | ***Density*** | ***Viscosity*** | ***Sulphate (as $SO_4^{2-}$)*** | ***Potassium (as $K^+$)*** | ***Sodium (as Na+)*** | ***Chloride (as $Cl^-$)*** | ***Fluoride (as F-)*** | ***Total Phosphurus*** |
|---|---|---|---|---|---|---|---|---|
| Lake | 1.01 | 0.96 | 402.59 | 40 | 820 | 923.17 | 5.12 | 2.72 |
| Spring | 1.01 | 0.78 | 99.72 | 50 | 1070 | 140.5 | 0.83 | 0.53 |
| CBR1 | 1.21 | 1.60 | 3139.43 | 520 | 5830 | 53.75 | 600.52 | 2.78 |
| CBR2 | 1.23 | 1.58 | 6399.4 | 510 | 6550 | 42.43 | 745.19 | <D.L |
| BH 5 | 1.19 | 1.33 | 13856.09 | 970 | 6530 | 31.39 | 388.97 | <D.L |
| BHU 1 | 1.19 | 1.59 | 5352.12 | 490 | 5600 | 66.95 | 212.68 | 1.94 |
| BH 13 | 1.2 | 1.68 | 8349.38 | 580 | 6220 | 29.23 | 362.8 | 0.4 |
| BHU 12 | 1.2 | 1.68 | 10672.6 | 760 | 6770 | 15.79 | 355.84 | 0.32 |
| BHU 2 | 1.13 | 1.65 | 8393.43 | 1150 | 6400 | 26.412 | 455.85 | 0.16 |
| BH 6 | 1.24 | 1.34 | 19318.4 | 850 | 5940 | 48.09 | 346.33 | 0.04 |
| ***Method Code*** | ***MZWQL-WI-7.2.011*** | ***MZWQL-WI-7.2.009*** | ***MZWQL-WI-7.2.017*** | ***MZWQL-WI-7.047*** | ***MZWQL-WI-7.8.022*** | ***MZWQL-WI-7.2.012*** | ***MZWQL-WI-7.2.009*** | ***MZWQL-WI-7.2.017*** |
| ***Units*** | ***mg/l*** | ***mg/l*** | ***mg/l*** | ***mg/l*** | ***mg/l*** | ***mg/l*** | ***mg/l*** | ***mg/l*** |
| ***Detection Limit*** | ***0.73*** | ***0.431*** | ***0.328*** | ***0.01*** | ***0.01*** | ***0.112*** | ***0.431*** | ***0.328*** |
| ***REFERENCE*** | ***APHA*** | ***APHA*** | ***APHA*** | ***APHA*** | ***APHA*** | ***APHA*** | ***APHA*** | ***APHA*** |
| ***Sample*** | ***Total Hardness (as what?)*** | ***Total alkalinity as CaCO3*** | ***$HCO_3^-$ alkalinity as CaCO3*** | ***$CO_3^{2-}$ alkalinity as CaCO3*** | ***$NaHCO_3$ (salt)*** | ***$Na_2CO_3$ (salt)*** | ***Total Organic Carbon (TOC)*** | ***Nitrate (as $NO_3^-$)*** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lake | 5.2 | 1123.5 | 223.5 | 900 | 187.7 | 954 | 13.95 | 5.42 |
| Spring | 66 | 153.5 | 73.5 | 80 | 61.7 | 85 | 7.92 | 0.78 |
| CBR1 | 60 | 292350 | 88350 | 204 | 74214.0 | 216 | 80.46 | 4.55 |
| CBR2 | 680 | 230350 | 36350 | 194000 | 30534.0 | 205640 | 12.64 | 3.76 |
| BHU5 | 475 | 247350 | 21350 | 226000 | 17934.0 | 239560 | 22.62 | 94.6 |
| BHU1 | 108 | 200350 | 30350 | 170000 | 25494.0 | 180200 | 13.24 | 2.85 |
| BHU13 | 196 | 194350 | 22350 | 172000 | 18774.0 | 182320 | 30.59 | 76.3 |
| BHU12 | 740 | 252700 | 20700 | 232000 | 17388.0 | 245920 | 10.96 | 3.23 |
| BHU2 | 100 | 137870 | 19070 | 118800 | 16018.8 | 125928 | 24.31 | 80.66 |
| BHU6 | 152 | 237080. | 14680 | 222400 | 12331.2 | 235744.0 | 26.35 | 29.79 |
| ***Method Code*** | ***MZWQL-WI-7.2.010*** | ***MZWQL-WI-7.2.008*** | ***MZWQL-WI-7.2.008*** | ***MZWQL-WI-7.2.008*** | ***MZWQL/WI 7.2.023*** | ***MZWQL/WI 7.2.17*** | ***MZWQL/WI 7.2.034*** | ***MZWQL-WI-7.2.005*** |
| ***Units*** | ***mg/l*** | ***mg/l*** | ***mg/l*** | ***mg/l*** | ***mg/l*** | ***mg/l*** | ***mg/l*** | ***mg/l*** |
| ***Detection Limit*** | ***1.211*** | ***3.0*** | ***3.0*** | ***3.0*** | ***0.01*** | ***0.72*** | ***0.03*** | ***1.0*** |
| ***REFERENCE*** | ***APHA*** | ***APHA*** | ***APHA*** | ***APHA*** | ***APHA*** | ***APHA*** | ***APHA*** | ***APHA*** |

## 6.8. Boreholes and Topographical Surveys

Boreholes and topographical surveys at the Basin were conducted by Mineral Resource Institute (MRI) located in Dodoma. DGPS survey was conducted between 2$^{nd}$ and 13$^{th}$ October 2019. The survey used Differential Global Positioning System (DGPS) to survey existing boreholes and spot heights of the basin.

The objective of the survey was to establish topographic data to be used in the resource modelling. Resource modelling requires high accuracy on X, Y and Z positions of the borehole locations whose parameters are used for resource modelling. Six (6) control points were established as reference points from the National Control Point (T124) prior to spot height topographical and boreholes surveying.

***Establishment of Control Points***

Engaruka has a National Control Monuments (T124) located 17km North-West of the project area. The point makers were checked and found to be in-situ. The coordinates of this point were obtained from Head Office of Ministry of Land, Housing and Settlement. This was regarded as the primary control point and based on this point, six (6) other points (secondary control points) namely ENG01, ENG02, ENG03, ARV, ENG04, ENG05 were established within basin. Real Time Kinematics (RTK)observation was used to establish these control points which are coordinated by the RTK mode of the Global Navigation Satellite System (GNSS) method using KOLIDA K5+ (Figure 6.20). All observations were tied to existing second order point T124 (Engaruka Chini Primary School) located in Engaruka Monduli District.

Figure 6.20. Photo showing DPGS positioned on the control points to record coordinate using RTK technique.

The datum and coordinated system used in the survey is Arc1960 Universal Transverse Mercator (UTM) Zone 37s. All surveys were tied to the National Levelling Datum benchmark.

***Borehole Pick-Up***

Borehole survey was done using the established control points as the references, the GNSS-RTK technique was used in surveying the holes. KOLIDA K5+ RTK system with 1 base receiver and 1 rover receiver were used in surveying the drill holes **(**Figure 6.22**).** Each position of drill holes was reached and picked using Rover Receiver (Figure 6.23). Since data recording was automatic, no field sketches of the detail surveyed were prepared in hardcopy; however, the positions of all the permanent details surveyed (i.e., boreholes) can be obtained from the digital maps submitted.

Figure 6.21. Photo showing RTK GPS Base Station

Figure 6.22. Photo showing DGPS survey on borehole number 6

Figure 6.23. Photo showing DGPS base station with receiver and rover

***Topographic Surveying***

Topographical surveying of the project includes pick-up of spot heights which was done using the established control points as the references and using the same technique and system used for drill hole surveying. The detail survey of the area comprises surveying of basin boundary and spot heights around lake edges. Using the same receiver topography was done by picking spot height at reasonable intervals. The project was very large for conducting detailed topographical survey so, only selected sport height land features were surveyed.

***Data Processing***

Data were digitally stored by using a Data logger/Survey controller. The captured data from the logger was downloaded and exported into computer in excel format. All surveying data were processed using the 12D software. The software was used to create a topographical map of the project area showing features such as boreholes, Lake and ground elevation using contour. The XYZ files in excel format for all features surveyed (i.e., basin boundary, lake edges, boreholes.) were prepared for easy export of these features to other software.

***DGPS Results Status***

A total of 16 boreholes and 59 sport height of selected features within the basin and lake water boundaries were surveyed (Table 6.17**,** Table 6.18 & Figure 6.24**).**

Data and information resulted from DGPS survey includes:

1. Coordinate lists in excel files for all surveyed features,
2. Drawing files AutoCAD dxf format,
3. The list of coordinates for the control points established,

4. A log report on the RTK GPS data fixation for the control points, and
5. Description Cards for all control points.

Table 6.17. Boreholes survey status

| BHID | UTM_North | UTM_East | Elevation | Boreholes Status | |
|---|---|---|---|---|---|
| BH1 | Nil | Nil | Nil | Covered by water | Not surveyed |
| BH2 | 9654480 | 187733.6 | 693.758 | Not seen | Surveyed |
| BH3 | 9656537 | 180526.5 | 693.26 | Not seen | Surveyed |
| BH4 | 9651236 | 183126.2 | 700.655 | Not seen | Surveyed |
| BH5 | 9662591 | 182441.3 | 698.653 | Disturbed | Surveyed |
| BH6 | 9660764 | 180271.9 | 705.965 | Capped | Surveyed |
| BH7 | 9660314 | 181605.9 | 696.624 | Disturbed | Surveyed |
| BH8 | 9658378 | 188138.6 | 699.161 | Not seen | Surveyed |
| BH9 | 9654440 | 180341.5 | 694.718 | Not seen | Surveyed |
| BH10 | 9659207 | 180537.2 | 700.825 | Capped | Surveyed |
| BH11 | 9652063 | 188875.7 | 694.618 | Beacon not seen (not placed during drilling) but indications of drilling was seen | Surveyed |
| BH12 | 9649148 | 185884.6 | 712.135 | Disturbed | Surveyed |
| BH13 | 9647781 | 188073.3 | 730.865 | Capped | Surveyed |
| BH14 | 9648850 | 182224.5 | 722.813 | Disturbed | Surveyed |
| BH15 | 9647564 | 184934.1 | 729.801 | Disturbed | Surveyed |
| BH16 | 9646118 | 187300.2 | 741.662 | Disturbed | Surveyed |
| WH1 | 9660403 | 186992.2 | 692.907 | Disturbed | Surveyed |
| WH2 | 9660253 | 188483.3 | 699.654 | Capped | Surveyed |
| WH | 9663436 | 180462.5 | 706.976 | Capped | Surveyed |

Table 6.18. List of topographical survey points

| PointID | Northing | Easting | Height | Description | | Point | Northing | Easting | Height | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| BDY0 | 9654690.042 | 177201.06 | 728.446 | SpotHeight | | L16 | 9653185.678 | 181622.353 | 692.25 | Lake |
| BDY1 | 9659729.973 | 178311.994 | 718.246 | SpotHeight | | L17 | 9653247.266 | 182197.455 | 692.44 | Lake |
| BDY2 | 9650680.027 | 181837.085 | 708.323 | SpotHeight | | L18 | 9653318.716 | 182638.49 | 692.43 | Lake |
| BDY3 | 9664930.028 | 178121.966 | 716.274 | SpotHeight | | L19 | 9653307.456 | 183245.161 | 692.32 | Lake |
| BDY4 | 9666790.008 | 178820.018 | 731.743 | SpotHeight | | L20 | 9653274.361 | 183525.171 | 692.15 | Lake |
| BDY5 | 9664690.22 | 182344.929 | 713.799 | SpotHeight | | L21 | 9653321.718 | 180499.715 | 692.41 | Lake |
| BDY6 | 9662790.043 | 186852.972 | 718.603 | SpotHeight | | L22 | 9658953.915 | 181930.645 | 692.36 | Lake |
| BDY7 | 9660220.011 | 188186.999 | 697.484 | SpotHeight | | L23 | 9659490.916 | 182007.371 | 692.37 | Lake |
| BDY8 | 9657050.023 | 189901.003 | 708.589 | SpotHeight | | L24 | 9660199.2 | 182592.186 | 692.28 | Lake |
| BDY9 | 9654200.001 | 190631.023 | 695.894 | SpotHeight | | L25 | 9660946.247 | 182960.96 | 692.41 | Lake |
| BDY10 | 9650640.002 | 191519.995 | 749.19 | SpotHeight | | L26 | 9661642.235 | 183076.108 | 692.41 | Lake |
| BDY11 | 9663240.065 | 179949 | 709.757 | SpotHeight | | L27 | 9661872.28 | 183478.629 | 692.34 | Lake |
| BDY12 | 9653020.079 | 180361.927 | 693.032 | SpotHeight | | L28 | 9653313.234 | 184171.622 | 692.07 | Lake |
| BDY13 | 9646019.965 | 183343.006 | 769.055 | SpotHeight | | L29 | 9653007.124 | 184939.026 | 692.12 | Lake |
| 1 | 9658862.401 | 180373.129 | 701.126 | Spotheight | | L30 | 9653078.735 | 185925.913 | 692.11 | Lake |
| 2 | 9658826.74 | 180498.795 | 700.85 | Spotheight | | L31 | 9653857.261 | 186444.091 | 692.16 | Lake |
| 3 | 9658718.482 | 180782.465 | 699.557 | Spotheight | | L32 | 9654792.363 | 186447.761 | 692.18 | Lake |
| L4 | 9658440.272 | 181640.372 | 692.222 | Lake | | L33 | 9655993.219 | 186369.6 | 692.11 | Lake |
| L5 | 9658128.342 | 181585.027 | 692.347 | Lake | | L34 | 9655993.177 | 186369.6 | 692.07 | Lake |
| L6 | 9657566.212 | 181367.041 | 692.319 | Lake | | L35 | 9656378.713 | 186381.684 | 692.46 | Lake |
| L7 | 9657124.636 | 181065.622 | 692.366 | Lake | | L36 | 9656794.316 | 186310.841 | 692.43 | Lake |
| L8 | 9656773.517 | 180914.804 | 692.056 | Lake | | L37 | 9657710.452 | 186225.159 | 692.16 | Lake |
| L9 | 9656234.11 | 180438.56 | 692.336 | Lake | | L38 | 9658502.735 | 186486.965 | 692.23 | Lake |
| L10 | 9655752.729 | 180335.748 | 692.336 | Lake | | L39 | 9659696.867 | 186568.923 | 692.14 | Lake |
| L11 | 9655095.957 | 180388.384 | 692.35 | Lake | | L40 | 9660595.419 | 186507.07 | 692.21 | Lake |
| L12 | 9654614.518 | 180463.84 | 692.438 | Lake | | L41 | 9661225.037 | 186150.818 | 692.18 | Lake |
| L13 | 9654043.373 | 180489.728 | 692.363 | Lake | | L42 | 9661627.531 | 185507.875 | 692.28 | Lake |
| L14 | 9653496.643 | 180560.055 | 692.39 | Lake | | L43 | 9661785.121 | 184745.985 | 692.3 | Lake |
| L15 | 9653222.387 | 181025.586 | 692.343 | Lake | | L44 | 9661508.821 | 184171.512 | 692.29 | Lake |
| | | | | | | L45 | 9661357.619 | 183877.966 | 692.05 | Lake |

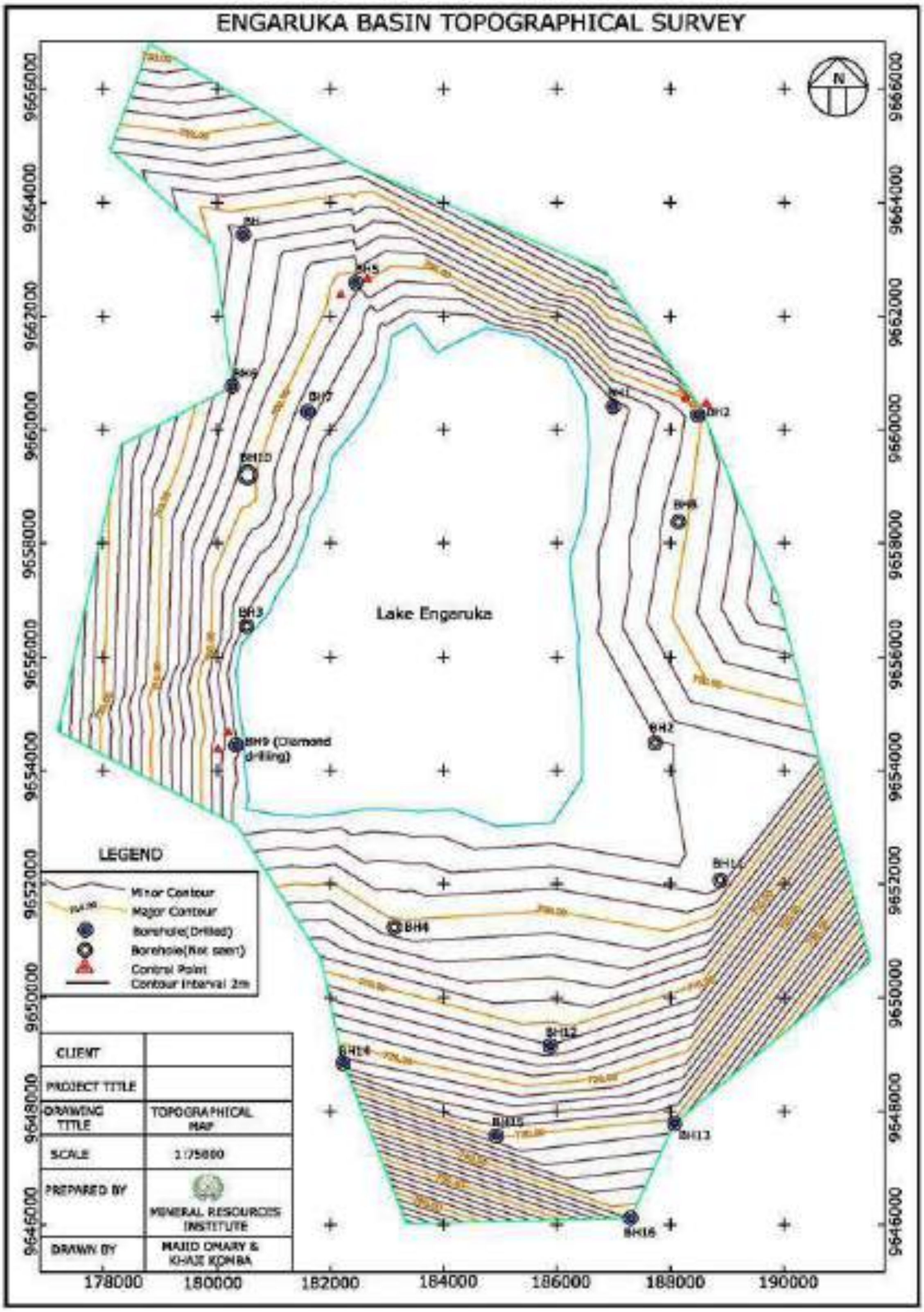


Figure 6.24. Topographic map showing distribution of Borehole surveyed

## 6.9. Vertical Electrical Sounding

***Vertical Electrical Sounding Data***

A total of nine (9) Vertical Electrical Soundings (VES) were executed at the study area (Table 6.19). VES was carried out with the aid of the LS ABEM Tetrameter deploying the Schlumberger configuration to maximum current electrode separation (AB) of 600 metres and potential electrode separation (MN) of 80 metres. VES 6 was executed to maximum current electrode separation (AB) of 400 metres and potential electrode separation (MN) of 50 metres, as the ground possessed lower resistivity below the instrument detection limit.

Among nine (9) VES's, seven (7) VES's were executed at the positions of exploratory boreholes drilled in 2013. However, in verification of positions of these boreholes it was realised that four (4) of these boreholes exist and were caped while three of them do not exist. Apart from these borehole positions, two (2) additional VES's were executed at the former VES's location done during exploratory work in 2011. This was done with the aim of validating VES measurements done in 2011so that measurements can be included in the data treatment and interpretation for the current study.

Table 6.19. The executed Vertical Electrical Soundings (VES)

| No | Easting's | Northing's | VES No | BH No | BH Status | Relative Resistivity | |
|---|---|---|---|---|---|---|---|
| | | | | | | From | To |
| 1 | 182442 | 9662588 | VES 1 | BH 5 | Exist | 0.74 | 39.97 |
| 2 | 181607 | 9660309 | VES 2 | BH 7 | Exist | 0.43 | 27.49 |
| 3 | 180540 | 9659201 | VES 3 | BH 10 | Exist | 0.24 | 13.15 |
| 4 | 180343 | 9654437 | VES 4 | BH 9 | Do Not Exist | 0.11 | 4.05 |
| 5 | 186992 | 9660402 | VES 5 | VES 2(BH 2) | Exist | 0.1 | 2.45 |
| 6 | 188143 | 9658371 | VES 6 | BH 8 | Do Not Exist | <0.05 | 519 |
| 7 | 186429 | 9656691 | VES 7 | Btw BH 2&8 | Do Not Exist | 0.13 | 1.62 |
| 8 | 187733 | 9654475 | VES 8 | BH 2 | Do Not Exist | 0.17 | 71.54 |
| 9 | 188872 | 9652045 | VES 9 | BH 11 | Beacon not Exist but position seen | 0.3 | 21.32 |

The resulted relative resistivity values range between 0.1 ohm-m to 0.74ohm-m for the minimum values and 1.62ohm-m to 71.54ohm-m for the maximum values. This range is for the all VES's except VES 6 which had the highest range of the relative resistivity ranging from less than 0.05ohm-m to 519.11ohm-m. Resistivity Raw Data and Apparent Resistivity Graphs are presented in Appendix 9.6 and 9.7.

*Validation of Previous VES data Conducted in 2011*

The verification team analysed authenticity of results presented in the "Geo-electric (Resistivity) Survey for the assessment of Soda ash deposit in Engaruka Basin conducted in 2011. It was seen that the report has a map showing position where VES measurements were taken. The same report has a table with coordinates of the respective VES measured positions.

The validation process was done by Geo-referencing the map and plotting the coordinates on the same map. In addition, measurements were taken at other positions where previous VES measurements were taken in 2011. The validation team repeated VES measurements and compared the interpreted stratigraphical sequence on whether they match for the purpose of validating the performance of VES equipment. This validation exercise was done acquire good quality measurement of the previous study and to include them in the current study so as to increase the number of data, and to minimize repetition.

***Observations of the Validation:***
In plotting coordinates on a georeferenced map of the study conducted in 2011 it was seen that the coordinates do not correspond with their respective location (Figure 6.25).

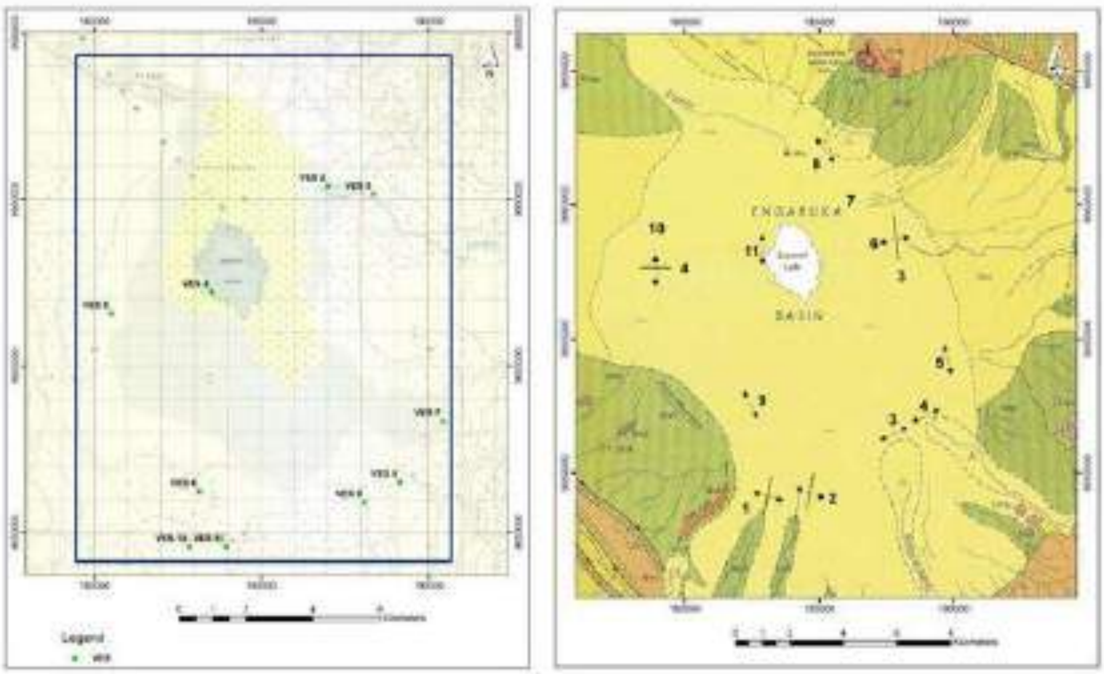


Figure 6.25: The maps for comparison of the VES locations for the VES executed in 2011.

***Concluding Remarks on Validation***
From the stipulated mismatch of data from VES measurement from the previous study, four (4) out of eleven (11) VES measurements were used in resource modelling.

***Current VES Measurement***
Map in Figure 6.26 is showing positions where new VES measurements were taken. Positions of the current VES measurements were close to the borehole locations for the

purpose of establishing the stratigraphy of the locations. This was done for the purpose of correlating low resistivity zones with aquifer positions.

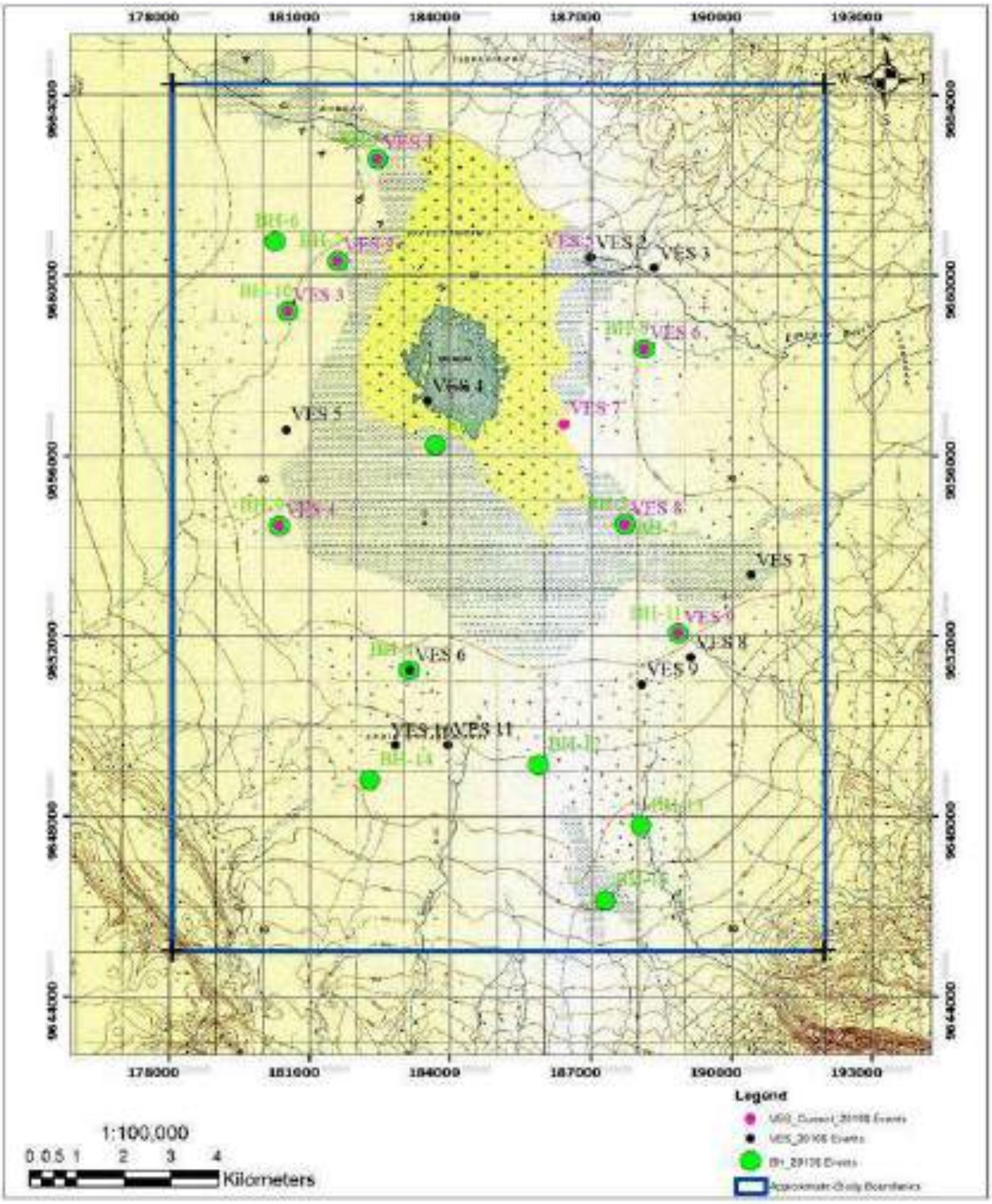


Figure 6.26: Current VES measurements in the Engaruka Basin

***Vertical Electrical Sounding Data Interpretation***

The interpretation of the VES's data was done using Interpret 1-D sounding Inversion Software Version 2009 that started by noise reduction from the data results by Inversion method in order to obtaining maximum fittings for the curves. Then the underlying layers with their respective relative resistivity and thicknesses were obtained (Table 6.20).

The classification of modelled layers was based on the following criteria: In each VES, the top layer considered the “Top Soil”. The underneath layers were classified according to the range in their respective relative resistivity, formation with resistivity less than 1 ohm-m “clay with brine”, formation with resistivity between 1 ohm-m and 20 ohm-m “sandy clay sediment”. Formation with resistivity between 20 ohm-m and 50 ohm-m “alluvium sediment, formation with resistivity between 50ohm-m and 100ohm-m “slightly/fractured salt crystal while formation with resistivity greater than 100ohm-m considered as “salt crystals” (Basokur, 1993).

- **VES 1:** Six layers were modelled at this VES point by which, the first layer has resistivity value of 20.21 ohm-m with thickness of 1.26 m is considered as top soil layer. The second, third and fourth layers have resistivity values of 4.98ohm-m, 1.05 ohm-m representing clay with brine (thickness 17.76), and 9.59 ohm-m respectively considered to form a Sandy Clay layer with total thickness of 29.49 m. The fifth layer has resistivity value of 30.90 ohm-m is considered as Alluvium Sediments with thickness of 61.83 m while sixth layer with resistivity value greater than 86.41 ohm-m and it is being interpreted as undefined sediments which extend from 110.33 m below the surface.
- **VES 2:** Six lithological layers were modelled at VES 2 whereby the first layer with resistivity value of 63.77 ohm-m and thickness of 0.71 m is referred as the top dry soil. The second, third and fourth layers with resistivity values of 0.77 ohm-m, 0.81 ohm-m and 0.31ohm-m form the Clay with brine layer with thickness of 27.42 m. The fifth layer has resistivity value of 16.87 ohm-m and thickness of 57.71 m form the Sandy Clay layer while the sixth layer with resistivity value of greater than 74.25 ohm-m form undefined sediments which extend from 85.83 m below the surface.
- **VES 3:** Six layers were modelled at this VES point by which the first layer with resistivity value of 20.27 ohm-m and thickness of 0.47 m is the top soil. The second and third layers with resistivity values of 1.32 ohm-m and 2.35 ohm-m form the Sandy Clay layer of thickness of 8.78m. The fourth layer has the resistivity value of 0.39 ohm-m forms the Clay with brine layer with thickness of 18.87 m. The fifth layer forms the Sandy Clay layer with resistivity value of 19.24 ohm-m and thickness of 25.51 m. The sixth layer has resistivity value greater than 106 ohm-m extending below 53.62 m form undefined sediments.
- **VES 4:** Five layers were modelled at this VES point by which the first layer with resistivity value of 4.22 ohm-m and thickness of 1.74 m form the top soil. The second and third layers with resistivity values of 0.62 ohm-m and 0.18 ohm-m form the Clay with brine layer of 28.8 m thickness. The fourth and fifth layers form the Sandy clay layer with resistivity values of 1.55 ohm-m and 4.48 ohm-m with thickness of more than 146.01 m.

- **VES 5:** Five layers were modelled at this VES point by which the first layer which form the top dry soil layer has the resistivity value of 137.33 ohm-m and thickness of 0.27 m. The second layer ha resistivity value of 1.83 ohm-m and thickness of 0.87 m is referred to the Sandy Clay layer. The third and fourth layers have resistivity values of 0.20 ohm-m and 0.26 ohm-m form the Clay with Brine layer with thickness of 32.62 m. The fifth layer has resistivity values of greater than 1.33 ohm-m and extends below 33.76 m form the Sandy Clay layer.
- **VES 6:** Five layers were modelled at this VES point by which, the top dry soil has resistivity values of 124.64 ohm-m and thickness of 0.25 m. The second layer has very high resistivity value of 754 ohm-m is considered to form the Dry Sandy Clay layer with thickness of 2.61 m. The third and fourth layers has resistivity values of 17.70 ohm-m and 2.80 ohm-m are considered to form the Sandy Clay layer with total thickness of 154.75 m. The fifth layer has resistivity value less than 0.55 ohm-m forms the Clay with Brine layer extending from 157.62 m below the surface.
- **VES 7**: Five layers were modelled at this VES point by which the top soil layer has resistivity values of 2.12 ohm-m and thickness of 1.07 m. The second, third and fourth layers have resistivity values of 0.41 ohm-m, 0.16 ohm-m and 0.81 ohm-m respectively form the Clay with brine layer with total thickness of 90.27 m. The fifth layer has resistivity value of 3.85 ohm-m form the Sandy Clay layer extending below 91.34 m.
- **VES 8**: Five layers were modelled at this VES point by which the top soil layer which is dry has the resistivity value of 185.24 ohm-m and thickness of 0.73 m. The second and third layers have resistivity values of 0.41 ohm-m and 0.27 ohm-m respectively form the Clay with Brine layer with total thickness of 15.59 m. The fourth layer has resistivity value of 3.39 ohm-m correspond to the Sandy Clay layer with thickness of 55.19 m. The fifth layer has resistivity value less than 0.19 ohm-m forms the Clay with brine layer which extend below 71.51 m.
- **VES 9:** Five layers were modelled too at this VES point by which the top soil layer has resistivity value of 3.46 ohm-m with thickness of 1.16 m. The second layer is the Sandy Clay layer with resistivity value of 1.03 ohm-m and thickness of 2.68 m. The third layer is the Clay with Brine layer with resistivity value of 0.73 ohm-m and thickness of 31.93 m. The fourth layer is the Alluvium sediment layer which has resistivity value of 27.04 ohm-m and thickness of 43.91 m. The fifth layer of undefined sediments with resistivity values greater than 425 ohm-m extends below 79.68 m from the surface.

Table 6.20. The relationship between resistivity and expected strati-graphical layer

| VES No. | Location (UTM) | Layer No. | Resistivity (Rho) | Thickness (m) | Depth (m) | Expected strati graphical layer |
|---|---|---|---|---|---|---|
| 1 | 0182442 9662588 | 1 | 20.21 | 1.26 | 1.2561 | Top Soil |
| | | 2 | 4.98 | 2.53 | 3.7845 | Sandy Clay |
| | | 3 | 1.05 | 13.98 | 17.767 | Clay with Brine |
| | | 4 | 9.59 | 30.73 | 48.501 | Sandy Clay |
| | | 5 | 30.90 | 61.83 | 110.33 | Alluvium Sediments |
| | Alt: 743m | 6 | >86.41 | +++ | >110.33 | Undefined Sediments |
| 2 | 0181607 9660309 | 1 | 63.77 | 0.71 | 0.71 | Top Soil |
| | | 2 | 0.77 | 2.91 | 3.62 | Clay with Brine |
| | | 3 | 0.81 | 7.12 | 10.75 | Clay with Brine |
| | | 4 | 0.32 | 17.38 | 28.13 | Clay with Brine |
| | | 5 | 16.87 | 57.71 | 85.83 | Sandy Clay |
| | Alt: 717m | 6 | >74.25 | +++ | >85.83 | Weathered/fractured |
| 3 | 0180540 9659201 | 1 | 20.27 | 0.47 | 0.47 | Top Soil |
| | | 2 | 1.32 | 5.35 | 5.82 | Sandy Clay |
| | | 3 | 2.35 | 3.43 | 9.25 | Sandy Clay |
| | | 4 | 0.39 | 18.87 | 28.11 | Clay with Brine |
| | | 5 | 19.24 | 25.51 | 53.62 | Sandy Clay |
| | Alt: 743m | 6 | >106.40 | +++ | >53.624 | Undefined Sediments |
| 4 | 0180343 9654437 | 1 | 4.22 | 1.74 | 1.74 | Top Soil |
| | | 2 | 0.62 | 9.70 | 11.44 | Clay with Brine |
| | | 3 | 0.18 | 19.18 | 30.62 | Clay with Brine |
| | | 4 | 1.55 | 146.01 | 176.63 | Sandy Clay |
| | Alt: 728m | 5 | >4.48 | +++ | >176.63 | Sandy Clay |
| 5 | 0186992 9660402 | 1 | 137.33 | 0.27 | 0.27 | Top Soil |
| | | 2 | 1.83 | 0.87 | 1.14 | Sandy Clay |
| | | 3 | 0.20 | 6.64 | 7.78 | Clay with Brine |
| | | 4 | 0.26 | 25.98 | 33.76 | Clay with Brine |
| | Alt: 726m | 5 | >1.33 | +++ | >33.76 | Sandy Clay |
| 6 | 0188143 9658371 | 1 | 124.64 | 0.25 | 0.25 | Top Soil |
| | | 2 | 754.26 | 2.61 | 2.86 | Dry Sandy Clay |
| | | 3 | 17.70 | 8.15 | 11.01 | Sandy Clay |
| | | 4 | 2.80 | 146.60 | 157.62 | Sandy Clay |
| | Alt: 718m | 5 | <0.55 | +++ | >157.62 | Clay with Brine |
| 7 | 0186429 9656691 | 1 | 2.12 | 1.07 | 1.07 | Top Soil |
| | | 2 | 0.41 | 3.90 | 4.97 | Clay with Brine |
| | | 3 | 0.16 | 11.18 | 16.15 | Clay with Brine |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 4 | 0.81 | 75.19 | 91.34 | Clay with Brine |
| | Alt: 725m | 5 | >3.85 | +++ | >91.339 | Sandy Clay |
| 8 | 0187733 9654475 | 1 | 185.24 | 0.73 | 0.73 | Top Soil |
| | | 2 | 0.41 | 4.85 | 5.57 | Clay with Brine |
| | | 3 | 0.27 | 10.75 | 16.32 | Clay with Brine |
| | | 4 | 3.39 | 55.19 | 71.51 | Sandy Clay |
| | Alt: 737m | 5 | <0.19 | +++ | >71.505 | Clay with Brine |
| 9 | 0188872 9652045 | 1 | 3.46 | 1.16 | 1.16 | Top Soil |
| | | 2 | 1.03 | 2.68 | 3.84 | Clay with Brine |
| | | 3 | 0.73 | 31.93 | 35.77 | Clay with Brine |
| | | 4 | 27.04 | 43.91 | 79.68 | Alluvium Sediments |
| | Alt: 762m | 5 | >425.13 | +++ | >79.68 | Undefined sediments |

***VES Concluding Remarks and Recommendation***

***Concluding Remarks***

- From the Table 6.20 it can be seen that, with exception of position of VES number 6, zones with low resistivity are mostly located from near surface to a depth not exceeding 35 m below the surface.

- VES measurements readings were not capable to penetrate the sedimentary layers to detect signal below 176 m deep while it known that sediments in the Engaruka basin continued to deeper levels and it is most likely that there are more aquifers below the detection limit of VES measurements.

***Recommendations***

It is recommended that, more efficient geophysical methods be conducted in Engaruka Basin for more precise determination of strati-graphical sequences of the sediments as well as for establishing the continuation of the strati-graphical sequences at greater depth below 200m depth. It is recommended that Electrical Resistivity Tomography (ERT) coupled with Transient Electromagnetics (TEM) method be applied in the proposed further studies.

## 6.10. Re-logging, re-sampling, and Analysis of the drill-cores/chips

***Re-logging***

The previous drill-cores and chips from Engaruka Basin were visited at TIRDO office Dar es Salaam on 8$^{th}$ and 9$^{th}$ November 2019, the diamond drill-cores were preserved in cores trays and the Reverse Circulation (RC) chips were preserved in plastic bottles. The drill chips metre interval labels were missing (most probably due to poor recovery or all the samples were used for analysis) and hence did not be used for re-logging and re-sampling activities. The Drill-cores for BH 09 and BH11 were selected for re-logging and re-sampling activities. The re-logging of the lithologies correlate with the previous lithologies of BH 09 and BH11 as shown in Table 6.21 and Table 6.22 respectively**.**

According to the report of 2013, borehole 09 was drilled 8.8 km North West of BH11 and intersected aquifers from 38 to 110m, from 126 to 140m and from 162 to 200m.

Table 6.21. Re-logging of BH 09

| **Previous logging** | **Re-Logging** |
|---|---|
| 0-18: Clay with negligible salt crystals | 0-13m: Clay with minor sand layers<br>13-18m: Sand layer with minor salt layers |
| 18-38: Clayey sand with salt crystals | 18-38m: Sand with clays with minor salt crystals |
| **38-110m: AQUIFER**<br>• 38.00-76.00m: Fine clay with 5-25% salt crystals<br>• 76.00-102.00m: Sandy clays with salt crystals and pure salt<br>• 102.00-110.00m: Massive salt layers alternating with solid clay layers. | **38-110m: AQUIFER**<br>• 38-41m: Fine sand with minor salt crystals.<br>• 41-42m: Black elongated pure salt crystals.<br>• 42-77.5m: Sand with variable amount of clays. Layers of pure detrital porous salts crystals @ 45m (0.20m) and 69.50m |

| | |
|---|---|
| | (0.50m).<br>• 77.5-89.50m: Pure elongated salt crystals with sand layers.<br>• 89.50-102.00m: Brown grey sand intercalated pure salt crystals.<br>• 102.00-110.00m: Fine white massive salts intercalated with elongated grey salt crystals. |
| 110-126m: Massive salt layers alternating with solid clay layers. | 110-126m: Alternating layers of white massive pure salts crystals and black elongated pure salt crystals. |
| **126-140m: AQUIFER**<br>Massive salt layers alternating with solid clay layers | **126-140m: AQUIFER**<br>• 126-136m: Grey clays with pure salt crystals<br>• 136-140m: Alternating pure salts crystals, elongated and massive fine salt crystals layers with minor amount of sand |
| 140-162m: Massive salt layers alternating with solid clay layers. | 140-150m: Alternating pure salts crystals, elongated and massive fine salt crystals layers with minor amount of sand<br>150-162m: Brown and grey clays with fine massive salt crystals |
| **162-200m: AQUIFER**<br>Massive salt layers alternating with solid clay layers.<br><br>**200m (EOH)** | **162-200m: AQUIFER**<br>162-181.00m: Brown and grey clays with fine massive salt crystals.<br>181-200m: Fine white massive salt crystals<br>**200m (EOH)** |

According to the report of 2013, borehole 11 was drilled 8.8 km south east of BH 09 and intersected aquifers from 38 to 100m, from 118 to 138m and from 154 to 200m

Table 6.22 Re-logging of BH11

| **Previous Logging** | **Re-Logging** |
|---|---|
| 0-24.00m: Clay with negligible salt crystals | 0-14m Dark grey clay soils |
| 24-36.00m: Clayey sand with salt crystals making 10-30% | 14-38m Sandy layer with variable layers of clays with small salt crystals. |
| 36-38: Clayey sand fine grained with salt crystals making 5-20% | |
| **38-100m: AQUIFER:**<br>• 38-36m: Clayey sand fine grained with salt crystals making 5-20% | **38-100m AQUIFER**<br>• 40-40.5m: Black detrital crystal salts layer |

| | |
|---|---|
| • 36-78m: Clayey sand fine grained with salt crystals making 5-20%<br>• 78-90m: Sandy clays with salt crystals and layers of pure salt<br>• 90-100m: Massive salt layers alternating with mudstone cement by salt | • 40.5-45m: Clayey sands<br>• 45-51m: Very porous sandy layer<br>• 51-54m: Fine clayey sands<br>• 54-62m: Course porous sandy layer with salt crystals<br>• 62-78m: Pure salt crystals with alternating layers of sands<br>• 78-83m: Alternating layers of detrital, elongated and fine massive crystal of pure salts with few layers of grey clays<br>• 83-87.5m Clayey sand and sandy clays layers<br>• 87.5-97m: Elongated and detrital salt crystal layers with clayey sand.<br>• 97-100m: Brown clayey sand layers |
| 100-118m: Massive salt crystal layers with alternating mudstone cement | 100-102m: Clayey sand layers<br>102-118m: Alternating layers of detrital, elongated and fine massive pure salt crystals with few clay layers |
| **118-138m: AQUIFER**<br>• 118-138m: Massive salt crystal layers with alternating mudstone cement | **118-138m: AQUIFER**<br>• 118-138m: Alternating layers of detrital, elongated and fine massive pure salt crystals with few clay layers |
| 138-154m: Massive salt crystal layers with alternating mudstone cement | 138-154m: Layers of detrital, elongated and fine massive pure salt crystals with few grey clay sands. |
| **154-200m: AQUIFER**<br>• 154-200m: Massive salt crystal layers with alternating mudstone cement | **154-200m: AQUIFER**<br>• 154-200m: Layers of detrital, elongated and fine massive pure salt crystals with few grey clay sands. |

Locations of these core drillhole were acquired from the previous studies of 2011 – 2013. The report and the elevation of BH 09 is 694.718m and the elevation of BH 11 is 694.618 were measured using DGPS in this study; hence they were on the same elevation from the sea level.

***Re-sampling of Diamond drill-cores***

The intervals deduced from the re-logging of BH 09 and BH 11 was used to design sampling intervals of borehole from the top of the hole to the end of the holes. Representative samples were collected from the specified intervals from top to end of hole. The description of each sample was recorded in the sample book. The samples were labelled with ID 00905 to 000934 and then packed in small plastic bags. A total 30 drill-core samples (14 samples from drill-core Number BH9 and 16 samples from drill-core Number BH11) were collected at depth interval indicated in Table 6.23 and Table 6.24 for laboratory analysis (X-Ray Diffraction Analysis and Chemical Analysis).

Table 6.23. Re-sampling of BH 09

| **From - To Interval (m)** | **Sample Number** | **Sample Descriptions/comments** |
|---|---|---|
| 8-13 | 000905 | Sandy clay layer |
| 13-18 | 000906 | Sandy Layer |
| 18-40 | 000907 | Sandy layer with clays |
| 41-42 | 000908 | Elongated pure salts crystals |
| 50-69.5 | 000909 | Sandy with variable layers of clays |
| 77.5-87.5 | 000910 | Pure elongated salt crystals with sands |
| 90-93 | 000911 | Black layers of pure salts crystals |
| 102-114 | 000912 | Fine white massive salts crystals |
| 114-121 | 000913 | Elongated black salts crystals |
| 121-124 | 000914 | Fine white massive salts crystals |
| 124-136 | 000915 | Black unconsolidated pure salts crystals |
| 136-153 | 000916 | Yellowish pure salt crystals |
| 153-181 | 000917 | Black grey salt crystals |
| 181-200 | 000918 | White massive pure salt crystals |

Table 6.24. Re-sampling of BH 11

| **From – To interval (m)** | **Sample Number** | **Sample Descriptions/comments** |
|---|---|---|
| 0-14 | 000919 | Clay soils |
| 14-38 | 000920 | Sandy clays |
| 40-40.5 | 000921 | Black elongated pure salt crystals |
| 45-51 | 000922 | Very porous sandy layer |
| 51-59 | 000923 | Porous sand layer |
| 59-75 | 000924 | Pure salt crystals with coarse sand layer |
| 80-82 | 000925 | Layers of detrital & elongated pure salts |
| 83-87 | 000926 | Clayey sand layer |
| 87-92 | 000927 | Elongated pure salt crystals |
| 92-96 | 000928 | Black grey clays with salt crystals |
| 102-114 | 000929 | White grey pure salt crystals |
| 114-132 | 000930 | White crystal of pure salts |
| 132-141 | 000931 | Black crystals of salts with clay powder |
| 141-156 | 000932 | Pure white massive crystals of salts |
| 156-162 | 000933 | Unconsolidated soils with salts crystals |
| 162-200 | 000934 | Pure white massive crystals salts |

***X-Ray Diffraction Analysis of drill-core Samples***

Mineralogical composition of drill-core samples collected at different depths of boreholes numbers BH09 and BH11 were determined by X-Ray Diffraction Analytical Method and the results presented in Appendix **Error! Reference source not found.**

The data in Table 6.25 showed that, there is significantly high amount of trona in the first 200-meter layer of the sediments in the Engaruka Basin (Maximum depth of boreholes). Borehole number BH09 shows that pure trona is encountered at depth intervals of 77.5 to 87 meters, 102 to 124 meters and 181 to 200 meters. In the same borehole trona is found mixed with nahcolite at depth interval of 41 to 42 meters, mixed with sylvite at 136 to 153 meters but it is also found mixed with other several clay minerals at depth interval of 124 to 136 meters. In borehole number BH11 pure trona is encountered at depth intervals of 80 to 82 meters, 87 to 92 meters, 141 to 156 meters and 162 to 200 meters. In the same borehole trona is found mixed with Nahcolite at depth interval of 40 to 40.5 meters, mixed with Sylvite at 114 to 132 meters but it is also found mixed with other several clay minerals at depth intervals of 102 to 114 meters and 132 to 141 meters (Table 6.25). Graphical results of X-Ray Diffraction analysis of these drill-core samples are submitted in hard copies together with this report.

Table 6.25 X-Ray Diffraction analysis of the collected Drill-Core Samples

| **Borehole Number BH09** | | | | |
|---|---|---|---|---|
| **Sample ID** | **Depth (meters)** | **Mineral Phases** | **Chemical Formula of Minerals** | **% Proportion (Semi - Quantitative)** |
| S-00905 | O8-13 | Analcime | $NaA1Si20_6 \cdot H_20$ | 31.46 |
| | | Natrolite | $Na_2AlSi_3010 \bullet 2H_20$ | 16.34 |
| | | Diopside | $MgCaSi_20_6$ | 24.92 |
| | | Titanite | $CaTiSi0_5$ | 10.98 |
| | | Leucite | $K[A1Si_20_6]$ | 16.3 |
| S-00906 | 13-18 | Gaylussite | $Na_2Ca(C0_3)_2 \cdot 5H_20$ | 48.79 |
| | | Natrolite | $Na_2Al_2Si_30_{10} \bullet 2H_20$ | 19.38 |
| | | Calcite | $CaC0_3$ | 18.46 |
| | | Analcime | $NaA1Si_20_6 \cdot H_20$ | 13.38 |
| S-00907 | 18-40 | Diopside | $MgCaSi_20_6$ | 13.7 |
| | | Analcime | $NaAlSi_20_6 \cdot H_20$ | 34.01 |
| | | Sanidine | $KA1Si_30_8$ | 18.59 |
| | | Merrillite | $Ca9N\ aMg(PO_4)1$ | 10.36 |
| | | Albite | $NaA1Si_30_8$ | 23.33 |
| S-00908 | 41-42 | Nahcolite | $NaHC0_3$ | 34.17 |
| | | Trona | $Na_2C0_3 \bullet NaHC0_3 \bullet 2H_20)$ | 65.83 |
| S-00909 | 50-69.5 | Analcime | $NaAlSi_20_6 \cdot H_20$ | 16.44 |
| | | Natrolite | $Na_2Al_2Si_30_{10} \bullet 2H_20$ | 15.43 |

| | | | | |
|---|---|---|---|---|
| | | Clinoenstatite | $MgSi0_3$ | 29.41 |
| | | Melilite | $(Ca,Na)i(Al,Mg,Fe^{2+})[(Al,Si)$ Si01 | 2.61 |
| | | Sanidine | $KA1Si_30_8$ | 14.19 |
| | | Diopside | $MgCaSi_20_6$ | 11.27 |
| S-00910 | 77.5-87.5 | Trona | $Na_2C0_3$•$NaHC0_3$•$2H_20)$ | 100 |
| S-00911 | 90-93 | Analcime | $NaA1Si_20_6 \cdot H_20$ | 45.14 |
| | | Titanite | $CaTiSi0_5$ | 6 |
| | | Pirssonite | $Na_2Ca(C0_3)2 \cdot 2H_20$ | 24.7 |
| | | Phlogopite | $KMg_3AlSi_30_{10}(F,OH)_2$. | 9.17 |
| | | Sanidine | $KA1Si_30_8$ | 14.99 |
| S-00912 | 102-114 | Trona | $Na_2C0_3$• $NaHC0_3$•$2H_20)$ | 100 |
| S-00913 | 114-121 | Trona | $Na_2C0_3$•$NaHC0_3$•$2H_20)$ | 100 |
| S-00914 | 121-124 | Trona | $Na_2C0_3$•$NaHC0_3$•$2H_20)$ | 100 |
| S-00915 | 124-136 | Trona | $Na_2C0_3$• $NaHC0_3$•$2H_20)$ | 27.09 |
| | | Sanidine | $KA1Si_30_8$ | 26.65 |
| | | Pirssonite | $Na_2Ca(C0_3)_2 \cdot 2H_20$ | 40.71 |
| | | Aegirine | $NaFeSi_20_6$ | 5.56 |

| | | | | |
|---|---|---|---|---|
| S-00916 | 136-153 | Sylvite | KCl | 9.11 |
| | | Trona | $Na_2C0_3$• $NaHC0_3$•$2H_20)$ | 90.89 |
| S-00917 | 153-181 | Diopside | $MgCaSi_20_6$ | 15.14 |
| | | Melilite | $(Ca,Na)z(Al,Mg,Fe^{2+})[(Al,Si)$ $Si0_7$ | 8.78 |
| | | Sanidine | $KA1Si_30_8$ | 50.45 |
| | | Titanite | $CaTiSi0_5$ | 17.7 |
| | | Marialite | $Na_4Al_3Si_90_{24}C$ | 7.93 |
| S-00918 | 181-200 | Trona | $Na_2C0_3$• $NaHC0_3$•$2H_20)$ | 100 |
| | | | | |
| **Borehole Number BH11** | | | | |
| S-00919 | 0-14 | Hedenbergite | $CaFeSi_20_6$ | 9.1 |
| | | Orthopyroxene | $FeMgSi0_3$ | 5.94 |
| | | Analcime | $NaA1Si_20_6 \cdot H_20$ | 20.13 |
| | | Sanidine | $KAlSi_30s$ | 12.59 |
| | | Natrolite | $Na_2Al2Si_3O_{10}$ • $2H_20$ | 15.19 |
| | | Ingersonite | $Ca_3Mn_2+Sb_5+ 40_{14}$ | 1.83 |
| | | Albite | $NaA1Si_30s$ | 35.22 |
| S-00920 | 14-38 | Hedenbergite | $CaFeSi_20_6$ | 4.46 |
| | | Orthopyroxene | $FeMgSi0_3$ | 26.35 |
| | | Analcime | $NaA1Si_20_6 \cdot H_20$ | 27.88 |
| | | Sanidine | $KA1Si_30_8$ | 27.46 |

| | | | | |
|---|---|---|---|---|
| | | Natrolite | $Na_2Al_2Si_30_{10}$ • $2H_20$ | 10.51 |
| | | Ingersonite | $Ca_3Mn_2$+S bs+$40_{14}$ | 1.72 |
| | | Albite | $NaA1Si_30_8$ | 1.63 |
| S-00921 | 40-40.5 | Trona | $Na_2C0_3$•$NaHC0_3$•$2H_20$) | 74.33 |
| | | Nahcolite | $NaHC0_3$ | 25.67 |
| S-00922 | 45-51 | Pirssonite | $Na_2Ca(C0_3)_2 \cdot 2H_20$ | 54.87 |
| | | Calcite | $CaC0_3$ | 22.89 |
| | | Analcime | $NaA1Si_20_6 \cdot H_20$ | 9.22 |
| | | Qandilite | $(Mg,Fe^{3+})i(Ti,Fe^{3+},Al)0_4$ | 10.22 |
| | | Titanomagnetite | $Fe_30_4$ | 2.8 |
| S-00923 | 51-59 | Enstatite | $MgSi0_3$ | 23.79 |
| | | Aegirine | $NaFeSi_20_6$ | 9.4 |
| | | Natrolite | Na2Al2Si3010 •2H20 | 38.65 |
| | | Qandilite | $(Mg,F\ e^{3+})i(Ti,Fe^{3+}\ ,Al)0_4$ | 11.9 |
| | | Sanidine | $KAlSi_30_8$ | 8.1 |
| | | Nepheline | $Na_3KA1_4Si_40_{16}$ | 8.16 |
| S-00924 | 59-75 | Pirssonite | $Na_2Ca(C0_3)_2 \cdot 2H_20$ | 22.41 |
| | | Aegirine | $NaFeSi_20_6$ | 7.72 |
| | | Natrolite | $Na_2Al_2Si_30_{10}$ •$2H_20$ | 16.9 |
| | | Analcime | $NaAlSi_20_6 \cdot H_20$ | 18.16 |
| | | Enstatite | $MgSi0_3$ | 10.13 |
| | | Sanidine | $KA1Si_30_8$ | 11.21 |
| S-00925 | 80-82 | Trona | $Na_2C0_3$• $NaHC0_3$•$2H_20$) | 100 |
| S-00926 | 83-87 | Titanite | $CaTiSi0_5$ | 9.52 |
| | | Hedenbergite | $CaFeSi_20_6$ | 10.65 |
| | | Analcime | $NaA1Si_20_6 \cdot H_20$ | 25.96 |
| | | Natrolite | $Na_2Al_2Si_30_{10}$ • $2H_20$ | 24.08 |
| | | Sanidine | $KA1Si_30_8$ | 14.45 |
| | | Enstatite | $MgSi0_3$ | 15.34 |
| S=00927 | 87-92 | Trona | $Na_2C0_3$•$NaHC0_3$•$2H_20$) | 100 |
| S-00928 | 92-96 | Analcime | $NaAlSi_20_6 \cdot H_20$ | 30.14 |
| | | Sanidine | $KA1Si_30_8$ | 23.19 |
| | | Titanite | $CaTiSi0_5$ | 4.2 |
| | | Melilite | $(Ca,Na)i(Al,Mg,Fe^{2+})[(Al,Si)\ Si0_7$ | 2.67 |
| | | Clinohvpersthene | | 7.41 |
| | | Trona | $Na_2C0_3$•$NaHC0_3$•$2H_20$) | 19.73 |
| | | Enstatite | $MgSi0_3$ | 12.66 |
| S-00929 | 102-114 | Trona | $Na_2C0_3$• $NaHC0_3$•$2H_20$) | 70.4 |
| | | Analcime | $NaA1Si_20_6 \cdot H_20$ | 5.44 |
| | | Natrolite | $Na_2Al_2Si_30_{10}$ •$2H_20$ | 10.71 |
| | | Rhodocrosite | $MnC0_3$ | 1.82 |

| | | | | |
|---|---|---|---|---|
| | | Wairakite | $Cas(Al_{16}Si_{32}0_{96})$• l 6$H_20$ | 11.64 |
| S-00930 | 114-132 | Sylvite | KCl | 4.91 |
| | | Trona | $Na_2C0_3$• $NaHC0_3$•2$H_20$) | 95.09 |
| S-00931 | 132-141 | Trona | $Na_2C0_3$• $NaHC0_3$•2$H_20$) | 11.71 |
| | | Sanidine | $KAlSi_30s$ | 21.01 |
| | | Enstatite | $MgSi0_3$ | 11.54 |
| | | Pirssonite | $Na_2Ca(C0_3)_2$ 2$H_20$ | 48.86 |
| | | Aegirine | $NaFeSi_20_6$ | 6.88 |
| S-00932 | 141-156 | Trona | $Na_2C0_3$• $NaHC0_3$•2$H_20$) | 100 |
| S-00933 | 156-162 | Aegirine | $NaFeSi_20_6$ | 13.83 |
| | | Sanidine | $KA1Si_30_8$ | 66.82 |
| | | Titanite | $CaTiSi0_5$ | 19.35 |
| S-00934 | 162-200 | Trona | $Na_2C0_3$• $NaHC0_3$•2$H_20$) | 100 |

***Chemical Analysis of Drill-Core Samples***

Samples of cores and chips collected from drilled core samples collected at different depth levels in Borehole Number BH09 and Borehole Number BH11 were analysed at the NESCH-Mintec Laboratory in Mwanza to establish their chemical composition. Anion content in the analysed samples is presented in Table 6.26 and results of Whole Rock Multi-Element Chemical Analysis of the analysed samples are presented in (Appendix 9.2).

Portions of samples with high content of Soda Ash (sample number 908, 910, 912, 913, 914 and 918 in core number BH09 and sample number 925, 927, 929, 930 and 934 in core number BH11 contain also high content of Chlorite indicating that they are indeed salt precipitates; some of these samples also contain relatively high amount of carbonates (Appendix 9.2). The samples also are shown to have high content of Sulphates (Table 6.26 although in their X-Ray Diffraction Analysis (Appendix 9.1) they are seen to be dominated by Carbonate Crystals. It is therefore interpreted that the Sulphates are contained in amorphous substance detected by the X-Ray Diffraction results; amorphous/Crystal's relationship are indicated in the graphs of Appendix 9.1.

Table 6.26. Anion chemical analytical results of core samples of borehole number BH09 and BH11.

| Sample ID | Depth in meters | Sample Number | Total Carbon (%) | Carbonate (ppm) | Chloride (ppm) | Nitrate (ppm) | Sulphate (ppm) |
|---|---|---|---|---|---|---|---|
| **BH9** | | | | | | | |
| 905 | 08-13 | S19/3618/34 | 0.19414 | 194.14 | 566.928 | 9.15 | 17987.35 |
| 906 | 13-18 | S19/3618/35 | 0.01487 | 14.87 | 1417.32 | 9.47 | 27155.4 |
| 907 | 18-40 | S19/3618/36 | 0.08771 | 87.71 | 850.392 | 4.23 | 15220.59 |
| 908 | 41-42 | S19/3618/37 | 0.03348 | 33.48 | 1133.856 | 4.07 | 23526.32 |
| 909 | 50-69.5 | S19/3618/38 | 0.00824 | 8.24 | 992.124 | 5.07 | 24291.91 |
| 910 | 77.5-87.5 | S19/3618/39 | 2.82488 | 2824.88 | 1133.856 | 7.8 | 26595.5 |
| 911 | 90-93 | S19/3618/40 | 0.0397 | 39.7 | 850.392 | 6.57 | 27433.3 |
| 912 | 102-114 | S19/3618/41 | 0.05329 | 53.29 | 992.124 | 18.41 | 21428.43 |
| 913 | 114-121 | S19/3618/42 | 0.85363 | 853.63 | 1275.588 | 7.01 | 25037.07 |
| 914 | 121-124 | S19/3618/43 | 0.58621 | 586.21 | 1133.856 | 7.92 | 26096.92 |
| 915 | 124-136 | S19/3618/44 | 0.29179 | 291.79 | 1417.32 | 5.03 | 25908.92 |
| 916 | 136-153 | S19/3618/45 | 0.78804 | 788.04 | 850.392 | 4.05 | 15495.77 |
| 917 | 153-181 | S19/3618/46 | 0.43172 | 431.72 | 4110.228 | 6.99 | 31659.04 |
| 918 | 181-200 | S19/3618/47 | 0.1116 | 111.6 | 992.124 | 22.82 | 15100.71 |

| BH11 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 919 | 0-14 | S19/3618/48 | 0.00753 | 7.53 | 850.392 | 4.77 | 29596.57 |
| 920 | 14-38 | S19/3618/49 | 0.34924 | 349.24 | 992.124 | 7.99 | 29493.04 |
| 921 | 40-40.5 | S19/3618/50 | 3.28576 | 3285.76 | 992.124 | 4.95 | 25978.4 |
| 922 | 45-51 | S19/3618/51 | 0.2006 | 200.6 | 1133.856 | 4.06 | 17842.95 |
| 923 | 51-59 | S19/3618/52 | 0.00195 | 1.95 | 1133.856 | 6.59 | 27386.98 |
| 924 | 59-75 | S19/3618/53 | 1.76177 | 1761.77 | 850.392 | 5.99 | 28989 |
| 925 | 80-82 | S19/3618/54 | 3.37144 | 3371.44 | 1275.588 | 9.33 | 26933.35 |
| 926 | 83-87 | S19/3618/55 | 0.14328 | 143.28 | 708.66 | 5.98 | 17547.34 |
| 927 | 87-92 | S19/3618/56 | 3.15521 | 3155.21 | 7653.528 | 4.96 | 25404.88 |
| 928 | 92-96 | S19/3618/57 | 0.3207 | 320.7 | 5244.084 | 12 | 26692.23 |
| 929 | 102-114 | S19/3618/58 | 0.23859 | 238.59 | 1275.588 | 5.02 | 24451.3 |
| 930 | 114-132 | S19/3618/59 | 0.11652 | 116.52 | 1417.32 | 5.42 | 22019.66 |
| 931 | 132-141 | S19/3618/60 | 0.28711 | 287.11 | 7795.26 | 5.95 | 13884.21 |
| 932 | 141-156 | S19/3618/61 | 5.53089 | 5530.89 | 3968.496 | 6.85 | 24685.61 |
| 933 | 156-162 | S19/3618/62 | 0.43094 | 430.94 | 3685.032 | 23.84 | 22608.15 |
| 934 | 162-200 | S19/3618/63 | 4.92002 | 4920.02 | 7511.796 | 12.15 | 24317.8 |

Whole rock geochemical results (Appendix 9.2) shows that samples with high content of Soda Ash (sample number 908, 910, 912, 913, 914 and 918 in borehole number BH09 and sample number 925, 927, 929, 930 and 934 in borehole number BH11 contain very small amount of Arsenic (which is considered as toxic element). This is therefore good situation as the Trona are not expected to be contaminated. These samples are seen to have relatively elevated values of Uranium but contamination of Trona by Uranium in this project will depend whether the Uranium compounds are soluble to the brines or not. This can be established later. The sections with high amount of Trona are seen to contain slightly elevated values of Manganese, Niobium, Rubidium, Strontium, Yttrium and Zinc. However, levels of these elements are not high enough to allow their economic extraction (Appendix 9.2).

***Concluding remarks on re-logging and re-sampling of drill-core samples***

Logging and Sampling of drill-core number BH 09 and BH 11 were conducted at TIRDO office in Dar es Salaam and there after the samples were sent to laboratory for analysis. However later during verification of position of these cores in the field it was noted that position of bore hole number BH 09 was not seen therefore its results could not be used in this report.

Position of Borehole number BH 11 in the field was very close to VES reading number 09 and from its VES reading zones with low resistivity were from 1.16 to 35.77 m deep (Table 6.20) and this zone is corresponding with a section of the core dominated by sand layers with variable layers of clays and with small salt crystals (Table 6.22&Table 6.24). The same layer is composed mainly silicate minerals (negligible amount of salts) including Sanidine, Natrolite, Analcime, orthopyroxene, albite, Hedenbergite and Ingersonite (only salt).

Domination of these silicates in this layer and less salts could contribute to high porosity and hence low resistivity.

### 6.11. Resource Estimation of the Brine

***Resource Modelling***

The final Modelling of the Engaruka brine deposit was carried out using data collected during the work done at Engaruka Brine deposit in September to October 2019. The geological data was interpreted using VES Survey and pumping test results conducted at Engaruka (Table 6.20&Table 6.16). These data were used to develop the geological model. A continuous low resistivity aquifer interpreted from VES Survey (resistivity ≤1.0 ohm) and pumping test results coupled with the brine assay data results received from Mwanza water laboratory namely sodium carbonate and sodium bicarbonate were modelled and used to establish the mineral resource.

***Database Establishment***

The drillhole Collar, Survey, Resistivity and Assay data (Appendix **Error! Reference source not found.**) was derived from the work done at Engaruka during the months of September to October 2019. Geometry and size of the aquifer were modelled using low resistivity measurements deduced from the studied 13 VES positions (9 New VES and 4 old VES) (Figure 6.27) and block model were modelled using composition of the brine obtained from 6 boreholes which were the only one available. The data was then imported into leapfrog Geo to verify it. Based on the size of the Engaruka basin (13m width by 19 m length) the available borehole was insufficient to generate proven reserves, in addition the available boreholes were not even distributed across the area (Figure 6.28) this situation humped further computation of proven reserves, findings of these computation are therefore categorized as Inferred resources.

Topographic model developed from DGPS data is presented in Figure 6.28 and example of cross section is shown in Figure 6.29 showing very flat topography.

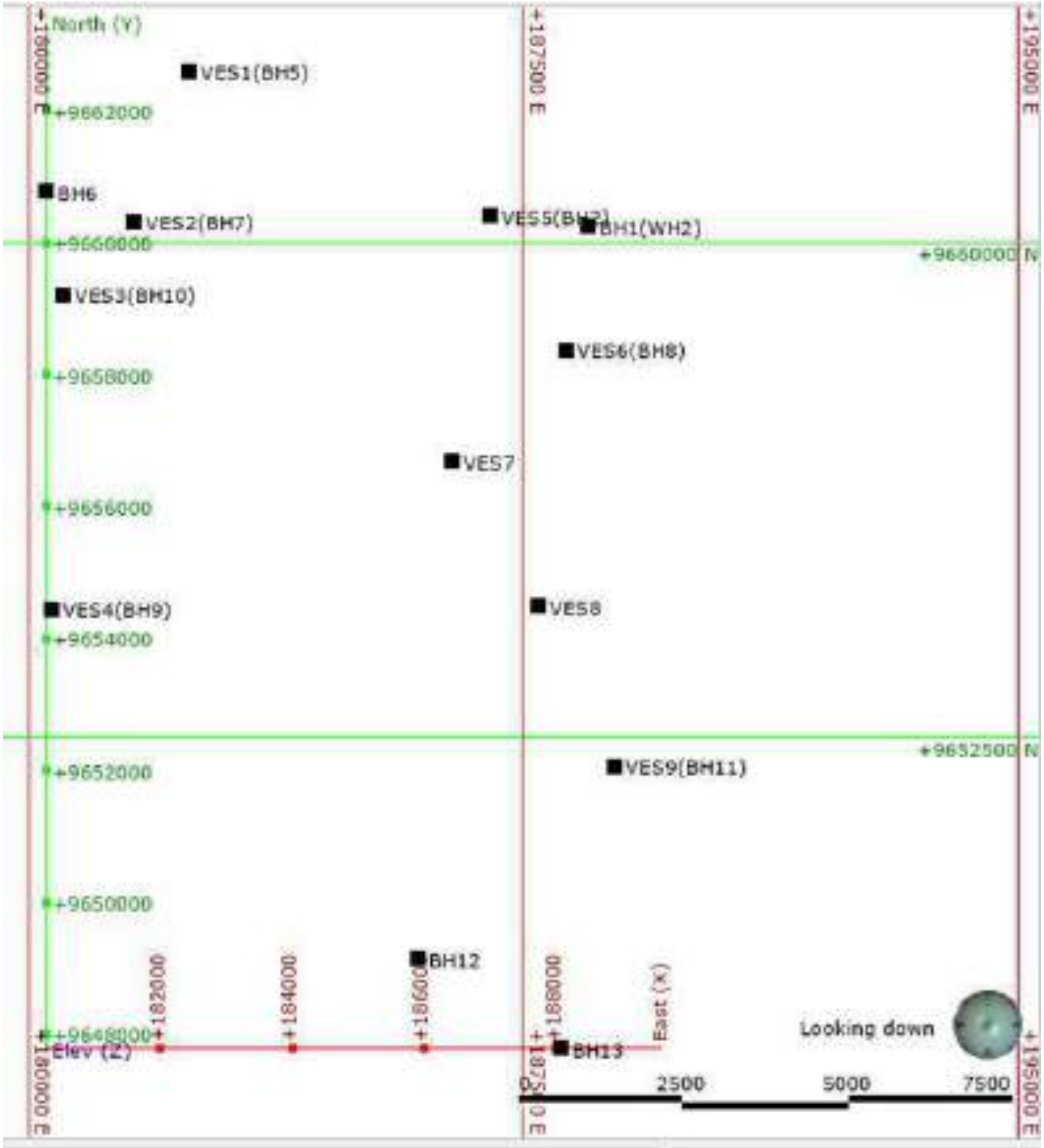


Figure 6.27. Location of 13 VES positions used for initial modelling of aquifer geometry for Engaruka brine deposit using the 2011 and 2013 drilling data.

***Topography Generation***

The topography was generated in Leapfrog Geo software using 80 survey points (6 DGPS control points, 15 bore position and 59 survey points) generated during topographic survey within the licensed Engaruka basin as described in section 6.8 (boreholes and topographic survey).

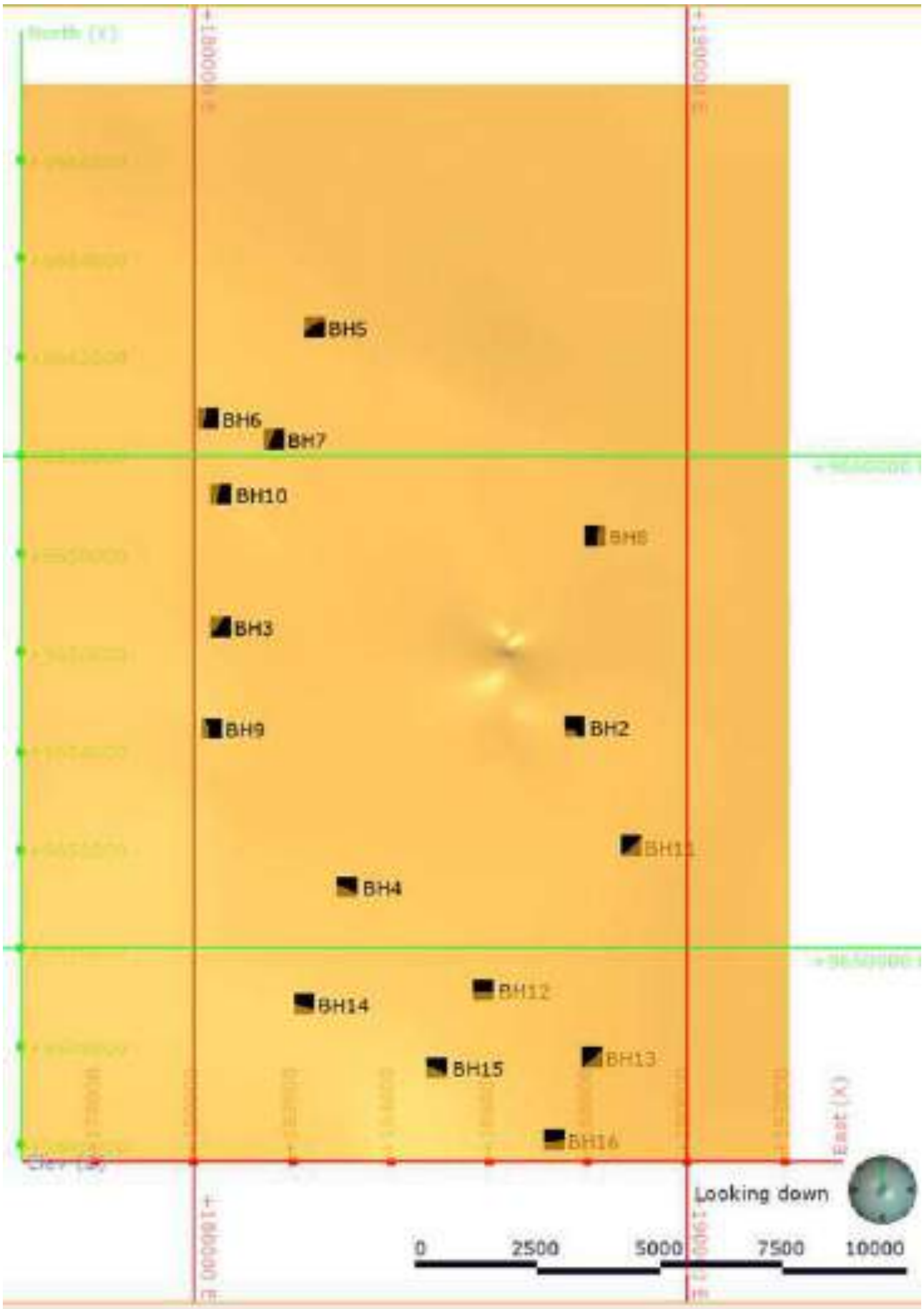


Figure 6.28. Topography of Engaruka basin generated from DGPS resurveyed points

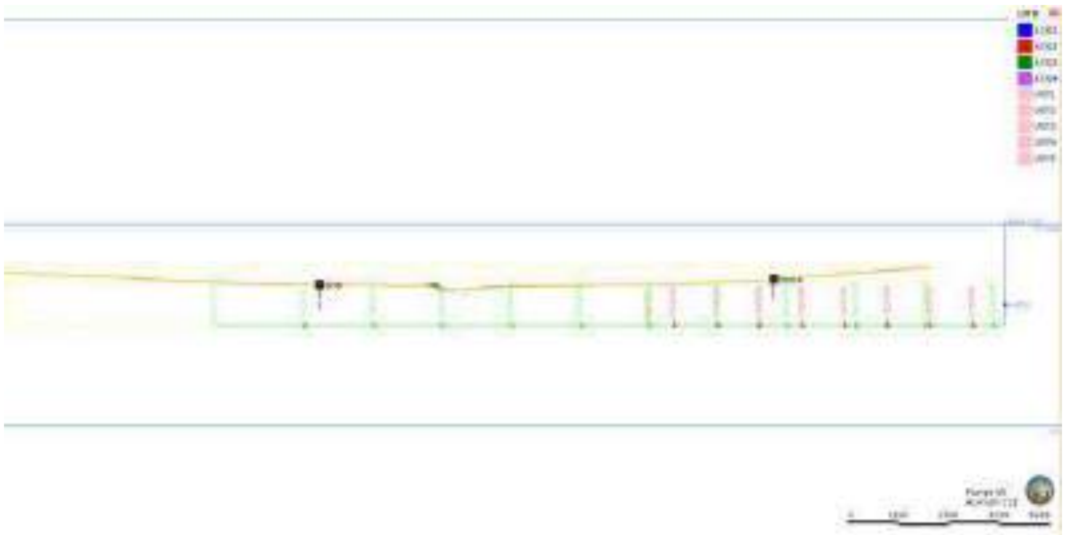

Figure 6.29. Cross section of the topography surface. The Z Value has been exaggerated by five times.

***3D Geological Model***

Six contacting boundaries were first interpreted in leapfrog geo, these included the following contact boundaries:-


The six boundaries were finally implicitly modelled to produce six wireframes from which the low resistivity wireframe (Sand with Brine wireframe) was used to estimate the brine resource block model (Figure 6.30). Geometrical section view of the modelled resource layer (blue block) viewed at the western edge of the block (section A-B viewing to the east) is presented in Figure 6.31. Cross section view of the eastern edge of the modelled block (Section C-D viewing to the west) is presented in Figure 6.32 whereas outlooks of southern and northern edges of the modelled block (Section B-C and D-A) looking to north and south, respectively) are presented in  Figure 6.33 and Figure 6.34, respectively.

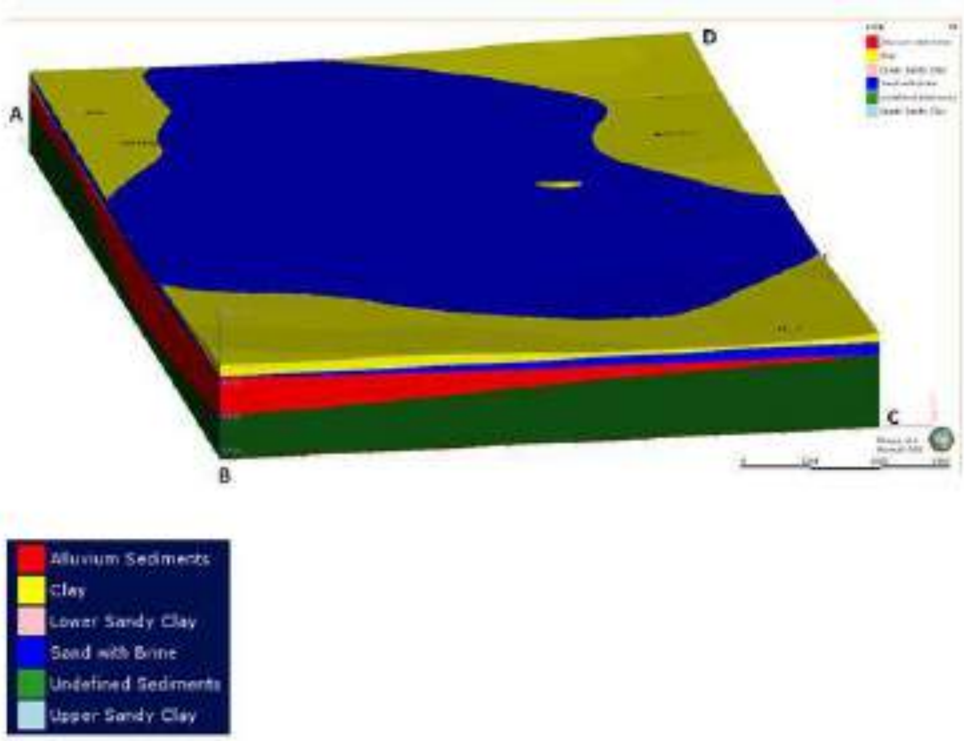


Figure 6.30. Oblique view of the modeled lithological wireframes

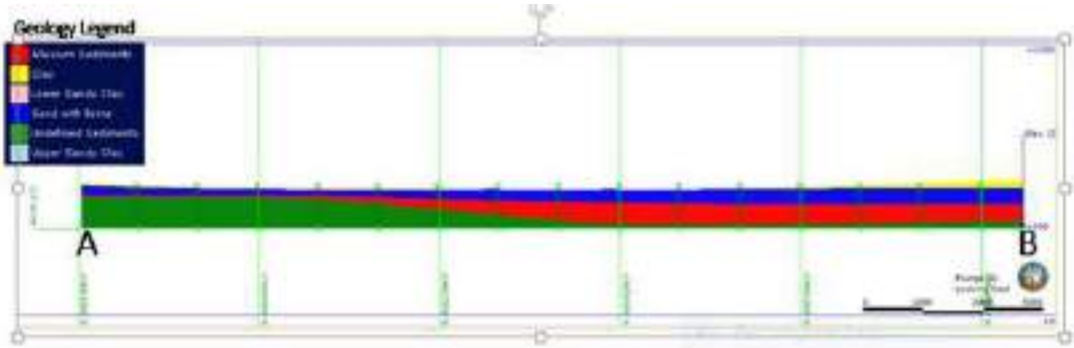


Figure 6.31. East looking view of the modelled lithological wireframes against boreholes

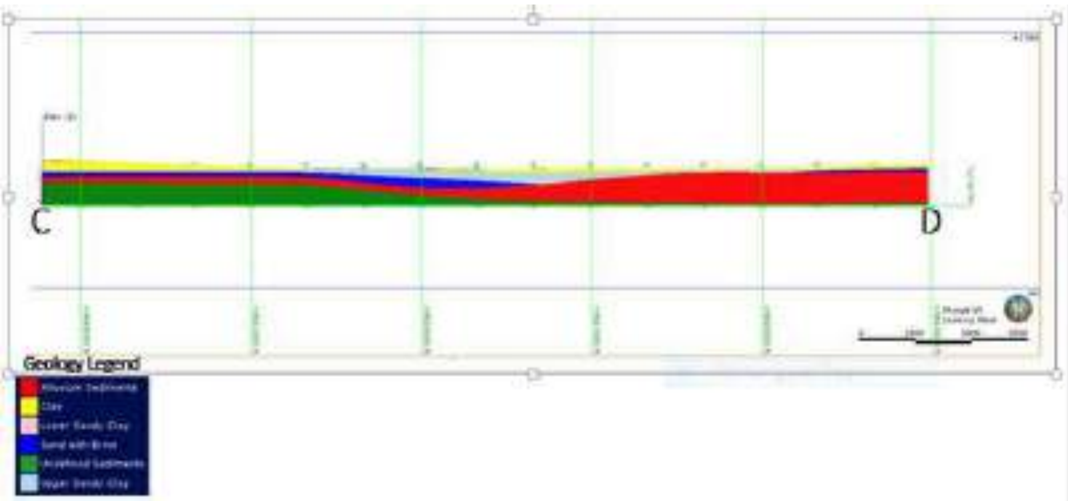


Figure 6.32. West looking view of the modelled lithological wireframes against boreholes

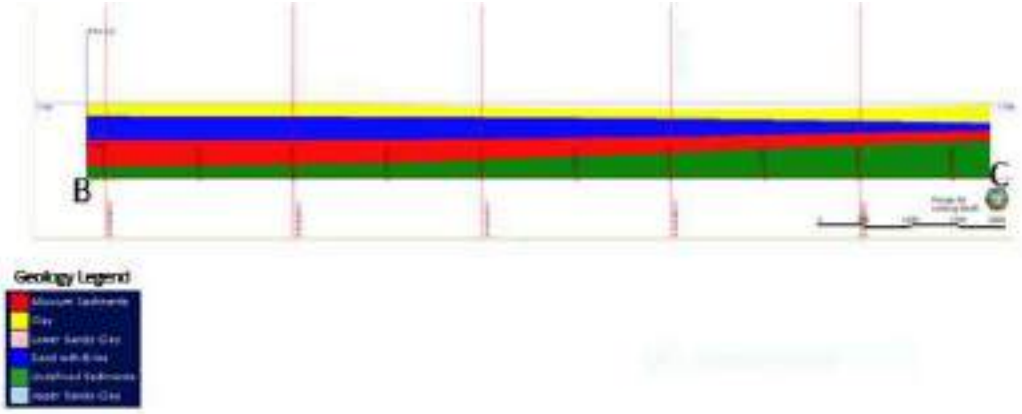


Figure 6.33. North looking view of the modelled lithological wireframes against boreholes

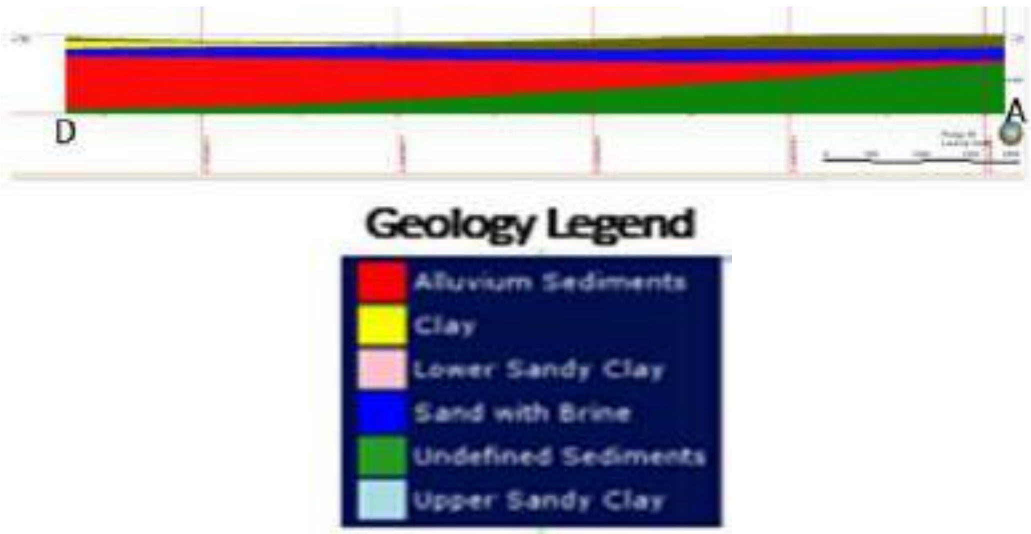


Figure 6.34. South looking view of the modelled lithological wireframes against boreholes

Taking into the fact that boreholes that were sampled are very few, widely spaced and not evenly distributed in the entire basin area (their distribution is restricted to the north and south of the basin) some areas of the 3D model are poorly supported by drilling data therefore geological interpretation of large parts of the basin was done through extrapolation of geological units of known areas. Additional drilling is required to improve this interpretation. Proper configuration of the block which is thought to hold much of the brine is depicted in Figure 6.35

***Resource Estimation and Modelling Techniques***

Only the low resistivity (sand with brine wireframe) was used as an estimation wireframe.Grades were estimated by inverse distance squared grade interpolation method. A minimum of one and a maximum of three samples were used for the estimation. No top cuts were applied to the estimation domain during the estimation process. A maximum search distance of 15km was used to ensure all blocks in the model were informed with grades.

The overall estimation and modelling techniques can be summarized as follows: -

a) The Brine grades were modelled using inverse distance squared method.
b) A single composite for the low resistivity (Sand with Brine) wireframe aquifer in each well was used to estimate grades.
c) Two brine attributes were modelled, these include $NaHCO_3$, and $Na_2CO_3$; their values presented in Figure 6.36&Figure 6.37.
d) A search box was used to eliminate the edge effect of using a search ellipse. The search box was 15km x 10km to ensure that the entire area where drilled exploratory bore holes existed was covered.
e) Minimum samples used in the estimation were 1 and the maximum was 3.
f) A total of 6 wells were sampled and analysed for sodium carbonate and sodium bicarbonate contained in the brine producing aquifer.

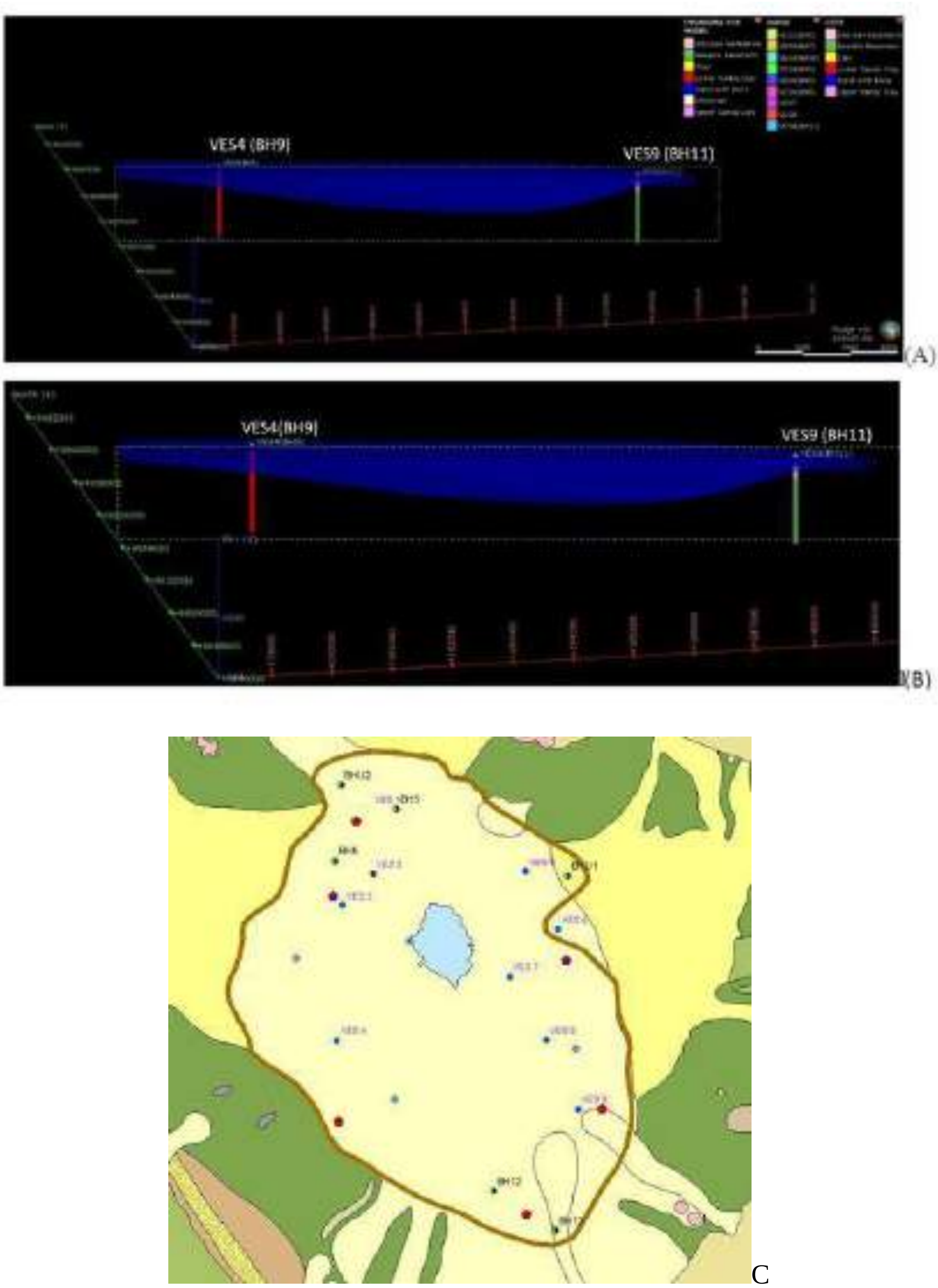


Figure 6.35. **(A, B and C)** Enlarged view of aquifer 1 on a West-East trending cross section from borehole number BH09 to BH11 {(A) = with Legend and (B) = enlarged clearer view and C plan view of the basin}.

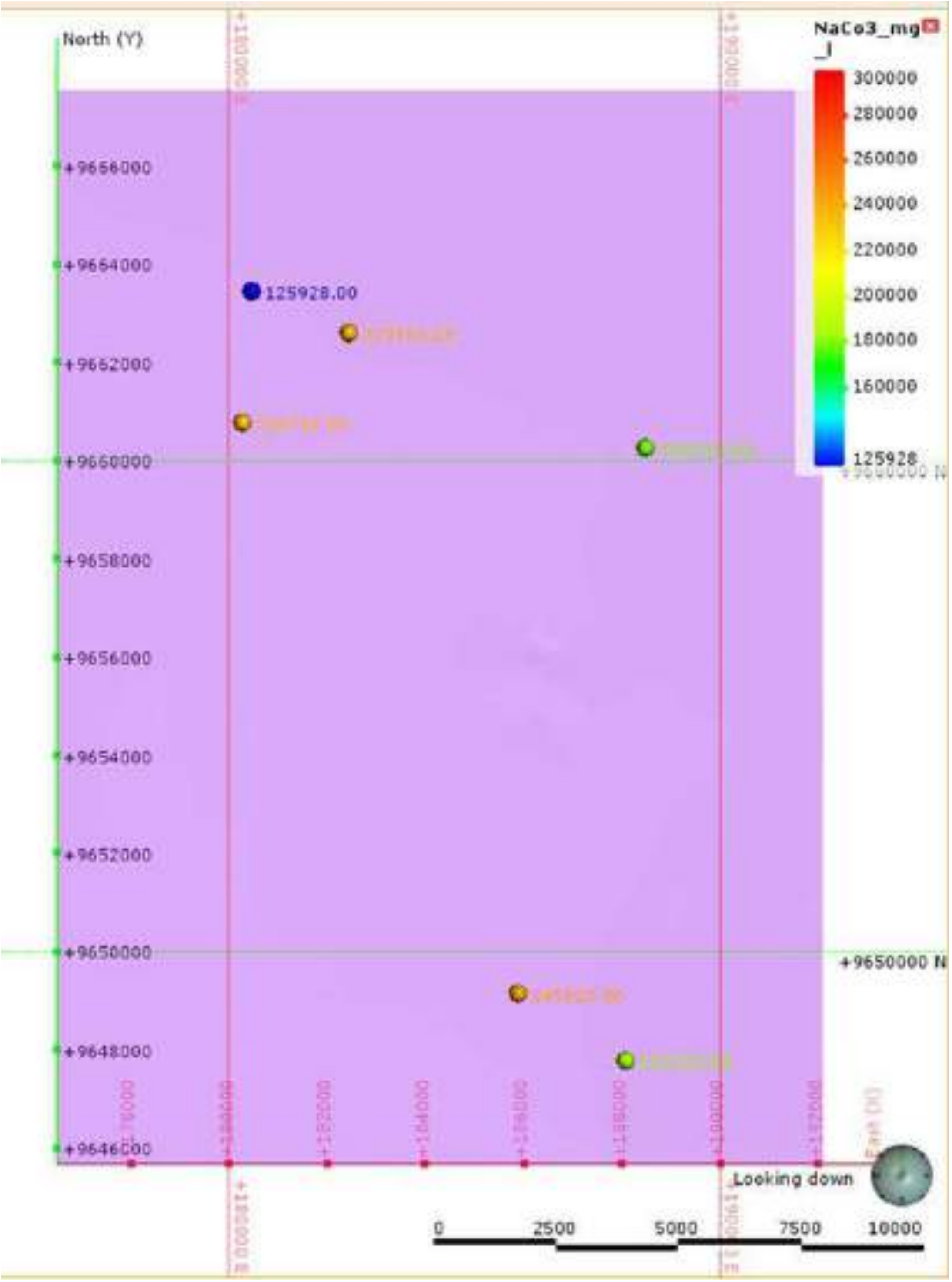

Figure 6.36. Sodium Carbonate values from six analyzed samples.

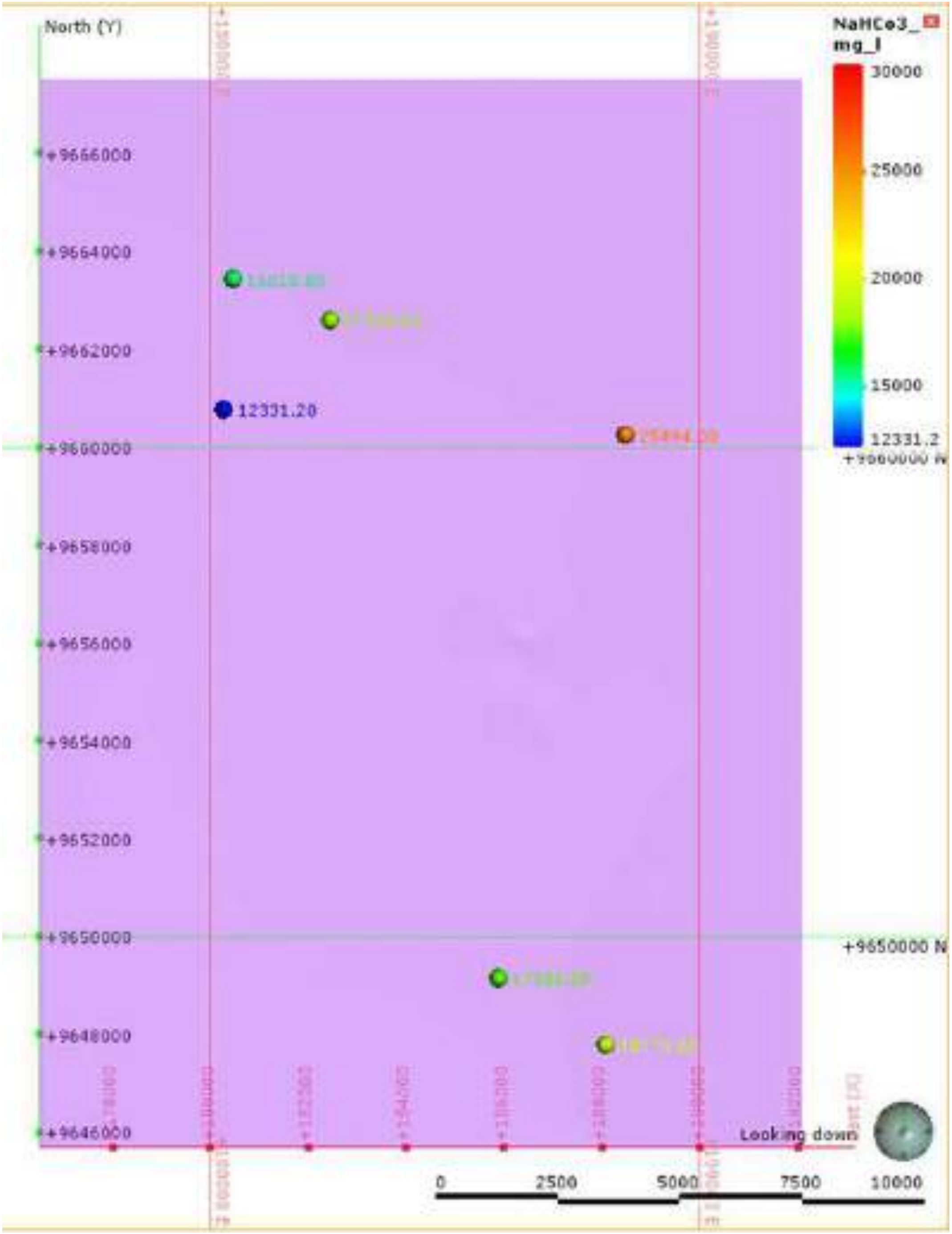


Figure 6.37. Sodium Bicarbonate values from six analysed samples.

g) The parent block size used was 4000m x 1000m x25m with sub-blocks to 125m x 62.5 x 3.125.
h) The brine is contained within a continuous low resistivity aquifer interpreted from VES Survey and pumping test results coupled with the brine assay data results received from Mwanza Water Laboratory namely sodium carbonate and sodium bicarbonate. The contained brine is estimated by multiplying the volume by the porosity of the aquifer formation.
i) No cut-off grade grades were applied.

The interpolated grade model for $Na_2CO_3$ within the sand with brine aquifer is shown in Figure 6.38&Figure 6.39 below: -

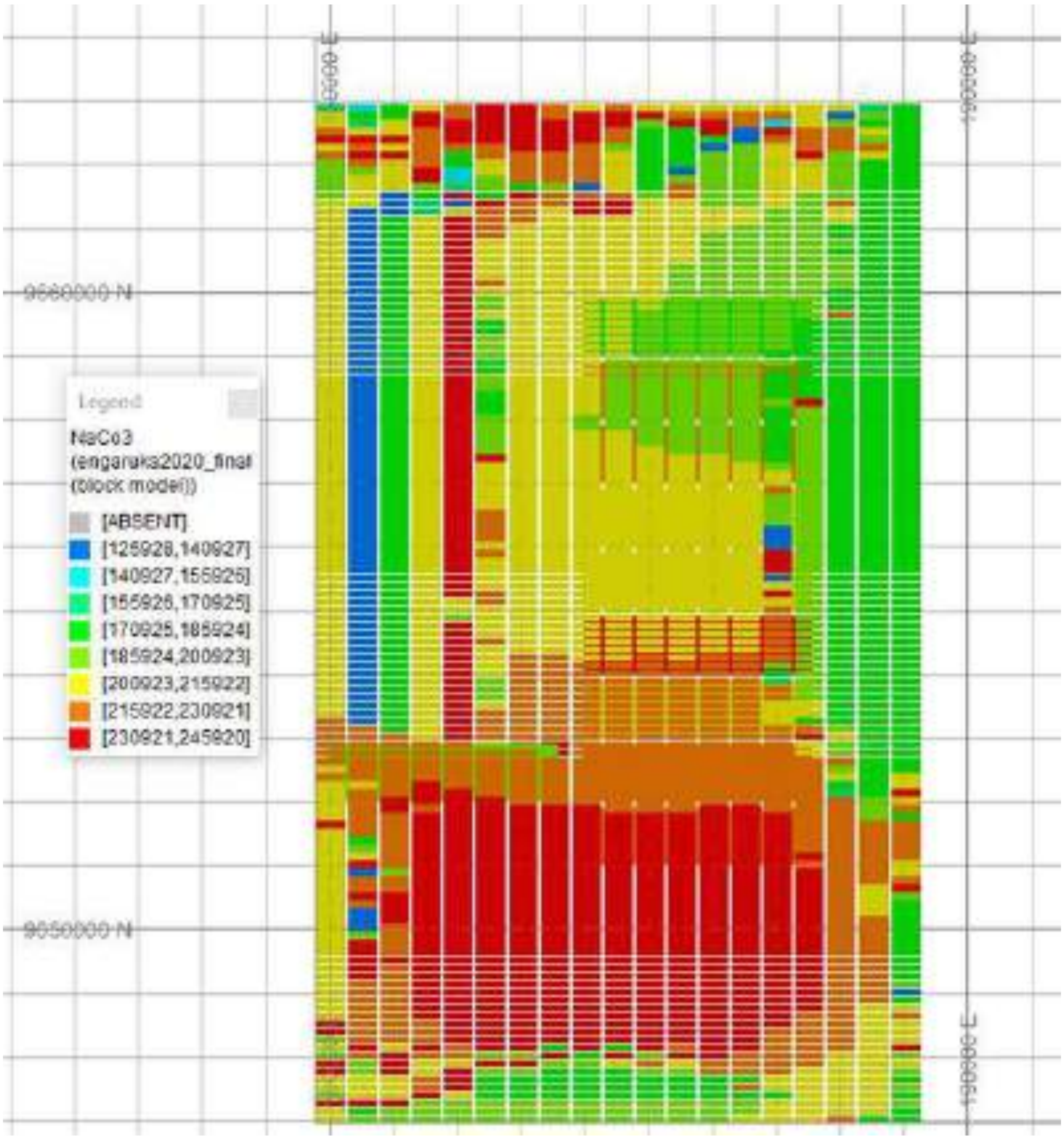


Figure 6.38. $Na_2CO_3$ grade distribution within the Sand with brine aquifer

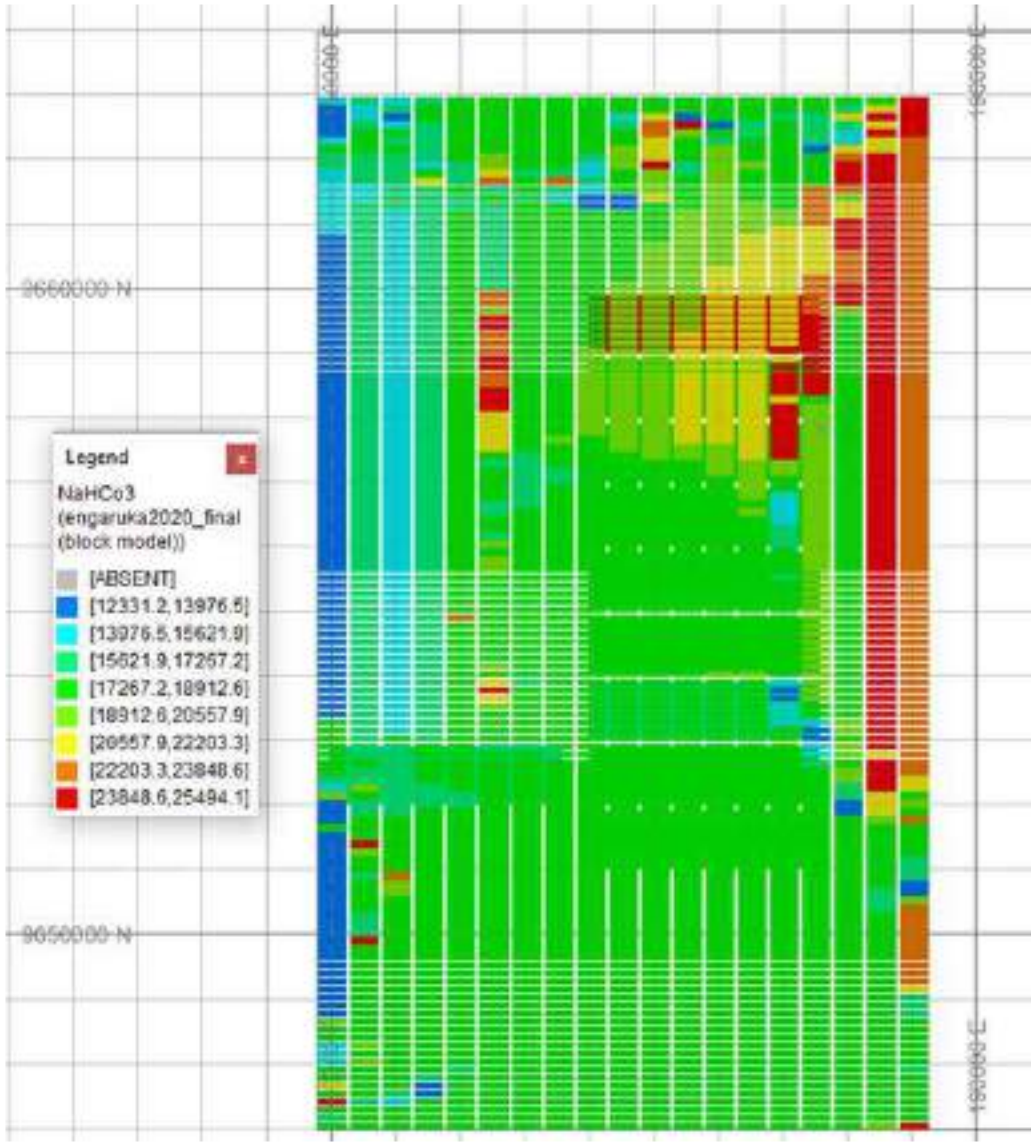

Figure 6.39. $NaHCO_3$ grade distribution within the Sand with brine aquifer

***Resource Estimation***

***For the Area within Engaruka Basin Covered by Exploratory Drill hole***

The mineral resource for the Engaruka basin within the area where existing exploratory drill holes covering an area of 153,146km$^2$ that were suitable for taking measurements (based on current appraisal work) is as summarized in Table 6.27 and the average grade of the Engaruka brine for $Na_2CO_3$ and $NaHCO_3$ are presented in Table 6.16.

Table 6.27.Modelled Brine volume resource for the Engaruka brine deposit (2019 Verification work)

| ENGARUKA GLOBAL RESOURCE | | | |
|---|---|---|---|
| **ACQUIFER** | **VOLUME** | **POROSITY%** | **VOLUME FROM POROSITY ($M^3$)** |
| ACQUIFER1 | 9,533,300,000.00 | 40.00 | 3,813,320,000.00 |
| **TOTAL** | **9,533,300,000.00** | **40.00** | **3,813,320,000.00** |

Grade estimate for the Engaruka brine assay for sodium carbonate and Sodium Bicarbonate are calculated as follows:

- **Sodium Carbonate →** Average = 201.61g/l x Total Volume of Brine = 3,813,320,000,000 litres. This is equal to **768.80 Million Tons of Sodium Carbonate**.
- **Sodium Bicarbonate→** Average = 17.90/l x Total Volume of Brine = 3,813,320,000,000 litres. This is equal to **68.30 Million Tons of Sodium Bicarbonate**.

***For the licensed area of NDC that lies within the Engaruka Basin)***

Apart from doing resource estimation for the entire area where exploratory drill holes were suitable for taking appropriate measurements it was noted that the licensed area for NDC does not cover the entire Engaruka Basin; the licensed area covers only 132,318km$^2$ within the Engaruka Basin. Resources within the NDC licensed area in the Basin (based on current Appraisal work) is estimated to host 3,294,704,894 cubic meters of brines and it is estimated that these brines contain 59.0 and 664.24 million tons of sodium bicarbonate and sodium carbonate, respectively.

***Resource estimates in the unlicensed area within Engaruka Basin***

As stated earlier, licenses of NDC do not cover the entire area within the Engaruka Basin that was explored by NDC (including drilling) through contractual agreement in 2011 – 2013. Through this Appraisal work it was realised that an area of about 21,036km$^2$within the Engaruka Basin and which contain exploratory Drill Holes that could allow measurement was outside the licensed area of NDC. Resources within this block (based on current Appraisal work) are estimated at 518,611,520 cubic meters of brines and it is estimated that these brines contain 9.28 and 104.55 million tons of sodium bicarbonate and sodium carbonate, respectively.

NDC is therefore advised to relinquish all of its licenses which fall on the hills dominated by massive volcanic rocks on the eastern edges of Engaruka Basin and relocate them within this part of Engaruka Basin which at the moment lies outside the licensed area.

***Comments on Brine Resources***

The geological data was interpreted using VES Survey and pumping test results conducted at Engaruka in 2019. These data were used to develop the geological model. A continuous low resistivity aquifer interpreted from VES Survey and pumping test results coupled with the brine assay data results received from Mwanza water laboratory namely sodium carbonate and sodium bicarbonate were modelled and used to establish the mineral resource.

It is admitted here that most areas of the 3D model are poorly supported by sufficiently close spaced drilling, VES data and pumping test results. In these areas estimation domain interpretation was extrapolated to obtain reasonable estimation domains. As such the computed resource results are Inferred Resources. Therefore, additional drilling and geophysical surveying are required to improve this interpretation.

More samples have to be collected and analysed for Sodium Carbonate and Sodium Bicarbonate from individual aquifers since the samples analysed in this work were for mixed water from different aquifers intersected by the boreholes.

***Comments on life-Span of the Engaruka Brine Deposit***

The Soda Ash Producing Plant expected to be installed at Engaruka is projected to have a throughput that will produce one (1) million tons of soda ash per year as maximum. With this production rate, the lifespan of the identified resource within Engaruka Basin is expected to last for eight hundred (800) years. Apart from this, it must also be taken into account that brines in Engaruka Basin are continuously being recharged from the surrounding highlands dominated by volcanic rocks which are thought to be the source rocks of the salts in the brines and will add up to the life of the resource beyond 800 years.

# CHAPTER SEVEN

# 7. CONCLUSIONS AND RECOMMENDATIONS

## 7.1. Conclusions

Re-evaluation of resources in this appraisal exercise was estimated at a total of **3,813,320,000 $m^3$** of brines hosted in the studied area (196.136km$^2$) within the Engaruka Basin. Taking an average composition of brines to be 17.90g/*l* for sodium bicarbonate and 201.61g/l for sodium carbonate, the brines is estimated to host 68.30 and 768.80 million tons of sodium bicarbonate and sodium carbonate, respectively. The brine resource estimates were calculated using computer based modelling and statistical software (Leapfrog Geo). However, the brine resources of 3,813,320,000 m$^3$ is categorised as **Inferred Resources**. Categorization of the resource to inferred resource is due to limited data from few and distantly positioned boreholes, uncertain pumping test results (resulted by failure to use big pumps of appropriate powers due to small boreholes diameters).

NDC owns three (3) prospecting licences (PLs) forming a total area of 132.318km$^2$ within the study area. Recalculation of the estimated brine resource in the study area to the area owned by NDC indicates a total of 3,294,704,894 cubic meters of brines with total tonnage of 664.24 and 59.0 for sodium carbonate and sodium bicarbonate, respectively. An area of about 21,036.78km$^2$ within the studied area which contain exploratory drill holes that could allow measurement was outside the licensed area of NDC. Resources within this block (21,036.78km$^2$) are estimated at 518,611,520 cubic meters of brines containing 9.28 and 104.55 million tons of sodium bicarbonate and sodium carbonate, respectively.

Using the carbonation process, to produce 1 million tons of soda ash per year will require 7,412,898.44m$^3$ of brines to be abstracted from the aquifer (This fact turns to 134.9kg of soda ash will produced for every 1m$^3$ of brines). The abstraction rate of 7,412,898.44m$^3$ of brines per year will deplete the brine resource of 3,813,320,000 m$^3$ for a period **over 500 years**. These estimates were based on the brine analytical results that show the concentrations of the Engaruka soda ash.  It has also to be taken into account that brines in Engaruka Basin are continuously being recharged and this will increase significantly the lifespan of the resource.

Although the study has come up with promising brine resource estimate, several challenges were encountered during the study and interpretation of data. These challenges include: -

- Some boreholes reported in previous reports were not allocated (6 RC boreholes and 1 diamond drill-core borehole), vandalized (4 boreholes), distantly positioned, and some boreholes have less depths than the reported depths. In addition, one (1) borehole was covered under the lake hence was not accessible, and most boreholes have smaller borehole diameters that could not allow insertion of efficient and powerful submersible pumps for pumping test.
- Fractured and mixed core samples that resulted into failure to have a practical determination of the porosity.
- Vertical Electrical Sounding (VES) technique has a capacity to penetrate up to 200 meters only, but the resource seems to be available even beyond 200 meters. With

VES data it was impossible to understand the results beyond 200 meters. Since VES could not penetrate the entire sequence of sedimentary pile in the Engaruka Basin, total thickness and characteristics of the sediments in the basin could not be established. Additionally, the VES data of 2011 could not match to their respective locations when were plotted on the geo-referenced map.

- Lack of meteorological weather station and meteorological data in the Engaruka Basin. The meteorological data used were obtained from Weather Stations of the geographical environments similar to that of Engaruka although these stations are very far (more than 100 km) from the basin.

### 7.2. Recommendations

Following several shortfalls encountered during the brine resource appraisal, the followings are recommended:

i. Further geophysical surveys using Electrical Resistivity Tomography (ERT) and Transient Electromagnetics (TEM) should be used for explore the depth beyond 200 meters. These geophysical methods have capability to penetrate to a greater depth of not less than 500m. This will help in establishing fully the lithological units and spatial extent of aquifers within the basin.

ii. Drilling of additional exploratory cum production boreholes should be done that will facilitate accurate assessment of aquifer properties before, during and after drilling. The boreholes final casing diameter should not be less than 10 inches to allow usage of big and efficient pumps. It is been proposed that:
    - Two (2) boreholes should be Diamond drill-ores for bringing better clarity of stratigraphic sequences of the sediments, understanding mineralogical composition of the sediments and computation of accurate porosity of the sediments.
    - Four (4) Reverse Circulation boreholes of at least 16 inches diameter be drilled and while drilling identification of layers of aquifer and their respective aquifer characteristics be established. Representative water samples for each aquifer should be collected in this exercise to allow determination of proper composition of brine in each aquifer. The same boreholes can later be used as production boreholes.

From geophysical data interpretation, the Engaruka Basin is seen to be dissected by a NE-SW trending Magnetic High zone located in the central part of the basin. Because of this dissection, the basin is having two portions located on the NW and SE side with Magnetic Low Fields. The tentative positions of the proposed Core and RC boreholes are selected such that one Core and one RC boreholes fall in the north-western zone whereas one Core and three RC boreholes fall in the south-eastern zones of the basin (zones with Magnetic Low Fields). Only one RC borehole is proposed to be in the north-western zone because this zone contains existing BH5 which has wide casing to allow insertion of powerful pump which can perform pumping test efficiently. Three RC boreholes are proposed to the south-eastern block because the block is larger (in size) than the north-western block and it does not have existing boreholes with wide casing to allow insertion of powerful pump which can perform pumping test fairly efficiently. As earlier stated, positions of the proposed boreholes are tentative and their exact positions will be determined based of the findings of the proposed Electrical Resistivity Tomography (ERT) coupled with Transient Electro Magnetics (TEM) surveys.

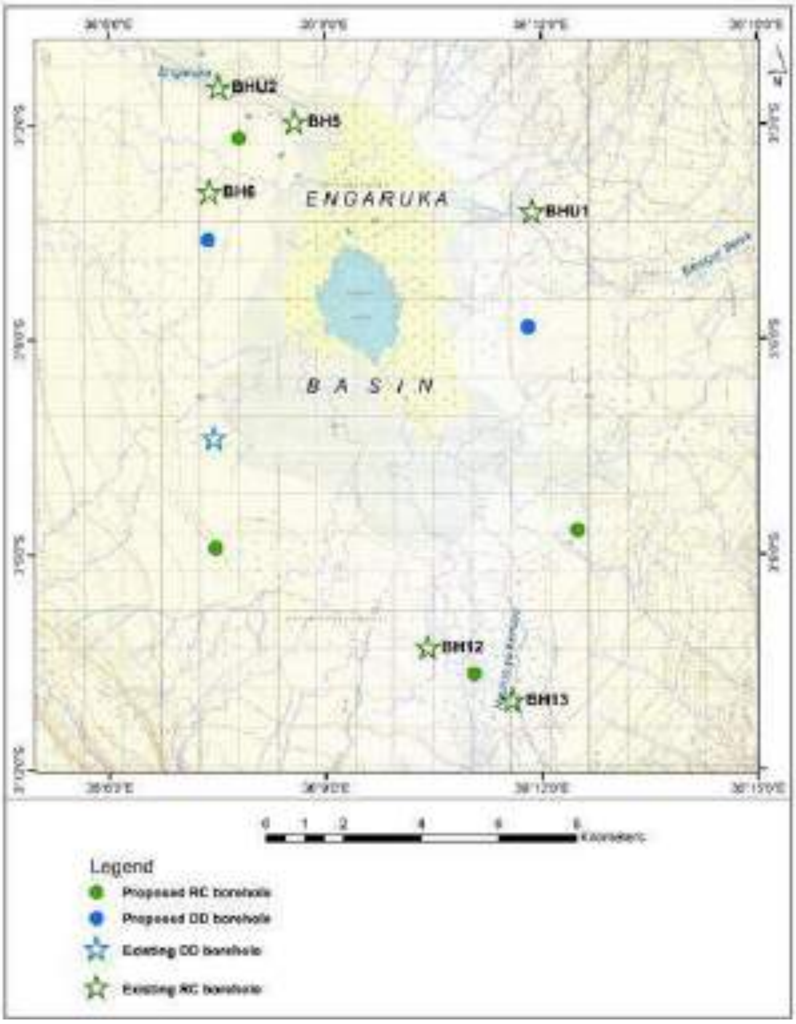


Figure 7.1 Proposed positions for further drilling

iii. Establishing meteorological weather station and conducting proper estimation of recharge rate using available standard techniques.

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**NATIONAL DEVELOPMENT CORPORATION**

# "TECHNO-ECONOMIC STUDY FOR SODA ASH PROJECT AT ENGARUKA IN MONDULI DISTRICT, ARUSHA REGION, TANZANIA"

## VOLUME II

## MARKET STUDY ANALYSIS

**Prepared By:**
**Tanzania Industrial Research and Development Organization**

**May 2021**

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# EXECUTIVE SUMMARY

Objectives of the market study assignment are to document market trends for soda ash demand and supply in Tanzania, East Africa and Globally; identify key areas in the soda ash value chain and comment on the drivers that may impact supply and demand for soda ash in the future; and identify market for soda ash and quantify the demand for each segment currently and in the future. To meet the objectives an extensive literature review was undertaken, review of previous development of soda ash industry in Tanzania, analysis of the sectors for potential or the use of soda ash were undertaken. Potential areas of investment for soda ash utilization in Tanzania were also considered. Analysis of local and regional markets based on the value chain analysis of the soda ash was considered. For International market analysis of major trading partners were analysed.

## Product Details

Soda ash is the trade name for sodium carbonate or washing soda, a chemical refined from the mineral trona or sodium-carbonate-bearing brines (both referred to as "natural soda ash") or manufactured from one of several chemical processes (referred to as "synthetic soda ash"). The soda ash, with the Chemical Formula $Na_2CO_3$, is the World mostly tradable commodity.

Soda ash is an important ingredient in manufacturing of all kinds of glasses, production of detergents, industrial chemicals, water treatment, textile industries, flue gas desulphurization and mineral process. It is also used in paper industries and petroleum refining. Soda ash is also used in the manufacture of aluminium, dye stuff, curative drugs, cosmetics, aluminium and fertilizers

## Global Market Trends

According to the International Market Analysis Research and Consulting Group (2020), soda ash market reached a volume of 59.30 Million Tons in 2018, growing at a cumulative annual growth rate (CAGR) of 1.67% during 2011-2018, while the market value of US$ 17.86 Billion was realized, exhibiting a CAGR of 2.53% during 2011-2018. This indicates an increase in the price of soda ash in the 8 years of analysis, but which was not quite substantial.

Globally, at least 50% of the main users of soda ash constituted glass industries during the past two years. According to the International Glass, the glassmaking industry used 53% of the 60 million tons of soda ash produced in the 2019. The flat glass sector consumed 29%, the container industry 19% and other glass segments 5%. The second largest consumer by segment is the soaps and detergents (15.0%), chemicals (8.6%), metallurgy (6.0%), pulp and paper (1.1%) and others (18.1%).

In 2018, China represented the largest consumer of soda ash globally, accounting for 41.6% of the total soda ash market. China was followed by Asia- Pacific (Excluding China) (21.7%), Europe (13.0%), North-America (12.1%), Middle East and Africa (6.9%) and Latin America (4.7%).

According to the International Trade Centre statistics, the United States of America (USA) is the world's largest exporter of soda ash (by volume) accounting for 41.7% of the total global export volumes of 6,965,000 Tons in 2018. The USA was followed by Turkey (20.6%), China (8.3%), Bulgaria (7.8%), Russian Federation (5.1%) and Germany (3.9%). The global market share of soda ash for the top five exporting countries covers 54.9% of the global market share.

Brazil represents the largest global importer of soda ash (by volume) accounting for 8.7% of the global import volumes of 1,388,019 Tons in 2018. Brazil was followed by Mexico (7.8%) with import volumes of 1,236,908 Tons, Indonesia (6.4%) with import volumes of 1,013,623 Tons, India (5.4%), Thailand (5.2%) and Republic of Korea (3.5%). However, Korea and India are the most importers of soda ash based on the value of the imports in 2018.

Prices of Soda ash are increasing in the World due to increased demand which does not match with the supply. The price of soda ash has been increasing at a CAGR of 0.84% during 2011-2018, reaching a value of around US$ 301 per ton in 2018.

Exporters generally earn a profit margin of 10% to 12% by exporting the final product to the end users and distributors based in foreign countries. Distributors generally add a profit margin of 9% to 11% and sell it to the end use industries.

**Regional Market Trends**

Based on the International Trade Centre (ITC) Statistics, SADC importation of soda ash in 2018 was 524,000. Botswana is the largest producer of Soda Ash in the SADC region with capacity of 300,000 tons per year, currently producing 280,000 tons per year. The major market for the Botswana soda ash is the South Africa which consumes about 250,000 tons per year. Other SADC countries (mostly to Zimbabwe – ZIM Glass) consume the rest of the production from Botswana. ITC estimated that Tanzania has an estimated untapped soda ash potential of US$ 3 million a year. This translates to about 10,000 tons extra to the current importation of about 35,000 tons per year. Trade indicators for the year 2014-2018 indicates that the region unit price for soda Ash was US 214 per ton, the lowest being in South Africa which was US$192 per ton.

Exports of soda ash in the EAC reached 342,780 tons in 2017 and declined to 289,350 tons in 2018. Kenya is the main exporter of Soda Ash in the region. Kenya export soda ash dense and main destination is in India following investment of Soda Ash plant by an Indian investor, TATA Chemicals. Based on the 2018 data of imports trend for EAC, the importation of Soda Ash is below 60,000 tons per year. The largest importer of Soda Ash is Tanzania with about 40,000 tons per year, followed by Uganda which imports about 15,000 tons per year. Based on the 2014-2018 trade indicators, average price per ton for imported soda ash was US$302.

**Local Market Analysis and Potential**

Importation of the soda ash in Tanzania is coordinated at the Office of Government Chemist. According to the Government Chemist Office, for the year 2019, importation certificates issued indicated that imports of soda ash were around 15.2 million kilograms. About 60% of the imported soda ash was used in the glass manufacturing firm. Soap and Detergent Industry is the second biggest user of the imported soda ash after the glass industries.

Based on the Trade map statistics maintained by the International Trade Centre, it was reported that in 2018, Tanzania imported a total of 38,899 tons valued at 11.4 mil US$. Currently, the Soda ash used in Tanzania is mainly imported from China, Romania, India, Bosnia and Herzegovina, Bulgaria, Russian Federation, Kenya, Turkey, Lebanon Hong Kong, China, Belgium and United Arab Emirates. On average, price per ton was US$328, lowest price being US$ 296 per ton.

Tanzania is a home to Kioo Limited, which is the largest single manufacturer of glass packaging for soft drinks, beer, liquor, food industries in East and Central Africa. In the last three years (i.e. 2017, 2018 and 2019), Kioo Limited imported an average of 18,450 tons of soda ash at an average price of US$353.67 per ton. This was equivalent to an average of 53% of total importation of soda ash in the country - from 2017 to 2019, the firm imported respectively 13,215 tons [@ US$ 321]; 16,762 tons [@ US$357] and 25,371 tons [@ US$ 383].

The next big players after glass manufacturing firm are producers of Soap and Detergents – the Big 6: Royal Soap and Detergent Industries Ltd, Murzah Soap and Detergents Ltd, Clinsoft, GandB Soap Industries Ltd, Mikoani Edible Oil and Detergent Ltd - usage in detergents ranges from 40% to 65%. Moreover, other significant soda ash importers and traders in the local market, include Tata Africa Holdings (T) Ltd, New Rainbow Africa Limited, Bomet Corporation Limited, Pu Sen Building Materials Company Limited, Global Leader Enterprise (T) Ltd, Chemi and Cortex Industries Ltd, and Prayosha Industries Ltd.

There are potential markets in the making. The planned factory in Mkuranga, Coastal region was planned to produce an average of 600 tons of float glass per day, with annual capacity of 135,000 tons to 160,000 tons per year. Tanzania ranks 8$^{th}$ within the Top 10 importers with USD 10.7 million accounting for 4.3% of the total float glass imported to Africa in 2013 and 2nd behind Kenya. Tanzania has favourable condition for glass manufacturing because of its rich in silica sand, limestone, dolomite and soda ash which are all essential materials in glass making.

Moreover, NDC has plans to establish the science apparatus industry in Mwanza and glass sheet industry in Dar es Salaam. With the number of education institutions from secondary school to universities increasing, the demand for science apparatus is expected to increase. Likewise, the housing construction industry is booming in large cities throughout the country with high demand for sheet glasses.

## Market Estimations

The Engaruka soda ash production of 500,000 tons per year has been considered and design is reasonable to meet the demands for local, regional and the international markets. It is estimated that the exports of soda ash is likely to be 87% of the total produce. The local market is expected to absorb 13% to 30% at the end of 2030 given promotion of local industrial uses of the soda ash as suggested in this plan. The main consumers in the local market will be glass as well as soap and detergent industries, which absorb more than 60% of the current soda ash, globally. Generally, the estimated demand for Engaruka Soda Ash will be as follows:

- In the local market, Total Demand for dense soda ash will be growing from 30,865 tons (in 2020) to 130,128 tons (in 2030); at a price of US$ 185.64 to US$ 226.29 respectively (Tax exclusive)
- In the local market, Total Demand for Light Soda Ash will be growing from 31,380 tons (in 2020) to 59,439 tons (in 2030) at a price of US$ 301.6 to US$ 339.3 respectively (Tax exclusive)
- Total Local Market Volume potential will be growing from 32,245 tons (in 2020) to 189,567 tons (2030) at an average price of US$ 239.27 to US$ 282.80 respectively
- Total Estimated Local Market Value will be growing from US$ 16,968,808 (in 2020) to US$53,609,548 (in 2030).
- In the short run, the production may be constant at 500,000 tons per annum to cater for both local and export markets. The demand is expected to rise depending on marketing efforts that will be invested in both the local and foreign markets.
- Local Market Share will increase from 31% (in 2020) driven by increased production at Kioo Limited and investments in the detergents industry to 165% (in 2030), given the strategies to stimulate soda ash consumptions are implemented.
- Total projections in exportation will vary from 432,453 tons (in 2023) to 310,433 tons (in 2030) at average prices of US$314 to US$353 respectively
- Total value of exportation is estimated at US$ 135,818,502 (in 2023) and US$ 109,582,849 (in 2030)
- Total estimated value, combining both local sales and exportation range between US$ 152,787,310 (in 2023) and US$ 163,192,397 (in 2030).

| Total Estimated Soda Ash Demand (Tons) in selected Industries locally | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Industries** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** |
| Glass | 25,903 | 25,903 | 69,784 | 81,059 | 99,953 | 111,228 | 114,275 | 118,846 |
| Soap and detergent | 27,308 | 28,674 | 30,108 | 31,614 | 33,195 | 34,855 | 36,598 | 38,428 |
| Others* | 14,246 | 14,784 | 22,962 | 27,463 | 28,594 | 29,774 | 31,006 | 32,293 |
| **Total Estimated Demand in Local Market and Exports (in Tons)** | | | | | | | | |
| Local Market | 67,457 | 69,361 | 122,854 | 140,136 | 161,742 | 175,857 | 181,879 | 189,567 |
| Exports | 432,543 | 430,639 | 377,146 | 359,864 | 338,258 | 324,143 | 318,121 | 310,433 |
| **Total (tons)** | **500,000** | **500,000** | **500,000** | **500,000** | **500,000** | **500,000** | **500,000** | **500,000** |
| **Total Estimated Revenue in Local Market and Exports (in US$)** | | | | | | | | |
| Local Market | 16,968,808 | 17,740,463 | 31,951,868 | 37,063,169 | 43,495,659 | 48,088,097 | 50,576,912 | 53,609,548 |
| Exports | 135,818,502 | 137,804,480 | 122,572,450 | 119,114,984 | 113,654,688 | 110,856,906 | 110,706,108 | 109,582,849 |
| **Total (US$)** | **152,787,310** | **155,544,943** | **154,524,318** | **156,178,153** | **157,150,347** | **158,945,003** | **161,283,020** | **163,192,397** |

* Leather Industry, Paper Pulp, Fertilizer industries, Textile industries, Water treatment, Animal feeds, etc.

**Marketing Strategies and Organization Structure**

Tanzania soda ash project in Engaruka has several competitive advantages for soda ash as compared to other competing producers such as Kenya and Botswana, especially when we take into account variables such as - non committed project, location, access to markets, logistics and supporting infrastructure for the industrial establishment. Several joint marketing strategies are suggested in the report.

| S/No. | Suggested Strategy/Activity | Responsible Party(ies) |
|---|---|---|
| 1. | Subscription to the local and international association for soda ash manufacturing and associated product users. | Envisaged Operator of the Project |
| 2. | Participation in trade fairs – local and international. Local trade fairs may be those related to the soda ash value chain. The exhibitions will create understanding of the company products and processes. | TANTRADE, EPZA, TIC and Ministry of Agriculture (Organizers of Nane Nane Trade Fairs). |
| 3. | Corporate social responsibility – this could be designed as per various guidelines include those of mining sector and TIC guidelines, TEIT, etc. | Envisaged Operator of the Project |
| 4. | Capacity building and Promotion of the local industrial development which will enhance the use of soda ash.<br>Capacity building by local colleges and universities on the soda ash value chains. | SIDO, TVET institutions |
| 5. | Development of effective and interactive marketing and promotion materials - logo, color, names and associated products names; interactive website(s) for communication of the company affairs, products and services; Creating and maintenance of company social media account(s) which will communicate various development of the company operations, products and activities as well as interaction with the potential customers. | Envisaged Operator of the Project |
| 6. | Analysis of the global industrial data and company data. This is important activities to inform the company on various developments in the market which may include price changes, potential new | Envisaged Operator of the Project |

| S/No. | Suggested Strategy/Activity | Responsible Party(ies) |
|---|---|---|
| | entrants, technologies and other market related activities relevant to the company business undertaking. | |
| 7. | Collaboration with the Ministry of Ministry of Foreign Affairs and East African Cooperation for potential market where Tanzania is represented, and where potential investors for Soda Ash or value chain products. Availability of the investors in the project will stimulate the locally usage of soda ash. | Ministries responsible for – Investment; Industry and Trade; Foreign Affairs |
| 8. | There is need to collaborate with the regional and international association in the soda ash value chain to access various information including among others related to the soda ash trade and access to the market. These include various committees within the EAC block and SADC, as well as those of WTO. | Ministries responsible for – Investment; Industry and Trade; Foreign Affairs |

Sales of the soda ash are expected to take two forms:

- ✓ Direct sales from the manufacturing or area of production to the export market and large-scale project company owned by the investors of the plant who will use soda ash in feed stock. Investors are expected to use soda ash in large quantities and thus preferably investors in glass making industry are preferable. Only huge quantities over 50,000 tons per year will be delivered directly from manufacturer.
- ✓ Sales through distributors: Local companies other than investors companies will need to buy from a distributor. This is due to the bulkiness of the products and need to undertake marketing and promotion purposes. Distributors can also seek export market. This model will create jobs and competition in the sale of the product in the world market. Threshold of tons per year for the distributor will be determined based on the market development and during the implementation stage. Distributors and manufacturers can maintain various storage facilities to ensure they preserve the quality of the soda ash.

Markets and Marketing of Soda Ash

- ✓ There is a need to create local capacity for consumption of the soda ash and investigate further the international market
- ✓ Logistics and transportation is an important aspect of the soda ash value chain. There is need to thoroughly design the transport and logistics which will ensure cost effective for the final product produced.

- ✓ There is need for capacity building for the marketing staff on how to market the products and get pace with the world trend of the products.
- ✓ The project company should subscribe to various marketing associations and regional trading blocks to ensure effective marketing of the product, and to compete with current exporters of similar product in the region.

Stimulation of Soda Ash Usage

- ✓ Regional and Local Government Administration to consider promoting industries which potentially use soda ash by setting up land for industrial investment and providing necessary infrastructure
- ✓ TFRA to invite investors who can invest in fertilizer production using soda ash as a feed stock
- ✓ TANROADS, TARURA and TRC to set up necessary infrastructure to facilitate transport to the industrial areas
- ✓ Utilities services providers such as TANESCO and water authorities to consider supporting LGAs and Regional Administration officers on the provision of necessary infrastructure in supporting industrialization which can potentially use soda ash
- ✓ Tanzania Investment Centre, TANTRADE, EPZA to come up with a strategy to publicize the potential investment for utilization of soda ash. This can be through formulation of a special unit to publicize investment using soda ash as a feedstock or important ingredients as the case of Botswana.
- ✓ TIC in collaboration with the Ministry of Foreign Affairs and East African Cooperation to find ways of informing the country representatives especially where Tanzania imports Soda Ash or imports substantially value-added products produced from soda ash on the need to invest in Tanzania to the identified economic zones, for the utilization of soda ash and exploring the neighbouring markets for secondary products made out of soda ash.
- ✓ There is need to train small scale producers who can potentially use soda ash e.g. capacity building through Small Industries Development Organization (SIDO).
- ✓ Sector development strategies which may lead to the consumption of soda ash should closely be monitored. These include strategies in the textile, livestock and leather industries.

**Conclusion and Recommendations**

Soda ash has high demand both in the local and international markets. Its market is majorly driven by the growing demand for end-user industries. The government efforts to promote Tanzania ya Viwanda need to be re-aligned with the industries that consume locally available input (to promote local content) – thus, the need to prioritize the proposed areas (industries and geographical wise).

Consumers for soda ash product are price sensitive (perfect elastic), prefer quality and are looking for consistence product supply. To be competitive, the Engaruka Project should always consider three main factors:

- ✓ Offering competitive price;
- ✓ Guarantees quality and
- ✓ Consistence supply – quantity and quality products.

Recommended marketing activities during various stages of the project:
Before construction

- ✓ Establishment of office for operations – We suggest that the company offices and marketing officer to be based proximity to the project area, in Arusha.
- ✓ Employment of Marketing Expert /Ag. Director of Marketing
- ✓ Collaboration with Ministries responsible for Investments, Industry and Trade, PO-RALG and Foreign Affairs & East African Cooperation collaborations with TBS, BRELA, CTI, TIC, EPZA and other institutions relevant to international
- ✓ Preparation of company branding code for marketing activities

During Construction

- ✓ Subscription to international association
- ✓ Visits to the symposiums and trade fairs of soda ash
- ✓ Development of various policies and procedures regarding marketing and promotions activities
- ✓ Undertaking various development related to pre-operational stage for marketing activities include development of brand mania and promotional tools
- ✓ Capacity building to promote local content

After Construction – Operation Stage

- ✓ Employment of the marketing team
- ✓ Implementation of marketing strategies

Policy to Promote Soda Ash Usage

- ✓ There is need to impose an import duty of soda ash and related products from soda ash utilization after the successful operation of the plant and associated value chain industries. Suggested rates may range from 5% to 25% depending on the market needs.
- ✓ There is need to liaise with various partners for bilateral trade agreements and to initiate anti-dumping measures of soda ash following the extraction of the resource.

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## ABBREVIATIONS & ACRONOMY

| | |
|---|---|
| **AGOA** | African Growth and Opportunity Act |
| **BRELA** | Business Registration and Licensing Authority |
| **CARG** | Cumulative Annual Growth Rate |
| **CSR** | Corporate Social Responsibilities |
| **CTI** | Confederation of Tanzania Industry |
| **DIT** | Dar es Salaam Institute of Technology |
| **DRC** | Democratic Republic of Congo |
| **EAC** | East Africa Community |
| **EPZA** | Export Processing Zones Authority |
| **FOB** | Free on Board |
| **FYDP** | Five-Year Development Plan |
| **HH** | Herfindahl Hirschman |
| **HS** | Harmonized System |
| **IDC** | Industrial Development Corporation |
| **IS** | Indian Standards |
| **ITC** | International Trade Centre |
| **Km** | Kilometres |
| **NBS** | National Bureau of Statistics |
| **NDC** | National Development Corporation |
| **SADC** | South Africa Development Cooperation |
| **SIDO** | Small Industries Development Organization |
| **TANESCO** | Tanzania Electricity Supply Company |
| **TANTRADE** | Tanzania Trade Authority |
| **TBS** | Tanzania Bureau of Standards |
| **TFRA** | Tanzania Fertilizer Regulatory Agency |
| **TIC** | Tanzania Investment Centre |
| **TIRDO** | Tanzania Industrial and Research Development Organization |
| **TVET** | Technical and Vocation Education Training |
| **TZS** | Tanzania Shillings |
| **UN** | United Nations |
| **US/ USA** | United States of America |
| **USD/US$** | United States Dollars |
| **USGS** | United States Geological Survey |
| **VAT** | Value added tax |
| **WTO** | World Trade Organization |

# CHAPTER ONE

# INTRODUCTION

## 1.1 Project Background

The Government of United Republic of Tanzania through the National Development Corporation (NDC) is undertaking techno-economic study for the establishment of Soda Ash Project at Engaruka Basin, Monduli District in Arusha region. The NDC has engaged the Tanzania Industrial and Research Development Organization (TIRDO) to carry out the study for the establishment of the proposed soda ash plant, in various aspects including analysis of global and local market for soda ash. The country is rated as one of the sodium carbonate-rich countries in the world.

The discovery and exploitation of soda ash is envisaged to stimulate the construction of industries, employment creation and infrastructure development. Likewise, the government will collect more revenues from different sources operating in these areas and export earnings from the soda ash exportation. Employment of youth who provide skilled and unskilled labour in the soda ash mining activities will be crucial to alleviate poverty and social unrests. Potential investors in the soda ash value chains are expected to engage on corporate social responsibilities (CSR) activities including support for social amenities such as education and health facilities.

The envisioned benefits necessitate undertaking a market study which will inform decision making processes regarding the best strategies and opportunities to maximize the benefits of the soda ash product; in the view of its value chains and the use of the product both within the local market and potential international markets.

## 1.2 Terms of Reference for Market Assessment

The study will cover description and analysis of the market information including:

i. Availability of local and regional market (EAC, SADC, etc.) including price structure and Regional soda ash production,
ii. Global past industry trends for the past 5 - 10 years (production, consumption, pricing),
iii. Globally existing industry structure (installed capacities, production and consumption levels, pricing),
iv. Global future scenario for the next 5 years (demand growth, production, pricing) and global demand supply gap,
v. Synthetic versus natural soda ash,
vi. Potential market share for the project (local, regional, worldwide),
vii. Envisaged market segments (and size of each segment),
viii. Product quality requirement for each market segment,
ix. Assessment of potential market barriers,
x. Assessment of barriers using Porter's Model.

xi. Marketing strategies, promotion methods and distribution channels to achieve projected sales, and
xii. Any other relevant marketing information.

### 1.3 Objectives of the Scope of the Market Study

Objectives of the market study assignment are:

a) To document market trend for soda ash demand and supply in Tanzania, East Africa and Global market trends,
b) To identify key areas in the soda ash value chain and comment on the drivers that may impact supply and demand for soda ash in the future, and
c) To identify market for soda ash and quantify the demand for each segment currently and in the future.

### 1.4 Approach and Methodology

The team has made the following progress:

a) ***Visit to the site – See Annex I of the visitation report***: The Market Study Team conducted site visitations from 17th to 20th September 2019 with the aim to (a) get the first hand information regarding the social, economic and political aspects as the basis for investment decisions; (b) study the local environment where the project will be undertaken and come up with a clear understanding of the product; and (c) to assess the marketing aspects related to the development of the project.
b) ***Desk Research:*** The desk research focused on the assessment of the Global Demand and Supply of Soda Ash. Various sources of data were reviewed [see references]. The main sources of data include (a) International Market Analysis Research and Consulting Group (2020) on Soda Ash Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2019-2024; (b) Soda Ash Market: Turkey to Replace China; and (c) United States Geological Surveys.
c) ***On-line survey:*** The Tanzania Investment Centre (TIC) and The Business Registrations and Licensing Agency (BRELA) provided some lists of potential users of soda ash [Refer to Appendix I] as registered in the respective authorities. The lists serve as sampling frames for the phone call and field visits.
d) ***Field visits***: in Arusha, Dar es Salaam, Dodoma, Iringa, Tanga and Mwanza [Appendix II].

## CHAPTER TWO

### 2.1 Product Details

Soda ash is the trade name for sodium carbonate or washing soda, a chemical refined from the mineral trona or sodium-carbonate-bearing brines (both referred to as "natural soda ash") or manufactured from one of several chemical processes (referred to as "synthetic soda ash"). Natural soda ash is obtained from trona and sodium carbonate-rich brines. The discovered Soda ash also known as sodium carbonate, washing soda, soda crystals, carbonic acid, disodium salt, disodium carbonate and calcined soda is best quality in the world and suitable for commercial production.

Synthetic soda ash is produced from either the Leblanc process, Solvay process, Modified Solvay (Dual) process or dry lime process. Each method contains a number of different chemicals that leave behind byproducts such as residual calcium carbonate, chloride, and other limestone components. These byproducts and carbonates are impurities that create additional waste products. This waste is usually discharged into waterways, leading to water pollution and deterioration of the surrounding environment, including the destruction of nearby coral reefs, seagrass, and seaweed communities.

The most widely used production process to synthetically manufacture soda ash is Solvay process. In Solvay process, limestone (CaCO3) and salt (NaCl) are combined to produce soda ash (sodium carbonate) with by-products such as calcium chloride and ammonium chloride, which made it readily available in the market. This combination is achieved through various series of reaction.

In synthetic soda ash, raw material cost, i.e. the cost of procuring ammonia, limestone and sodium chloride is the highest cost component accounting for around 65% -70% of the total costs of production. As a result, any fluctuations in the prices of raw materials will have a direct impact on the final product prices unlike the natural soda ash process. Raw material prices fluctuate based on currency volatility, and mining regulations in respective countries. In China where synthetic soda ash materials are subjected to high environmental conditions resulting from its production process. There has been an increase in the price of the synthetic soda ash around the world due to mitigations of environmental costs.

Soda ash is made in three main grades - light, medium and dense. These have the same chemical properties and only differ in physical characteristics, such as bulk density and particle size and shape.

**Dense Soda Ash:** Dense soda ash, an anhydrous substance, is an important industrial chemical and is used in the manufacture of many products.

**Washing Soda:** Washing soda is a hydrous substance made by combining light soda ash with additional water molecules. It is used most often to improve the cleaning properties of detergents and soaps.

**Light Soda Ash:** Light Soda Ash is used as a buffering/pH regulator in many industrial processes.

### 2.2 Product Applications

Numerous applications of Soda Ash cover both domestic and commercial usage including the following major categories of use.

**Industrial Applications** – Being a highly soluble substance, soda ash is used for numerous chemical reactions. It's mostly used as an ingredient in the manufacture of dyes and colouring agents, synthetic detergents and fertilizers. It's also an important chemical agent used in enamelling and petroleum industries.

**Environmental Applications** – Sodium carbonate is used to improve and treat the alkalinity of lakes that have been affected by rain. It is also used to reduce the acidity of emissions being generated from a power plant.

**Detergent Manufacture** – Soda ash is replacing phosphates that were earlier being used in a number of household detergents. Many other cleaning products such as dishwashing soaps also contain varying amounts of soda ash in their formulations.

**Metallurgy** – Sodium carbonate is used to remove or de-clarify phosphates and sulphurs from a number of non-ferrous and ferrous ores. It's also used in recycling of aluminium and zinc.

**Glass Manufacture** – Soda ash is an important ingredient in the manufacture of glass, since it helps reduce silica's melting point.

**Other Applications –** Soda ash is also a common addition to spa and pool treatment chemicals helping in reducing the acidity in water. It is also used in manufacture and sealants and glues, preparing pulp in paper manufacture, and sometimes in soil preparation as well.

Soda ash is used in the manufacturing of aluminium, dye stuff, curative drugs, cosmetics, aluminium and fertilizers. It is also used in softening of water in oil refineries (see e.g. Kenya oil refinery at the coast). Soda ash is also used as a preservative for meat and fish where it is sprinkled on the meat and then it helps in removing water thus drying the meat and preventing it from getting spoilt.

Several chemicals, such as sodium silicate, sodium bicarbonate and per carbonate, and sodium chromate and dichromate, are produced using soda ash, which is expected to generate significant traction in near future. In the metallurgical processing industry, soda ash is utilized for the recycling of aluminium and zinc

The potential markets include industries manufacturing detergents, papers, and glasses, steel; as well as petroleum and water treatments. Figure 2.1 presents World soda ash major uses by end user.

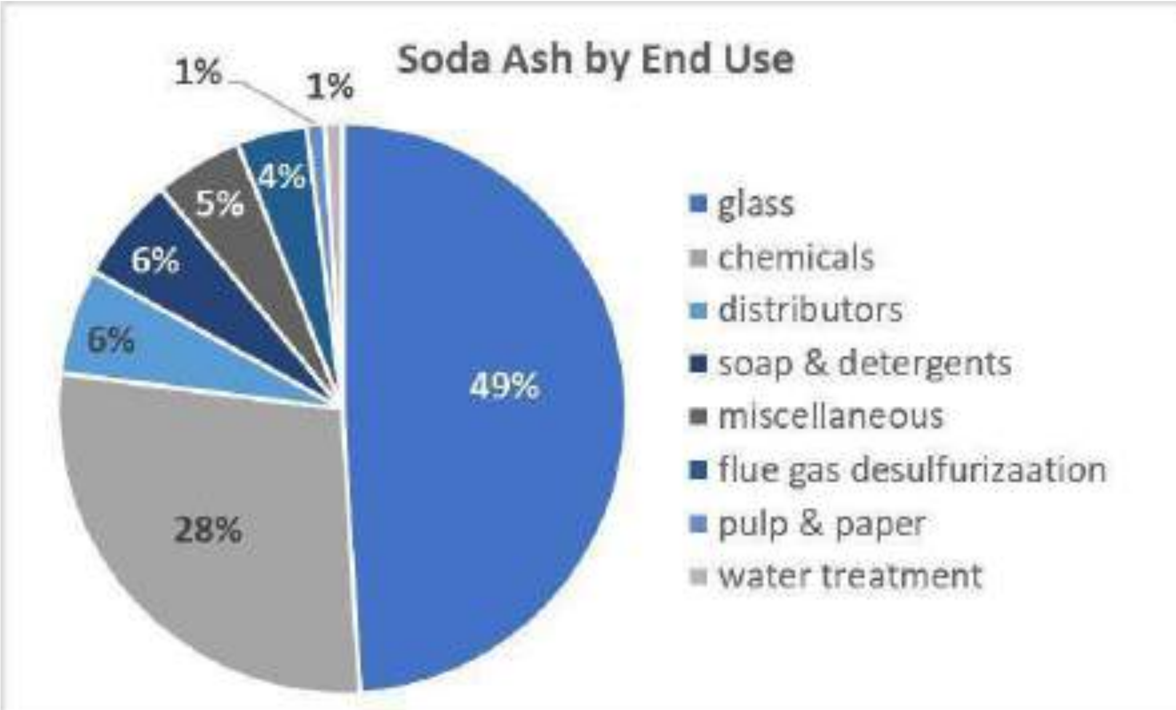



Figure 0.1: Soda Ash by End User 2017

Source: https://blog.tridge.com/soda-ash-market-turkey-to-replace-china-410ff8499b04

### 2.3 Product Quality and Standardization

In Tanzania there is no standard for soda ash. The standard in use is the one from India IS296-2003[1]. Other standards for soda ash related. The product has the design for the soda ash should follow these standards. The summarized production specifications and requirements as per various standards are as indicated in Table 0.1.

Table 0.1: Product Specification

| **Product Identification** | **Dense** |
|---|---|
| Product name | Soda Ash / Sodium Carbonate /Anhydrous |
| Chemical Formula | $Na_2CO_3$ |
| Molecular Weight Range | 105.99 |
| Purity Level | 95-98 |
| PHYSICAL CHARACTERISTICS | |
| Physical Appearance | White Powder |

[1] However our search for such standards reveals that the recent available standard is IS 251 : 1998 available from https://www.services.bis.gov.in:8071/php/BIS/PublishStandards/published/search_data_list/?isno=c29kYSBhc2g=

| Product Identification | Dense |
|---|---|
| pH (1 % solution) | 10 -11.4 , 5% |
| Specific gravity | 2.51 |
| Solubility | 51g/100 ml at $20^0$C to $30^0$C |
| Odour | Odourless |
| Colour | Colourless to white |
| Particle size | 694 µm |
| Melting point | $851^0$C |
| Packaging | The product is transported in bulk by railway in soda containers and hoppers, and also soda trucks. Soda ash packaged in soft special containers is carried by railway in open cars and covered cars, and also by road transport. |
| | Various, 25kg, 40kg, 50kg, 500kg, 750kg, 1000kg agreeable between the purchaser and supplier<br>Can be packed in pallets are plastic-wrapped. Polypropylene bags used with nylon inner lining or paper bags. Must be covered to avoid moisture contact. |
| Marking | Manufacturer's name<br>Mass and grade of the material in the container<br>Lot number/batch number<br>Standard mark – as necessary. |
| Labelling | According to Applicable standards of manufacturing/importing country |
| | Warning, wear eye/face protection, wash hands after handling.<br>Not classified as dangerous |
| Storage | Store in cool area. Dry area, ventilated place |
| Expiry | 2 years/ depends on the storage environment |

Source: Compiled from various source based on the Material Safety Data Sheets for Soda Ash. Sample for Data sheet is as indicted in Appendix III.

Other applicable standards for other secondary products produced by soda ash include Sodium Hydroxide TZS 378:2018 and Sodium Bicarbonate TZS507:1999. Tanzania Bureau of Standards is also in the process of developing a code of practice for glass manufacturers which will be applicable across the East African Countries.

## 2.4 Packaging and Transportation

### 2.4.1 Package for Industry Use and Large Distributors

Globally the product packages for the pricing distributors are in 1 ton bulk bags and 32 tons pneumatic tankers. This is normally applicable for soda ash dense.

### 2.4.2 Package in For Export

For export purposes, soda ash light and dense is package packaged in 50kg and 25kg bags (shrink-wrapped). In some countries they might require palletized packages and thus is it important to consider this during implementation of the plan.

## CHAPTER THREE

### 3.1 Global Market Analysis

According to the market information[2], in 2018, the soda ash market reached a volume of 59.30 Million Tons, growing at a CAGR of 1.67% during 2011-2018, while the market value of US$ 17.86 Billion was realized, exhibiting a CAGR of 2.53% during 2011-2018. This indicates an increase in the price of soda ash in the 8 years of analysis. In 2018, China represented the largest consumer of soda ash globally, accounting for 41.6% of the total soda ash market. China was followed by Asia- Pacific (Excluding China) (21.7%), Europe (13.0%), North-America (12.1%), Middle East and Africa (6.9%) and Latin America (4.7%). In terms of application, for the year 2018, glass represented the largest application for soda ash market, accounting for a share of 51.2% of the total market. Glass was followed by soaps and detergents (15.0%), chemicals (8.6%), metallurgy (6.0%), pulp and paper (1.1%) and others (18.1%).

### 3.2 Production

According to the United States Geological Survey (USGS), the world's largest deposit of trona is in the Green River Basin of Wyoming, in USA. About 47 billion tons of identified soda ash resources could be recovered from the 56 billion tons of bedded trona and the 47 billion tons of interbedded or intermixed trona and halite. The production in the Wyoming recovers 30-45% of the soda ash for production uses in the world. A total of 15 million tons of soda ash resources (8.3 million tons of final soda ash) are recovered in Wyoming per year. At least 95 natural sodium carbonate deposits have been identified in the world, but only few have been quantified. Soda ash (synthetic soda ash) can be manufactured from salt and limestone (these minerals are practically inexhaustible) but the cost of production is high and costly to produce and not environmental friendly. Table 0.1 indicates World production and reserves. Figures are in thousand tons.

Table 0.1: World Natural Soda Ash Production and Reserves

| **Natural:** | **2016** | **2017** | **Reserves** |
|---|---:|---:|---:|
| United States | 11,800 | 11,800 | 23,000,000 |
| Botswana | 250 | 250 | 400,000 |
| Kenya | 450 | 450 | 7,000 |
| Turkey | 1,900 | 2,100 | 840,000 |
| Other countries | — | 15,000 | 280,000 |
| World total, natural (rounded) | 14,400 | 15,000 | 25,000,000 |
| World total, synthetic (rounded) | 39,200 | 39,000 | -- |
| World total (rounded) | 53,600 | 54,000 | --- |

Source: USGS (2019). Mineral Commodity Summaries 2018 p.152

[2] This is based on the purchased market report from International Market Analysis Research and Consulting Group, 2020

Figure 3.1 indicates global soda ash production, while Table 3.2 presents a countrywide production.

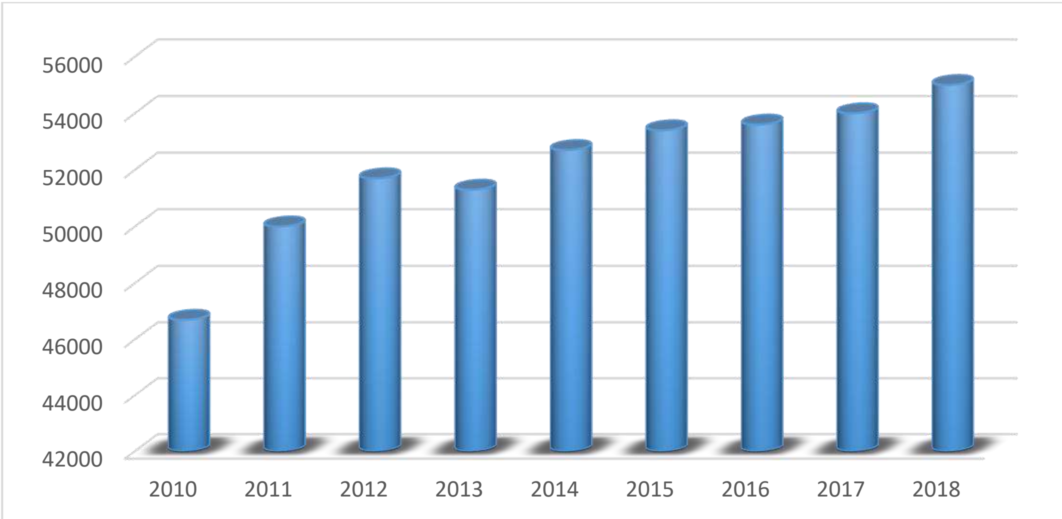



Figure 0.1: World soda ash production in 1,000 tons (2010 - 2018)

Source: USGS (2019). Mineral Commodity Summaries 2018 p.152

Table 0.2: Soda Ash Production Country Wide in Thousand Tons

| **Countries/Year** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** |
|---|---|---|---|---|---|---|
| Australia | 310 | 300 | 150 | -- | -- | -- |
| **Botswana** | **260** | **250** | **228** | **269** | **250** | **250** |
| China | 22,940 | 24,010 | 24,320 | 25,260 | 26,130 | 26,000 |
| Egypt | 130 | 130 | 130 | 130 | 130 | 130 |
| Ethiopia | 5 | 5 | 5 | 6 | 6 | 6 |
| France | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Germany | 2,668 | 2,627 | 2,548 | 1,558 | 2,600 | 2,600 |
| India | 2,300 | 2,460 | 2,390 | 2,380 | 2,400 | 2,400 |
| Italy | 500 | 500 | 500 | 500 | 500 | 500 |
| Japan | 373 | 344 | 361 | 350 | 350 | 350 |
| **Kenya** | **499** | **499** | **468** | **409** | **450** | **450** |
| Mexico | 290 | 290 | 290 | 290 | 290 | 290 |
| Pakistan | 372 | 367 | 379 | 437 | 400 | 400 |
| Poland | 1,060 | 1,111 | 1,052 | 1,100 | 1,100 | 1,100 |
| Portugal | 150 | 150 | 75 | -- | -- | -- |
| Romania | 420 | 430 | 430 | 425 | 425 | 425 |
| Russia | 2,822 | 2,807 | 2,477 | 3,052 | 2,800 | 2,800 |

| Countries/Year | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|
| Taiwan | 140 | 140 | 140 | -- | -- | -- |
| Turkey | 1,749 | 1,853 | 1,665 | 1,828 | 1,900 | 1,900 |
| Ukraine | 700 | 720 | 720 | 600 | 600 | 600 |
| UK | 500 | 500 | 450 | 450 | 450 | 450 |
| US | 10,700 | 11,500 | 11,500 | 11,700 | 11,600 | 11,800 |
| Uzbekistan | 90 | 90 | 90 | 90 | 90 | 90 |
| **Total** | **49,979** | **51,683** | **51,368** | **52,784** | **53,421** | **53,600** |

**Source:** Persistence Market Research, 2018

## 3.3 Consumption

### 3.3.1 Export Volumes

The United States of America (USA) is the world's largest exporter of soda ash accounting for 41.7% of the total global export volumes of 6,965,000 Tons in 2018. The United States of America was followed by Turkey (20.6%), China (8.3%), Bulgaria (7.8%), Russian Federation (5.1%) and Germany (3.9%). The information featured in

Table 0.3 is an overview of the global export markets of soda ash. The table reflects export volume, export value; share in world export, and annual growth in value from 2017 to 2018 for the top ten exporting countries.

Analysis based on the Herfindahl Hirschman Index (HH index) defined as the sum of the squares of the market share of the firms within the industry is provides indicator for market concentration[3]. A higher HH index concentration (above 0.18) means that supplies are dominated by a few countries and vice versa. As it is indicated in

Table 0.3; Bulgaria, Spain and Kenya exports soda ash too few countries compared to other countries which are moderately concentrated. For few concentrated countries it also indicates that major investors are also concentrated. Example, Kenyan Investor to Soda Ash is TATA which is an Indian based company and hence its major exporting country is India.

[3] The concentration is based on the Herfindahl index. It is calculated by squaring the share of each country in the selected market and by summing the resulting numbers, and it ranges from 1 / N to one, where, N is the number of countries. Herfindahl indices between 0.10 and 0.18 to be moderately concentrated and indices above 0.18 to be concentrated.

Table 0.3: Top Ten Exporting Countries of Soda Ash in 2018

| Rank | Exporters | Export Volume (in Tons) | Export Value (in '000 US$) | Shares in world export (%) | Annual growth in value (2017-2018) | HH Index |
|---|---|---|---|---|---|---|
| 1 | United State | 6,965,000 | 1,463,460 | 22 | -12 | 0.17 |
| 2 | Turkey | 3,446,642 | 599,980 | 9.4 | 41 | 0.06 |
| 3 | China | 1,378,865 | 344,004 | 13.9 | 19 | 0.1 |
| 4 | Bulgaria | 1,304,821 | 239,367 | 3.2 | 10 | 0.23 |
| 5 | Russia | 845,481 | 181,546 | 3.2 | 15 | 0.09 |
| 6 | Germany | 658,607 | 174,208 | 7.2 | 9 | 0.1 |
| 7 | Spain | 481,114 | 104,506 | 2.4 | 1 | 0.24 |
| 8 | Bosnia | 452,898 | 90,734 | 1.5 | 4 | -- |
| 9 | Kenya | 289,332 | 65,375 | 0.9 | 11 | 0.68 |
| 10 | France | 279,805 | 76,932 | 2.4 | 7 | 0.14 |

**Source:** UN COMTRADE and ITC statistics, Feb 2020. Accessed from www.trademap.org

### 3.3.2 Export Value

The USA has recorded the drop of its corresponding export value of almost 12% from 2017 to 2018. Turkey seems to be joining the list of the exporters of Soda ash in recent years. This means it has developed its trading potential and as indicated in

Table 0.3; it exports to various countries. Global Soda Ash Exports in-terms of Value are as indicated in Table 0.4 and reflected in Figure 0.2.

Table 0.4: Top Five Soda Ash Exporting Countries (in USD '000)

| Exporters | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|
| World | 428,697 | 418,038 | 420,304 | 447,581 | 481,429 | 511,517 | 521,474 | 604,621 | 680,208 |
| China | 75,241 | 108,127 | 115,410 | 111,483 | 121,522 | 122,935 | 113,324 | 122,988 | 146,514 |
| Germany | 38,429 | 46,551 | 47,778 | 51,809 | 57,773 | 50,525 | 52,630 | 93,746 | 101,873 |
| Turkey | - | - | - | 479 | - | 46,303 | 45,886 | 53,750 | 75,570 |
| USA | 47,531 | 40,445 | 43,571 | 45,885 | 54,964 | 61,891 | 73,215 | 83,986 | 73,935 |
| Spain | 24,530 | 28,277 | 33,024 | 39,259 | 37,868 | 37,427 | 33,518 | 40,888 | 41,337 |

Source: UN COMTRADE and ITC Statistics, Feb 2020. Accessed from www.trademap.org

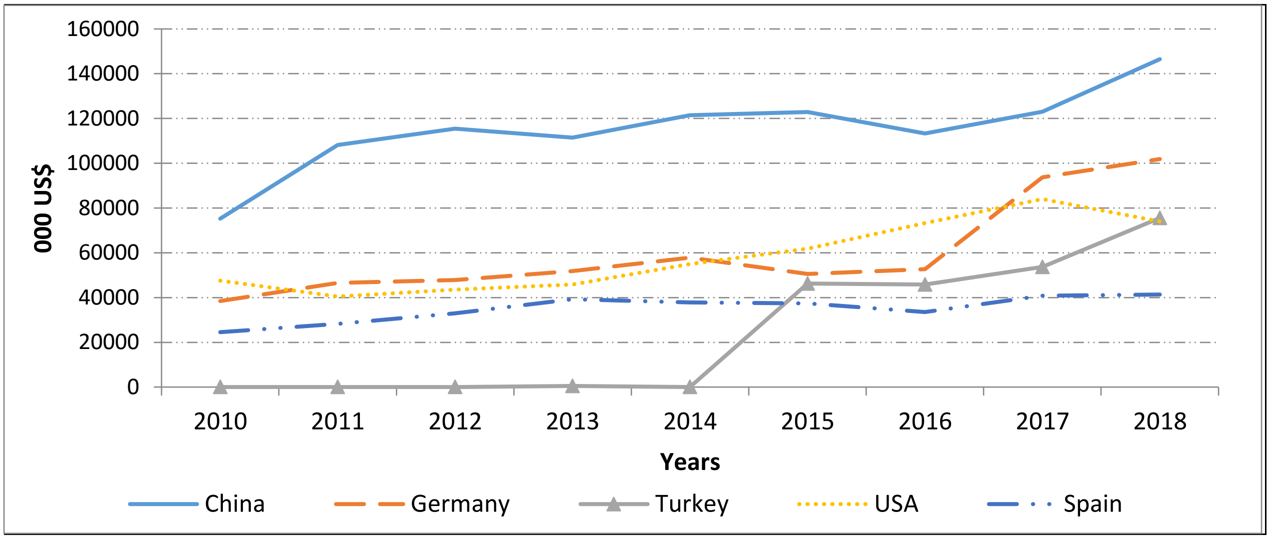



Figure 0.2: Soda Ash Export Value Trend (in USD '000)
Source: UN COMTRADE and ITC statistics, Feb 2020. Accessed from www.trademap.org

The global market share of soda ash for the top five exporting countries covers 54.9% of the global market share.

### 3.3.3 Importers by Volume

Brazil represents the largest global importer of soda ash accounting for 8.7% of the global import volumes of 1,388,019 Tons in 2018. Brazil was followed by Mexico (7.8%) with import volumes of 1,236,908 Tons, Indonesia (6.4%) with import volumes of 1,013,623 Tons, India (5.4%), Thailand (5.2%) and Republic of Korea (3.5%) as reflected in Table 0.5.

Table 0.5: Global Soda Ash Import Data of Major Countries, 2018

| Rank | Importers | Import volume (Tons) | Import value (US$ '000) | Share in world import (%) | HH Index | Average Tariffs | # of non-tariffs requirement |
|---|---|---|---|---|---|---|---|
| 1 | Brazil | 1,388,019 | 277,868 | 3.5 | 0.34 | 5.9 | 8 |
| 2 | Mexico | 1,236,908 | 338,142 | 4.2 | 0.91 | 5 | 1 |
| 3 | Indonesia | 1,013,623 | 255,385 | 3.9 | 0.3 | 1.2 | 7 |
| 4 | India | 860,967 | 205,964 | 4.7 | 0.08 | 6 | 2 |
| 5 | Thailand | 818,198 | 200,789 | 2.9 | 0.19 | 0.5 | -- |
| 6 | Korea | 552,154 | 136,911 | 8.2 | 0.31 | 2.4 | -- |
| 7 | Italy | 505,820 | 98,090 | 2.9 | 0.21 | 1.3 | 6 |
| 8 | Viet Nam | 484,662 | 106,712 | 2 | 0.25 | 3.4 | -- |
| 9 | Spain | 466,203 | 91,615 | 2.9 | 0.25 | 1.3 | 6 |
| 10 | S/Africa | 448,503 | 86,206 | 1.8 | 0.17 | 2 | -- |

Source: UN COMTRADE and ITC statistics, Feb 2020. Accessed from www.trademap.org

Observing the Herfindahl Hirschman index in Table 0.5, only India and South Africa out of the top ten importing countries appear to have moderate concentration. This is due to their investment in the production countries, Kenya and Botswana respectively. The remaining eight countries have a higher concentration (above 0.18) indicating that their supplies are dominated by a few countries. Also, Brazil, Mexico and India appeared to have large average tariffs compared to other countries, meaning that it is hard to penetrate their markets. Tariff aggregations indicators are based on simple averages of the underlying tariffs applied at the national tariff line. The number of non-tariffs requirement for Brazil, Indonesia, Italy and Spain seems to be higher than other countries implying that it is difficult to access their market compared to other countries.

### 3.3.4 Importers by Value

Korea and India are the most importers of soda ash based on the value of the imports in 2018. As indicated in Table 0.6, top 10 countries by value constitute about a third of the global value of soda ash in 2018.

Table 0.6: Soda Ash Import Value for the Top Ten Countries (in USD '000)

| **Importer** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** |
|---|---|---|---|---|---|---|---|---|---|
| **World** | **5,487,403** | **6,483,717** | **6,649,088** | **6,602,609** | **6,797,209** | **6,648,509** | **6,813,626** | **7,622,480** | **8,924,203** |
| Korea | 207,733 | 285,252 | 282,049 | 265,591 | 288,539 | 297,783 | 369,512 | 487,036 | 729,869 |
| India | 195,874 | 211,577 | 276,783 | 284,748 | 333,430 | 333,832 | 302,118 | 328,871 | 417,857 |
| Mexico | 221,262 | 254,440 | 273,269 | 271,290 | 283,668 | 294,121 | 313,949 | 326,723 | 338,555 |
| Indonesia | 226,039 | 325,461 | 301,979 | 281,212 | 299,117 | 303,225 | 261,742 | 280,876 | 297,219 |
| Brazil | 189,830 | 197,118 | 255,176 | 244,937 | 287,006 | 280,920 | 280,185 | 268,840 | 277,892 |
| Italy | 155,477 | 160,991 | 155,976 | 180,302 | 179,466 | 148,638 | 153,122 | 169,310 | 190,739 |
| Spain | 129,385 | 71,601 | 72,292 | 160,474 | 161,679 | 140,050 | 146,158 | 163,016 | 186,484 |
| Viet Nam | 78,211 | 127,670 | 109,656 | 108,463 | 125,534 | 126,924 | 119,540 | 155,289 | 106,368 |
| **S/Africa** | **181,817** | **138,460** | **115,436** | **115,944** | **104,447** | **121,092** | **115,075** | **160,434** | **163,440** |
| Thailand | 126,975 | 287,738 | 193,478 | 168,431 | 179,729 | 195,509 | 182,997 | 216,303 | 261,851 |

Source: UN COMTRADE and ITC statistics, Feb 2020. Accessed from www.trademap.org

### 3.3.5 Export Potential Indicator

Potential (or standard) export value of product *k* supplied by country *i* to market *j*, in dollars, is calculated as supply × demand (corrected for market access) × bilateral ease of trade. The export potential value is projected by an economic model based on the characteristics of the exporter, target market, and the strength of the relationship between them. The estimated dollar value serves as a benchmark for comparison with actual export performance and should not be interpreted as a ceiling value. In reality, the actual trade value may be below or above the potential value.

### 3.3.6 Actual Exports

The value of actual exports is calculated as an arithmetic average of direct and mirror data of reliable reporters over the past five years. The actual exports to a region, including to the world as a whole, only include exports to markets where the country has export potential. Actual exports can, therefore, be equivalent to or lower than export values recorded in other trade databases, such as Trade Map.

### 3.3.7 Untapped Potential

This is the extent to which potential exports deviate from actual exports. Actual exports may be higher or lower than the expected potential value. When actual exports exceed potential exports, this can be driven by an exporter's exceptional export performance in some markets while neglecting others. Conversely, the untapped potential value signals room for export growth if frictions, for example in the form of regulations or buyer-seller mismatches, can be overcome.

Table 0.7: Export Potential for Soda Ash – End User Industries in Mil US$

| HS-Code | Description of HS-Code | World's Import | Tanzania Export potential | Actual Exports | Untapped Potential |
|---|---|---|---|---|---|
| 281511 | Sodium hydroxide 'caustic soda' solid (DS) | 821.9 | 0.9 | 0.71 | 0.46 |
| 283630 | Sodium hydrogen carbonate 'Sodium bicarbonate' (DS) | 640 | 0.23 | 0.21 | 0.2 |
| 310390 | Mineral or chemical phosphoric fertilizers (MP) | | 8.8 | 2.1 | 7.7 |
| 701090 | Carboys and other glass Containers (GL) | 9600 | 126.2 | 70 | 67.2 |
| 482110 | Paper (board) labels printed (PI) | 3900 | 6.1 | 4.8 | 4.4 |
| 340119 | Soap and organic Surface active products (PD) | 7600 | 48 | 30.5 | 27.4 |

**Source:** ITC Export potential map, Dec 2019. Accessed from www.trademap.org

### 3.3.8 Global Demand for End User Industries of Soda Ash with Potential from Tanzania

Based on the International Trade Centre potential map, the description of the various items which uses soda ash and their potential for export is as indicated in the section that follows.

(i) In petroleum refining (PR)
(ii) In production of detergents (PD)
(iii) In paper industries (PI)
(iv) A raw material for making glass (GL)
(v) In water treatment (WT)
(vi) In de-sulphurising steel (DS)

(vii) In textile industries (TI)

(viii)In mineral processing (MP)

#### 3.3.8.1 Carboys and Other Glass Containers

From the analysis of export potential, the markets with the greatest potential for Tanzania's exports of 701090 Carboys and other glass containers are the Democratic Republic of Congo, Uganda and the United States of America. Tanzania has closest export links with Burundi. Nevertheless, the United States of America is the market with the highest demand potential for 701090 Carboys and other glass containers.

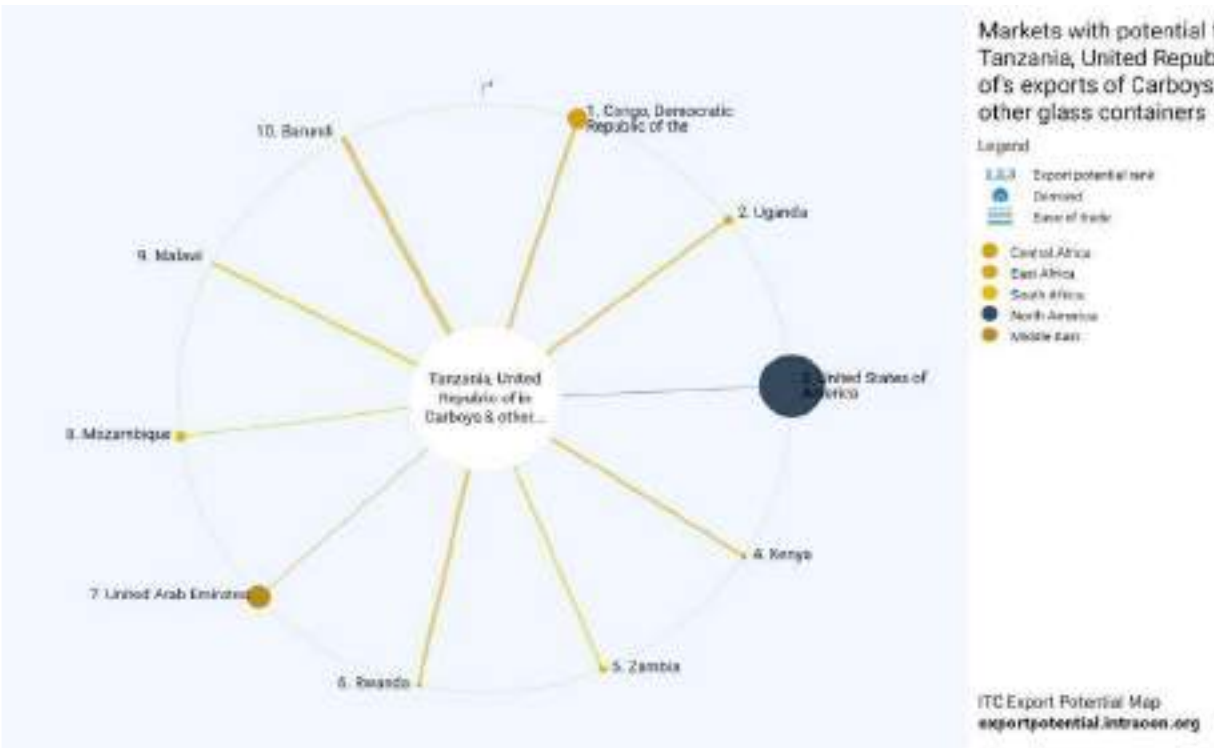



Figure 0.3: Tanzania Carboys and Glass Containers Export Potential

**Source:** ITC Export potential map, Dec 2019. Accessed from [www.trademap.org](http://www.trademap.org)

The gap chart shows that Uganda has the largest absolute difference between potential and actual exports in value terms, leaving room to realize additional exports worth $10.1 million.


Figure 0.4: Tanzania Carboys and Glass Containers Export Potential in US$

**Source:** ITC Export potential map, Dec 2019. Accessed from www.trademap.org

### 3.3.8.2 Soap and Organic Surface Active Products

The markets with the greatest potential for Tanzania's exports of soap and organic surface-active products are Malawi, Congo and Rwanda. Tanzania has closest export links with Comoros. The export potential analysis shows that the United States of America is the market with the highest demand potential for soap and organic surface-active products.

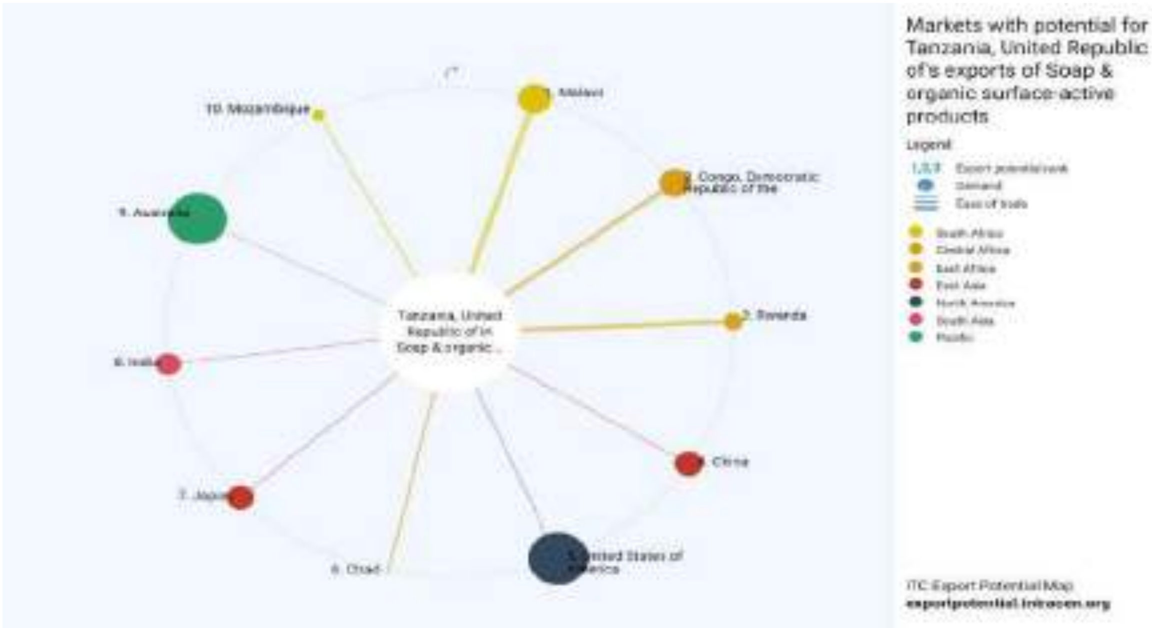



Figure 0.5: Tanzania Soap and Organic Surface Active Products Export Potential

**Source:** ITC Export potential map, Dec 2019. Accessed from www.trademap.org

Observing the gap chart, Rwanda shows the largest absolute difference between potential and actual exports in value terms, leaving room to realize additional exports worth $3.5 million.

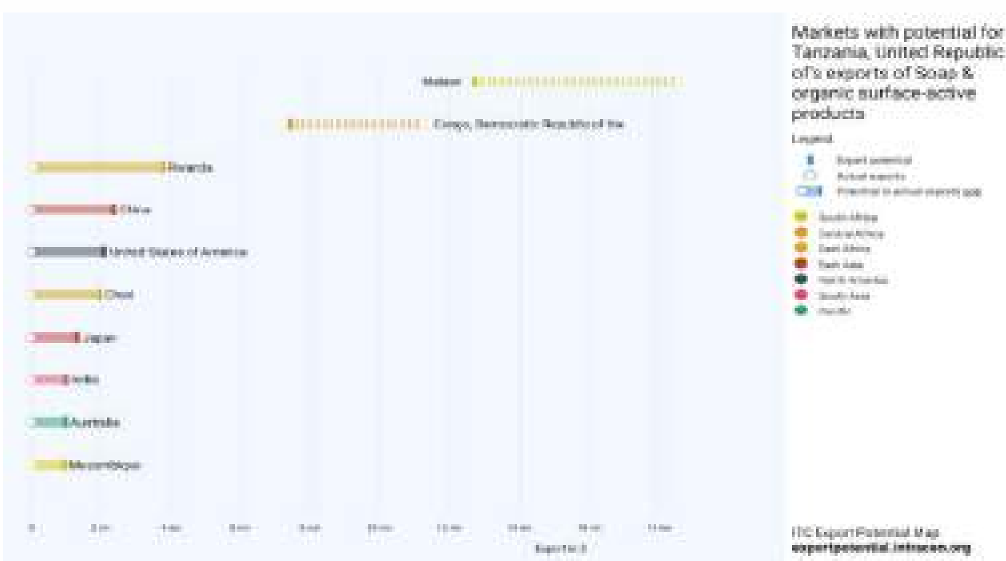



Figure 0.6: Tanzania Soap and Organic Surface Active Products Potential in US$

**Source:** ITC Export potential map, Dec 2019. Accessed from www.trademap.org

Table 0.8: Potential Market for Soda Ash (End-Use Industry Products)

| End-use industry products | Potential market | Country's import (US$) in Mil | Total trade with Tanzania (US$ in Mil) | Applied tariffs (%) |
|---|---|---|---|---|
| **701090 Carboys and other glass Containers (GL)** | | | | |
| 701090<br><br>Carboys and other glass Containers (GL) | Congo | 52.5 | 184.5 | 12 |
| | Uganda | 10.2 | 103.8 | 0 |
| | US | 1.5 Bil | 93.7 | 0 |
| | Kenya | 22.9 | 208.4 | 0 |
| | Zimbabwe | 22.4 | 101.6 | 0 |
| **340119 Soap and organic Surface active products (PD)** | | | | |
| 340119<br><br>Soap and organic Surface active products (PD) | Malawi | 26.0 | 51.8 | 0 |
| | Congo | 20.0 | 184.5 | 0 |
| | Rwanda | 11.7 | 64.6 | 0 |
| | China | 35.5 | 299.7 | 0 |
| | US | 168.0 | 93.7 | 0 |
| | Chad | 19.8 | 1.1 | 30 |
| | Japan | 65.3 | 131.3 | 0 |
| | India | 17.0 | 918.0 | 5 |
| | Australia | 58.3 | 7.4 | 0 |
| | Mozambique | 2.6 | 12.4 | 0 |

**Source:** ITC Export potential map, Dec 2019. Accessed from www.trademap.org

**Soda Ash Future Demand**

About half of global soda ash (sodium carbonate) production is used in the glass industry. Recent surveys indicate that there is increase demand of soda ash globally. A number of global soda ash producers have announced plans to increase capacity in order to meet rising demand. Ciner Group from Turkey is planning to increase its usage capacity of trona (trisodium hydrogendicarbonate dihydrate) by 4 million tons per year. This would include expanding its Ciner Resources operation from 2.94 million tons per year to 3.94 million tons per year by 2022 and adding a new Greenfield 3 million tons per year by 2024.

India also has presence in the manufacturing of soda ash. GHCL is the largest manufacturer in India with capacity of 1.1 million tons per year and plans to increase it to 1.2 million tons/yr, all resources are based in India. Tata Chemicals is also a major player in the soda ash industry with operations in Kenya whereby 95% of the soda ash produced is transported to India for further processing of industrial use.

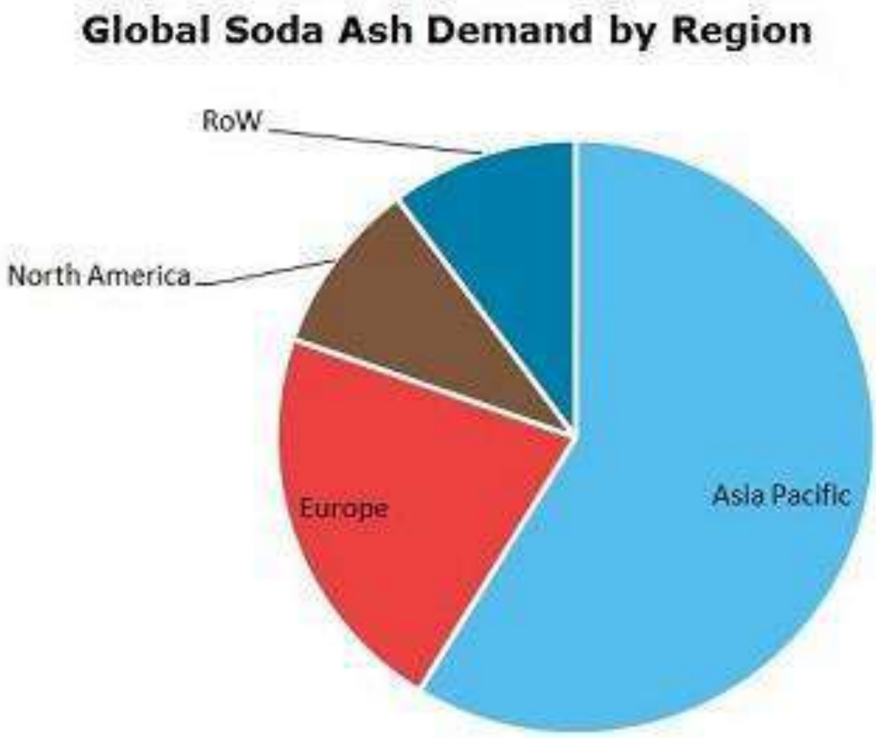



Figure 0.7: Global Demanders of the Soda Ash in The World. RoW- Rest of the World.

Source: www.tridge.com

Table 0.9: World Demand for Soda Ash

| Breakup by Region | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | CAGR 2019-2024 |
|---|---|---|---|---|---|---|---|
| China | 24,963 | 25,237 | 25,488 | 25,716 | 25,921 | 26,102 | 0.90% |
| Asia Pacific (Excluding China) | 13,240 | 13,610 | 13,976 | 14,338 | 14,695 | 15,046 | 2.59% |
| Europe | 7,815 | 7,914 | 8,007 | 8,093 | 8,171 | 8,243 | 1.07% |
| North America | 7,250 | 7,318 | 7,380 | 7,434 | 7,482 | 7,523 | 0.74% |
| Middle East and Africa | 4,248 | 4,407 | 4,567 | 4,727 | 4,889 | 5,052 | 3.52% |
| Latin America | 2,910 | 3,029 | 3,143 | 3,252 | 3,356 | 3,453 | 3.48% |

Source: International Market Analysis Research and Consulting Group, 2020

Note. Figures in '000 Tons

By 2024, we expect China to represent the largest soda ash consuming region, accounting for 39.9% of the global soda ash market. China will be followed by Asia Pacific (Excluding China)

(23.0%), Europe (12.6%), North America (11.5%), Middle East and Africa (7.7%) and Latin America (5.3%)

China has significantly expanded its soda ash capacity, driven by its fast-growing construction and manufacturing industries to support urbanization. Also, the growing glass industry due to the use of glass in new housing and industrial expansion has boosted the China soda ash market growth in the past few years.

## 3.4 Regional Analysis

### 3.4.1 South Africa Development Cooperation

Botswana is the largest producer of Soda Ash in the SADC region with capacity of 300,000 tons/yr, currently producing 280,000 tons/yr. Major market is South Africa four industries and about 35,000 tons per year is sold in other SADC countries (mostly to Zimbabwe – ZIMGlass[4]). Excluding SA which consumes about 250,000 tons/yr, the rest of SADC countries imports about 150,000 tons per year which makes the total demand for the SADC region to be estimated at 400,000 tons/yr. However, SADC region is not such an industrialized and most of the products produced from the Soda ash such as importation of glass, chemical products and detergents. These are driven by among others industrialization, level of technology and population growth.

Soda Ash Exporters to the SADC region as shown in Figure 0.8.

[4] Note. ZIM Glass is currently under liquidation

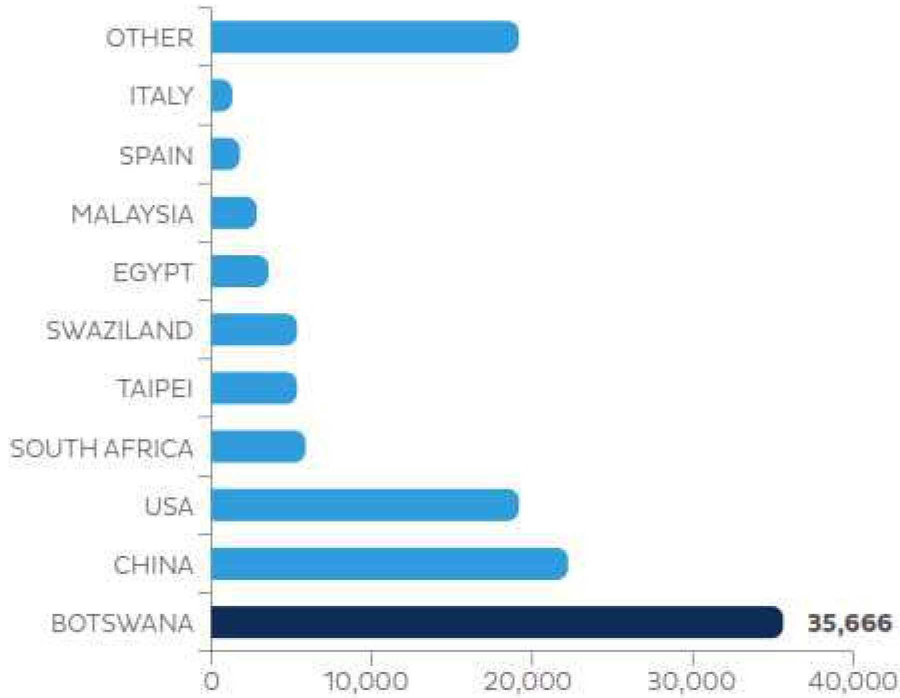



Figure 0.8: Soda Ash Exportes to the SADC Market

Source: Botswana Investment and Trade Centre – Soda Ash Value Proposition Fact Sheet, 2017.

Based on the International Trade Centre (ITC) Statistics, SADC importation of soda ash in 2018 was 524,371 tons. This is accounting for substantial amount which is imported by South Africa from Botswana for making glass and for re-export. Details of the imported Soda Ash by the SADC region and countries are as indicated in Table 0.10.

Table 0.10: Importation of Soda Ash in SADC Region in Tons

| Importers | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|
| World | 14,504,539 | 14,660,609 | 11,205,147 | No Quantity |
| Southern African Development Community (SADC) Aggregation | 454,919 | 447950 | 505,143 | 524,371 |
| South Africa | 425,968 | 407,179 | 451,119 | 448,503 |
| Tanzania, United Republic of | 7,855 | 14,590 | 22,354 | 34,899 |
| Congo, Democratic Republic of the | 6,118 | 5,774 | 3,590 | 12,002 |
| Namibia | 1,410 | 6,356 | 9,325 | 11,622 |
| Angola | 3,313 | 5,854 | 6,851 | 8,175 |
| Zambia | 5,235 | 4,824 | 7,332 | 5,980 |
| Mauritius | 1,820 | 1,168 | 1,864 | 2,050 |

| | | | | |
|---|---|---|---|---|
| Madagascar | 627 | No Quantity | No Quantity | 563 |
| Eswatini | 5 | 18 | 232 | 266 |
| Malawi | 77 | 87 | 16 | 173 |
| Mozambique | 70 | 161 | 223 | 116 |
| Seychelles | 64 | 83 | 77 | 22 |
| Botswana | 6 | 13 | 65 | No Quantity |
| Zimbabwe | 2,351 | 1,842 | 2,095 | No Quantity |
| Lesotho | 0 | 1 | 0 | |

Source: UN COMTRADE and ITC Statistics, Feb 2020. Accessed from www.trademap.org

Trade indicators for the year 2014-2018 indicates that the region unit price for soda Ash was US$ 214 per ton, the lowest being in South Africa which was US$192 per ton. This is because South Africa imports from Botswana, and the price is based on the netback price of Soda Ash. The region comprised 2.8% of the world share market for soda Ash. There is still potential for importation of the soda Ash in the region, and especially in South Africa. The next potential country for importation of soda ash is Tanzania with estimated untapped potential of US$ 3 million a year. This translates to about 10,000 tons extra to the current importation of about 35,000 tons. Based on the ITC data it can be observed that the estimated demand for soda ash in Tanzania is only 45,000 tons per year. On other hand, untapped potential for South Africa is about US$ 40 Mil. Assuming price of US$200, the potential untapped is about 200,000 tons per year. Further details are as indicated in Table 0.11.

Table 0.11: Key Indicators in Importation of Soda Ash by SADC Members and Untapped Potential

| Region/Country | Value imported in 2018 (USD thousand) | Quantity imported in 2018 | Quantity Unit | Unit value (USD/unit) | Annual growth in value between 2014-2018 (%) | Annual growth in quantity between 2014-2018 (%) | Annual growth in value between 2017-2018 (%) | Share in world imports (%) | Estimation of untapped potential trade, USD thousand |
|---|---|---|---|---|---|---|---|---|---|
| Southern African Development Community (SADC) Aggregation | 112,821 | 526,838 | Tons | 214 | | | | 2.8 | |
| South Africa | 86,206 | 448,503 | Tons | 192 | 11 | 5 | 11 | 2.1 | 39,623 |
| Tanzania, United Republic of | 11,431 | 34,899 | Tons | 328 | 54 | 56 | 78 | 0.3 | 3,128 |
| Congo, Democratic Republic of the | 3,932 | 12,002 | Tons | 328 | 15 | 8 | 247 | 0.1 | 1,951 |
| Angola | 3,645 | 8,175 | Tons | 446 | 29 | 76 | 26 | 0.1 | 1,383 |
| Namibia | 2,728 | 11,622 | Tons | 235 | 144 | 182 | -11 | 0.1 | 1,628 |
| Zambia | 2,403 | 5,980 | Tons | 402 | -4 | -1 | -22 | 0.1 | 1,786 |
| Zimbabwe | 1,284 | 2,463 | Tons | 521 | 15 | 5 | 46 | 0 | 576 |
| Mauritius | 653 | 2,050 | Tons | 319 | 14 | 8 | 14 | 0 | 459 |
| Madagascar | 211 | 563 | Tons | 375 | 5 | 8 | 19 | 0 | 152 |
| Malawi | 108 | 173 | Tons | 624 | 35 | 48 | 476 | 0 | 32 |
| Eswatini | 102 | 266 | Tons | 383 | 132 | 120 | 3 | 0 | |
| Mozambique | 97 | 116 | Tons | 836 | 17 | 7 | -68 | 0 | 548 |
| Seychelles | 16 | 22 | Tons | 727 | 88 | 89 | -76 | 0 | 23 |
| Botswana | 5 | 4 | Tons | 1250 | 6 | 17 | -84 | 0 | 17 |

Source: UN COMTRADE and ITC Statistics, Feb 2020. Accessed from www.trademap.org

Analysis of Exports of Soda Ash indicated Botswana is the largest exporter of Soda Ash which is exported mostly to South Africa. Botswana commands 1.3% of the world exports of soda ash. In 2018 Botswana exported 250,023 tons of which price per ton was US$182 per ton. Analysis of the exports of Soda Ash from SADC members is as indicated in Table 0.12.

Table 0.12: Analysis of Exports of Soda Ash from SADC Members

| | **Value exported in 2018 (USD thousand)** | **Trade balance in 2018 (USD thousand)** | **Quantity exported in 2018** | **Quantity Unit** | **Unit value (USD/unit)** | **Annual growth in value between 2014-2018 (%)** | **Annual growth in quantity between 2014-2018 (%)** | **Annual growth in value between 2017-2018 (%)** | **Share in world exports (%)** |
|---|---|---|---|---|---|---|---|---|---|
| World | 3,529,388 | -534,811 | 16,881,906 | Tons | 209 | 7 | 7 | 11 | 100 |
| Southern African Development Community (SADC) Aggregation | 49,230 | -63591 | | | | | | | 1.4 |
| Botswana | 45,580 | 45,575 | 251,023 | Tons | 182 | 6 | -2 | 8 | 1.3 |
| South Africa | 3,556 | -82,650 | 9,303 | Tons | 382 | 33 | 41 | 103 | 0.1 |
| Mauritius | 91 | -562 | 105 | Tons | 867 | 9 | -8 | 175 | 0 |
| Angola | 2 | -3,643 | 2 | Tons | 1000 | | | | 0 |
| Zambia | 1 | -2,402 | 34 | Tons | 29 | | | | 0 |

Source: UN COMTRADE and ITC Statistics, Feb 2020. Accessed from www.trademap.org

### 3.4.2 East Africa Community

EAC Imports trends indicate that the importation of Soda Ash is below 60,000 tons per year based on the 2018 data. The largest importer of Soda Ash is Tanzania with about 35,000 tons per year, following by Uganda which imports about 15,000 tons per year. The details of the importation are as indicated in Table 0.13.

Table 0.13: Import Trends of Soda Ash in EAC Countries in Tons

| Importers | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|
| World | 14,504,539 | 14,660,609 | 11,205,147 | No Quantity |
| **East African Community (EAC) Aggregation** | **25,674** | **38,299** | **43,585** | **58,989** |
| Tanzania, United Republic of | 7,855 | 14,590 | 22,354 | 34,899 |
| Uganda | 8,921 | 15,192 | 14,568 | 15,371 |
| Kenya | 8,826 | 8,436 | 6,426 | 8,614 |
| Rwanda | 44 | 48 | 199 | 104 |
| Burundi | 28 | 33 | 38 | 1 |

Source: UN COMTRADE and ITC Statistics, Feb 2020. Accessed from www.trademap.org

Based on the 2014-2018 trade indicators, average price per ton for imported soda ash was US$302. Lowest price soda ash was imported to Uganda. Details of importation of soda ash in the EAC region are as indicated in Table 0.14. While Kenya is a next exporter of Soda Ash, it imports light soda ash, which is higher quality than the dense soda ash produced locally.

Table 0.14: EAC Trade Indicators for Soda Ash 2014-2018

| | Value imported in 2018 (USD thousand) | Quantity imported in 2018 | Quantity Unit | Unit value (USD/unit) | Annual growth in value between 2014-2018 (%) | Annual growth in quantity between 2014-2018 (%) | Annual growth in value between 2017-2018 (%) | Share in world imports (%) | Estimation of untapped potential trade, USD thousand |
|---|---|---|---|---|---|---|---|---|---|
| World | 4,064,199 | 0 | No quantity | | 4 | 4 | 14 | 100 | |
| East African Commu | 17,790 | 58,989 | Tons | 302 | | | | 0.4 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| nity (EAC) Aggregation | | | | | | | | | |
| Tanzania, United Republic of | 11,431 | 34,899 | Tons | 328 | 54 | 56 | 78 | 0.3 | 3,128 |
| Uganda | 3,590 | 15,371 | Tons | 234 | 9 | 15 | 13 | 0.1 | 2,339 |
| Kenya | 2,695 | 8,614 | Tons | 313 | 1 | 4 | 55 | 0.1 | 1,626 |
| Rwanda | 73 | 104 | Tons | 702 | 56 | 62 | -34 | 0 | 32 |
| Burundi | 1 | 1 | Tons | 1000 | -38 | -35 | | 0 | 18 |

Source: UN COMTRADE and ITC Statistics, Feb 2020. Accessed from www.trademap.org

Exports of soda ash in EAC reached 342,780 tons in 2017 before they dropped to 289,347 tons in 2018. Kenya is the main exporter of Soda Ash in the region. Kenya export soda ash dense and main destination is in India following investment of Soda Ash plant by an Indian investor, TATA Chemicals. Details of the Soda Ash exports for the EAC region is as indicated in Table 0.15.

Table 0.15: Analysis of EAC Exports of Soda Ash 2015-2018

| Exporters | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|
| World | 13,823,496 | 13,976,715 | 12,746,353 | 16,240,987 |
| East African Community (EAC) Aggregation | 11,248 | 96,455 | 342,780 | 289,347 |
| Kenya | 11,231 | 96,392 | 342,704 | 289,332 |
| Uganda | 12 | 63 | 50 | 15 |
| Rwanda | 0 | 0 | 1 | 0 |
| Tanzania, United Republic of | 5 | 0 | 25 | 0 |

Source: UN COMTRADE and ITC Statistics, Feb 2020. Accessed from www.trademap.org

According to the EAC Common external tariffs, Disodium Carbonate or Soda Ash under code 2836.20.00 is a zero rated in its importation within the EAC block. This means, importation of this produce to each market is free and thus, local production is not enough to meet the current demands for soda ash. This applies to other derived products of soda ash such as Sodium Bicarbonate (2836.30.00) and other chemicals such as sodium hydroxide/ caustic soda (2815.11.00)[5].

[5] EAC Common External Tariff 2017 version available from https://www.eac.int/documents/category/eac-common-external-tariff

### 3.5 Pricing, Price Structure and Margins

#### 3.5.1 Prices

Prices of Soda ash are increasing in the World. This follows increased demand which does not match with the supply. The demand gap of soda ash is estimated to be 29.55 tons per year in Asia alone. The total supply is currently at 21.62 tons per year. The main drivers are production of flat glass industry which is consider demanding 88% of the consumption and mainly linked with the construction market.

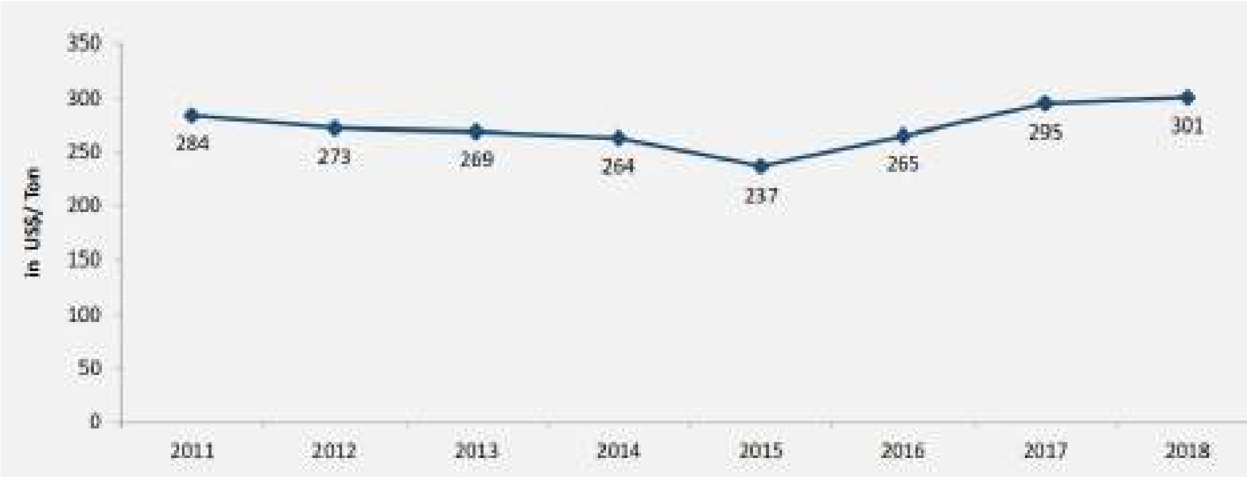



Figure 0.9: Soda Ash Price Trends in Asian Region

The price of soda ash increased at a CAGR of 0.84% during 2011-2018, reaching a value of around US$ 301 per ton in 2018.

The variations in soda ash prices are due to the fluctuating raw material prices and environmental restrictions especially in China.

#### 3.5.2 Price Structure

Price structure is important to determine the competitive nature of the industry in general. This is also important to understand the market for the product in the near future and how to optimize the production processes.

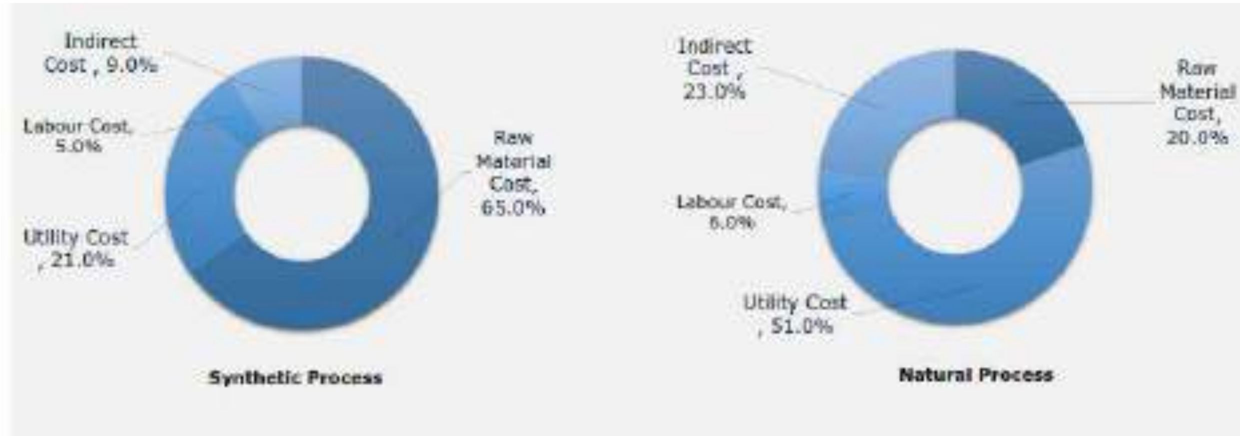



Figure 0.10: Price Structure of Synthetic Soda Ash Process Vs Natural Soda Ash Process

Natural process has significantly lesser cost of production, as most of the costs are involved in mining activities, while synthetic process involves more of raw material costs. Raw material cost, natural gas and fuel oil are the most significant cost parameters in the synthetic process, as it is very energy intensive.

### 3.5.3 Margin Analysis

Soda Ash Manufacturers: The soda ash manufacturers generally add 7% to 9% to the production costs while selling the product either to the distributors/exporters or directly to the end use industries. Setting a price for soda ash is influenced by the amount of competition, the type of market, and the demand for the product. It is particularly important to know whether an enterprise is critically dependent on one buyer and whether it is able to influence the price for the sodium chlorate. As the price of inputs increase, it is important that manufacturers fix the price of their end products in such a way that it reflects that increase and the customer bears some of the burden of the increased costs.

Exporters generally earn a profit margin of 10% to 12% by exporting the final product to the end users and distributors based in foreign countries.

Distributors: Distributors generally adds a profit margin of 9% to 11% and sell it to the end use industries which use soda ash as feedstock for manufacturing their respective products.

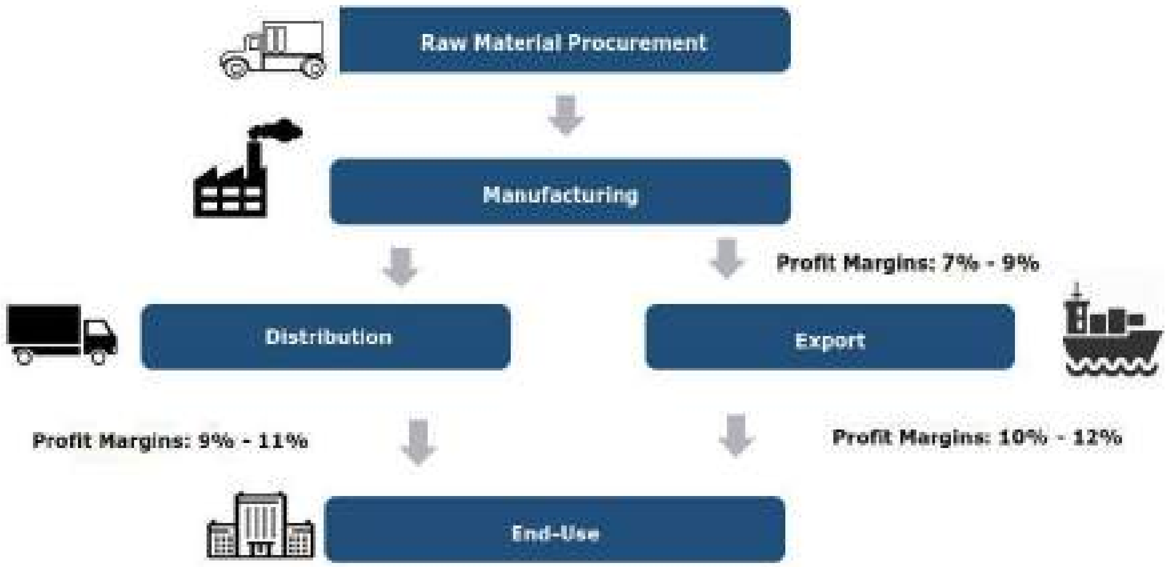



Figure 0.11: Soda Ash Margin from Manufacturing to End User

## CHAPTRE FOUR

## MARKET POTENTIAL FOR SODA ASH IN TANZANIA

### 4.1 Overview

The potential markets for soda ash include industries manufacturing detergents, papers, and glasses, steel; as well as petroleum and water treatments.

### 4.2 Analysis of Imports

Data on imports of the soda ash in Tanzania can be obtained from three different sources namely Government Chemist, Tanzania Revenues Authority and International Trade Centre – Trade Map. These sources differ significantly as indicated in the following sections.

#### 4.2.1 Data from Government Chemist

Soda ash is treated as a chemical product and hence its importers must register the product with Government Chemist Office each time they import soda ash. Based on the Government Chemist Office, for the year 2019, importation certificated issued indicated that imports of soda ash was 15.2 million kilograms. About 60% of the imported soda ash was used by Kioo limited, a glass manufacturing firm. Soap and Detergent Industry is the second user of the imported soda ash after the glass industries. As indicated in Table 0.1; India, Turkey, China, Kenya, Bulgaria, UAE, Romania, Bosnia and Herzegovina are the main exporters of soda ash to Tanzania.

Table 0.1: Importers, Amount Imported of Sodium Carbonate during Calendar Year 2019

| Sn | Name of importer | Industry | Amounts Imported in 2019 (kgs) | Main Source(s) |
|---|---|---|---|---|
| 1 | Indeepth Scientific Company Limited | Other | 7,000 | India |
| 2 | Gravita (T) limited | Other | 21,500 | India |
| 3 | G and B Soap Industries Limited | Detergents | 372,700 | Turkey, China |
| 4 | Prayosha Industries Limited | Other | 857,500 | Kenya, Bulgaria |
| 5 | Keds Tanzania Company Limited | Other | 810,600 | China, Turkey |
| 6 | Mikoani Edible Oil and Detergent Limited | Detergents | 102,500 | Romania |
| 7 | Kioo Limited | Glass | 9,285,470 | Bulgaria, Kenya, Turkey, UAE |
| 8 | Murzah Wilmar East Africa Limited | Detergents | 2,250,000 | Romania, Bosnia and Herzegovina |

| Sn | Name of importer | Industry | Amounts Imported in 2019 (kgs) | Main Source(s) |
|---|---|---|---|---|
| 9 | Royal Soap and Detergent Industries Limited | Detergents | 1,033,000 | Romania |
| 10 | Tata Africa Holdings (T) Limited | Other | 41,000 | Romania |
| 11 | New Rainbow Africa Limited | Other | 40,000 | India |
| 12 | Bomet Corporation Limited | Other | 26,500 | China |
| 13 | Pu Sen Building Materials Company Limited | Other | 82,000 | Turkey |
| 14 | Global Leader Enterprise (T) Limited | Other | 53,800 | China |
| 15 | A to Z Textile Mills Limited | Textile | 38,000 | Turkey |
| 16 | Mtamwega Teaching Quality Materials Company | Other | 2 | Kenya |
| 17 | Chemi and Cortex Industries Limited | Other | 125,000 | China |
| | **Total importations** | | **15,146,572** | |

Source: Government Chemist (2020). Sodium Carbonate: Quantities Imported from January 1st to December 31st 2019

### 4.2.2 Tanzania Revenues Authority

Tanzania Revenues Authority maintains database of all products imported in the country. Sodium Carbonate or Disodium Carbonate is maintained under HS Code 28362000000. Trend for the years 2012 to 2019 is as indicated in Table 0.2. It can be indicated that there has been on average CAGR 34% from the year 2012 to 2019. The prices has been ranging from US$263.25 to US$ 327.20 per ton. Graphical presentation of the importation is as indicated in Figure 0.1.

Table 0.2: Importation of Disodium Carbonate in Tanzania based on TRA Statistics

| Year | Imported Tons | Customs Value (mil TZS) | Price in US$ | CAGR |
|---|---|---|---|---|
| 2012 | 10,571.55 | 5,361.72 | 322.70 | |
| 2013 | 4,648.54 | 2,170.31 | 292.04 | -56% |
| 2014 | 6,285.90 | 3,624.93 | 348.97 | 35% |
| 2015 | 7,854.57 | 4,609.99 | 295.62 | 25% |
| 2016 | 14,568.77 | 8,349.58 | 263.25 | 85% |
| 2017 | 22,354.36 | 14,367.85 | 288.36 | 53% |

| | | | | |
|---|---|---|---|---|
| 2018 | 35,037.10 | 25,584.62 | 323.71 | 57% |
| 2019 | 48,843.56 | 36,569.49 | 327.20 | 39% |
| Average | | | | 34% |

Source: Consultant Analysis from TRA Statistics

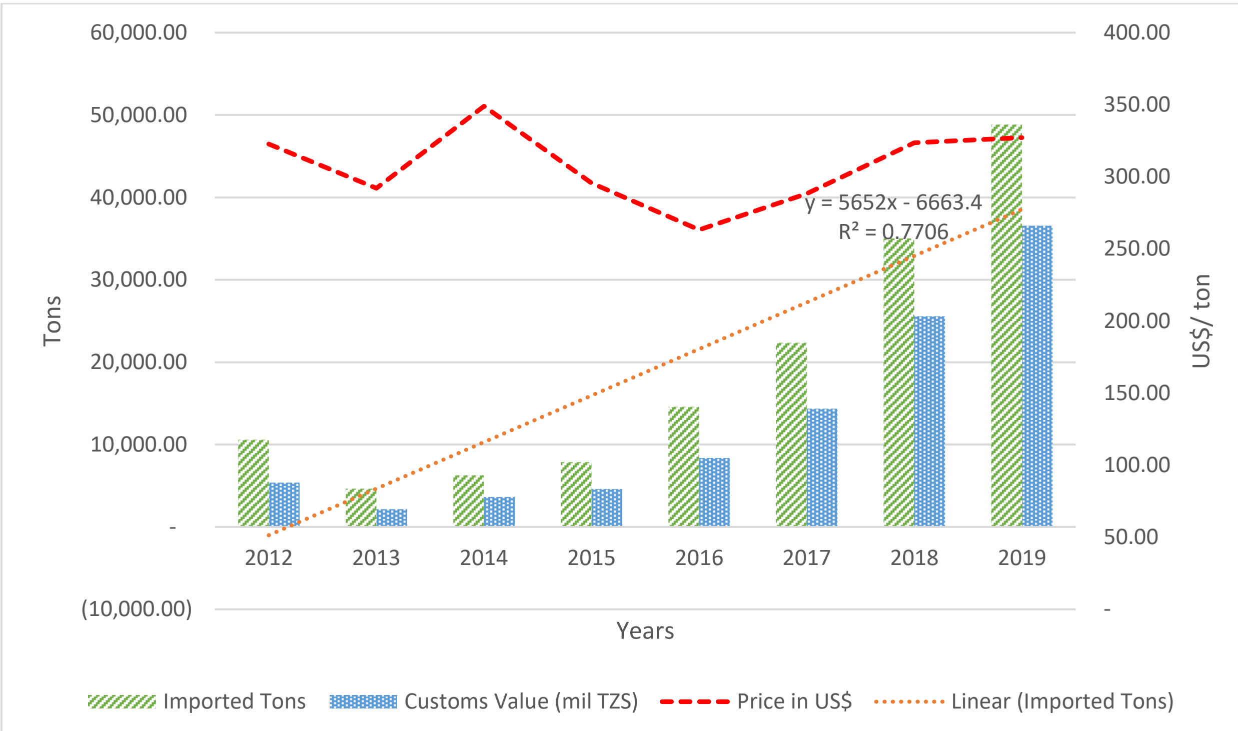



Figure 0.1: Trend of Importation of Disodium Carbonate in Tanzania based on TRA Statistics

### 4.2.3 Trade Map Statistics

Trade map statistics maintained by the International Trade Centre, it was reported that in 2018, a total of 38,899 tons were imported valued at 11.4 mil US$. On average, price per ton was US$328, lowest price being US$ 296 per ton. The growth of the volume of soda ash imported under the product HS Code 283620 Disodium carbonate was 56% for the year 2014-2018. Considering year 2017 and 2018 the import value increased by 78%. Main countries exporting the product to Tanzania are as indicated in Table 0.3.

Table 0.3: Soda Ash Importation in Tanzania

| S/No | Country | Value imported in 2018 (USD thousand) | Quantity imported in 2018 in Tons | Quantity unit | Unit value (USD/unit) | Growth in imported value between 2014-2018 (%, p.a.) | Growth in imported quantity between 2014-2018 (%, p.a.) | Growth in imported value between 2017-2018 (%, p.a.) |
|---|---|---|---|---|---|---|---|---|
| **1** | **World** | **11,431** | **34,899** | **Tons** | **328** | **54** | **56** | **78** |
| 2 | Bulgaria | 2,300 | 7,765 | Tons | 296 | | 142 | -5 |
| 3 | Russian Federation | 1,957 | 5,367 | Tons | 365 | 68 | 67 | 171 |
| 4 | Kenya | 1,781 | 7,421 | Tons | 240 | 109 | 191 | 68 |
| 5 | Turkey | 1,599 | 4,320 | Tons | 370 | 160 | 91 | 75 |
| 6 | China | 1,522 | 3,620 | Tons | 420 | -2 | -7 | 195 |
| 7 | Lebanon | 542 | 1,505 | Tons | 360 | | | |
| 8 | Romania | 495 | 1,488 | Tons | 333 | 42 | 106 | |
| 9 | Hong Kong, China | 481 | 1,238 | Tons | 389 | | | 401 |
| 10 | Belgium | 453 | 1,273 | Tons | 356 | | | 153 |
| 11 | United Arab Emirates | 199 | 566 | Tons | 352 | 15 | 64 | |

Sources: ITC calculations based on National Bureau of Statistics – NBS statistics.

### 4.3 Analysis of Market Potential for Soda Ash

#### 4.3.1 Glass Industry

Soda ash is used to make the most common type of glass, soda-lime silica glass, generally used in the flat glass (automotive and construction), glass container (food and drink/beverages) and many other glass industries such as glass used in lighting, technical glass for video screens, computer, solar panels and many other specialty glasses.

Soda-lime silica glass combines three essential ingredients. Silica (sand) is the glass forming oxide, lime provides chemical stability and soda ash acts as the fluxing agent. Soda ash plays a vital role by reducing the furnace temperature necessary to melt the silica used, thus reducing the energy required to produce glass. As a cost-effective source of $Na_2O$, it also usually supplies the bulk of the alkali element needed in glass making. According to the International Glass, the glassmaking industry used 53% of the 60 million tons of soda ash produced in the 2019. The flat glass sector consumed 29%, the container industry 19% and other glass segments 5%[6].

Efforts to industrialized the glass industry in Tanzania started in long time ago. Kioo Limited was the first factory to set up and start operations for container glass. In 1980s, the government through NDC established the Tanzania Sheet Glass Limited (Reg No. 7656) with the aim of producing sheet glass. The capacity was estimated to be 15,000 tons per year with one third consumed in the local market[7]. The factory could not take off due to various operational reasons. Another initiative was the establishment of Nyanza Glass Works Limited which was established in 1980 with registration number 8075 and owned by the government. Based on the 2007/2008 audit report Nyanza Glass works was owned by the government by 100% and was having a capital worth 7.7 billion TZS. The company is under the NDC. Nyanza Glass Works Limited was established to produce educational related glass ware in Tanzania and it was aiming to supply to schools, colleges and Universities with science experimental works. The company identified silica from Kimondo bay in Kagera and production site in Mwanza. The glass industry didn't work due to various reasons.

Kioo Limited, is the largest manufacturer of glass Packaging for the Soft Drink, Beer, Liquor, Food Industries in East and Central Africa.

In 2016 Chinese-Tanzanian Company Announced USD 80 Million Investments to setup largest Float Glass Factory in Tanzania. The planned factory in Mkuranga, Coastal region was planned to produce an average of 600 tons of float glass per day, with annual capacity of 135,000 tons to 160,000 tons per year[8]. Float glass is a sheet of glass made by floating molten glass on a bed of molten metal, used in modern windows.

According to the same source, Tanzania ranks 8th within the Top 10 importers with USD 10.7 million accounting for 4.3% of the total float glass imported to Africa in 2013 and 2nd behind Kenya. Tanzania has favourable condition for glass manufacturing because of its rich in silica sand, limestone, dolomite and soda ash which are all essential materials in glass making. Other includes availability of energy as most of the glass plats utilized natural gas as energy source. According to the market information[9], four global glass companies namely, NSG Group, AGC, Saint-Gobain and Guardian - produce ~60% of the world's high quality float glass.

[6] https://www.glass-international.com/news/glass-consumes-more-than-half-of-soda-ash-production

[7] https://open.unido.org/api/documents/4990157/download/REVISED%20INTEGRATED%20INDUSTRIAL%20PROMOTION%20PROGRAMME%20FOR%20THE%20EASTERN%20AND%20SOUTHERN%20AFRICAN%20SUBREGION.%20PROPOSALS%20FOR%20THE%20SUBREGIONAL%20PROGRAMME%20FOR%20THE%20SECOND%20IDDA.%20BACKGROUND%20DOCUMENT%20NO.1%20(18793.en) page 44-45.

[8] https://www.tanzaniainvest.com/industry/giga-tanzanian-announces-usd-80-million-investment-to-setup-float-glass-factory

[9] https://rwandatrade.rw/media/2017%20RDB%20Float%20Glass%20Manufacturing.pdf

The National Development Corporation has plans to establish float/sheet glass and container glass for educational uses. The quantities are unknown. The proposed establishment of the educational glass is based on the current location of Nyanza Glass Works Limited in Mkuyuni, Mwanza.

#### 4.3.1.1 Case Study: Glass Manufacturing in Africa

In Africa[10], there are several plants of glass in Africa. For float glass, there are five of such industries three of them located in Egypt. These industries are Sphinx, 200,000 tons per year, Saint-Gobain/Sisecam, 900 tons per day and Guardian, 700 tons per day. South Africa's PFG, 260 tons per year, 2 lines with sales offices in various African countries including Tanzania. Algeria's Mediterranean Float Glass, 800T/day. The planned 600 tons per day plant in Tanzania is yet to be operational.

Other glass manufacturers in South Africa include Consol Glass, the largest producer of glass packaging products in Africa; and Nampak, which manufacturers one-third of all glass bottle products in South Africa.

Zimglass Holdings (Pvt) Limited is a wholly owned subsidiary of the Industrial Development Corporation of Zimbabwe Limited (a state enterprise). This Company was formed due to the growth of the original Zimbabwe Glass Industries Limited. The company was incorporated in 1963 as a subsidiary of Consol Glass and became an Industrial Development Corporation (IDC) company in 1984. The company manufactures glass packaging and utilizes soda ash from Botswana. The factory has a capacity of 240 per day. Currently, Zim glass is under liquidation.

It is estimated the SADC market demand for bottling and packaging glass is 1.3 mil tons per year.

Kioo Limited is based in Chang'ombe industrial area in Dar es Salaam, and occupies 24.44 acres of land of which the production plant occupies 12.7 acres. It was established in 1963 and it was a family owned business. Kioo limited is owned by Madhvani Group Company, which was established in 1914. Kioo limited is the biggest glass packaging company in East and Central Africa. It has over 500 permanent employees, with latest technology in glass packaging, operated uninterrupted for 24hrs/7 days a week for over 30 years. Mr. Mohammed V. Remtulla is Administrative manager of the factory who has worked with the factory for 50 years. He assured the team that Kioo Limited is committed 100% on the success of the plant and can take stake in financing. Kioo Limited has two factories with six production lines. It has a capacity of producing 85,000 tons a year equivalent to 360 million container bottles a year. 13% of the materials producing glass is soda ash.

In making white bottles, a total of 565kg of soda ash is used in a batch. Kioo uses more than 3,000 tons of soda ash per month, which translates to 36,000 tons per year, given full production. Soda ash dense (natural and synthetic) is used by the company. The company sources soda ash from

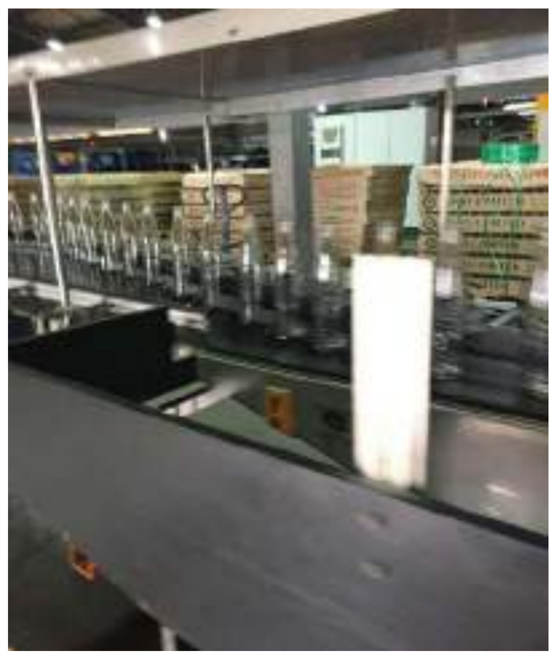
[10] https://rwandatrade.rw/media/2017%20RDB%20Float%20Glass%20Manufacturing.pdf

TATA Chemicals in Kenya and another company from Turkey, parked in 1,000kg with 5 years expiry period since packaging (Pictures in Figure 0.2).


Picture 1: TATA (Kenya) Soda Ash Dense Standard Grade


Picture 2: Agir Soda (Turkey) Soda Ash Dense

Picture 3: Kioo Limited Production Line for Printed Bottles.



Picture 4: Kioo Limited Production Line and Finished Products ready to Customer

Figure 0.2: Kioo Limited Field Visit Pictures

According to Kioo Limited Plant Manager Mr. P. Mozumder, the company is willing to test Engaruka soda ash and ensure that it established since it will be important partner in their production. The company is also available for technical guidance of the set up of the factory. They can provide on their own costs analysis of the sample produced if they fit to their production. Key technical features include purity level ~ 100%, soluble in water, transparent in the solvent and Iron content $FeO_3$ =< 0.05% maximum.

#### 4.3.1.2 Case Study: University of Dar es Salaam

The University of Dar es Salaam, department of chemistry has a unit known as Glass Blowing Unit which is responsible to manufacturer and repair most of the glass ware used by the UDSM laboratories. The unit has also been able to supply lab equipment to various government owned Universities namely Sokoine University, Nelson Mandela African Institute of Science and Technology, University of Dodoma and Muhimbili University of Health and Allied Sciences. The unit buys raw materials from fabricated glass of various sizes and blow the glass tubes to various glassware lab equipment. No soda ash is used in the process. Figure 4.3 shows some of the equipment manufactured by the unit.

Figure 0.3: Labaratory Apparatus Made by UDSM Glass Blowing Unit

#### 4.3.1.3 Projected Use of Soda Ash in Glass

Based on the industrial standards for production of glass the Table 0.4 ranges are provided for glass packaging bottle.

Table 0.4: Range of Commonly Used Glass Compositors

| Chemical Constituent | Range Compositions (%) |
|---|---|
| Silica ($SiO_2$) | 70-74 |
| Soda Ash ($Na_2O$) | 11-14 |
| Lime (CaO) | 11-11.5 |
| Potash ($K_2O$) | 0.2-0.5 |
| Magnesium (MgO) | 10-11.5 |
| Alumina ($Al_2O_3$) | 1-2 |
| Baria (BaO) | 0-0.5 |
| Iron Oxide ($Fe_2O_3$) | 03-0.5 |

Source: Draft East African Standard, DEAS 935:2018, ICS 55.120 available from http://www.puntofocal.gov.ar/notific_otros_miembros/ken774_t.pdf

According to the importation statistics of soda ash, Kioo limited consumes 60% of imported soda ash (dense and light). 16% of soda ash is used and thus, total daily production is estimated to be 215 tons with 270 working days per year.

Estimated Demand (in Tons) for the Production of Glass in Tanzania is as indicated in Table 0.5.

Table 0.5: Estimated Demand for Soda Ash for Glass Industry 2019-2030 (in Tons)

| | | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kioo Limited | Annual Capacity | 58,037 | 85,000 | 85,000 | 85,000 | 85,000 | 85,000 | 85,000 | 110,000 | 110,000 | 110,000 | 110,000 | 110,000 |
| | Soda Ash Consumption | 17,686.07 | 25,902.30 | 25,902.30 | 25,902.30 | 25,902.30 | 25,902.30 | 25,902.30 | 33,520.62 | 33,520.62 | 33,520.62 | 33,520.62 | 33,520.62 |
| GIGA/Sheet glass | | | | | | | | | | | | | |
| | Annual Capacity | - | | | | | | 120,000 | 130,000 | 140,000 | 150,000 | 150,000 | 150,000 |
| | Soda Ash Consumption | | | | | | | 43,881.54 | 47,538.34 | 51,195.13 | 54,851.93 | 54,851.93 | 54,851.93 |
| NDC | | | | | | | | | | | | | |
| | Annual Capacity | | | | | | | | | 50,000 | 75,000 | 85,000 | 100,000 |
| | Soda Ash Consumption | | | | | | | | | 15,236.65 | 22,854.97 | 25,902.30 | 30,473.29 |
| | | | | | | | | | | | | | |
| **Sub Total: Glass Making Estimates** | | **17,687** | **25,903** | **25,903** | **25,903** | **25,903** | **25,903** | **69,784** | **81,059** | **99,953** | **111,228** | **114,275** | **118,846** |

Source: Consultant Estimations.

Note. 1. The estimation is based on the current estimations based on the official recorded statistics and consideration of the diversification of the sources, also assuming that Kioo Limited is not a participant in the financing of Engaruka project.

2. It is estimated that the production of the Resource from Engaruka will start in year 2025.

### 4.3.2 Textile Industry

#### 4.3.2.1 Overview

The National Five-Year Development Plan (FYDP II) 2016/17–2020/21 listed the cotton-to-textiles value chain listed as a priority area for the first stage of FYDP II implementation. This follows several policy emphases on the domestic textiles and garment sector, in Tanzania. There have been sector-specific strategies designed to develop an integrated value chain and boost domestic cotton, textile and garment production. The government has also developed a plan of action known as Cotton- to-Clothing Strategy, which aims at the following:

- raise the profitability of cotton production
- boost the efficiency and competitiveness of the country's cotton-to-clothing value chain
- improve the competitiveness of Tanzania's textile and clothing firms through enhanced productivity and product diversification
- Focus more on investment as a vector for growth and integration in the value chain and strengthen the capacity of firms to diversify markets and raise their profitability (URT, 2016).

Recent moves by the URT suggest it may be looking to protectionist models.

The country is also participating in various export-led initiatives such as the United States (US) under the African Growth and Opportunity Act (AGOA) and the EU's everything but Arms (EBAS) programmes. Main regions for cotton production in Tanzania are the Western Lake Zone which includes Mwanza, Shinyanga, Geita, Simiyu and Mara regions. Cotton production for the past 7 years as presented in Table 0.6.

Table 0.6: Cotton Produced Vs. Sold

| Year | Produced (Tons) | Growth (y/y) | Exported (Tons) | Growth (y/y) | Local Consumption (tons) | Growth (y/y) |
|---|---|---|---|---|---|---|
| **2012** | 225,938 | | 132,000 | | 93,938 | |
| **2013** | 357,130 | 58% | 89,000 | -33% | 268,130 | 185% |
| **2014** | 246,767 | -31% | 49,500 | -44% | 197,267 | -26% |
| **2015** | 203,312 | -18% | 28,100 | -43% | 175,212 | -11% |
| **2016** | 149,445 | -26% | 33,000 | 17% | 116,445 | -34% |
| **2017** | 164,709 | 10% | 25,300 | -23% | 139,409 | 20% |
| **2018** | 269,393 | 64% | 47,400 | 87% | 221,993 | 59% |
| **CAGR (7 years)** | | 9% | | 9% | - | 9% |

Source: NBS, 2019. Tanzania in Figures, 2018 and National Economic Survey, 2018

Textile is used to make various manufactured goods. Tanzania production of the manufactured goods from textile is as indicated in Table 0.7.

Table 0.7: Textile Manufactured Goods 2013-2016

| Year | Value in TZS Mil |
|---|---|
| **2013** | 404,590 |
| **2014** | 410,454 |
| **2015** | 414,992 |
| **2016** | 421,007 |

Source: WTO, 2019. Trade Policy Tanzania Report, 2018

#### 4.3.2.2 Usage of Soda Ash in Textiles

Soda ash is used in Textile industry during various stages of textile manufacturing. Soda ash changes the pH of the fibre -reactive dye and cellulose fibre so that the dye reacts with the fibre, making a permanent connection that holds the dye to the fibre. It actually activates the fibre molecules so that they can chemically attack the dye. It can also be used with silk, but not other protein fibres such as wool. Soda ash has a cleaning power and help colour fading effects of garment. It is used also for colour fixing in dye bath.

Other alternative chemicals used in the Textile industry include.

1. Caustic chemicals. Other chemicals that can, in theory, be used to reach this ideal pH include NaOH (sodium hydroxide, or lye) and TSP (trisodium phosphate, sold as a heavy duty cleaner at hardware stores).

2. Sodium silicate. Fabric that has been painted with Procion MX or similar dyes, and the dye allowed to dry, can be treated with a liquid sodium silicate solution, also known as water glass

3. Sodium bicarbonate. Baking soda, or sodium bicarbonate, decomposes at sufficiently high temperatures to form sodium carbonate, so it is an ideal substitute for dyes

4. Acetic acid or citric acid. Protein fibre s such as wool and silk can also be dyed at low pHs, substituting white vinegar

#### 4.3.2.3 Field Study Case Study

MWATEX: Uses Sodium Silicate and Sodium Bicarbonate. Supplier: TATA Chemicals, Dar es Salaam. Why not using Soda Ash? Sodium bicarbonate is favoured due to its various usages such as in printing, dyeing and peddling while soda ash can only be used for one use. Also, textile industry uses several chemicals, about 40. Usage: 250kg Sodium carbonate for every 15,000kg of fabrics.

#### 4.3.2.4 Estimated Demand

Based on the industrial information the following are estimated local consumption of sodium bicarbonate in textile industry. The estimated cotton production, garments and the associated use of soda ash products is as indicated in Table 0.8.

Table 0.8: Estimated Sodium BiCarbonate in Textile Industry in Tons

| Year | Cotton Produced (A) | Conversion to Garments (B) | Sodium Bicarbonate Potential Usage (C) | Local Market Consumption (D) |
|---|---|---|---|---|
| | | 75% of A | 2% of B | 32% of C |
| **2017** | 164,709 | 123,532 | 2,059 | 659 |
| **2018** | 269,393 | 202,045 | 3,367 | 1,078 |
| **2019** | 294,985 | 221,239 | 3,687 | 1,180 |
| **2020** | 323,009 | 242,257 | 4,038 | 1,292 |
| **2021** | 353,695 | 265,271 | 4,421 | 1,415 |

| Year | Cotton Produced (A) | Conversion to Garments (B) | Sodium Bicarbonate Potential Usage (C) | Local Market Consumption (D) |
|---|---|---|---|---|
| **2022** | 387,296 | 290,472 | 4,841 | 1,549 |
| **2023** | 424,089 | 318,067 | 5,301 | 1,696 |
| **2024** | 464,377 | 348,283 | 5,805 | 1,858 |
| **2025** | 508,493 | 381,370 | 6,356 | 2,034 |
| **2026** | 556,800 | 417,600 | 6,960 | 2,227 |
| **2027** | 609,696 | 457,272 | 7,621 | 2,439 |
| **2028** | 667,617 | 500,713 | 8,345 | 2,670 |
| **2029** | 731,041 | 548,281 | 9,138 | 2,924 |
| **2030** | 800,490 | 600,367 | 10,006 | 3,202 |

Source: Consultant Estimations

It can be noted that if the entire textile produced can be processed in the local market, a total of 10,000 tons demand for sodium bicarbonate will be required by the textile sector in 2030. Given that the local potential is only 32%, the potential is estimated to be 3,202 tons. This may be realised based on the fact that there is an increase in cotton production given opening of the new growing areas such as Katavi and Rukwa regions.

### 4.3.3 Leather Industry

#### 4.3.3.1 Overview

Livestock sector is a cultural lifestyle of many Tanzanian communities and it is a major source of many household's income. Tanzania is the second country in Africa after Ethiopia with livestock[11]. According the National Census of livestock in 2016/17[12] Tanzania has 30.5 million cattle, 8.9 million goats and 5.56 million sheep potential for providing hides and skins for the leather sector. Most livestock keepers are smallholder farmers who keep at most 10 heads per household. Commercial ranching is practiced by state owned ranch, (NARCO) and it accounts for only 7% of all livestock and few private ranches. Large population of livestock represent a formidable supply of Hides and Skins which is important in leather industry. The sector has potential for growth and became a reliable supplier of leather and leather products in the region and world at large. This is due to desirable environment to support the sector such as labour availability, harbour facilities, well planned economic development zones and current government. Additionally, availability of

[11] http://www.intracen.org/uploadedFiles/Tanzania_Leather_inv_prof%204_web.pdf
[12] https://www.thecitizen.co.tz/news/Tanzania-has-30-5ml-cows--NBS/1840340-4565204-mf8rrnz/index.html

proper training in the leather production and chemical use, local availability of chemicals such as soda ash would help the sector to flourish.

There are 9 tanneries in Tanzania with installed capacity of producing 74.3 mil square feet of leather per year. Number of tanneries and their capacities is as indicated in Table 0.9[13].

Table 0.9: Capacity of Tanneries in Tanzania

| S/No. | Factory Name | Location | -Units (Pieces)) | | Status |
|---|---|---|---|---|---|
| | | | **Hides** | **Skin** | |
| 1 | Lake Trading Co. Ltd | Kibaha | 90,000 | 420,000 | Working |
| 2. | Himo Tanneries and Planters | Moshi | 90,000 | 900,000 | Working |
| 3 | Sak International Ltd | Arusha | 450,000 | 900,000 | Working |
| 4 | ACE Leather Tanzania Ltd | Morogoro | 1,200,000 | 3,600,000 | Working |
| 5 | Salextanneries Ltd | Arusha | 624,000 | 1,500,000 | Working |
| 6 | Moshi Leather Industries Ltd | Moshi | 180,000 | 1,200,000 | Working |
| 7 | AfroLeather Industries | Dar es Salaam | 300,000 | 700,000 | Not operational |
| 8 | Hua Cheng | Dodoma | 900,000 | 1,500,000 | Not operational |
| 9 | Xing Hua Investment Co. Ltd | Shinyanga | 900,000 | 2,100,000 | Not operational |
| Total | | | **4,734,000** | **12,820,000** | |

Source: Ministry of Livestock and Fisheries, Budget Speech 2016/17

According to the various sources, the government plans to set up leather processing factories in Dar es Salaam, Geita and Shinyanga regions in an industrialisation drive aimed at providing reliable market for skins from abattoirs in the regions[14]. Regions with high share of livestock in Tanzania include Tabora (8.7%), Mwanza (7.9%) and Manyara (7.2%).

Tanzania continues to apply export levies in order to promote local leather industry. On wet blue leather of 10% on f.o.b.; and on raw hides and skins of 80% of f.o.b. value or USD 0.52 per kg.

[13] https://www.mifugouvuvi.go.tz/pages/private-sector-desk-strategy
[14] http://www.ibn-tv.co.tz/2016/01/govt-to-set-up-leather-factories/

### 4.3.3.2 Use of Soda Ash in Leather Case Studies

Himo Tanneries and Planters: This is based in Himo Kilimanjaro in Moshi District Council. The Tannery is one of the largest in Tanzania. There are various chemicals used in leather. Soda ash is only used for treatment of waste water and in some processes to increase pH levels. The usage is not that huge and soda ash is obtained locally from market places and local suppliers. Over 40 chemicals are in use, mostly from overseas and specifically produced for leather industry.

DIT Leather Academy - Mwanza: This is the only training institution in leather technology in Tanzania and probably in the Eastern African region. Soda ash is in use in the training of the leather in the initial stages and finishing stages, also treatment of waste water. Soda ash Supplier: TATA Chemicals, Dar es Salaam. Monthly demand for the training leather unit is 100kg per month. Other chemicals also in use including sodium bicarbonate but rarely used. Since 2010, a total of 100 trainers were awarded certificates. The training involves the use of chemicals in leather industry. It was noted that the closure of various factories include among others lack of proper and sustainable training in leather technology. Capacity building for the upcoming leather factories such as Karanga leather factory is highly and timely needed for effective leather production and usage of locally available chemicals.

Given low usage of soda ash, it is likely that most of the tanneries buy soda ash locally from the local retailers.

### 4.3.3.3 Estimated Demand

Based on the industrial information the following are estimated local consumption of soda ash. The estimation is based on the size and nature of the skin/hide as indicated Table 0.10.

Table 0.10: Estimated Usage of Soda Ash Based on the Kg of Skin/Hide

| Nature/Process | Estimated Weight in Kg (A) | Soda Ash Ratio | Soda Ash Kg |
|---|---|---|---|
| **Dry** | 6 | 0.8% | 0.05 |
| **Processed/Wet** | 12 | 0.2% | 0.02 |
| **Final Process** | 5 | 2% | 0.10 |
| | Total | | 0.17 |

Note. Assumption is for every cow hide a total of 0.17kg of soda ash is used given. To estimate the demand for the skins it is assumed for every goat/sheep skin 30% of the weight used in cow is used for goat/sheep.

The estimated Potential for Soda Ash usage in Leather Industry as indicated in Table 0.11.

Table 0.11: Estimated Soda Ash in Leather Industry in Tons

| | | | **Year 2016/17** |
|---|---|---|---|
| Installed Capacity | Hides | | 4,734,000 |
| | Skins | | 12,820,000 |
| Operating Capacity | Hides | | 2,634,000 |
| | Skins | | 8,520,000 |
| Estimated Soda Ash in Tons Installed Capacity | Hides | 0.17 | 804.78 |
| | Skins | 0.051 | 653.82 |
| | Potential Soda Ash Usage | | 1,459 |
| | | | |
| Estimated Soda Ash in Tons Operating Capacity | Hides | 0.17 | 447.78 |
| | Skins | 0.051 | 434.52 |
| | Soda Ash Operating Usage per year | | **882** |

Source: Consultant Estimations.

Given the fact that investment in the tanneries requires special skills and there is uncertainty in the investment, and the optional use of soda ash in leather industry, the study assumes a demand of 882 to 1,459 tons over the period of 10 years.

### 4.3.4 Detergents Industry

#### 4.3.4.1 About the Sector

Soaps and detergents are vital necessities as consumer goods and are used by the large population base both in urban and rural areas. Easiness of detergents usage, penetration of washing machines in the developing countries such as Tanzania, has accelerated the use of detergents, and increased use of washing powdered soaps. Another derived factor is the urbanization and the increase of disposable income, as well as developments in the textile industry, as well as healthcare awareness. Laundry detergent market with high foaming represent about 60% of soaps consumption. Evidence from some countries such as Egypt suggests that per capita consumption ranges from about 3 kg in Egypt, while in Iran is 6 kg.

According to market survey, there are six factories manufacturing detergents in Tanzania with per hour capacities as indicated Table 0.12.

Table 0.12: Capacity of Detergent Manufacturers in Tanzania

| S/No. | Factory Name | Location | Installed Capacity (Tons per Hr) |
|---|---|---|---|
| 1 | Nice One | Pwani | 6 |
| 2. | Mohammed Enterprises Limited/ Royal Soap Limited | Dar es Salaam | 10 |
| 3 | Azania Limited | Dar es Salaam | 5 |
| 4 | Muzah Oil and Soaps | Dar es Salaam / Tanga | 10 |
| 5 | Clinsoft | Pwani | 6 |
| 6 | GnB Soap | Dar es Salaam | 4 |
| **Total tons per hour** | | | **41** |

Source: Market Intelligence and Consultant Estimations

It can be noted that the installed capacity is about 40 tons per hour. This excludes other small manufacturers who are trained by SIDO. Assuming one shift, the total production per day is estimated to be 320 tons per day, with 270 days in a year, annual capacity is 86,400 tons in a year of detergents. Further, an industry efficiency ratio of 65% if assumed, giving the current production to 56,160 tons per year.

Tanzania is also strategically located for export market. There is also increase in urbanization. According to the International Growth Centre, the urban population increases by 5% annually[15]. The consultant will consider the increase in urbanization as a proxy for the increase in the usage of detergents, not considering the potential for export outlined in the previous part of the report.

### 4.3.4.2 Analysis of Imports and Exports

Data from the International Trade Centre (ITC) indicates that about 2,256 tons of the soap detergents *HS Code 340120 Soap in the form of flakes, granules, powder, paste or in aqueous solution* were imported to Tanzania. However, the main importing country is Kenya that commands 44% of the total importation to the country followed by Uganda. The importation may be linked to the availability of soda ash in Kenya. However, there is an increase in importation of the product attributed by the industrialization agenda from 2014-2018, a decrease of 21%. The biggest losers of the market share are China (58%) and Turkey (30%) probably given the investment by companies of Chinese origin to the detergent market in Tanzania. Kenya lost 12% of the Tanzanian market share. Details for the importation is as indicate in Table 0.13.

[15] https://www.theigc.org/wp-content/uploads/2014/09/Wenban-Smith-2014-Working-Paper.pdf

Table 0.13: Detergents Importation to Tanzania

| S/No. | Country | Value imported in 2018 (USD thousand) | Share in Tanzania imports (%) | Quantity imported in 2018 | Quantity unit | Unit value (USD/unit) | Growth in imported quantity between 2014-2018 (%, p.a.) |
|---|---|---|---|---|---|---|---|
| 1 | World | 1,922 | 100 | 2,526 | Tons | 761 | (21) |
| 2 | Kenya | 838 | 44 | 707 | Tons | 1,185 | (12) |
| 3 | Uganda | 730 | 38 | 1,363 | Tons | 536 | 5 |
| 4 | Turkey | 146 | 8 | 261 | Tons | 559 | (30) |
| 5 | India | 62 | 3 | 3 | Tons | 20,667 | 12 |
| 6 | Zambia | 31 | 2 | 25 | Tons | 1,240 | |
| 7 | China | 28 | 2 | 78 | Tons | 359 | (58) |
| 8 | Spain | 17 | 1 | 11 | Tons | 1,545 | 82 |
| 9 | Indonesia | 13 | 1 | 30 | Tons | 433 | (13) |
| 10 | South Africa | 11 | 1 | 10 | Tons | 1,100 | (20) |
| 11 | Singapore | 11 | 1 | 4 | Tons | 2,750 | (38) |

Source: UN COMTRADE and ITC Statistics, Feb 2020. Accessed from www.trademap.org

#### 4.3.4.3 Use of Soda Ash in Detergents

Soda ash (light soda ash) usage in detergents ranges from 40% to 65%, and it is used as a filler. Other materials used in the same way as light soda ash include sodium sulphate. According to the information from GnB Soaps Limited, soda ash is imported from China, Russia, Romania and South Korea. Quality of the soda ash should be purity between 95-98%. The manufacturers require competitive prices, quality products and consistency in supply as key determinants for the decision to buy soda ash.

#### 4.3.4.4 Estimation of Soda Ash in Detergents

The estimation is for 10 years with estimated 40% of the detergents utilize soda ash as its main feedstock. The estimated for annual growth is based on that of urban areas. There is also opportunity to increase the demand based on the potential for export of soda ash to neighbouring countries. The estimated demand for local consumption of soda ash in the detergents industry is as indicated in Table 0.14.

Table 0.14: Demand Estimation for Usage of Soda Ash in Detergent Industry

| Year | Detergents Produced (Tons) | Soda Ash Usage (40%) |
|---:|---:|---:|
| 2019 | 56,160 | 22,464 |
| 2020 | 58,968 | 23,587 |
| 2021 | 61,916 | 24,767 |
| 2022 | 65,012 | 26,005 |
| 2023 | 68,263 | 27,305 |
| 2024 | 71,676 | 28,670 |
| 2025 | 75,260 | 30,104 |
| 2026 | 79,023 | 31,609 |
| 2027 | 82,974 | 33,190 |
| 2028 | 87,123 | 34,849 |
| 2029 | 91,479 | 36,591 |
| 2030 | 96,053 | 38,421 |

Source: Consultant Estimations

### 4.3.5 Sodium Bicarbonate

#### 4.3.5.1 Overview

Sodium bicarbonate or sodium hydrogen carbonate is the chemical compound with the formula $NaHCO_3$. Sodium bicarbonate is a white crystalline powder derived from disodium carbonate[16]. Other names are baking soda, bread soda, cooking soda, bicarbonate of soda. Sodium Bicarbonate is one of the basic alkaline chemicals and it has a wide variety of applications. It is applied to fields such as fibre, soap, paper, food, electricity, etc. Natural Sodium Bicarbonate is low in purity so it is usually manufactured by passing carbon dioxide through soda ash.

[16] 1 kg sodium carbonate (Na2CO3) produce 1.585 kg of sodium bicarbonate (NaHCO3) through carbonation in presence of water. $Na_2CO_3$ +CO2+H2O = 2$NaHCO_3$

#### 4.3.5.2 Uses of Sodium Bicarbonate

Sodium Bicarbonate is widely used as a weak alkali buffer agent for supplementary feeds, a major raw material for baking powder as food additives and acid neutralizer agent after chromium tanning in leather manufacturing, as well as dye stuffs and pharmaceutical ingredients.

**Food additives:** Sodium Bicarbonate is an essential ingredient in the food and beverage industry. Sodium Bicarbonate is acted as a chemical leavening agent for baked goods. Sodium Bicarbonate is a valuable buffer and neutralizer in beverages. It is used as a source of carbon dioxide in several soft drinks.

**Feed Supplements:** Buffer agent, Sodium Bicarbonate is a universally recognized feed ingredient that functions as a unique safe, natural buffering system in the animal. Sodium Bicarbonate acts as a buffer agent and antacid cattle feed ingredient.

**Pharmaceuticals:** Sodium Bicarbonate has a long history as an antacid. Sodium Bicarbonate is used as an antacid for short-term relief of stomach upset. Sodium Bicarbonate plays a vital role in human health, as a therapeutic agent in itself, as an agent in the manufacture of other health-aids and as an essential component of the body physiological operation. A highly pure grade of Sodium Bicarbonate is used in haemodialysis. Patients in treatment are less stressed when bicarbonate is present in the dialysis fluid.

**Leather and textile:** Sodium Bicarbonate is a valuable agent in treating wool and silk fibres and dyeing and printing fabrics. The complex processes involved in producing natural leather require precise control of tanning solutions. Sodium bicarbonate is therefore used in tanning as a neutralizer, buffer, pre-treating agent and cleaner.

**Other uses:** Sodium Bicarbonate is used in production of many chemicals. It is used as a fungicide and pest control. Sodium Bicarbonate is used in synthesizing, processing and purifying chemicals and polymers, serving as a catalyst, as a neutralizing buffering agent and a reactant. It is also used as a blowing agent in rubber and plastics. Sodium Bicarbonate has odour absorbent properties and the deodorizers are used in carpet and room, refrigerator, also garbage containers. Highly effective and inexpensive, Sodium Bicarbonate absorbs smoke and musty odours. It is used in several kinds of dry chemical fire extinguishers. It is used in poultry diets as a sodium source to maintain electrolyte balance, improve heat stress tolerance, eggshell quality and dry litter.

#### 4.3.5.3 Importation of Sodium Bicarbonate in Tanzania

Tanzania is a net importer of sodium bicarbonates. According to the TRA data, importation of Sodium hydrogencarbonate "sodium bicarbonate" HS code 283630 for the years 2012-2019 is as indicated in Table 0.15. There has been a CAGR of -17% on average on the importation of Sodium Bicarbonate. Price ranges from US$ 168.84 to US$ 356.72 per ton. Trend on the importation is as indicated in Figure 0.4.

Table 0.15: Importation of Sodium Bicarbonate in Tanzania based on TRA Statistics

| Year | Imported Tons | Customs Value (mil TZS) | Price in US$ | CAGR | Estimated Soda Ash Content (tons/1.585) Tons |
|---|---|---|---|---|---|
| **2012** | 21,126.48 | 8,969.14 | 270.12 | | 13,329.01 |
| **2013** | 24,451.47 | 11,429.01 | 292.37 | 16% | 15,426.79 |
| **2014** | 19,808.39 | 9,040.24 | 276.18 | -19% | 12,497.41 |
| **2015** | 19,500.50 | 11,337.70 | 292.84 | -2% | 12,303.15 |
| **2016** | 18,723.41 | 11,273.06 | 276.55 | -4% | 11,812.88 |
| **2017** | 8,459.01 | 6,725.76 | 356.72 | -55% | 5,336.91 |
| **2018** | 9,006.23 | 3,430.24 | 168.84 | 6% | 5,682.16 |
| **2019** | 3,573.17 | 2,588.28 | 316.57 | -60% | 2,254.37 |
| **Average** | | | | **-17%** | **9,830.34** |

Source: Consultant Analysis from TRA Statistics

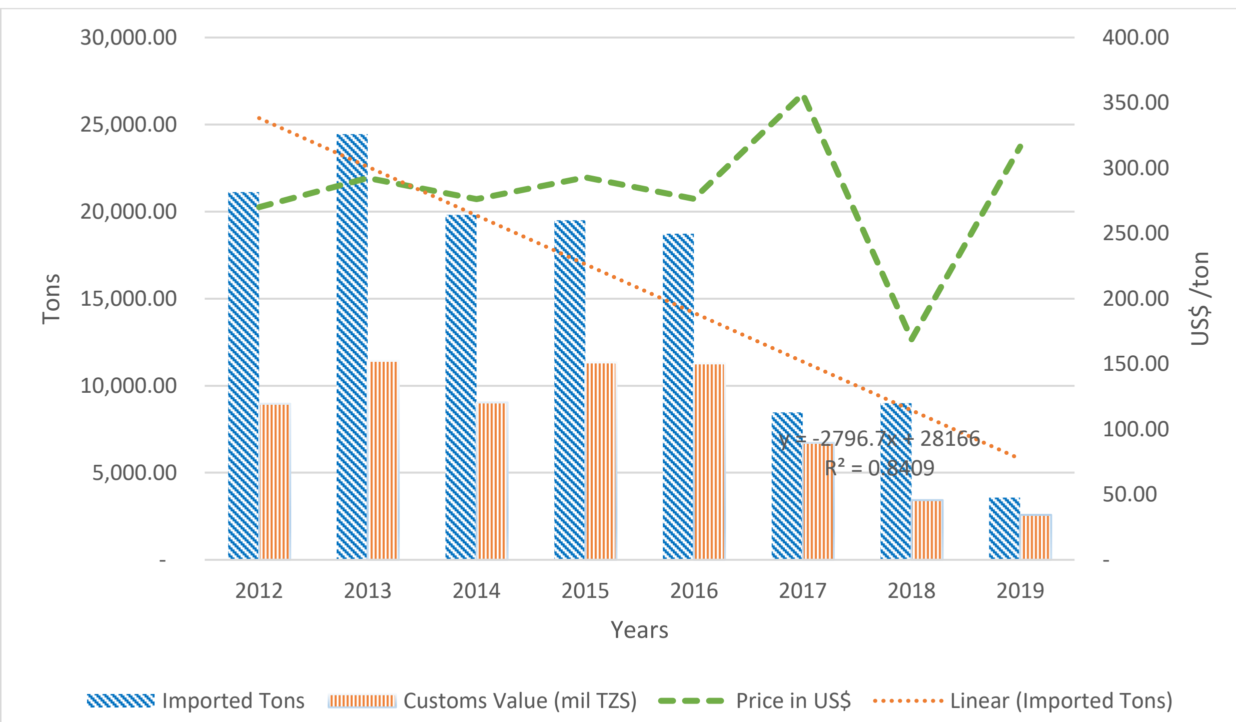


Figure 0.4: Trend of Importation of Sodium Bicarbonate in Tanzania based on TRA Statistics

Exporting countries for sodium bicarbonate are China, Romania, Poland, India, Singapore and Cyprus.

#### 4.3.5.4 Estimation of Soda Ash Usage

Soda ash as is feedstock for manufacturing sodium bicarbonate. For the past 8 years, on average for the imported sodium bicarbonate, a total of 9,830.34 tons of equivalent soda ash was imported in Tanzania. This means that with promotion of establishment of the factories to manufacture sodium bicarbonate, which will be important for the consumption of soda ash. The estimated soda ash is likely to grow with the increase in the population given the huge usage of the product in food additives. For this case, estimation is based on the average tonnage of equivalent soda ash with an increase with the population which on average, 3%. Given the speciality nature in the diversified use of soda ash, we will consider only 50% of the demand as the base year. Table

Table 0.16: Estimated Demand for Soda Ash Content in Sodium Bicaronate Consumption

| Year | Consumption of Sodium Bicarbonate (Tons) | Estimated Soda Ash Content in Tons |
|---|---|---|
| 2020 | 7,790.00 | 4,914.00 |
| 2021 | 8,023.00 | 5,061.00 |
| 2022 | 8,263.00 | 5,213.00 |
| 2023 | 8,510.00 | 5,369.00 |
| 2024 | 8,765.00 | 5,529.00 |
| 2025 | 9,027.00 | 5,695.00 |
| 2026 | 9,297.00 | 5,865.00 |
| 2027 | 9,575.00 | 6,041.00 |
| 2028 | 9,862.00 | 6,222.00 |
| 2029 | 10,157.00 | 6,408.00 |
| 2030 | 10,461.00 | 6,600.00 |

Source: Consultant Analysis from TRA Statistics

### 4.3.6 Paper Pulp Industry

#### 4.3.6.1 Overview

Tanzania is manufacturer of paper kraft in the EAC region. There is only one factory known as Mgololo paper mill which was established in early 1980s[17]. Once a government owned factory, it was privatised in early 2000s to a private operator. The factory has an integrated plantation pine based 60,000 tons per year. Tanzania is a net exporter of paper products HS Code: *4804 uncoated*

[17] http://documents.worldbank.org/curated/en/109201468311391499/pdf/multi-page.pdf

*kraft paper and paperboard, in rolls of a width > 36 cm or in square or rectangular*. The country also imports about 6,000 tons of paper from various sources as indicated in Table 0.17. The main exporting counties for Tanzania kraft paper imports 36,805 tons of the product. Kenya imports 77.4% of the paper kraft, while Uganda imports 19.2% and Rwanda 3.4%. With increase in the agroforestry especially in Iringa, following investment of various companies such as green resources, and individuals, there is a potential to increase the capacity of the factory or establish several other factories of the same nature.

Table 0.17: Tanzania Imports of Paper Krafts

| S/No | Exporter | Value imported in 2018 (USD thousand) | Trade balance 2018 (USD thousand) | Share in Tanzania imports (%) | Quantity imported in 2018 | Quantity unit | Unit value (USD/ unit) | Growth in imported quantity between 2014-2018 (%, p.a.) |
|---|---|---|---|---|---|---|---|---|
| 1 | World | 6,029 | 30,465 | 100 | 7,074 | Tons | 852 | -1 |
| 2 | South Africa | 3,631 | -3,631 | 60.2 | 4,258 | Tons | 853 | 35 |
| 3 | Sweden | 391 | -391 | 6.5 | 506 | Tons | 773 | -38 |
| 4 | Iran | 277 | -277 | 4.6 | 405 | Tons | 684 | |
| 5 | Belgium | 276 | -276 | 4.6 | 389 | Tons | 710 | 101 |
| 6 | Indonesia | 233 | -233 | 3.9 | 297 | Tons | 785 | 25 |
| 7 | India | 210 | -210 | 3.5 | 79 | Tons | 2,658 | -34 |
| 8 | United States of America | 200 | -200 | 3.3 | 222 | Tons | 901 | -46 |
| 9 | France | 173 | -173 | 2.9 | 124 | Tons | 1,395 | -23 |
| 10 | Germany | 149 | -149 | 2.5 | 193 | Tons | 772 | 12 |
| 11 | Thailand | 110 | -110 | 1.8 | 142 | Tons | 775 | |
| 12 | China | 95 | -95 | 1.6 | 151 | Tons | 629 | 2 |

Source: UN COMTRADE and ITC Statistics, Feb 2020. Accessed from www.trademap.org

There is also potential of such factories in Arusha and Kilimanjaro, as well as Tanga region following the favourable conditions for log tree farms.

#### 4.3.6.2 Usage of Soda Ash in Paper pulp

Mgololo uses soda ash, on average; 200 tons per month, making 2,400 tons per year. It is anticipated that if promoted, and given the environmental concerns and given the current move by the governments of East African region to ban the use of plastic as packaging materials, there is a room to add the production of paper pulp and thus soda ash usage. We anticipate a growth of 100% of the current usage of soda ash in this industry in the next 8 years. However, there is need to find a strategic investor in the paper pulp especially in Iringa region. The increase is possible following also high rate of log farming and promotions of such economic activities in Iringa and Njombe regions.

### 4.3.7 Other uses of Soda Ash

#### 4.3.7.1 Water Treatment

In several conditions, soda ash is used in the treatment of water. However, field findings indicate that only two water and sewerage authorities in Tanzania are using soda ash. These are Morogoro and Chalinze within their catchment areas. An amount of 9,100 kgs of soda ash was used by the authorities for water treatment based on the survey which was undertaken by the Ministry of Water in 2018. Price per kg was TZS 1,200. It is anticipated that this consumption will not change or increase as pea national survey. Thus, it can be concluded that in Tanzania soda ash is used for water treatment to a small extent.

#### 4.3.7.2 Treatment of Swimming pools

Soda ash is used to regulate pH in swimming pools. Soda ash light is used for this purpose. Soda ash is used to increase the water pH, as soda ash has high pH content. Davis and Shirtliff is one of the companies providing swimming solutions. 5kg for a product known as pH Plus (see Figure 4.5) which is soda ash is sold for TZS 15,340/- + VAT it is packed in an air tight 5 kg plastic container. A 20kg pack goes for TZS 49,560/- + VAT. Depending on the pH of water, various measurements are available for the water treatment in swimming pools. The amount used is not quite significant. To market this products, specialized companies in water treatments provides special packaging and training on its usage.

#### 4.3.7.3 Paints industries

Soda ash is used in painting production to increase binding power of the paints. Application is 10-20g per Litre of paints. There are about 5 major painting manufacturers with an estimated capacity of 5 tons per day. This makes an estimated consumption of soda ash to be about 202 tons per year. With potential for export and increase in the housing construction in Tanzania, we anticipate new players in the market and increase in production capacity of existing manufacturers. Tanzania export paints and related products under HS Code 3209 to Uganda, Rwanda, Burundi, Malawi and DRC.


Figure 0.5: Davis and Shirtliff 5 Kg Soda Ash for Swimming pool usage

#### 4.3.7.4 Soil Health

Soda ash is used to neutralize acidic soils. Acidic soils are available in SAGCOT regions including Iringa, Ruvuma and Mbeya regions and areas with high rainfall. Currently, the use of Limestone is used to neutralize soils of such nature. Two factories exist including ABM Equipment in Tanga and Dodoma Cement in Dodoma. A visit to ABM Equipment and Fertilizers Limited in Tanga revealed that the company supplies such products to various regions including Tanga, Ruvuma, and Kilimanjaro.

#### 4.3.7.5 Metallurgical processes

Usually, Soda Ash is not used in large quantities in the metallurgical processes. However, caustic soda or sodium hydroxide ($NaOH$) is used instead. Caustic soda is used at a rate of 0.206 kg per ton, and this also depends on the volume of mixing tank and cell design. This is used alongside with the Cyanide which is used at a rate of 0.38kg/t.

To estimate the volume of the caustic soda used in metallurgical processes, we used importation figures of Cyanide. According to the International trade imports of Sodium Cyanide is as indicated in Table 0.18.

Table 0.18: Imports of Sodium Cyanide in Tanzania 2014-2018

| S/No | Exporters | 2014 | 2015 | 2016 | 2017 | 2018 | Average |
|---|---|---|---|---|---|---|---|
| 1. | World | 10,021 | 9,115 | 12,277 | 13,023 | 12,714 | 11,430.00 |
| 2. | Australia | 6,284 | 5,213 | 8,199 | 9,047 | 7,212 | 7,191.00 |
| 3. | Korea, Republic of | 1,400 | 2,353 | 1,977 | 1,710 | 3,104 | 2,108.80 |
| 4. | Georgia | 36 | 108 | 888 | 1,051 | 907 | 598.00 |
| 5. | United Arab Emirates | 150 | 39 | 170 | 55 | 454 | 173.60 |
| 6.. | China | 97 | 325 | 223 | 424 | 401 | 294.00 |
| 7. | Czech Republic | | 148 | 254 | 246 | 293 | 235.25 |
| 8. | Hong Kong, China | | | 20 | 119 | 277 | 138.67 |
| 9. | Germany | | 40 | 103 | | 65 | 69.33 |
| 10. | India | 145 | 278 | 59 | 140 | 0 | 124.40 |

Source: UN COMTRADE and ITC Statistics, Feb 2020. Accessed from www.trademap.org

Assuming that on average 11,430 tons of Cyanide is used in a years, from the usage of 0.38kg/t of ore, a total of 30,079 tons of ore are produced. Given usage of 0.206kg of caustic soda, on average 6,196 tons of caustic soda are used in metallurgical processes on annual basis.

Imported caustic soda (sodium hydroxide) in Tanzania is as indicated in Table 0.19.

Table 0.19: Sodium Hydroxide Imports to Tanzania

| **Exporter** | **Value imported in 2018 (USD thousand)** | **Share in Tanzania imports (%)** | **Quantity imported in 2018** | **Quantity unit** | **Unit value (USD/unit)** | **Growth in imported value between 2014-2018 (%, p.a.)** | **Growth in imported quantity between 2014-2018 (%, p.a.)** |
|---|---|---|---|---|---|---|---|
| World | 24,829 | 100 | 33,010 | Tons | 752 | 17 | -1 |
| India | 13,345 | 53.7 | 18,319 | Tons | 728 | 32 | 19 |
| China | 7,455 | 30 | 9,097 | Tons | 820 | 3 | -19 |
| United Arab Emirates | 961 | 3.9 | 1,322 | Tons | 727 | 3 | -4 |
| Hong Kong, China | 857 | 3.5 | 956 | Tons | 896 | 65 | 39 |
| Taipei, Chinese | 672 | 2.7 | 833 | Tons | 807 | 62 | 47 |
| Bangladesh | 583 | 2.3 | 1,033 | Tons | 564 | | |
| Kuwait | 296 | 1.2 | 362 | Tons | 818 | 3 | -8 |
| Mauritius | 191 | 0.8 | 287 | Tons | 666 | | |
| Saudi Arabia | 158 | 0.6 | 163 | Tons | 969 | -28 | -37 |
| Indonesia | 80 | 0.3 | 101 | Tons | 792 | | |
| Switzerland | 53 | 0.2 | 13 | Tons | 4,077 | | |
| Iran, Islamic Republic of | 50 | 0.2 | 75 | Tons | 667 | | |
| South Africa | 41 | 0.2 | 32 | Tons | 1,281 | -14 | -17 |
| Russian Federation | 39 | 0.2 | 131 | Tons | 298 | 27 | 15 |
| United Kingdom | 35 | 0.1 | 49 | Tons | 714 | -32 | -44 |

Source: UN COMTRADE and ITC Statistics, Feb 2020. Accessed from www.trademap.org

Based on the information from the Ministry of Minerals, soda ash is used in a ratio of 4% to 7% in gold smelting of concentrates. It is estimated that on average 70 tons of gold concentrate is produced per day which is equivalent to 24,500 tons of gold concentrate per year, taking into consideration 350 working days. Given that smelting would require say 7% of the concentrate volume, only 1,450 tons of soda ash per year. This is not quite material to be considered separately as a demand driven item in the consumption of soda ash. Also, gold is rare mineral and thus its availability and processing is also rare. It is not even clear if such concentrates will be produced in massive in coming years.

#### 4.3.7.6 Animal feeds

A refined sodium bicarbonate is used in poultry feed and diet for dairy animals. Bicarbonate is essential for strengthening eggshell quality under intensive production systems. When added to diets for dairy animals, sodium bicarbonate effectively counters the acidity of silage- and cereal-based concentrates, maintaining feed pH at its optimum level. For dairy cows a total of 200-250gms/cow/day is added to the feed. For beef cattle a ratio of 1% is added which may be 100-150gms/cow/day. Given the potential for cattle in Tanzania and the need for commercial farming it is likely that there will be a demand for such products in the future.

### 4.4 Potential Regions for Soda Ash Investment

In Tanzania, potential regions for soda ash investment were visited. Various considerations were taken into account in the analysis of the potential regions. This includes the fact that soda ash can be used as a feed stock and it is a bulk product. Also, analysis of the logistics, raw materials, infrastructure and potential for export of the already made products were considered. The potential areas for investment are as shown in Figure 0.6. Most of the regions have developed investment profiles recently, but unfortunately potential for utilization of feedstocks and minerals such as soda ash was not put into consideration.

The potential regions can be summarized as indicated in Table 0.20. Further details of the investment areas visited and the findings based on the investment areas and potential are as indicated in Annex 2.

Table 0.20: Potential Areas for Utilization of Soda Ash for Industrial Use

| **Region** | **Project Area** | **Industrial Area Availability** | **Industrial Uses of Soda Ash** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Glass Making** | **Detergents** | **Leather** | **Textiles** | **Paper Pulp** | **Others** |
| Arusha | ● | ●●● | | ● | | | ● | ● |
| Tanga | | ●● | ●●● | ● | | | | ● |
| Mwanza | | ●● | ●● | ● | ● | ● | | ● |
| Dodoma | | ●●● | | ● | | | | ● |
| Iringa | | ● | | | | | ●● | |
| Dar es Salaam | | ●● | ●● | ● | | | | ● |
| Coastal Region | | ●●● | ● | ● | ● | | | ● |

Source: Market Survey

Note. Dar es Salaam and Coastal Regions were not analysed for investment potential as they have already well established industries.

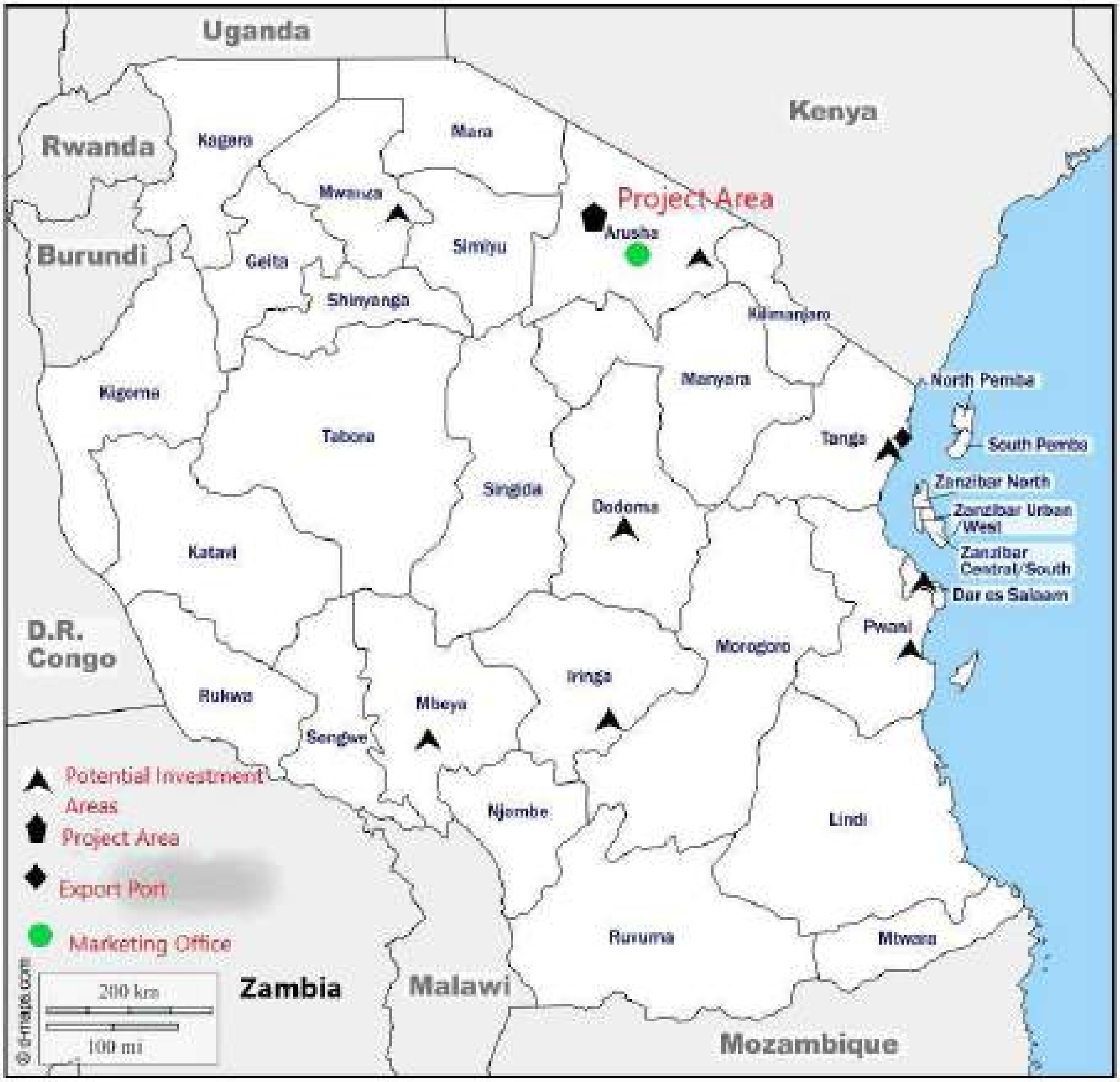



Figure 0.6: Potential Investment Areas for Soda Ash Utilization

## 4.5 Local Market Prices

According to the market survey, there are various prices for soda ash as indicated in Table 0.21. Based on the survey conducted the following prices were revealed.

Table 0.21: Local Market Prices Based on Market Survey

| Soda Ash Type | Source | Price per Ton | Price per Kg | Pack Sizes | Source |
|---|---|---|---|---|---|
| Light Soda Ash | Tata Chemicals | $250 | | 40kg/ 50 kg | China/Romania/Russia |
| Light Soda Ash | Organic Chemicals Limited | $420 | | 40 kg | Romania |
| Light Soda Ash | GnB Soap | $325 to $300 | | 40kg/ 50 kg | Russia |
| Dense Soda Ash | ACL Cleaners, Mwanza | | TZS 3,000/- | | Kenya |
| Light Soda Ash | ACL Cleaners, Mwanza | | TZS 3,000/- | | TATA Chemicals, Dar es Salaam |

Source: Market Study

## 4.6 Market Potential Estimation

The Engaruka soda ash production of 500,000 tons per year has been considered and design is reasonable to meet the demands for local, regional and the international markets. It is estimated that the exports of soda ash is likely to be 87% of the total produce. The local market is expected to be 13% to 30% at the end of 2030 given promotion of local industrial uses of the soda ash as suggested in this plan. Market demand based on the quantities of Soda Ash in tons is as shown in Figure 0.7. Prices for local markets and export market as indicated in Figure 0.8. The details of the market estimations are as shown in Table 0.22.

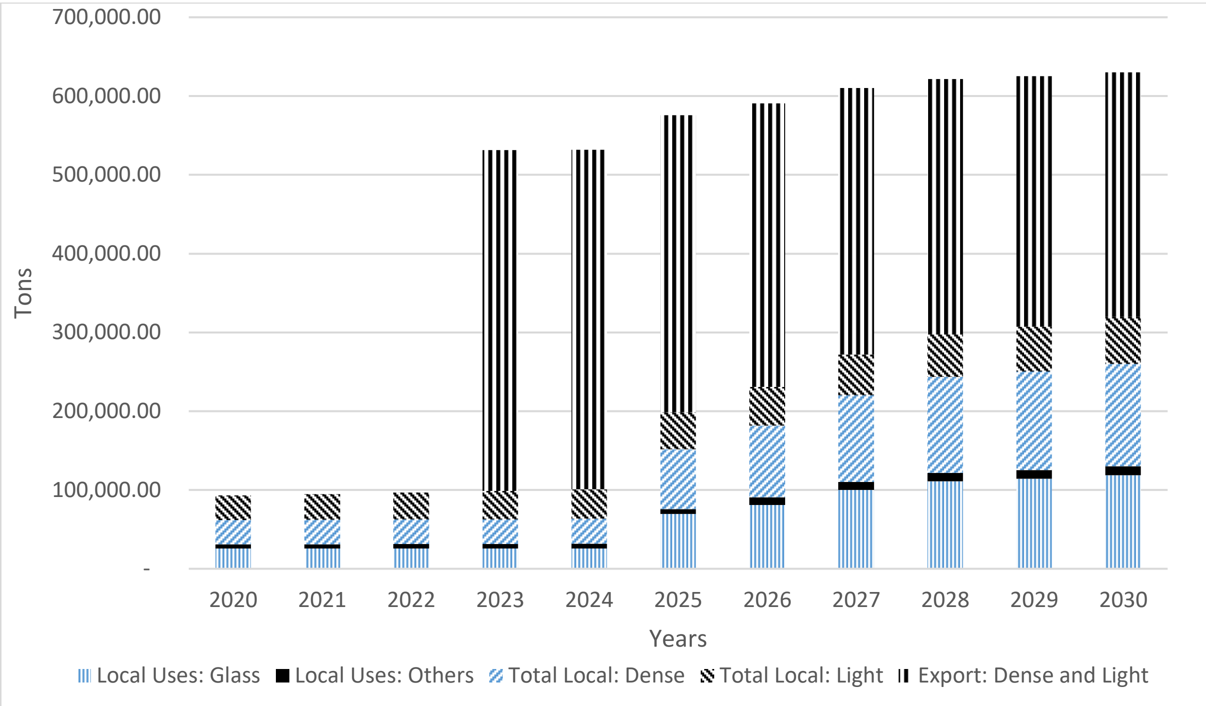



Figure 0.7: Market Estimation for Engaruka Soda Ash in Tons

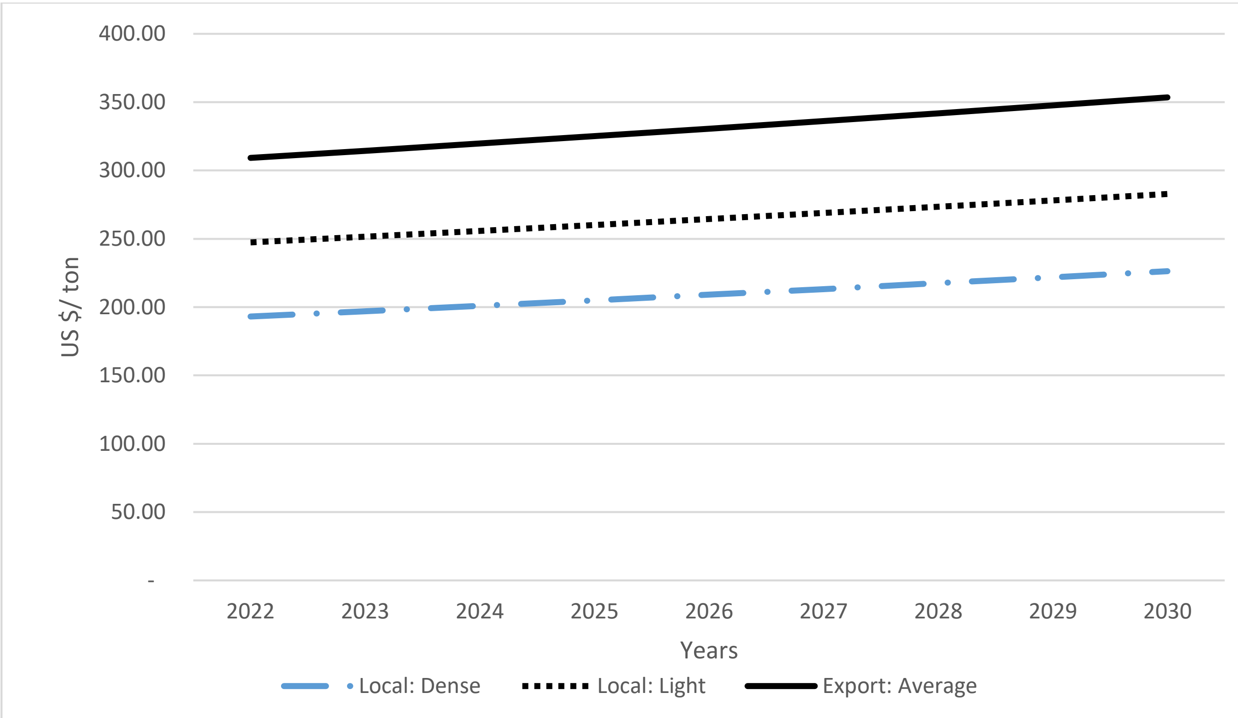



Figure 0.8: Estimated Prices for Soda Ash per Ton in US$

Table 0.22: Estimated Demand forEngaruka Soda Ash

| **Activity Plan** | | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** |
|---|---|---|---|---|---|---|---|---|---|
| Soda Ash: Dense | | | | | | | | | |
| Glass Making (See Table 4:7) | | | | | | | | | |
| | **Sub Total: Glass Making Estimates (tons)** | **25,903** | **25,903** | **69,784** | **81,059** | **99,953** | **111,228** | **114,275** | **118,846** |
| Other Uses | | | | | | | | | |
| | Leather Industry**(tons)** | 1,072.08 | 1,125.68 | 1,181.96 | 1,241.06 | 1,303.12 | 1,368.27 | 1,436.69 | 1,508.52 |
| | Paper Pulp**(tons)** | 2,649.15 | 2,715.38 | 2,783.26 | 5,000.00 | 5,125.00 | 5,253.13 | 5,384.45 | 5,519.06 |
| | Others - Fertilizer/Water treatment/ Animal feeds, etc **(tons)** | 1,823.26 | 1,914.42 | 2,010.14 | 3,500.00 | 3,675.00 | 3,858.75 | 4,051.69 | 4,254.27 |
| | **Sub Total: Others (tons)** | **5,544.49** | **5,755.48** | **5,975.37** | **9,741.06** | **10,103.12** | **10,480.15** | **10,872.83** | **11,281.86** |
| **Total Demand Dense** | **(tons)** | **31,448** | **31,659** | **75,760** | **90,801** | **110,057** | **121,709** | **125,148** | **130,128** |
| | Price per ton (US$) (Based on Botswana Current Price) | 197.00 | 200.94 | 204.96 | 209.06 | 213.24 | 217.51 | 221.86 | 226.29 |

| Activity Plan | | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|
| | **Total Value of Soda Ash Dense (US$)** | **5,102,959.72** | **5,205,018.92** | **14,303,037.52** | **16,946,258.70** | **21,314,178.36** | **24,192,851.63** | **25,352,706.90** | **26,894,151.48** |
| Light Soda Ash | | | | | | | | | |
| | Detergents | 27,308 | 28,674 | 30,108 | 31,614 | 33,195 | 34,855 | 36,598 | 38,428 |
| | Chemical Industries (Caustic soda, etc) 2% of Detergents - Next 5 years, 25% of detergents after 5 years**(tons)** | 546.16 | 573.48 | 7,527.00 | 7,903.50 | 8,298.75 | 8,713.75 | 9,149.50 | 9,607.00 |
| | Sodium Bicarbonate production **(tons)** | **5,369.00** | **5,529.00** | **5,695.00** | **5,865.00** | **6,041.00** | **6,222.00** | **6,408.00** | **6,600.00** |
| | **Others (10% of the usage) (tons)** | **2,785.42** | **2,924.75** | **3,763.50** | **3,951.75** | **4,149.38** | **4,356.88** | **4,574.75** | **4,803.50** |
| | Total Soda Ash: Light**(tons)** | **36,009** | **37,702** | **47,094** | **49,335** | **51,685** | **54,148** | **56,731** | **59,439** |

| Activity Plan | | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|
| | Price per ton (US$) (Based on Cheap price of importation less 12.5%) = 325*(1.125) with 1.5% annual incremental | 306.1 | 310.6 | 315.2 | 319.9 | 324.6 | 329.4 | 334.3 | 339.3 |
| | **Total Value of Soda Ash: Light** | **11,022,354.90** | **11,710,241.20** | **14,844,028.80** | **15,782,266.50** | **16,776,951.00** | **17,836,351.20** | **18,965,173.30** | **20,167,652.70** |
| | | | | | | | | | |
| **Total Local Market Volume** | **Tons** | **67,457.00** | **69,361.00** | **122,854.00** | **140,136.00** | **161,742.00** | **175,857.00** | **181,879.00** | **189,567.00** |
| Average Price (This is below, the low industrial world price as indicated in Figure 3-9) (US$) | | 251.55 | 255.77 | 260.08 | 264.48 | 268.92 | 273.45 | 278.08 | 282.80 |
| **Total Estimated Local Market Value** | (US$) | **16,968,808** | **17,740,463** | **31,951,868** | **37,063,169** | **43,495,659** | **48,088,097** | **50,576,912** | **53,609,548** |
| | | | | | | | | | |
| Planned Production | Tons | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 |
| Local Market Share | | 10% | 10% | 20% | 23% | 29% | 30% | 31% | 32% |
| **Export Market Share** | | **90%** | **90%** | **80%** | **77%** | **71%** | **70%** | **69%** | **68%** |
| **Quantity for Export** | **Tons** | **432,543** | **430,639** | **377,146** | **359,864** | **338,258** | **324,143** | **318,121** | **310,433** |
| **Average Price (Local +12.5%)** | **in US$ (Ref,** | **314** | **320** | **325** | **331** | **336** | **342** | **348** | **353** |

| Activity Plan | | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|
| | Figure 3-9) | | | | | | | | |
| **Total Exports** | **US$** | **135,818,502** | **137,804,480** | **122,572,450** | **119,114,984** | **113,654,688** | **110,856,906** | **110,706,108** | **109,582,849** |
| **Total Revenues from Soda Ash Sale** | | **152,787,310** | **155,544,943** | **154,524,318** | **156,178,153** | **157,150,347** | **158,945,003** | **161,283,020** | **163,192,397** |

## 4.7 Porters Competitive Model

Based on the Porters Competitive model, the establishment of the Engaruka Soda Ash project can be viewed based on the parameters as presented in Figure 4.9.

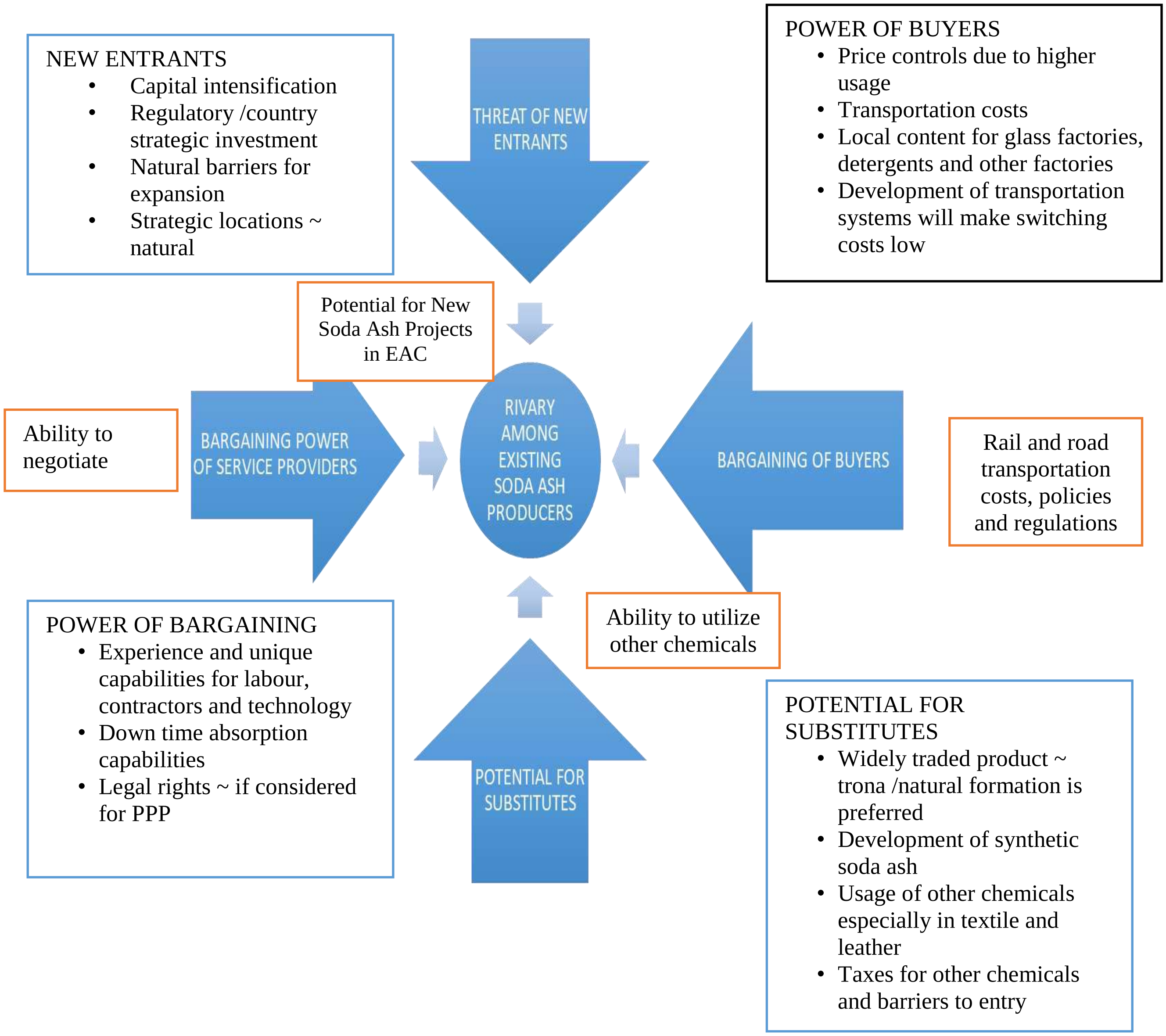



Figure 0.9: Evaluation of Engaruka Soda Ash Project Based on Porter’s Model

## 4.8 SWOT Analysis

SWOT analysis of the soda ash market and products is as shown in Figure 0.10.


Figure 0.10: SWOT Analysis of Soda Ash Across the World

Abundant Deposits of Soda Ash across the World: is the major factor that has driven the growth of the soda ash industry across the world is the abundant deposits of trona and brines which are used as a raw material to manufacture natural soda ash. They are found in large quantities in different regions of the world but major locations include United States, China, Botswana, Uganda, Kenya, Mexico, Peru, India, Egypt, South Africa and Turkey. It is found both as extensive beds of sodium minerals and as sodium-rich waters (brines).

## CHAPTER FIVE

## MARKETING STRATEGIES AND ORGANIZATION STRUCTURE OF MARKETING DEPARTMENT

### 5.1 Marketing Mix based on 5 Ps Model

Based on the 5Ps model developed by Jerome McCarthy in 1960 as presented in Figure 0.1, provides mapping of the marketing activities in this initial stage of assessment of the marketing of the envisaged soda ash project. In later stages, during the implementation of the product, assessment based on the 8 Ps may be undertaken and considered for implementation.


Figure 0.1: Soda Ash Marketing Mix Based on 5Ps

### 5.2 Engaruka Competitive Advantage

Tanzania soda ash project in Engaruka has several competitive advantages for soda ash as compared to other competing producers such as Kenya and Botswana. The competitive advantage relies on the following facts:

1. *Non committed project*

   The project is not committed to one investor as it is for Kenya for-instance. The mined soda ash can be used substantially in the development of the local market for value added products such as glass making.

2. *Location*

   Project location provides low price per unit especially in transport logistics to and from Tanga and Dar es salaam ports as compared to other markets such as Botswana and Zimbabwe markets.

3. *Access to markets*

   Tanzania stands a better chance in accessing markets from the value added service products in the soda ash value chain which includes markets from the EAC countries and SADC countries especially neighbouring countries of DRC Congo, Malawi, Zambia and Mozambique. The EAC and SADC Countries mentioned have no plants for soda ash or large scale use of soda ash especially on glass production. This means, if established in identified locations, a glass making factory will be quite potential to capture markets of these countries as discussed in 3.6.

4. *Logistics*

   Tanzania provides more logistics to the markets, whether local, regional and international markets for the raw soda ash and products from soda ash value chain. This is due to the road networks available in the country, development of the SGR and access to the ocean freight. The project matches with the current development of the logistics infrastructure undertaken by the government which includes expansion of rail, ports and roads.

5. *Supporting infrastructure for the industrial establishment*

   There is supporting infrastructure and political will in the investment of the envisaged project which includes among other development in the power generation, natural gas discoveries and logistics network. Tanzania also has good diplomatic relationship with EAC and SADC countries as well as other potential regions for consumption of Soda ash in the world.

## 5.3 Marketing Strategies

Several marketing strategies are suggested as indicated in this section.

### 5.3.1 Activities for the marketing and promotion

Various marketing activities and promotions should be undertaken in marketing of the soda ash as well as maintain stable relationship with various partners. These may include the following:

1. Participation in trade fairs – local and international. Local trade fairs may be those related to the soda ash value chain. These may be done in collaborations with local and international organization such as TANTRADE, EPZA, TIC and Ministry of Agriculture (Organizers of Nanenane Trade Fairs). The exhibitions will create understanding of the company products and processes.
2. Subscription to the local and international association for soda ash manufacturing and associated product users. Local associations also may be important for the company such

as Confederation of Tanzania Industries and Tanzania Private Sector Foundations (depends on the company structure).

3. Corporate social responsibility – this could be designed as per various guidelines include those of mining sector and TIC guidelines,
4. Promotion of the local industrial development which will enhance the use of soda ash such as collaboration with SIDO for training of SMEs on the use of soda ash to various products. Also training institutions such as VETA, colleges and universities in undertaking training and research on the use of soda ash.
5. Development of effective and interactive marketing and promotion materials. These includes among others the following:
   a. Development and registration of company branding mania – logo, color, names and associated products names
   b. Creation of interactive website(s) for communication of the company affairs, products and services
   c. Increasing and maintenance of company social media account(s) which will communicate various developments of the company operations, products and activities as well as interaction with the potential customers.
6. Analysis of the global industrial data and company data. This is important activities to inform the company on various developments in the market which may include price changes, potential new entrants, technologies and other market related activities relevant to the company business undertaking.

### 5.3.2 Marketing strategies for global companies

1. Collaboration with the Ministry of Foreign Affairs and East African Cooperation for potential market where Tanzania is represented, and where potential investors for Soda Ash or value chain products. Availability of the investors in the project will stimulate the locally usage of soda ash.
2. There is need to collaborate with the regional and international association in the soda ash value chain to access various information including among others related to the soda ash trade and access to the market. These include various committees within the EAC block and SADC, as well as those of WTO.

### 5.3.3 Marketing activities during various stages of project

Before construction

1. Establishment of office for operations – We suggest that the company offices and marketing officer to be based in Arusha.
2. Employment of Marketing Consultant /Ag. Director of Marketing
3. Collaboration with Ministry of Foreign Affairs and East African Cooperation
4. Discussions and collaborations with TBS, BRELA, CTI, TIC, EPZA and other institutions relevant to international
5. Preparation of company branding code for marketing activities

During Construction

1. Subscription to international association
2. Visits to the symposiums and trade fairs of soda ash
3. Development of various policies and procedures regarding marketing and promotions activities
4. Undertaking various development related to pre-operational stage for marketing activities include development of brand mania and promotional tools

After Construction – Operation Stage

1. Employment of the marketing team
2. Implementation of marketing strategies

### 5.3.4 Estimated marketing costs

The estimated marketing costs capitalized and operational for the first year of the project implementation is as indicated in Table 0.1.

Table 0.1: Estimated Marketing Costs

| | | | Construction (Capitalized) | | | | Operation based on 10% year 4 |
|---|---|---|---|---|---|---|---|
| **S/No** | **Main Activity** | **Sub -Activities** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** |
| 1 | Project Promotion Activities | 1.1 Website and Social Media preparation | 30,000,000 | | | | 33,000,000 |
| | | 1.2 Promotional Materials e.g. Profile, Flyers, Banners, Documentaries | 20,000,000 | | | 30,000,000 | 22,000,000 |
| | | 1.3 Local Travels | 12,000,000 | 13,200,000 | 14,520,000 | 15,972,000 | 17,569,200 |
| | | 1.4 International Travels | 18,000,000 | 19,800,000 | 21,780,000 | 23,958,000 | 26,353,800 |
| | | 1.5 Marketing and Promotion costs ~ Media | 36,000,000 | 39,600,000 | 43,560,000 | 47,916,000 | 52,707,600 |
| | | 1.6 Remuneration of Marketing Team/Retainer Fees for marketing* | 27,000,000 | 29,700,000 | 32,670,000 | | |
| | | 1.7 Project Launching costs | | | | 350,000,000 | - |
| | | | | | | | |
| 2 | Subscription to the local and international association for soda ash manufacturing | 2.1 Local Association - CIT | 4,000,000 | 4,000,000 | 4,000,000 | 4,000,000 | 4,400,000 |

| | | | Construction (Capitalized) | | | | Operation based on 10% year 4 |
|---|---|---|---|---|---|---|---|
| **S/No** | **Main Activity** | **Sub -Activities** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** |
| | and associated product users. | | | | | | |
| | | 2.2 International Association (02) | 10,000,000 | 10,000,000 | 10,000,000 | 10,000,000 | 11,000,000 |
| 3 | Participation in trade fairs – local and international. Local trade fairs may be those related to the soda ash value chain. The exhibitions will create understanding of the company products and processes. | 3.1 Local Trade Fairs (7/7 and 8/8) | | | 16,520,000 | 16,520,000 | 18,172,000 |
| | | 3.2 TANRADE, EPZA, TIC Organized (at least 1 quarterly | | | 80,000,000 | 80,000,000 | 88,000,000 |
| 4 | Corporate social responsibility – this could be designed as per various guidelines include those of mining | 4.1 Gross Budget for Corporate Social Responsibility | | 30,000,000 | 40,000,000 | 50,000,000 | 55,000,000 |

| | | | Construction (Capitalized) | | | | Operation based on 10% year 4 |
|---|---|---|---|---|---|---|---|
| **S/No** | **Main Activity** | **Sub -Activities** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** |
| | sector and TIC guidelines, TEIT, etc | | | | | | |
| | *costs before employment of permanent staff | | 157,000,000 | 146,300,000 | 263,050,000 | 628,366,000 | |
| | Total Estimated Marketing costs - Capitalized | | | | | **1,194,716,000** | |
| | **Marketing Annual Costs - Year of Operations - OPEx** | | | | | | **328,202,600** |

### 5.3.5 Key partners in marketing

Key partners in the marketing value chain are as outlined in Figure 0.2. During the implementation stage a details of the partners and engagement strategy should be prepared for effective marketing of the soda ash.


Figure 0.2: Key Partners in the Marketing Activities of the Envisaged Soda Ash Project

### 5.3.6 Sales

Sales of the soda ash are expected to take two forms:

1) Direct sales from the manufacturing or area of production to the export market and large scale project company owned by the investors of the plant who will use soda ash in feed stock. Investors are expected to use soda ash in large quantities and thus preferably investors in glass making industry are preferable. Only huge quantities over 50 tons/ year will be delivered directly from manufacturer.
2) Sales through distributors

Local companies other than investors companies will need to buy from a distributor. This is due to the bulkiness of the products and need to undertake marketing and promotion purposes. Distributors can also seek export market. This model will create jobs and competition in the sale of the product in the world market. Threshold of tons per year for the distributor will be determined based on the market development and during the implementation stage.

Distributors and manufacturers can maintain various storage facilities to ensure they preserve the quality of the soda ash. The sales model is as indicated in Figure 0.3

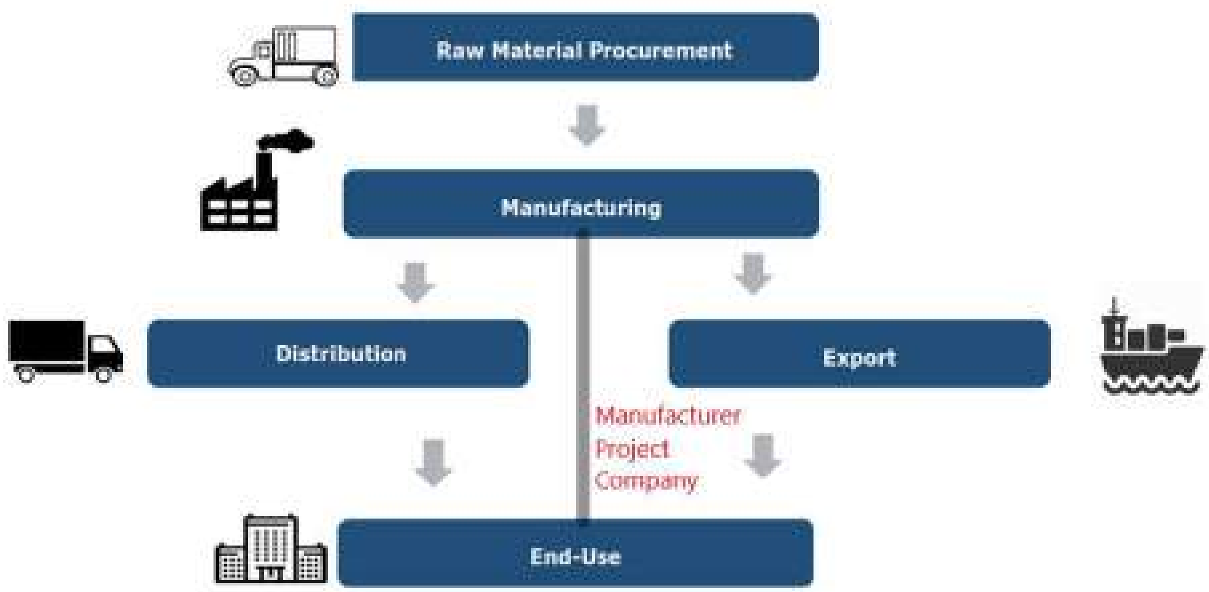



Figure 0.3: Sales Model for Engaruka Soda Ash

### 5.3.7 Price as Key Determinant Factor in Marketing

Price is the key determining factor for the marketing of soda ash. For this matter, there is an importance of setting up good pricing mechanisms which should be determined by technology, production processes, logistics arrangement and operation plan of the mined soda ash in Engaruka. The business structure, financial arrangement, ownership structure and business model of the proposed vehicle will also determine the price and usage of soda ash within the country and the soda ash required for production. The main driver of the consumption of soda ash within the country should be linked with the ownership and financial structure. This has been the case in several countries which mine soda ash.

## 5.4 Analysis of Key Market Barriers and Risks

### 5.4.1 Key Market Barriers

Soda ash is a widely and mostly traded product in the world. This is due to its potential usage in various sectors and industries. Various international companies and countries set trade barriers to such product to among others protect their local production or value addition products, especially where there is a new entrant in the market. Such market barriers may include the following:

1) Trade barrier which may resulting from filing of anti-dumping investigations. Several countries have anti-dumping policies and rules and their various provisions and aim for this policies and rules are attributed in the protection of the domestic industries. Anti-dumping rules relate to the price settings and may affect the business. Recent world disputes on soda ash include that of India vs. USA and Turkey which is currently under investigation. Anti-dumping is restrictions of a product where current market of a product from another country can be sold cheaply thank the cost of manufacturing it at the local market. These forms of restriction in soda ash are common given the duo process of producing light soda ash.
2) Imposition of non-tariff barriers in the exports of goods across countries. This form of market protection which may force changes in prices of the produce. E.g. Major Glass companies may have direct linkage with the soda ash producing companies as shareholders and thus determine various volumes and prices for soda ash. Changes in the market for the glass industry automatically change the prices of soda ash and thus affect the manufacturer. Given the market entry is controlled is unlikely to compete in the local market. Major distributors may also threaten consumers by various ways given the nature and usability of the product. Since the product is to be used in international markets, there is also a possibility that international distributors may not be willing to sell the product as it may compete with the local market. To mitigate this, soda ash may be mentioned in bilateral trade agenda of major trade partners.
3) Embargo – various restrictions based on embargo may be imposed on the soda ash. E.g. Evidence of utilizing soda ash and exporting products resulting from soda ash as feedstock. This may include e.g. evidence of glass producers to export equivalent value of glass to an exporting country.
4) Tariffs – to protect local industries and availability of soda ash countries set tariffs to non-trading partners not to take advantage of the product. E.g. selling to Country X may be subject to 25% import duty but another country with bilateral trade agreement or in the same trading block may agree on 0% tariff. For this case market penetration of the countries may be difficult, also market access to such trading blocs with preferential advantage and where soda ash is produced or used. For instance countries like US have certain relationships with other trading partner in the world, and soda ash is the mostly traded product by the USA. USA maintains permanent normal trading relationships with various countries which favors USA and partner product relationship in such countries.

5) Barriers involving environment concerns – recently there has been an attachment to the environment to business dealings. Companies across the world places high value for the utilization of feedstock or products that do not take care of environmental aspects and social responsibility.
6) Technological concerns – in some cases products which are made through a certain technology may be banned from other countries for trading purposes. There is need to investigate technologies applicable for the extraction of soda ash and for the subsequent products which has potential to produce value.

### 5.4.2 Risks

Market risks which are of concern to the market include the following:

1) Competition: Soda ash is a widely traded product. Various investors in the past have shown interest to invest in Tanzania soda ash. These include Chinese, Japanese and Indian Investors. They were not successful due to various reasons. These companies are also global investors in other parts of the World. E.g. Tata Chemicals an Indian company which showed interest in investing in soda ash plant in Tanzania has also such ventures in Kenya and USA. On the other hand, various technologies are available for making soda ash including the synthetic process. Given the widely traded product like soda ash, competition in the global industry is expected to be high. To mitigate the competition, there should be a measure to collaborate with potential investors of partner countries where Tanzania has favorable terms of trade and at the same time with potential for internal consumption.
2) Thin local market: The consumption of soda ash in Tanzania and the EAC region is still very low. Sustainable soda ash sales resulting from building local customers and create competitive pricing and consistency in supply of the product. There is need to boost local manufacturing for products which utilize soda ash as feedstock. Also, there is need to liaise with various partners to attract foreign direct investment in the various sectors such as glass marking.
3) Prices: Soda ash prices have been subjected to price changes and in the future may be volatile. Lower soda ash prices may affect financial position and results of operations. The company will deal with one product only which is soda ash, and the market price of soda ash will directly affect the company profitability. Prices for soda ash may fluctuate in response to relatively minor changes in the supply of and demand for soda ash, market uncertainty and other factors such as overall economic conditions in the world, additional suppliers, customer demands especially in the glass making industry, global production trends, costs of producing soda ash, political conditions and trade relations. Prevailing international economic conditions may affect foreign exchange rates, and adversely affect the markets and envisaged clients.
4) Transportation and freight costs: These may substantially affect the prices and delivery to the clients. There is need to ensure a well-planned logistic for soda ash as may affect the

cost as well as reliability of the product to the customers. Increase in transport cost which may be affected by various aspects such as fuel prices may affect the price per unit sold and thus, profitability of the company.

5) Exchange rate fluctuations: Exchange rate fluctuations may affect price and operations of the proposed plant. This may also affect customers of soda ash.

6) Customer business diversification: A significant portion of the demand for soda ash comes from glass manufacturers and other industrial customers. Companies that operate in the industries that glass manufacturers serve, including the automotive, construction and glass container industries, may experience significant fluctuations in demand for their own end products because of economic conditions, changes in consumer demand, or increases in raw material and energy costs. A recent case has been on the ZIMGlass which was major importer of soda ash from Botswana which is now under restructuring. Several factors may as well impact these major customers such as credit availability, increased use of recycled glass, markets and operations of such industries – including price of energy which may affect their demand for soda ash and thus affects project company operations.

7) Mining policies and rules on development, exploration and processing may pose challenges in production and marketing of soda ash for consumption both locally and in international markets.

8) Taxes, regulations, governmental policies, trade agreements (bilateral, regional, and global) or their interpretations to products related to mining, soda ash, or industries that use soda ash may affect the estimated market for soda ash project.

## 5.5 Organization Structure

The organization structure of the marketing department is designed to be headed by a Director, with three managers dealing with communications, Local and Overseas sales. The local manager may have two functions which are dealing with institutional customers (possibly the investors who are also off takers) and agents/distributors. It is proposed that for effective marketing function, there is need to separate roles of the producers from those of distributors as it is for various countries. Appendix IV provides list of Manufacturers of Soda Ash and distributors. The list may also be important in the future market of the product as to search which are international customers to consider.

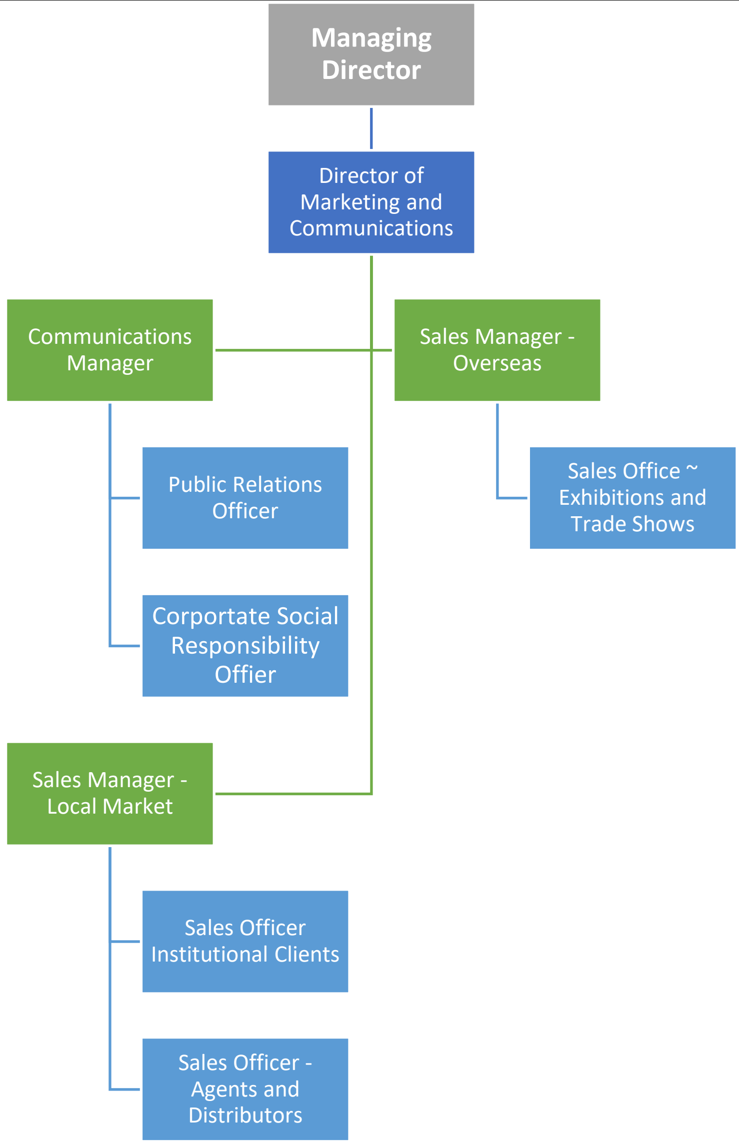



Figure 0.4: Organization Structure of Marketing Department of the Proposed Engaruka Soda Ash Project

Number of staffing required for the marketing department is as indicated in Table 0.2.

Table 0.2: Staffing Required for Marketing Activities

| Position | | No Year 0 | No Year 1 |
|---|---|---|---|
| Director Marketing and Communication | | 1 | 1 |
| Communications Manager | | 0 | 1 |
| Sales Manager - Local Market | | 0 | 1 |
| Sales Manager - Export Market | | 1 | 1 |
| Sales Personnel | | 0 | 3 |
| Total | | 2 | 7 |
| Note. | Year 0 >Before and During Construction | | Year 1> Operation |

# CHAPTER SIX

# CONCLUSION AND RECOMMENDATIONS

## Conclusion

Soda ash has high demand both in the local and international markets. Its market is majorly driven by the growing demand for end-user industries. The government efforts to promote Tanzania ya Viwanda need to be re-aligned with the industries that consume locally available input (to promote local content) – thus, the need to prioritize the proposed areas (industries and geographical wise).

The soda ash market reached a volume of 59.30 Million Tons in 2018, growing at a cumulative annual growth rate (CAGR) of 1.67% during 2011-2018, while the market value of US$ 17.86 Billion was realized, exhibiting a CAGR of 2.53% during 2011-2018. This indicates an increase in the price of soda ash in the 8 years of analysis.

Globally, at least 50% of the main users of soda ash constituted glass industries during the past two years. More specifically, the glassmaking industry used 53% of the 60 million tons of soda ash produced in the world in 2019; followed by soaps and detergents (15.0%), chemicals (8.6%), metallurgy (6.0%), pulp and paper (1.1%) and others (18.1%). The float glass sector consumed 29%, the container industry 19% and other glass segments 5%.

In 2018, China represented the largest consumer of soda ash globally, accounting for 41.6% of the total soda ash market. China was followed by Asia- Pacific (Excluding China) (21.7%), Europe (13.0%), North-America (12.1%), Middle East and Africa (6.9%) and Latin America (4.7%).

The United States of America (USA) is the world's largest exporter of soda ash (by volume) accounting for 41.7% of the total global export volumes of 6,965,000 Tons in 2018. The USA was followed by Turkey (20.6%), China (8.3%), Bulgaria (7.8%), Russian Federation (5.1%) and Germany (3.9%). The global market share of soda ash for the top five exporting countries covers 54.9% of the global market share.

Brazil represents the largest global importer of soda ash (by volume) accounting for 8.7% of the global import volumes of 1,388,019 Tons in 2018. Brazil was followed by Mexico (7.8%) with import volumes of 1,236,908 Tons, Indonesia (6.4%) with import volumes of 1,013,623 Tons, India (5.4%), Thailand (5.2%) and Republic of Korea (3.5%). However, Korea and India are the most importers of soda ash based on the value of the imports in 2018.

Prices of Soda ash are increasing in the World due to increased demand which does not match with the supply. The price of soda ash has been increasing at a CAGR of 0.84% during 2011-2018, reaching a value of around US$ 301 per ton in 2018.

Exporters generally earn a profit margin of 10% to 12% by exporting the final product to the end users and distributors based in foreign countries. Distributors generally add a profit margin of 9% to 11% and sell it to the end use industries.

Based on the International Trade Centre (ITC) Statistics, SADC importation of soda ash in 2018 was 524,400 tons. Botswana is the largest producer of Soda Ash in the SADC region with capacity of 300,000/yr, currently producing 280,000 tons/yr. The major market for the Botswana soda ash is the South Africa which consumes about 250,000 tons/yr. Other SADC countries (mostly to Zimbabwe – ZIMGlass) consume the rest. Tanzania has an estimated untapped soda ash potential of US$ 3 million a year. This translates to about 10,000 tons extra to the current importation of about 35,000 tons per year. Trade indicators for the year 2014-2018 indicates that the region unit price for soda Ash was US 214 per ton, the lowest being in South Africa which was US$192 per ton.

Exports of soda ash in the EAC reached 342,780 tons in 2017 and declined to 289,350 in 2018. Kenya is the main exporter of Soda Ash in the region. Kenya export soda ash dense and main destination is in India following investment of Soda Ash plant by an Indian investor, TATA Chemicals. Based on the 2018 data of imports trend for EAC, the importation of Soda Ash is below 60,000 tons per year. The largest importer of Soda Ash is Tanzania with an average of 35,000 tons per year, followed by Uganda which imports about 15,000 tons per year. Based on the 2014-2018 trade indicators, average price per ton for imported soda ash was US$302

Importation of the soda ash in Tanzania is coordinated at the Office of Government Chemist. According to the Government Chemist Office, for the year 2019, importation certificates issued indicated that imports of soda ash were around 15.2 million kilograms. About 60% of the imported soda ash was used in the glass manufacturing firm. Soap and Detergent Industry is the second biggest user of the imported soda ash after the glass industries.

Based on the Trade map statistics maintained by the International Trade Centre, it was reported that in 2018, Tanzania imported a total of 38,899 tons valued at 11.4 mil US$. Currently, the Soda ash used in Tanzania is mainly imported from China, Romania, India, Bosnia and Herzegovina, Bulgaria, Russian Federation, Kenya, Turkey, Lebanon Hong Kong, China, Belgium and United Arab Emirates. On average, price per ton was US$328, lowest price being US$ 296 per ton.

According to the International Glass, the glassmaking industry used 53% of the 60 million tons of soda ash produced in the 2019. The flat glass sector consumed 29%, the container industry 19% and other glass segments 5%.

Tanzania is a home to Kioo Limited, which is the largest single manufacturer of glass packaging for the soft drink, beer, liquor, food industries in East and Central Africa. In the last three years (i.e. 2017, 2018 and 2019), Kioo Limited imported an average of 18,450 tons of soda ash at an average price of US$353.67 per ton. This was equivalent to an average of 53% of total importation of soda ash in the country - from 2017 to 2019, the firm imported respectively 13,215 tons [@ US$ 321]; 16,762 tons [@ US$357] and 25,371 tons [@ US$ 383].

The next big players after glass manufacturing firm are producers of Soap and Detergents – the Big 6: Royal Soap and Detergent Industries Ltd, Murzah Soap and Detergents Ltd, Clinsoft, GandB Soap Industries Ltd, Azania Limited, Mikoani Edible Oil and Detergent Ltd - usage in detergents ranges from 40% to 65%. Moreover, other significant soda ash importers and traders in the local market, include Tata Africa Holdings (T) Ltd, New Rainbow Africa Limited, Bomet Corporation Limited, Pu Sen Building Materials Company Limited, Global Leader Entreprise (T) Ltd, Chemi and Cortex Industries Ltd, and Prayosha Industries Ltd.

There are potential markets in the making. It is necessary that the responsible authorities pursue them as they provide a significant demand for the soda ash product. For instance, in 2016 Chinese-Tanzanian Company announced USD 80 Million Investments to setup largest float glass factory in Tanzania. The planned factory in Mkuranga, Coastal region was planned to produce an average of 600 tons of float glass per day, with annual capacity of 135,000 tons to 160,000 tons per year. Tanzania ranks 8$^{th}$ within the Top 10 importers with USD 10.7 million accounting for 4.3% of the total float glass imported to Africa in 2013 and 2nd behind Kenya. Tanzania has favourable condition for glass manufacturing because of its rich in silica sand, limestone, dolomite and soda ash which are all essential materials in glass making. Moreover, NDC has plans to establish the science apparatus industry in Mwanza and glass sheet industry in Dar es Salaam. With the number of education institutions from secondary school to universities increasing, the demand for science apparatus is expected to increase. Likewise, the housing construction industry is booming in large cities throughout the country with high demand for sheet glasses.

The design for Engaruka plant is estimated to be 500,000 tons per year. This design is reasonable to meet the demands for local, regional and the international markets. It is estimated that the exports of soda ash is likely to be 87% of the total produce. The local market is expected to absorb 13% to 30% at the end of 2030 given promotion of local industrial uses of the soda ash as suggested in this plan.

**Recommendations**

Tanzania soda ash project in Engaruka has several competitive advantages for soda ash as compared to other competing producers such as Kenya and Botswana, especially when we take into account variables such as - non committed project, location, access to markets, logistics and supporting infrastructure for the industrial establishment. Several joint marketing strategies are suggested in the report.

| Sn | Suggested Strategy/Activity | Responsible Party(ies) |
|---|---|---|
| 1. | Subscription to the local and international association for soda ash manufacturing and associated product users. | Envisaged Operator of the Project |
| 2. | Participation in trade fairs – local and international. Local trade fairs may be those related to the soda ash value chain. The exhibitions will create understanding of the company products and processes. | TANTRADE, EPZA, TIC and Ministry of Agriculture (Organizers of Nane Trade Fairs). |

| Sn | Suggested Strategy/Activity | Responsible Party(ies) |
|---|---|---|
| 3. | Corporate social responsibility – this could be designed as per various guidelines include those of mining sector and TIC guidelines, TEIT, etc | Envisaged Operator of the Project |
| 4. | Capacity building and Promotion of the local industrial development which will enhance the use of soda ash.<br>Capacity building by local colleges and universities on the soda ash value chains. | SIDO, TVET institutions |
| 5. | Development of effective and interactive marketing and promotion materials - logo, color, names and associated products names; interactive website(s) for communication of the company affairs, products and services; Creating and maintenance of company social media account(s) which will communicate various development of the company operations, products and activities as well as interaction with the potential customers. | Envisaged Operator of the Project |
| 6. | Analysis of the global industrial data and company data. This is important activities to inform the company on various developments in the market which may include price changes, potential new entrants, technologies and other market related activities relevant to the company business undertaking. | Envisaged Operator of the Project |
| 7. | Collaboration with the Ministry of Foreign Affairs and East African Cooperation for potential market where Tanzania is represented, and where potential investors for Soda Ash or value chain products. Availability of the investors in the project will stimulate the locally usage of soda ash. | Ministries responsible for – Investment; Industry and Trade; Foreign Affairs |
| 8. | There is need to collaborate with the regional and international association in the soda ash value chain to access various information including among others related to the soda ash trade and access to the market. These include various committees within the EAC block and SADC, as well as those of WTO. | Ministries responsible for – Investment; Industry and Trade; Foreign Affairs |

Sales of the soda ash can take two forms:

- ✓ Direct sales from the manufacturing or area of production to the export market and large scale project company owned by the investors of the plant who will use soda ash in feed stock. Investors are expected to use soda ash in large quantities and thus preferably investors in glass making industry are preferable. Only huge quantities over 50,000 tons/ year will be delivered directly from manufacturer.
- ✓ Sales through distributors: Local companies other than investors companies will need to buy from a distributor. This is due to the bulkiness of the products and need to undertake marketing and promotion purposes. Distributors can also seek export market. This model will create jobs and competition in the sale of the product in the world market. Threshold of tons per year for the distributor will be determined based on the market development and during the implementation stage. Distributors and manufacturers can maintain various storage facilities to ensure they preserve the quality of the soda ash

Markets and Marketing of Soda Ash

- ✓ There is a need to create local capacity for consumption of the soda ash and investigate further the international market
- ✓ Logistics and transportation is an important aspect of the soda ash value chain. There is need to thoroughly design the transport and logistics which will ensure cost effective for the final product produced.
- ✓ There is need for capacity building for the marketing staff on how to market the products and get pace with the world trend of the products.
- ✓ The project company should subscribe to various marketing associations and regional trading blocks to ensure effective marketing of the product, and to compete with current exporters of similar product in the region.

Stimulation of Soda Ash Usage

- ✓ Regional and Local Government Administration to consider promoting industries which potentially use soda ash by setting us land for industrial investment and providing necessary infrastructure
- ✓ TFRA to invite investors who can invest in fertilizer production using soda ash as a feed stock
- ✓ TANROADS, TARURA and TRC to set up necessary infrastructure to facilitate transport to the industrial areas
- ✓ Utilities services providers such as TANESCO and water authorities to consider supporting LGAs and Regional Administration officers on the provision of necessary infrastructure in supporting industrialization which can potentially use soda ash
- ✓ Tanzania Investment Centre, TANTRADE, EPZA to come up with a strategy to publicize the potential investment for utilization of soda ash. This can be through formulation of a special unit to publicize investment using soda ash as a feedstock or important ingredients as the case of Botswana.

- ✓ TIC in collaboration with the Ministry of Foreign Affairs and East African Cooperation to find ways of informing the country representatives especially where Tanzania imports Soda Ash or imports substantially value added products produced from soda ash on the need to invest in Tanzania to the identified economic zones, for the utilization of soda ash and exploring the neighbouring markets for secondary products made out of soda ash.
- ✓ There is need to train small scale producers who can potentially use soda ash e.g. capacity building through Small Industries Development Organization (SIDO).
- ✓ Sector development strategies which may lead to the consumption of soda ash should closely be monitored. These include strategies in the textile, livestock and leather industries.

Recommended marketing activities during various stages of the project:

Before construction

- ✓ Establishment of office for operations – We suggest that the company offices and marketing officer to be based proximity to the project area, in Arusha.
- ✓ Employment of Marketing Expert /Ag. Director of Marketing
- ✓ Collaboration with Ministries responsible for Investments, Industry and Trade, LGAs, Foreign Affairs and East African Cooperation , etc.
- ✓ Discussions and collaborations with TBS, BRELA, CTI, TIC, EPZA and other institutions relevant to international
- ✓ Preparation of company branding code for marketing activities

During Construction

- ✓ Subscription to international association
- ✓ Visits to the symposiums and trade fairs of soda ash
- ✓ Development of various policies and procedures regarding marketing and promotions activities
- ✓ Undertaking various development related to pre-operational stage for marketing activities include development of brand mania and promotional tools
- ✓ Capacity building to promote local content

After Construction – Operation Stage

- ✓ Employment of the marketing team
- ✓ Implementation of marketing strategies

Additionally, there is need to consider the following:

Policy to Promote Soda Ash Usage

- ✓ There is need to impose an import duty of soda ash and related products from soda ash utilization after the successful operation of the plant and associated value chain industries. Suggested rates may range from 5% to 25% depending on the market needs.

- ✓ There is need to liaise with various partners for bilateral trade agreements and to initiate anti-dumping measures of soda ash following the extraction of the resource.

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# APPENDICES

## APPENDIX I: DATA FROM TANZANIA INVESTMENT CENTRE (TIC) AND THE BUSINESS REGISTRATIONS AND LICENSING AGENCY (BRELA)

Number of Potential Users of Soda – Ash in the local market (TIC)

| S/N | Potential Users | No. of Establishment Registered at TIC |
|---|---|---|
| 1 | Petroleum Refining Industry | 7 |
| 2 | Detergents | 16 |
| 3 | Paper Industries | 35 |
| 4 | Glass Making Industry | 19 |
| 5 | Water treatment Industry | 7 |
| 6 | Steel Industry | 75 |
| 7 | Textile Industry | 36 |
| 8 | Mineral Processing | **47** |
| | **Total Establishments** | **242** |

Number of Potential Users of Soda – Ash in the local market (BRELA)

| S/N | Potential Users | No. of Establishment Registered at TIC |
|---|---|---|
| 1 | Petroleum Refining Industry | 6 |
| 2 | Detergents | 27 |
| 3 | Paper Industries | 28 |
| 4 | Glass Making Industry | 6 |
| 5 | Water treatment Industry | 51 |
| 6 | Steel Industry | 40 |
| 7 | Textile Industry | 23 |
| 8 | Mineral Processing | 5 |
| | **Total Establishments** | **186** |

Appendix II: **List of the Respondents from the Field Study**

| S/No | Name | Institution | Location | Title | Tel No |
|---|---|---|---|---|---|
| 1 | Richard Kwitega | Arusha Regional Office | Arusha | Regional Administrative Secretary | 0754750067 |
| 2 | Mathias Seif | Arusha Regional Office | Arusha | Regional Economist | 0754264435 |
| 3 | Jerry Muro | Arumeru District Council | Arusha | District Commissioner | 0745333833 |
| 4 | Mwl. James Mchembe | Arumeru District Council | Arusha | District Administrative Offer | 0767687438 |
| 5 | Emmanuel J. Mkongo | Arumeru District Council | Arusha | District Executive Director | 0755657797 |
| 6 | Maarufu Mkwaya | Arumeru District Council | Arusha | District Planning Officer | 0765102259 |
| 7 | Mahuma Yudas | Arumeru District Council | Arusha | District Land Officer | 0754274255 |
| 8 | Kitwana | Crown Paints (T) Limited | Arusha | Production Manager | 0786901227 |
| 9 | Stephen Anderson Ulaya | Monduli District Council | Arusha | District Executive Director | 0755757910 |
| 10 | Iddi Kimanta | Monduli District Council | Arusha | District Commissioner | 0767880580 |
| 11 | Mwakyeto Colex | Monduli District Council | Arusha | District Planning Officer | 0752599742 |
| 12 | Matuba | Monduli District Council | Arusha | Treasurer | 0768250597 |
| 13 | Humphrey Myombela | AUWASA | Arusha | Technical Manager | 0737833663 |
| 14 | | Government Chemist | Dar es Salaam | | |
| 15 | Gerald Magola | Tanzania Bureau of Standards | Dar es Salaam | Head, Department of Chemicals | 0755291350 |
| 16 | Joseph Nziku | Tanzania Bureau of Standards | Dar es Salaam | Standards Officer, Chemical Department | 0767141069 |
| 17 | Henry Msuya | Tanzania Bureau of Standards | Dar es Salaam | Standards Officer, Chemical Department | 0765877509 |

| S/No | Name | Institution | Location | Title | Tel No |
|---|---|---|---|---|---|
| 18 | Joseph Mwita Wichoka | TATA Chemicals | Dar es Salaam | Technical and Sales Manager | 0784214105 |
| 19 | Godliving Makundi | GnB Soap | Dar es Salaam | Operations Manager | 0713786354 |
| 20 | Mohammed V. Remtulla | Kioo Limited | Dar es Salaam | Administrative Manager | 0784780240 /0222860190 |
| 21 | Dr Anthony Marwa | Kioo Limited | Dar es Salaam | Health Safety and Environmental Manager | 0754079444 /0222860190 |
| 22 | P. Mozumder | Kioo Limited | Dar es Salaam | Plant Manager | 0222860190 |
| 23 | Eng. Ramson Mwilangali | National Development Corporation | Dar es Salaam | Director, Heavy Industry | 0754782524 |
| 24 | Eng. Wallu Kapaya | National Development Corporation | Dar es Salaam | Mineral Engineer | |
| 25 | Mr. Said Tunda | National Development Corporation | Dar es Salaam | Ag. Director, Value Addition | |
| 26 | Richard Msumule | Kioo Limited | Dar es Salaam | Human Resources Manager | 0222860190 |
| 27 | Pramond Balasubramanian | Organic Chemicals Ltd | Dar es Salaam | Product Manager - Expansions | 0787470545 |
| 28 | \shabeen Sudevan | Organic Chemicals Ltd | Dar es Salaam | GM Product innovation and Technology | 0693690121 |
| 29 | Daudi Mwansasu | University of Dar es Salaam | Dar es Salaam | Dept. Chemistry, Glass Blowing Unit | 0754289275 |
| 30 | Abdiel Msangi | Dodoma City Council | Dodoma | Planning Officer | 0784416176 |
| 31 | Condrad Mtui | Mineral Commission | Dodoma | Mineral Officer | 0655266723 |
| 32 | Geofrey Malya | Geological Survey of Tanzania | Dodoma | Geologist | 0756238434 |
| 33 | Elinami Kimaro | Mineral Commission | Dodoma | Investment Analyst Officer | 0737891189 |
| 34 | Stanley Daudi | Ministry of Water | Dodoma | Water Quality officer | 0715994957 |

| S/No | Name | Institution | Location | Title | Tel No |
|---|---|---|---|---|---|
| 35 | Leon M. Lyayuka | Ministry of Industry and Trade | Dodoma | Director of Industrial Development | 0784218155 |
| 36 | Mona Mahecha (Mrs) | Foreign Affairs | Dodoma | Representative of Europe and America Embassy | 0754536453 |
| 37 | Mavuruko Msechu | Geological Survey of Tanzania | Dodoma | Ag. Director of Geological Services | 0754273977 |
| 38 | Erick Koko | Davis and Shirtliff | Dodoma | Branch Manager, Dodoma | 02623211616 |
| 39 | | Ministry of Water | Dodoma | Director of Water Quality | |
| 40 | Mr. William Martin Mwasi | | Engaruka, Arusha | Resident – Engaruka; Site Guide | 0762705461 |
| 41 | Mr. Mayunga Danga | | Engaruka, Arusha | Village Executive Officer - Irereni Engaruka | 0714393372 |
| 42 | Mr. Machungwa Sekino | | Engaruka, Arusha | Village Chairman, Engaruka Chini | 0763555582 |
| 43 | Happines W. Seneda | Regional Office | Iringa | Regional Administrative Secretary | 0788398030 |
| 44 | Elias Luvanda | Regional Office | Iringa | Assistant to Regional Administrative Secretary - (Economist) | 0735717846 |
| 45 | Fred Kazembe | Regional Office | Iringa | Assistant to Regional Administrative Secretary - (Planning) | 0768260159 |
| 46 | Richard Maketta | IRUWASA | Iringa | Head, Water Quality Lab | 0754880506 |
| 47 | Eng.Martine Maingu Lusindiko | IRUWASA | Iringa | Water Engineer | 0754748457 |
| 48 | Eng. Chogo G. J | Mufindi Paper Mills Ltd | Iringa | Manager | 0755683118 |

| S/No | Name | Institution | Location | Title | Tel No |
|---|---|---|---|---|---|
| 49 | Emmanuel Tutuba | Mwanza Regional Office | Mwanza | Regional Administrative Secretary | 0767620242 |
| 50 | Dr Yohana Sagenge | Mwanza Regional Office | Mwanza | Act. Assnt RAS Economic and productive Sectors | 0767859246 |
| 51 | Eng. Gogadi Mgwatu | MWAUWASA | Mwanza | Water Quality Engineer | 0754536912 /1017846221 |
| 52 | Eng. Joseph Mwita | MWAUWASA | Mwanza | Water Engineer | 0754533430 /0717856187 |
| 53 | Martha Ndetto | Nyanza Cooperative Union | Mwanza | General Manager | 0754443211 |
| 54 | Masalu | Nyanza Cooperative Union | Mwanza | Operations Manager | 0754624831 |
| 55 | Eng. Stanley Minja | Serengeti Breweries Limited | Mwanza | Quality Engineer | 0689560788 |
| 56 | Deminic Mkenagwa | Serengeti Breweries Limited | Mwanza | | 0788041660 |
| 57 | Bakari Songwe | SIDO | Mwanza | Manager | 0735291014 |
| 58 | Alvin Vemula | Nyakato Steel Mills Limited | Mwanza | Acting Managger | 0787370432 |
| 59 | Silvanus Phillip | Nyakato Steel Mills Limited | Mwanza | Human Resources Manager | 0757806224 |
| 60 | Amin | Mwatex | Mwanza | Managiing Director | 0784484204 /0282570550 |
| 61 | Emmanuel Bamgaya | DIT | Mwanza | Leather Processing Supervisor | 0755526932 |
| 62 | Issa Mwangosi | DIT | Mwanza | Head, Leather Technology Dept | 0754660973 |
| 63 | Benedicto Malale | ACL Cleaners and Hygiene | Mwanza | Propriator | 0755099572 |
| 64 | Propser Kulaya | Tanzania Cotton Boaord | Mwanza | Actng. Director General | 0784626457 |
| 65 | Buluma Kalidushu | Tanzania Cotton Boaord | Mwanza | Regulatory Incharge | 0784626457 |
| 66 | Renatus Boniface | ACL Cleaners and Hygiene | Mwanza | Machine Operator | 0755898286 |

| S/No | Name | Institution | Location | Title | Tel No |
|---|---|---|---|---|---|
| 67 | Benedict Njau | Regional Office | Tanga | Asst. RAS Economics and Manufacturing | 0754945242 |
| 68 | Rahma Nasoro | Regional Office | Tanga | Business, Industry and Investment Officer | 0674862612 |
| 69 | Daudi Mayegi | Tanga City Council | Tanga | City Director | 065099900/ 0787800003 |
| 70 | Ramadhani S. Possi | Tanga City Council | Tanga | City Economist | 0763639797 |
| 71 | Jitesh Tamakuwala | ARM Minerals | Tanga | Director Operations | 0784111385 |
| 72 | **Felix Tarimo** | **ARM Minerals** | **Tanga** | **Technical Manager** | 0782443569 |
| 73 | Sikander Hussein | Unique Still Mill Limited | Tanga | General Manager | 0713315469 |
| 74 | Jaggi Nimrmal | Unique Still Mill Limited | Tanga | Operations Manager | 0787491567 |
| 75 | Lucy Mosi | Tanga City Council | Tanga | Head, Trade and Industrial Department | 0715300594 |
| 76 | Reuben Maimu | ABM Equipment | Tanga | Factory Manager | 0754465722 /065370317 0 |
| 77 | Vailet Miho | Tanga City Council | Tanga | Trade Officer | 0683002929 |

Note. Bolded, to be invited in Person to the Stakeholder's workshop

## ANNEXES

### 1.1 Background

The Government of United Republic of Tanzania through the National Development Corporation (NDC) is undertaking techno-economic study for the establishment of Soda Ash Project at Engaruka Basin, Monduli District in Arusha region. The NDC has engaged the Tanzania Industrial and Research Development Organization (TIRDO) to carry out the study for the establishment of the proposed soda ash plant, in various aspects including analysis of global and local market for soda ash.

The Market Study Team [Appendix I] conducted site visitations from 17$^{th}$ to 20$^{th}$ September 2019 with the aim to capture relevant information related to the site location and surrounding areas. Also, the Team aimed to get the first-hand information regarding the social, economic and political aspects as the basis for investment decisions; Study the local environment where the project will be undertaken and come up with a clear understanding of the product; and to assess the marketing aspects related to the development of the project.

### 1.2 About Engaruka Soda Ash Project

Engaruka, is an area within Monduli District Council, Arusha region. The area contains among others, deposits of soda ash which is demarcated in a basin area of 27,000 acres as a potential project area. The project area is yet to be compensated by the government for mining. Engaruka is located in Arusha Region. The project area is located approximately 168 km from Arusha City. It is also located about 58 km South-East of Lake Natron (which is believed to have huge potential for soda ash) and it is accessible by a rough road for about 60 km from Mto wa Mbu town in Monduli district towards Loliondo District.

### 1.3 About the Visitation

A brainstorming meeting with the locals was held at the project area and Engaruka Town involving residents, village and ward leadership.

## 2 Field Findinds and Location

The project area is located in Engaruka area, Monduli district.

The project area contains three wards surrounded with four villages in total namely,Engaruka ward which has two villages; Engaruka Chini and Irerendeni. Selela and Mfereji wards have one village each, the Mbaashi and Idonyonado villages respectively. Mbaashi Village is likely to be the most affected village for the project. The project area contains Lake Engaruka (See Picture 2), which separate Engaruka Chini and Mbaashi villages. According to the interviews conducted, lake Engaruka is too salty and thus, it has no fish and is mostly used by wild animals as a source of drinking water. The project site is as indicated in Figure 2.1.


Figure 2-1: Engaruka Location Source: Google Maps

## 2.1 Population

According to the 2012 Census, the project area had 35,578 residents as indicated in the table 2.1. The three wards represent 22.5% of the population in Monduli district.

Table 2-1: Population in the Project Area

| | | Population (Number) | | | |
|---|---|---|---|---|---|
| | | Total | Male | Female | Household |
| S/N | Monduli DC Total | 158,929 | 75,615 | 83,314 | 4.7 |
| 1 | Engaruka (Containing Engaruka Juu, | 11,121 | 5,314 | 5,807 | 5.1 |
| 2 | Selela (Containing Mbaashi, and | 8,703 | 4,244 | 4,459 | 4.60 |
| 3 | Monduli Juu (Currently with Mfereji ward and Monduli Juu ward) Mfereji | 15,914 | 7,321 | 8,593 | 4.80 |

Source: National Bureau of Statistics, 2013

## 2.2 Social Economic Profile of the Area

The main economic activities at Engaruka project area is livestock keeping. The livestocks are of local breed and the pastoralists do move from one area to another in search for pastures. The land is semi-arid occupied by pastoralists with large herds of traditional livestock, with insignificant crop production. There are few businesses in Engaruka. Also, there are small farmers growing maize, beans /legumes and finger millet. The project area wards affected has about 40 acres of irrigation with a potential of 320 acres of irrigation

(Planning Commission 1998).

Monduli district and thus, part of the project area has two rainy seasons i.e. Long and Short rains. The short rains normally starts in October and ends in December while the long rains start in February and ends in June.

Engaruka project area is largely occupied by Masai with very low population density.

There is presence of small businesses such as retail shops, guest houses, open air and restaurants. There are no hospital services, but at least primary school is within the Engaruka ward. There is also a secondary school is located in another village away from Engaruka village.

Mto wa Mbu which is a nearby town center to the project area is the most developed urban area with a lot of economic activities. The economic activities ranges from tourism activities and crop production with over 1,500 acres of irrigation. Mto wa Mbu also has several hotels and guest houses and it is connected with tarmac road from Arusha (About 74km from Arusha region).

### 2.3 Vegetation

The project area has an open grass land, bused and wooded grass lands.  Soils is brown/grey soils. The area has various wild animals such as giraffe, antelope and ostrich were observed during the site visit as it can be observed in Picture 3 in Appendix II.


Figure 2-2: Engaruka Site Topology

Source: Google Earth

**Land Topology**

The area is flat, and it can be observed from a distant. However, large part of Monduli district is characterised by hills. Details are as indicated in Picture 4

Appendix II. There is Soda ashes as the sandy seem to be so glimmer with a sparkling texture around the mining area, and especially near Lake Engaruka. The soil of the area is loose sand, which can be easily waved by the wind during dry season which is difficult for construction of infrastructure such as roads and railway.

**Availability of Utilities**

The project area has no electricity nor fresh water. In the project area, there is not evidence of crop production. The main electricity line is in the township of Mto wa Mbu, its location is as indicated in Figure 2-1. The project area can be accessible through Mto wa Mbu, through a 74km rough road. The area is in a remote area though it is accessible in term of communications through major mobile telephone providers.

**Housing Structures**

There are scattered houses around the flat land area. There is also a presence of ongoing housing constructions activities in the project area. This suggests that the area is not compensated for the project. The observed housing structure from a distant is as indicated in picture 4 in Appendix II.

**Residents Expectations to the Project**

There is high expectation from the locals given the speculations of the soda ash project. One of the major expectations is employment which will result from the project activities. There is also expectation to supply local supplies such as food items. They regard the investment as a mega project and that there are various skills around the project area to undertake the mining activities.

**Final analysis**

The marketing team managed to visit the project area and envisage various aspects related to the market and infrastructure development. This is important determinants for the product location. Product location is important to suggest various related activities such as pricing and costs of production which are important factors in the pricing structure of the product.

Also management of the expectations based on the fact that soda ash is bulk and normally transported to other areas for industrial processing as by itself is an addictive or part of the raw material to other industrial processes, which need to be near to market. Transportation of materials to the product site for industrialization and back to the market would make the cost of production to be higher and hence not attractive for investment.

We recommend the following for other teams regarding the project area.

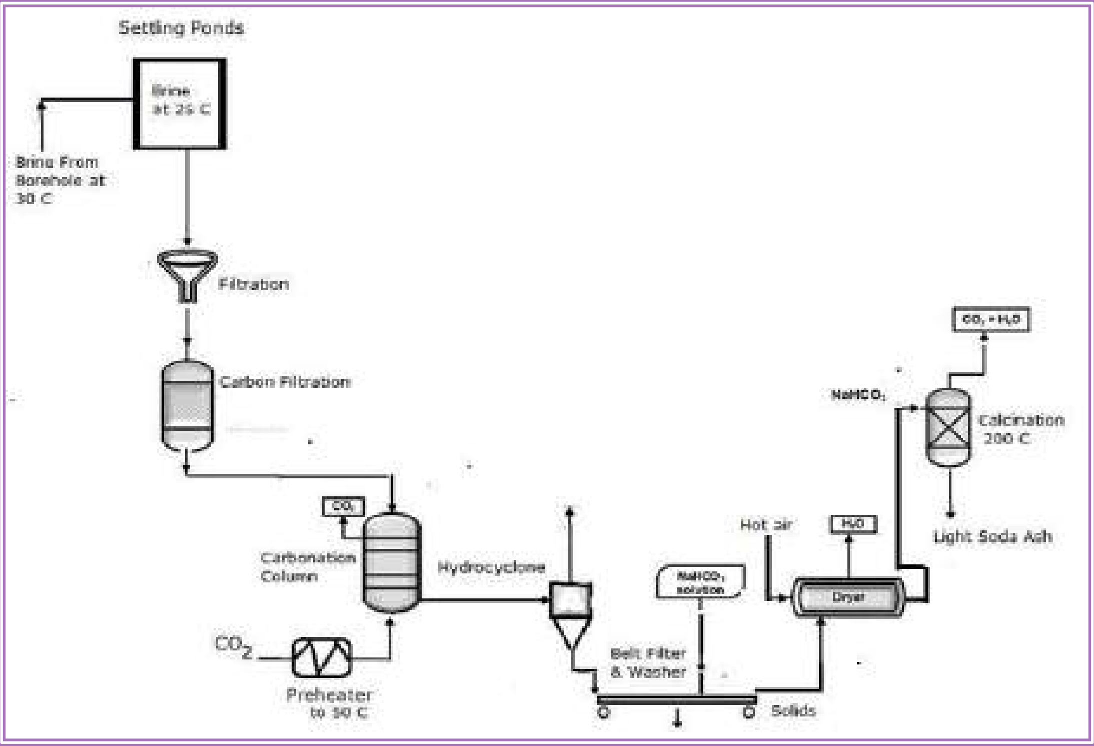
1) To have clear resource estimation of the area and its mining potential (tonnage and number of years)
2) To have a clear boundary of the project area
3) To ensure that the area is legally designated as a mining area with licences at hand. The details of licensing can be obtained from the Ministry of Minerals – Mining Commission.
4) To draw up sustainability plan and local content for the area to ensure sustainable availability of the product in the near future to meet both local and international market demands. The sustainability plan may involve development of the area
5) To assess the development of infrastructure (roads and railways) - a well-planned infrastructure which will ensure transportation of the material to various local and global market areas
6) To assess the utilities of the area which among others include water availability as well as electricity and conduct cost benefit analysis of the investment in the area for the product to be competitive in the market.
7) To assess clearly give an account of production process and methods which will ensure that costs of production are minimized and hence being competitive in the soda ash industrial market.
8) To assess the environmental impact of the site area which will give confidence for funders of the project and the associated industries which are to be consumers of the soda ash from the project site.
9) The local government should be engaged fully in the management of the local community expectations in the project area also to ensure that there is no excessive developments in the area which will affect the compensation planned for the project.
10) To draw up implementation plan which will inform the market study on the possible year of availability of the product from the project area? This is important to assess various marketing strategies to sell the product in the future

**NATIONAL DEVELOPMENT CORPORATION**

# TECHNO-ECONOMIC STUDY FOR SODA ASH PROJECT AT ENGARUKA IN MONDULI DISTRICT, ARUSHA REGION, TANZANIA

**VOLUME III**

**SODA ASH TECHNOLOGICAL ASSESSMENT**




**Prepared by:**
**Tanzania Industrial Research and Development Organization**

**May 2021**

**Team Members**

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## SUMMARY OF EXCUTIVE SUMMARY

The main objective of this **Volume III** on soda ash technological assessment component is to establish the appropriate and most economical methods for extraction and processing of soda ash resource available at Engaruka Basin

The raw material is natural soda ash deposit, which occurs naturally as brine or solid crust under Engaruka Basin

The solar salt pond technology among others was evaluated in respect to its application for processing of brine to recover soda ash and table salt. Solar method requires further purification by dissolving of the salt to obtain brine. Since Engaruka brine is in a saturated state and in contact with the solid crystals, re-slurring of the salt for further purification of the obtained crude salts is a repetition process.

This study has evaluated and selected the carbonation process as the suitable process for production of soda ash from Engaruka Basin. The process involves treatment of filtered brine with carbon dioxide gas in carbonation towers to convert the sodium carbonate ($Na_2CO_3$) in solution to less soluble sodium bicarbonate ($NaHCO_3$) which precipitates out. The precipitated sodium bicarbonate salt is separated from the mother liquor by hydro-cyclone and filtration. The recovered salt is washed, dried and a fraction of this product is marketed as sodium bicarbonate. The major faction is calcined to convert the sodium bicarbonate to light soda ash. Finally, the light soda ash is compacted in roller mills to convert it into dense soda ash pellets or it is steamed to produce fine dense soda ash.

The wastes generated in the carbonation process in large quantity are the mother liquor, used process water, and mud sludge as presented in the table below. Additionally, 49,500 tonnes of carbon dioxide will be generated annually from the calcination step and recycled back to the carbonation unit. Low concentration of table salt in the brine, it will need to evaporate large quantities of water and harvest other salts before recovering table salt. This will be uneconomical process.
Other raw materials required for the production of soda ash are: fresh water, liquid carbon dioxide, flocculating agents, coal for steam generation, hot air for drying, water treatment chemicals, and packaging materials

## EXECUTIVE SUMMARY

The main objective of this **Volume III** on soda ash technological assessment component is to establish the appropriate and most economical methods for extraction and processing of soda ash resource available at Engaruka Basin. The envisaged capacity of production is 500,000 tonnes per year which will eventually expand to 1,000,000tonnes per year. The adopted methods and technologies should be environmentally safe and produce soda ash products that meet international standards.

**Brine Mining/Extraction Technology**

The raw material is natural soda ash deposit, which occurs naturally as brine or solid crust under Engaruka Basin. This resource will be extracted from the aquifers by pumping the raw material to the surface for further processing to recover soda ash. This method was evaluated as the least cost option and environmentally friendly when compared with other methods such as mining of the solid crust and solution mining. In addition, the method has the advantage of producing better quality of soda ash products through controlled process of precipitation or selective crystallisation.

**Solar Salt Pond Technology**

The solar salt pond technology was evaluated in respect to its application for processing of brine to recover soda ash. The technology has advantages in relation to the cost of energy and its simplicity in the technology used. However, it has demerits on the requirement for further purification of the obtained crude salt. The crude salt requires further purification by dissolving of the salt to obtain brine. Since Engaruka brine is in a saturated state and in contact with the solid crystals, re-slurring of the salt for further purification of the obtained crude salts is a repetition process. In addition, the requirement of having large pond sizes to meet the production capacity has environmental concerns as the project is located at Engaruka Basin which is wildlife sanctuary.

**Soda Ash Processing Technology**

This study has evaluated and selected the carbonation process as the suitable process for production of soda ash from Engaruka Basin. The process involves treatment of filtered brine with carbon dioxide gas in carbonation towers to convert the sodium carbonate ($Na_2CO_3$) in solution to less soluble sodium bicarbonate ($NaHCO_3$) which precipitates out. The precipitated sodium bicarbonate salt is separated from the mother liquor by hydro-cyclone and filtration. The recovered salt is washed, dried and a fraction of this product is marketed as sodium bicarbonate. The major faction is calcined to convert the sodium bicarbonate to light soda ash. Finally, the light soda ash is compacted in roller mills to convert it into dense soda ash pellets or it is steamed to produce fine dense soda ash.

**Soda Ash Recovery Process**

The recovery process involves pre-treatment of brine in settling ponds followed by double filtration. Saturated brine is reacted with carbon dioxide in carbonation tower to produce sodium bicarbonate followed by calcination to produce soda ash.

**Materials and Energy Balance**

Material and energy balance for the production of 500,000 tonnes per year of soda ash (at commencement of the project, but eventually to 1,000,000 tonnes/year) by the carbonation process is summarised in the table 1 below:

Table 1: Material and energy balance by the carbonation process

| No. | Component | Unit | Yearly | Daily | Hourly |
|---|---|---|---|---|---|
| 1 | Brine | $m^3$ | 2,883,506 | 9,612 | 401 |
| 2 | Carbon Dioxide (liquid) | tonnes | 286,620 | 955 | 39.8 |
| 3 | Process Wash Water | $m^3$ | 66,667 | 222.2 | 9.3 |
| 4 | Process Steam | tonnes | 53,333 | 178 | 7.4 |
| 5 | Coal | tonnes | 3,581 | 12 | 0.5 |

**Quantity and Quality of Wastes (Solids/Liquids/Gases) to be generated**

The wastes generated in the carbonation process in large quantity are the mother liquor, used process water, and mud sludge as presented in the table below. From the calculations, it is estimated that a total of 836,898 $m^3$/yr of mother liquor and 250,000 $m^3$/yr of process water will be used. And 33,670 tonnes/yr of mud sludge will be generated annually. Additionally, 49,500 tonnes of carbon dioxide will be generated annually from the calcination step. However, almost all the carbon dioxide will be recovered and reused.

Table 2: Quality of Bittern to Dispose, Mud Sludge and Spent Process Water to be generated

| No. | Component | Unit | Yearly | Daily | Hourly |
|---|---|---|---|---|---|
| 1 | Bittern to Dispose | $m^3$ | 2,500,000 | 8,300 | 350 |
| 2 | Mud Sludge | tonnes | 33,670 | 122 | 5 |
| 3 | Spent Process Water | $m^3$ | 200,000 | 670 | 28 |

**Consideration for Commercial Exploitation of Edible Salt and Other Products in Order to Maximize Resource Utilization**

Based on the analytical results of Engaruka brine, the edible salt (NaCl) concentration is very low as compared to carbonate and bicarbonate contents. The sodium chloride content in the brine is about 7.2 mg/l as compared to sodium carbonate at 202g/l as reported in Volume I of this study. For the improvement of the economic viability of the project, mother liquor (bitterns) from the carbonation process which will be in a saturation state, may be evaporated in solar salt ponds to recover common salt and additional sodium carbonate by fractional crystallisation as is done at Lake Magadi in Kenya and Sua Pan in Botswana. Due to its low concentration, it will need to evaporate large quantities of water and harvest other salts before recovering table salt.

**Other Raw Material Requirements (Quality and Quantity) for the Envisaged Product Use and Plant Capacity**

Other raw materials required for the production of soda ash are: fresh water, liquid carbon dioxide, flocculating agents, coal for steam generation, hot air for drying, water treatment chemicals, and packaging materials.

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| BFD: | Block Flow Diagram |
| CRS | Crushed Refined Soda |
| NDC | National Development Corporation |
| P&ID | Piping and Instrumentation Diagram |
| SADCAS | Southern African Development Community Accreditation Services |
| TIRDO | Tanzania Industrial Research and Development Organisation. |
| tonne | Metric Tons |

## CHAPTER ONE

# 1. INTRODUCTION

### 1.1. Background

Engaruka Basin located in Monduli District Arusha Region, on the northern part of Tanzania has been discovered to contain vast amount of natural soda ash deposits. The Basin is about 58 km South-East of Lake Natron and about 190 km North-West of Arusha City. The area is reached by a gravel road from Mto wa Mbu to Loliondo along the Arusha Musoma Trunk Road.

Exploration studies of the area were conducted by O.C. Industrial Holdings Limited from 2011 to 2013. In the year 2020, TIRDO conducted appraisal of the brine resource based on previous exploration studies (Volume I-Appraisal of Brine Resource). The appraisal confirmed the presence of soda ash deposits under the basin. Preliminary findings indicate presence of aquifers hosting brine estimated at **3,813,320,000$m^3$.** The study has also confirmed that the brine is highly alkaline, and is composed mostly with sodium carbonate and sodium bicarbonate with average composition of 202g/l and 18g/l respectively. The deposit is equivalent to **768.80 and 68.30** million tonnes of sodium carbonate and sodium bicarbonate respectively. This resource can last for about 700 years for annual production of 1,000,000 tonnes of soda ash.

In addition, the study established the presence of several layers (crust) containing high content of sodium bicarbonate crystals (sometimes with sodium bicarbonate content of up to 100% in weight) deeper under the basin. However, the study did not measure the amount of the crust deposit.

The source of the brine and solid crust has been established to occur as a result of ion rich water discharging into the basin, followed by a concentration process. The surrounding area has ridges made up of volcanic rocks. Springs (hot and cold) that flow from the ridges into the basin are continuously re-charging the aquifers in the basin and also bring in additional salts into the underground aquifers. Preliminary results has estimated annual brine recharge rate, of **513,334,000 $m^3$**per year. The report however, recommended further exploration studies to be conducted at the Basin to increase the confidence of the results due to some limitations on the data.

With such huge deposits, an appropriate technology for the extraction and purification of the brine resource to manufacture commercial soda ash products is being sought. The technology must be able to produce soda ash products of the required market quality, comparable to other producers internationally, but also must be economically viable for sustainable production.

In view of the above, the Government through the National Development Corporation (NDC) intends to exploit this resource for economic development of the country, and has assigned TIRDO to undertake Techno-Economic study for the establishment of the proposed Soda Ash Project. The Techno-Economic Study is undertaken in order to establish total project cost, carry out Environmental and Social Impact Assessment (ESIA) and finally prepare a Bankable Feasibility Study Report for project financing. The construction of the soda ash extraction plant will devolve on the outcome of the techno-economic study.

## CHAPTER TWO

## 2. OBJECTIVES OF THE SCOPE

The objective of the scope is to cover appropriate mining/extraction and processing technologies for soda ash deposit available at Engaruka Basin including:

1. Assessment of available brine mining/extraction technologies (merits and demerits);
2. Assessment of available soda processing technologies (merits and demerits) and justification for selecting particular technology;
3. Assessment of inclusion of solar ponds system in the processing technology;
4. Establish flow diagram for processing soda ash, edible salt, etc.;
5. Mathematical modelling of boreholes which will enable maximum brine collection to Solar Pans;
6. Complete description of the selected processing technology for soda ash, edible salt, industrial salts, etc. (including Piping and Instrumentation Diagram - P&ID);
7. Quantity and Quality of wastes (solids/liquids/gases) to be generated;
8. Selection of plant capacity for economies of scale;
9. Consideration for commercial exploitation of edible salt and other products in order to maximize resource utilization;
10. Quality requirements of end products for different users/applications;
11. Other raw material requirements (quality and quantity) for the envisaged product use and plant capacity;

# CHAPTER THREE

## 3. APPROACH AND METHODOLOGY

In carrying out this scope, the focus was mainly on five main activities:

a) Desk study on the available brine extraction methods to assess and determine the best effective method for extraction of Engaruka soda ash deposit.
b) Desk study on existing soda ash processing methods applied worldwide to extract resources of the similar nature to the soda deposit available at Engaruka Basin.
c) Literature review on solubility data for multi-component salt system phase equilibrium diagrams to establish conditions required for crystallization of soda ash from multi-component salts present in the brine.
d) Characterisation of the brine samples through laboratory tests and simulations to determine the composition of different salts, their saturation status, present of impurities and the best methods to purify the recovered salts(s).
e) Conduction of materials and energy balance for the determination of the values and composition of process streams and the energy requirement.

## CHAPTER FOUR

## 4. SODA ASH PRODUCTS INFORMATION

### 4.1 Soda Ash

Soda ash is a common name for Sodium Carbonate ($Na_2CO_3$), an inorganic compound with a chemical formula $Na_2CO_3$ and its various hydrates. It is a white crystalline powder or granular material which is readily soluble in water. Other names of Sodium Carbonates are Disodium Carbonate, washing soda, soda ash and soda crystals. All the various hydrates have a strong alkaline taste and gives moderately alkaline solution in water

### 4.2 Sodium Carbonate Derivatives

Soda ash is graded according to its bulk density, light soda ash, medium and dense soda ash. Light soda ash has a density ranging from 0.52 – 0.60 tonnes/$m^3$, medium dense has density ranging from 0.61 to 0.95 tonnes/$m^3$and dense soda ash from 0.96 - 1.04 tonnes/$m^3$. The commercial standard that is accepted is expressed in terms of the total equivalent sodium oxide ($Na_2O$) that it contains, meaning that commercial 58 % soda ash contains an equivalent of 58 % $Na_2O$. The equation to convert is % $Na_2O$ x 1.71 = $Na_2CO_3$ %; 58 % of $Na_2O$ is equivalent to 99.2 % $Na_2CO_3$.

Sodium carbonate exists as anhydrous, or as several hydrates such as sodium carbonate monohydrate, sodium carbonate heptahydrate, ($Na_2CO_3.7H_2O$) and sodium carbonate decahydrate, ($Na_2CO_3.10H_2O$).

#### 4.2.1 Sodium Carbonate Monohydrate:

Sodium carbonate monohydrate ($Na_2CO_3.H_2O$) has a molecular mass of 124.00 g/mol and contains 85.48 % of $Na_2CO_3$ and 14.52 % crystallized water. It can be formed by wetting soda ash using a calculated quantity of water at or above the temperature of 35.4$^oC$. Sodium carbonate monohydrate loses water on heating and its solubility decreases a little with increasing temperature. If it is in contact with its saturated solution it changes to $Na_2CO_3$ at the temperature of 109$^oC$.

#### 4.2.2 Sodium Carbonate Heptahydrate:

Sodium carbonate heptahydrate ($Na_2CO_3.7H_2O$) contains 45.7 % of $Na_2CO_3$ and 54.3 % of water of crystallization. This hydrate is of no commercial interest because of its narrow range of stability, which extends from 32$^oC$ to 35.4$^oC$.

#### 4.2.3 Sodium Carbonate Decahydrate

Sodium carbonate decahydrate ($Na_2CO_3.10H_2O$) contains 37.06 % of $Na_2CO_3$ and 62.94 % of water of crystallization. This hydrate is formed by making soda ash wet with the calculated quantity of water at the temperature below 32.0$^oC$ and above -2.1$^oC$. The crystals effloresce in dry air to form monohydrate.

### 4.3 Chemical Properties of Soda Ash

Sodium carbonate is hygroscopic and its weight increases by approximately 1.5 % within thirty minutes when it is in air at 96 % relative humidity. Sodium carbonate is alkaline and its alkalinity is reduced if it is stored under moist conditions because it absorbs carbon dioxide and moisture from the atmosphere. At a temperature greater than 400$^{o}$C, sodium carbonate reacts with water vapors to form sodium hydroxide and carbon dioxide.

### 4.4 Uses of Soda Ash

Soda ash is an important ingredient in manufacturing of all kinds of glasses, detergents, industrial chemicals, water treatment, textile industries, in flue gas desulphurization and mineral processes. It is also used in paper industries, in metallurgy and in petroleum refining.

# CHAPTER FIVE

## 5. ENGARUKA SODA ASH DEPOSIT

### 5.1 Engaruka Deposit

Soda ash occurs naturally at Engaruka Basin as carbonate rich brine present in underground aquifers. The brine is in contact with solid crystalline crystals of sodium carbonate such as trona at higher depths (>100m).

### 5.2 Brine Composition

The brine deposit contains mostly carbonate and bicarbonate salts, with other salts being present in minor composition. Brine samples were collected from the existing boreholes and analysed for various parameters at the Water Quality Laboratory of Ministry of Water and Irrigation. This Laboratory is accredited by the Southern African Development Community Accreditation Services (SADCAS) with Accreditation Number Test-50011 (**Appendix 2**).

Chemical analysis of the samples indicated the brine is highly alkaline, with a total alkalinity content averaging at 212g/l. Major compositions of the salts are sodium carbonate ($Na_2CO_3$) averaging 202g/l and sodium bicarbonate ($NaHCO_3$) averaging about 18 g/l. In addition, the brine contains other ionic salts such as sulphate, chloride, fluoride, and nitrate salts as indicated in **Table 1** below.

Table 1: Chemical analysis of brine samples

| No. | Component | Formula | Composition (mg/l) | Composition (wt/wt%) |
|---|---|---|---|---|
| 1 | Sodium Carbonate | $Na_2CO_3$ | 201,612.00 | 83.03 |
| 2 | Sodium Bicarbonate | $NaHCO_3$ | 17,990.00 | 7.41 |
| 3 | Sulphate | $SO_4^{2-}$ | 10,990.34 | 4.53 |
| 4 | Sodium | $Na^+$ | 10,990.34 | 4.53 |
| 5 | Potassium | $K^+$ | 800.00 | 0.33 |
| 6 | Fluoride | $F^-$ | 353.75 | 0.15 |
| 7 | Nitrate | $NO_3^-$ | 47.91 | 0.02 |
| 8 | Chloride | $Cl^-$ | 36.31 | 0.01 |

Source: TIRDO - Volume I: Appraisal of the Brine Resource at Engaruka Basin 2020

**Table 1**, shows that Engaruka, brine is composed of sodium carbonate and sodium bicarbonate as major salts in the brine. The amount of carbonate and bicarbonate is about 90% of the total dissolved salts. In another note, the amount of chloride ions is very low at 0.01%, thus the possibility of extraction of common salt is very limited.

# CHAPTER SIX

## 6. BRINE MINING/EXTRACTION METHOD

### 6.1 Introduction

Brine or solid crust will be extracted and brought to the surface for further processing. There are several commercial processes used to extract soda ash from natural deposits. The processes vary depending on the nature of occurrence of the deposit and the intended recovery of the contained salts. In selection of the extraction method, the costs of extraction and purification process must be considered. The following are the available soda ash extraction methods that are used in other places worldwide.

#### 6.1.1 Mining Method

The majority of the world’s natural soda deposits occur as solid crust of trona deposits, and are mined by the conventional surface or underground mining methods similar to coal mining. The underground mining methods include room and pillars, longwall, shortwall and solution mining. These methods can be applied individually or in combination, depending on the nature of the deposit.

For instance, extraction of soda ash in the form of tronais carried at Green River Wyoming in USA, and at Kazan and BeypazarıBasins in Turkey. The extraction method involves undercutting, drilling, shooting or blasting, crushing, loading and hauling of the mined ore to the ground. In another note, trona at Lake Magadi in Kenya is mined from the Lake surface deposits by specially designed dredgers to extract trona from the lake surface.

##### 6.1.1.1. Mining Merits and Demerits

Mining of trona has the advantage of selection and accessing high grade soda ash deposits (trona), and avoiding low grade deposits. In addition, it has the advantage of obtaining solid raw material instead of brine, thus, avoiding substantial amount of brine which require extensive storage ponds.

##### 6.1.1.2. Solution Mining

The salts crust existing underground can alternatively be extracted by appropriate solution mining techniques. In this process, an array of injection and recovery wells are sunk at appropriate depth to intercept the trona bed. Hot water or saturated solution of sodium hydroxide is introduced under pressure into the ground, to dissolve the salts. Multiple pumping systems are used to pump the enriched solution to the surface for processing.

##### 6.1.1.3. Solution Mining Merits and Demerits

Solution mining is less expensive as compared to underground mining in terms of infrastructures and operation cost. Purer products can be obtained through selective extraction of the contained salts in the deposit. In addition, flexibility in the plant location is achieved by locating the purification plant away from the extraction site.

However, solution mining has some drawbacks in extraction efficiency and may yield over time brine solutions of varying strength, which must be accommodated by the processing plant. In addition, solution mining produces dilute solutions thus, substantial amount of brine is needed which require extensive storage ponds and or tanks to evaporate the extracted brine to concentrating and crystallise the contained salts.

In another note, trona is an incongruently dissolving double salt that has a relatively slow dissolving rate. It requires high temperatures to achieve maximum solubility and to yield highly concentrated solutions which are required for high efficiency in processing plants.

### 6.1.2 Brine Extraction

Soda ash resource at Engaruka Basin occurs mainly as brine hosted in aquifers, thus, it can be extracted directly by pumping out brine from the aquifers. Similar to this method are the one used at Sears Valley Lake in California and Sua Pan in Botswana. The method involves sinking wells underground to specific depth where it favours maximum brine extraction. Production boreholes and the associated pumping and storage infrastructures are installed at appropriate places in the basin. The spent mother liquor is returned back to the underground at a suitable location, and injected to further dissolve the solid crust deposit.

#### 6.1.2.1. Brine Extraction Merits and Demerits

Brine extraction process has lower cost as compared to crust mining and solution mining. In addition, it is simple, similar to abstraction of water from boreholes in water schemes. The disadvantage of this process is that, the amount of brine needed require extensive storage ponds, which poses environmental concerns, in relation to birds and fauna.

### 6.1.3 Recommended Soda Ash Extraction Method

From Section 6.1 it is noted that, **brine extraction** has more advantages than the other two methods. Brine extraction is the least cost option compared with others and best quality products can be obtained through controlled crystallisation of the salts. It should be noted that, Engaruka brine resource is in contact with the underground salt crystals, hence is saturated with sodium carbonate and bicarbonate. This phenomenon was also physically noted during pumping test, where it was observed that the brine was crystallising upon reaching the surface. Thus, **brine extraction** will be the best option for extraction of soda ash at Engaruka Basin.

# CHAPTER SEVEN

# 7. PROCESSING TECHNOLOGY

## 7.1 Production of Soda Ash Processes

Soda ash can be produced by synthetic methods or from purification of natural soda ash deposits.

### 7.1.1 Synthetic Soda Ash

About 75% of the world soda ash production is obtained by synthetic process. Synthetic method chemically transforms limestone ($CaCO_3$) and common salt (NaCl) to produce soda ash ($Na_2CO_3$) with calcium chloride and ammonium chloride as by-products. The most widely used production process to Solvay process and Hou's process.

### 7.1.2 Natural Soda Ash

Soda ash can also be recovered from natural deposits such as trona or carbonate rich brine. Natural soda deposits contain a mixture of soda ash, other contained salts, as well as a variety of impurities. For instance, trona ore contains an average of 90% pure sodium sesquicarbonate, with 10% being other associated minerals and impurities. Brine also can contain sodium carbonate and bicarbonate with a variety of other soluble salts such as sodium sulphate; sodium chloride; potassium chloride; and sodium fluoride, organic matters; and other insoluble. These impurities must be physically and chemically separated from the commodity to obtain commercial soda ash of more than 99% purity.

Production of soda ash from natural deposits has a significant competitive advantage compared to synthetic methods. The costs for producing soda ash from natural deposits is more cost competitive because the costs associated with procuring the raw materials needed for synthetic production are greater than the costs associated extraction of natural deposits. Additionally, natural soda ash production requires less energy and produces fewer undesirable by-products than synthetic production. These by-products require additional storage and disposal costs. The average cost of production per ton cost of soda ash (excluding freight and logistics costs) from natural deposits is approximately 50% lower than the average per ton cost of synthetically producing soda ash. However, most of the world's soda ash (75%) is produced by synthetic methods due to limited availability of natural deposits.

## 7.2 Natural Soda Ash Processing Methods

The three distinct methods of production of soda ash from natural deposits such as trona ore or brine are the **monohydrate, sesquicarbonate** and **carbonation process**. These processes are similar in nature, whether starting from trona or from brine. The only difference is on the crushing and dissolving steps, which is not available when processing brine. These methods can be applied individually or in combination when processing natural soda ash, and can be modified depending on the nature of the resource and the intended recovery of other contained salts.

### 7.2.1 Monohydrate Process

The monohydrate method is the primary process used to make soda ash from natural deposits. In this method, trona is firstly calcined at 150$^o$C to 300$^o$C in rotary calciners. Water and carbon dioxide are evolved leaving the impure product containing about 85% sodium carbonate and about 15% of other insoluble. The thermal decomposition of trona is as per the below equation.

$$2Na_2CO_3.NaHCO_3.2H_2O \text{ (trona) } ^{Heat}\text{------}{>}3Na_2CO_3 + CO_2 + 5H_2O$$

The calcinate is further dissolved in hot water and the resulting clear hot solution containing about 30% sodium carbonate is sent to evaporative multiple effect crystallisers. Sodium carbonate monohydrate ($Na_2CO_3.H_2O$) precipitates out at 40 to 100$^o$C, which is below the transition temperature of monohydrate to anhydrous soda ash. Before crystallisation, the solution is passed through activated carbon beds to remove dissolved organic matters, to avoid interference with crystal growth rate and crystal habits in crystallisers.

The insoluble portion of the ore contains shales and other insoluble matter, is collected in clarifiers, and filtered. Insoluble are then washed to recover any additional alkali before being piped out in a slurry form to tailing ponds, or injected underground.

Crystals are dewatered consecutively in hydro-cyclones and in centrifuges to between 2 to 6% free moisture. The cake is conveyed to steam dryers where the crystals are dehydrated into anhydrous soda ash at 150$^o$C. The product is screened and sent to the storage for sale. The final product made by the monohydrate process is dense soda ash, with bulky density of about 0.9 to 1.04g/cm$^3$ and average particle size of about 250µm.

### 7.2.2 Sesquicarbonate Process

The sesquicarbonate process has similar operations to the monohydrate process, except that in the monohydrate process, the ore is calcined prior to dissolution, whereas in the sesquicarbonate process, calcination is performed at the end of the process, producing a light to intermediate grades of soda ash with bulky density of about 0.8g/cm$^3$.

In this process, trona is crushed, dissolved in hot (95$^o$C) mother liquor, clarified and passed to cooling crystallisers where crystals of sodium sesquicarbonatecrystallise. The sodium sesquicarbonate slurry is hydro-cycloned, centrifuged and calcined at 110 to 170$^o$C using gas or indirect steam. Dense soda ash can be obtained by calcining the light soda ash at 350$^o$C.

### 7.2.3 Carbonation Process

In this process, sodium bicarbonate is produced by reacting carbon dioxide with a solution of sodium carbonate and sodium bicarbonate. The reaction converts sodium carbonate ($Na_2CO_3$) in solution to sodium bicarbonate ($NaHCO_3$), which is less soluble compared with other contained salts and it precipitates out.

### 7.3 Case Study of Available Natural Soda Ash Processing Operations

Several processes operations have been developed and commercialised worldwide to process natural soda resources from soda deposits similar to brine deposits available at Engaruka Basin. The following are examples of processes used to extract soda ash from naturally occurring soda ash brines from other parts of the world.

#### 7.3.1 Searles Lake in California

Soda ash occurs naturally as brine at the bottom of Searles Lake. The brine contains several salts such as sodium carbonate, sodium chloride, sodium sulphate, potassium chloride and various sodium salts of boric acid.

Brine is treated with carbon dioxide gas in carbonation tower to convert the sodium carbonate ($Na_2CO_3$) into sodium bicarbonate ($NaHCO_3$), which is less soluble compared with other contained salts and it precipitates out. The sodium bicarbonate precipitates are separated from the mother liquor by settling and filtration. It is then calcined to convert it to soda ash ($Na_2CO_3$). Further purification of the obtained soda ash is done through a second dissolution of the sodium carbonatecrystals in water, and treating the resulting solution with carbon dioxide, following with filtration and calcining the light soda ash is converted to dense soda ash. The de-carbonated brine is cooled to recover borax and Glauber's salt. This process results in a refined product of with 99% sodium carbonate.

#### 7.3.2 Sua Pan in Botswana

At Sua Pan in Botswana, soda resource occurs naturally as carbonate rich brine associated with other salts, mainly common salt.

Wells sunk in the underground extracts brine to the surface, where it is transferred to the shallow solar ponds. Evaporation by solar energy takes place to concentrate the brine and crystallise the salt (*mainly sodium chloride*). The concentrated brine from solar ponds is then contacted with carbon dioxide to convert sodium carbonate to bicarbonate, which is less soluble, therefore precipitates out, and is filtered out, calcined and compacted into dense soda ash.

#### 7.3.3 Lake Magadiin Kenya

Lake Magadi facility in Kenya produces both soda ash and common salt. The soda resource occurs naturally as trona ($Na_2CO_3.NaHCO_3.H_2O$) in the form of solid crystals with interstitial saturated alkaline liquor. The trona is harvested by dredgers and crushed, slurried and pumped to the washery plant or at the dewatering tower. Washing and blending with processed water is carried out to the required specifications targeting in reducing the sodium chloride level. The resulting Crushed Refined Soda (CRS) is calcined in rotary kilns to chemically decompose sodium sesquicarbonate into soda ash, carbon dioxide and water vapour. The product is ground, and physically graded by screening before is conveyed to the storage silos.

Common salt (NaCl) is extracted from the lake waters by solar evaporation and crystallisation in solar salt pans. The Lake Magadi brine is normally saturated with solid content of about 32% of which sodium chloride is approximately 30 – 40 percent and the rest being almost exclusively sodium carbonate compounds and small amount of sodium fluoride. The brine is pumped to pre concentration ponds where solid deposition takes place. Because of the higher concentration of sodium carbonate compounds in the brines, sodium carbonate monohydrate is deposited predominantly in the pre concentration ponds.

When the brine contains equal amounts of sodium chloride and sodium carbonate, it is transferred to the salt making ponds. With more evaporation, a mixture of soda and common salt is deposited as solids in the salt making ponds. Because of the daily temperature differences and the solubility characteristics of sodium carbonate, the final stages of evaporation result in a superficial layer of sodium chloride rarely more than 1cm thick. This 1cm thick layer is manually harvested and transported to the factory for processing into various grades of sodium chloride for different salt markets.

### 7.4 Alternative Process for Soda Ash Crystallisation

There are several process alternatives to crystallise soda ash starting from brine. The first one is by **solar evaporation of brine** in solar salt pans, crystallisation of salt, and purification of the recovered salt. The second one is the evaporation of concentrated brine in multiple effect **evaporators and crystallisation** of the salt. The last one is the **carbonation of the brine** to precipitate sodium bicarbonate. Each processing method has its advantages and disadvantages**. Table 2** summarises the available soda ash processing technologies with their merits and demerits.

Table 2: Process alternatives for crystallisation of soda ash, their merits and demerits

| No | Description | Merits | Demerits |
|---|---|---|---|
| 1. | Solar evaporation of brine, crystallisation of salt, and purification of the recovered salt. | a) Low investment and operation cost since solar energy is readily available at Engaruka basin.<br>b) The climatology and meteorological condition with little rain and high solar insolation throughout the year is favourable to solar evaporation.<br>c) The land is ideally flat and suitable for construction of solar salt pans at minimum costs.<br>d) The technology is simple and known in Tanzania, similar to the technology used in production of common salt from sea water. | a) Solar salt technology is a slow process.<br>b) Inefficient manual or mechanised salt harvesting technology.<br>c) Possibility of interruption of production during rain season by pond flooding.<br>d) The area is prone to typhoons which may bring various contaminants to the salt ponds.<br>e) The technology requires vast area for installations of solar salt ponds, which has associated environmental concerns with regards to birds and fauna. In addition, the basin is a wildlife |

| No | Description | Merits | Demerits |
|---|---|---|---|
| | | | sanctuary, being a Game Controlled Area (GCA). |
| 2. | Direct evaporation of concentrated brine in multiple effect evaporators to crystallise salt. | a) Operations are not affected by flooding and it's possible to operate throughout the year.<br>b) It is easy to control the crystallisation process to produce high grade soda ash.<br>c) High throughput production as compared to solar evaporation.<br>a) Potential for recovery of other contained salt such as common salt from the mother liquor. | a) Have higher investment and operation costs as compared to solar salt pans.<br>a) Require skilled workforce. |
| 3. | Carbonation of the brine to precipitate out sodium bicarbonate | a) Operations are not affected by flooding and it's possible to operate throughout the year.<br>b) It is easy to control the crystallisation process to produce purer soda ash low in NaF and NaCl.<br>b) Potential for recovery of other contained salt such as common salt from the mother liquor. | a) High cost of investment and operations of the treatment facility.<br>b) Requirement of skilled workforce.<br>c) Requirement of additional raw materials (*carbon dioxide*) |

From **Table 4,** it is noted that direct evaporation of the brine in multiple effect evaporators, solar evaporation and that of carbonation are all potential processes that can be applied. The processes can be applied individually or in combination. However, solar evaporation has more challenges in relation to environmental concerns, the area is under the wildlife protection.

It is anticipated that the process chosen must produce high quality soda ash with comparable quality as other products manufactured by synthetic means or from natural soda ash. It is therefore recommended to use a combination of solar salt pans, carbonation process and crystallisation. It is also noted that, whichever process is selected, the purification process cannot be ignored. The process involves re-crystallisation to obtain required product quality

# CHAPTER EIGHT

# 8. SOLAR SALT POND METHOD

## 8.1 Overview

The solar salt pond technology is the mostly used technology to recover salt from brine. The process involves concentration of brine through solar evaporation in solar salt ponds, crystallisation of salt, and purification of the recovered salt. The technology has lower cost of investment and operation since it uses solar energy.

Climatology and meteorological condition at Engaruka Basin with little rain and high solar insolation throughout the year is favourable to solar evaporation. In addition, the area has plenty of clay soil favourable for making of solar salt pans. Furthermore, the technology is simple and known in Tanzania, similar to the technology used in production of common salts from sea water and at Uvinza salt works.

However, solar salt pond technology has some drawbacks to be applied at Engaruka Basin. Firstly, solar salt pond technology is a slow process which depends purely on solar evaporation of the brine to concentration and crystallise the salt. Secondly, it is difficulty in controlling the crystallization process, as results, impure salt crystallises out that requires further purification. Thirdly, the possibility of production interruptions during heavy rainy season caused by flooding of the solar salt ponds is inevitable. Fourthly, the area around Engaruka Basin is prone to typhoons, which can bring various contaminants to the salt ponds. Lastly, Engaruka Basin is a wildlife sanctuary, being a Game Controlled Area (GCA). The requirement of vast area for installations of solar ponds has associated environmental concerns with regards to birds and fauna.

It should be noted that, the brine characteristics is highly concentrated with sodium carbonate and therefore the solar pond technology which can be applied for pre-concentration of the brine will be used as settling ponds to remove mud. However, some crystallisation of soda ash will occur at these ponds.

## CHAPTER NINE

## 9. SODA ASH RECOVERY PROCESS DESCRIPTION

### 9.1 The General Process Description

The general process description depicts that, brine will be pumped out of the extraction wells and collected in storage ponds whereby primary sedimentation will take place. The concentrated brine will be treated with carbon dioxide gas in the carbonation tower to convert all the sodium carbonate ($Na_2CO_3$) present in the solution, to a less soluble sodium bicarbonate ($NaHCO_3$). The bicarbonate will precipitate and the resulting slurry will be filtered out and calcined to produce light soda ash, which will be converted to dense soda ash.

The process requires brine obtained at Engaruka Basin. In addition, carbon dioxide gas and process water, are also required. Fuel materials such as coal for steam and electricity generation, diesel for mobile equipment, and packaging materials are required.
The process flow diagram for processing soda ash production from Engaruka Basin brine is illustrated in **Figure 1,**

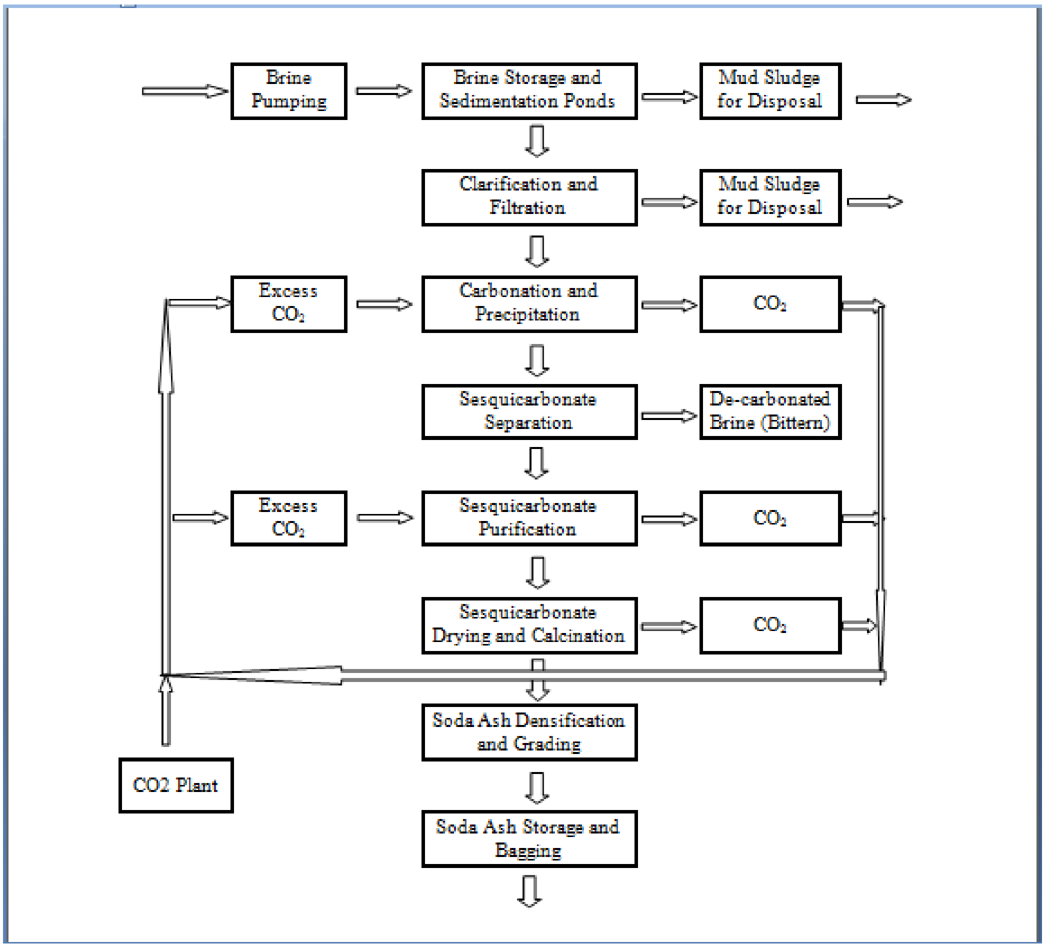


Figure 1: Process flow block diagram for soda ash recovery from brine

### 9.2 Expected End Product Quality

According to the market study, soda ash products required by the market are the dense soda ash for the glass industry, light soda ash for the detergent and chemical industry and sodium bicarbonate. The sodium bicarbonate requirements are minimal as compared to dense and light soda ash. It is anticipated that the process will produce high quality soda ash of different grades **Table 3** illustrates the product quality specifications from some selected producers of soda ash by natural and synthetic methods.

Table 3: Quality specifications of soda ash from some selected producers

| **Company Name and Soda Product (Natural or Synthetic)** | | **Solvay Chemicals, Inc (Synthetic)** | **Ciner Wyoming, (Natural)** | **Searles Valley Minerals, (Natural)** | **TATA Chemicals, Magadi (Natural)** |
|---|---|---|---|---|---|
| **Characteristics** | **Unit** | **Specification** | | | |
| Total Alkalinity (as $Na_2CO_3$) | % min | 99.8 | 99.6 | 99.6 | 95.0 |
| Sulphates (as $Na_2SO_4$) | % max | 0.01 | 0.02 | 0.02 | 0.03 |
| Chlorides (as NaCl) | % max | 0.05 | 0.01 | 0.01 | 0.02 |
| Fluorides (as NaF) | % max | none | none | none | 2.40 |
| Insoluble matter in water | % max | 0.03 | 0.05 | 0.05 | 1.00 |

Source: TIRDO analysis from Companies Products Information 2020 -Volume II,

Characteristics of soda resources deposits of East Africa, such as those found at Engaruka, Lake Natron and Lake Magadi, contains sodium fluoride (NaF) within the trona crystals and in brine unlike deposit in other parts of the world (USA). The sodium fluoride is present at a level of 0.5% to 3% (more typically 1% to 1.5%) by weight. The fluoride content is not a problem to affect processes in which soda ash is used. However, since many of these processes (steel making, and glass making) involve high temperatures, the sodium fluoride gives rise to fluoride containing emissions which are undesirable to the environmental. Soda ash from Magadi has similar composition as that at Engaruka, and is sold worldwide; therefore, the fluoride issue might not be a problem.

## CHAPTER TEN

## 10. DESCRIPTION OF UNIT OPERATIONS

### 10.1. Introduction

Descriptions of the recovery and purification process and unit operations involved in the process are briefly explained in this chapter.

### 10.2. Brine Pumping and Storage

Several production wells will be sunk at suitable areas and at appropriate depth to abstract brine. Wells will provide the required amount of brine for the planned production capacity. Submersible pumps will pump out the brine and deliver to the plant storage ponds. The storage ponds will be constructed with holding capacity enough to run the plant for at least three months, to provide uninterrupted supply.

In the storage ponds, the brine will undergo primary sedimentation for settling down suspended solids and mud. In addition, the ponds will perform primary concentration of the brine. Temperature difference between well temperature and pond temperature, will lead to primary crystallisation of sodium carbonate in the storage ponds. The mud sludge will be removed and disposed in a contained environment at an appropriate place within the basin away from the point of abstraction.

### 10.3. Clarification and Filtration

Brine stored in the storage tanks, will undergo further clarification by settling out solids. The clear solution from the storage tanks will be filtered in carbon filters to remove colouring matters, and other dissolved organic matters; this will also involve a pass to a second filter to remove carbon particles entrained during the carbon filtration process

### 10.4. Carbonation

Brine carbonation is the most important process step in the production of soda ash. In this process, the brine is contacted with carbon dioxide to convert sodium carbonate to bicarbonate. The resulting sodium bicarbonate is less soluble than other salts contained, therefore will precipitate out of the solution. Carbonation will be done in carbonation columns which are large steel columns which are baffled and lined with fibreglass. These columns are also similar to the carbon dioxide absorption columns used in the Solvay process for the manufacture of synthetic soda ash.

Prior to carbonation process, the clarified filtered brine will be warmed in a heat exchanger, to about 50– 70$^{o}$C to enhance the chemical reaction process then pumped to the carbonation columns where it will react with carbon dioxide. This will involve carbon dioxide gas absorption in a brine liquid phase. The treatment of brine with carbon leads to the formation of sodium sesquicarbonate (artificial trona) $Na_2CO_3.NaHCO_3.H_2O$ which precipitates out of the slurry upon cooling to 40$^{o}$C.

As the reaction proceeds, evolution of a solid phase continues is enhanced by continuous agitation to convert all the alkali in the brine to less soluble bicarbonate.

### 10.5. Sesquicarbonate Separation

The resulting sodium sesquicarbonate slurry is separated in hydro cyclones to raise its solid concentration. The thickened slurry from hydro cyclones will be filtered in large horizontal belt filters, to remove more water followed by washing of the filtered sodium bicarbonate cake to purify the product. The washing of the sodium bicarbonate will take place in sequence with filtration in a horizontal belt filter.

The collected filtrate is still saturated with sodium bicarbonate, and may be re-processed by recirculating it back to the carbonation column. Alternatively, the filtrate may be pumped down the well to dissolve soda ash

### 10.6. Sesquicarbonate Purification

The obtained sesquicarbonate crystals will require further purification to obtain concentrations above 99.5%. This will be done by re-slurring the crystals and a second reaction with carbon dioxide to precipitate sodium sesquicarbonate, which will then be thickened in a hydro cyclone and filtered in belt filters.

### 10.7. Drying and Calcination

Drying and calcination will be done to convert the purified sodium sesquicarbonate to soda ash. The calcination will be done at 200ºC, whereby the following reaction will take place.

$$2(Na_2CO_3.NaHCO_3.H_2O) \text{ ------------}\rightarrow \ 3Na_2CO_3 + CO_2 + 5H_2O$$

Calcination will take place in large rotary kilns which will be indirectly heated with steam to convert sodium sesquicarbonate to light sodium bicarbonate with the liberation of $CO_2$ and water vapour. Alternatively, the light sodium carbonate will be converted into dense sodium carbonate by compacting in large horizontal nip rollers to produce soda ash flakes, which will be milled and screened to produce dense soda ash. The final product will be refined soda ash of about 99 - 99.6% sodium carbonate.

### 10.8. Storage and Bagging

Storage facility will be provided for bulky storage of soda ash in silos before packaging in different sizes. Soda ash will be packed in bulky polythene or sack craft paper bags having plastic laminations to avoid absorption of moisture. The packing size will be 1 tonne and 50kg bag which will be palletised and wrapped or strapped in shrink films. In addition, bulky unpacked soda ash will be provided for customers with pneumatic tankers. Facilities for bulky weighing and packaging will be provided.

### 10.9. Carbon Dioxide Capturing and Purification

The liberated $CO_2$ during the calcination step will be recaptured, compresses, and recycled to be used again in the carbonation columns. Additional carbon dioxide may be recovered from purification of emissions from power generation (boiler and power generators) to obtain carbon dioxide or by burning of limestone. Another source of carbon dioxide is from fresh supply through Tanzania Oxygen Limited

**CHAPTER ELEVEN**

# 11. MATERIALS AND ENERGY BALANCE

## 12.1 Introduction

Based on the market requirement, the processing plant is designed for production of 500,000tonnes/yr of various grades of soda ash. At start production volume will increase gradually as the market grows to the designed capacity. However, long term plan is to produce 1,000,000tonnes/year and may go beyond that as the market grows.

Materials and energy balance has been conducted to determine the quantity of brine required for production of the required soda ash volume (500,000t/yr) as well as the quantity of other raw materials and energy required for the purification process

Calculations for material and energy balance have been determined for both alternative methods of brine carbonation and evaporation process. This will be used for the selection of the best method based on the energy requirement, soda ash recovery (yield) and the cost of the technology as well. Calculations were based on the result of laboratory analysis of brine samples and the chemical data of solubility of the dissolved salts. The energy required for the process was determined for the process theoretically. Detailed calculations of material balance and energy balance is illustrated in **Appendix 1.**

## 12.2 Quantity of Raw Materials Required for Carbonation Process

Material and energy balance calculations for the planned production of 500,000tonnes/yr of soda ash, has established the quantity of brine required for soda ash production by carbonation process is 173.4kg of $Na_2CO_3$ per $m^3$ of brine, carbon dioxide requirement is 99.4 kg $CO_2$ per $m^3$ of brine, and steam requirement is 800 kg per $m^3$ of brine for the evaporation process (**Appendix 1**). From Volume VI of this study on project engineering design, it has been established that, the quantity of steam required for process use as well as electricity generation is about 73.85 tonnes/h and the quantity of coal energy requirement is 10.2tonnes/h. The summary of materials and energy requirement is as illustrated in **Table 4**.

Table 4: Summary of material and energy balance for the soda ash process

| No. | Component | Unit | Yearly | Daily | Hourly |
|---|---|---|---|---|---|
| 1 | Brine | $m^3$ | 2,883,506 | 9,612 | 401 |
| 2 | Carbon Dioxide (l) | tonnes | 286,620 | 955 | 39.8 |
| 3 | Process Wash Water | $m^3$ | 66,667 | 222.2 | 9.3 |
| 4 | Process Steam | tonnes | 53,333 | 178 | 7.4 |
| 5 | Coal | tonnes | 3,581 | 12 | 0.5 |

## 12.3 Quantity and Quality of Wastes (Solids/Liquids/Gases) to be generated

Wastes generated in both the carbonation process and evaporation in large quantity is the bittern (mother liquor), used process water, and mud sludge. In addition, flue gas from power generation from the coal fired boiler and the exhaust from the calciner and domestic wastes. From material balance calculations it is estimated that a total of 2,373,563$m^3$ of mother liquor, 250,000 $m^3$ of process water will be discharged per year and 33,670 tons of mud sludge will be generated annually (**Table 5**).

Additionally, 49,500 tonnes carbon dioxide will be generated annually from the calcination step. However, all the carbon dioxide will be recovered and reused. The flue gas from the coal fired boiler will be treated before discharge.

Table 5: Summary of material and energy balance for the soda ash process

| No. | Component | Unit | Yearly | Daily | Hourly |
|---|---|---|---|---|---|
| 1 | Bittern to Dispose | $m^3$ | 2,500,000 | 8,300 | 350 |
| 2 | Mud Sludge | tonnes | 33,670 | 122 | 5 |
| 3 | Spent Process Water | $m^3$ | 250,000 | 903 | 38 |

The quality of wastes will not pose any environmental challenges as the mother liquor will have the same properties as brine except that it will be depleted with sodium carbonate and sodium bicarbonate. Similarly, spent process water has no any contaminants as it is used mainly for washing the soda ash produced.

### 12.4 Consideration for Commercial Exploitation of Edible Salt and Other Product

Data from Volume I of this study show that the concentration of table salt is very low in comparison with concentrations of carbonate and bicarbonate. The sodium chloride content in the brine is about 7.2mg/l.

For the improvement of the economic viability of the project, mother liquor (bitterns) from the carbonation process may be evaporated in solar salt ponds to recover common salt and additional sodium carbonate by fractional crystallisation as is done at Lake Magadi in Kenya and Sua Pan in Botswana. However, due to low concentration of NaCl in the Engaruka brine the process will involve evaporation of large amount of water, which might not be economical given that NaCl from the sea is much cheaper.

In addition, Caustic soda (NaOH) is another product that may be produced from soda ash. The process use limestone which is converted to calcium hydroxide $Ca(OH)_2$and reacted with soda ash to produce sodium hydroxide and calcium carbonate. The process is environmentally friendly and the by-products can be recycled or reused.

$$Na_2CO_3 + Ca(OH)_2 \text{ ------ } 2NaOH + CaCO_3$$

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# APPENDICES

## APPENDIX 1: Evaluation of Soda Ash Recovery Processes

### Material and Energy Balance

The process of converting Trona $Na_2CO_3$. $NaHCO_3$ .$2H_2O$ and $Na_2CO_3$ $10H_20$ to $NaHCO_3.H_2O$ requires addition of $CO_2$ to $Na_2CO_3$ .$10H_2O$ solution. The governing equation is:

$$Na_2CO_3 + H_2O + CO_2 => 2NaHCO_3$$

Solubility of $Na_2CO_3$ is higher than that of $NaHCO_3$ at any given temperature as shown in **Table A.1** and **Figure A.1**.

**Table A.1:** Solubility data for sodium carbonate, sodium chloride and sodium bicarbonate in g/100 ml of water

| Substance | Formula | Temperature $^{O}C$ | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Sodium carbonate | $Na_2CO_3$ | 7 | 12.5 | 21.5 | 39.7 | 48.8 | 47.3 | 46.4 | 44.9 | 43.9 | 43.9 | 45.5 |
| Sodium chloride | NaCl | 35.65 | 35.72 | 35.89 | 36.09 | 36.37 | 36.69 | 37.04 | 37.46 | 37.93 | 38.47 | 38.99 |
| Sodium hydrogen carbonate | $NaHCO_3$ | 7 | 8.1 | 9.6 | 11.1 | 12.7 | 14.5 | 16.5 | 18.1 | 19.7 | 21.7 | 23,6 |

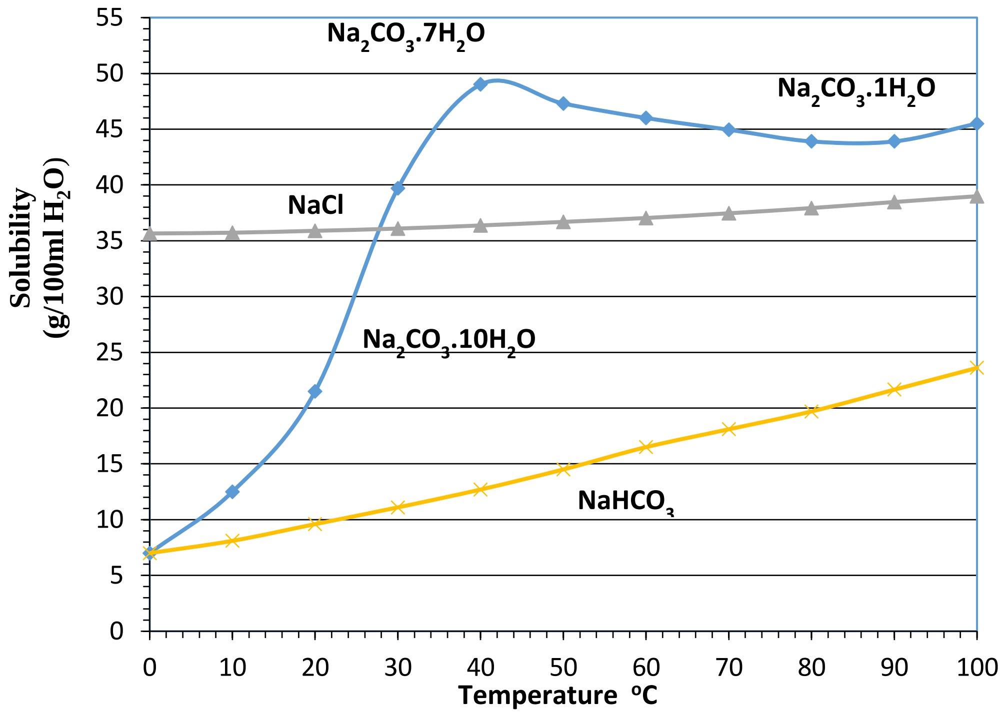



**Figure A.1:** Solubility curves of sodium carbonate, sodium chloride and sodium bicarbonate.

In this preliminary design and assessment of methods to be used in the recovery of sodium carbonate and sodium bicarbonate, data from the borehole BH5 will be used. This borehole was selected because, when compared to others, it has the largest borehole diameter (8”), it was the deepest (110 m) and a larger pump (capacity 75m$^3$/hr) was used during pump testing.

**Temperature Rise of Brine Due to Pumping**

The solubility of soda ash in the temperature range below 45 $^oC$ is very sensitive to temperature changes. Therefore, it is imperative to check if the pumping action of brine to the surface using submersible pump causes temperature rise. During pumping, electric energy is converted into mechanical energy, which transforms the potential energy of the resting brine into kinetic energy (momentum change). This process results in temperature rise of the fluid being pumped. Sometimes, it may be high enough to cause boiling of the fluid. This results in a negative NPSH (net positive suction head) which leads to pump cavitation. This scenario will be checked during the selection of extraction pump from the suppliers. During pump testing the borehole brine temperature was measured and recorded as 30 $^oC$ at the discharge point.

**Recovery of Soda Ash by Carbonation Process**

In this analysis it is considered that carbonation process is done at 50$^o$C by bubbling preheated $CO_2$ in a fluidization column containing brine. Taking into consideration data obtained from the deepest bore hole (BH5), that the solution at the bottom of the borehole is at 30$^o$C and is in contact with the solid trona ($Na_2CO_3$ $NaHCO_3$ .$2H_2O$) therefore it is saturated (if not super saturated) with $Na_2CO_3$.

During the operation, extracted brine will be held in settling ponds. Temperature at these ponds is at ambient temperature. Evaporation and wind breeze on the brine surface will result in cooling effects lowering brine temperature from 30$^o$C to 25$^o$C leading to crystallization of soda ash.

Data from laboratory analysis (conducted at 25$^o$C) for brine from BH5 and literature solubility data at 30$^o$C for $Na_2CO_3$ and $NaHCO_3$ are shown below and their conversions to other units:

**Table A.2:** Solubility data for $Na_2CO_3$ and $NaHCO_3$ in the feed stream and in the pond

| Component per *litre* of feed solution | Concentration (g/l of solution) at 25$^o$C | Amount of salt (g per l of feed) | Amount of liquid (ml per l of feed) | Amount of water (g per l of feed) | Solubility (g/ 100 g water at 25$^o$C)* | Solubility (g/ 100 g water at 30$^o$C) |
|---|---|---|---|---|---|---|
| | *BH5 data* | *BH5 data* | *BH5 data* | *BH5 data* | *BH5 data* | *Literature data* |
| $Na_2CO_3$ | 239.5 | 239.5 | | | 25.4 | 39.7 |
| $NaHCO_3$ | 17.93 | 17.93 | | | 1.9 | 11.1 |
| Solution | | | 1,000* | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Water | | | | 942.57 | | |

* Density of brine is taken as 1200g/l.
Assuming $Na_2CO_3$ and $NaHCO_3$ as the major salts dissolved in the brine.

For every cubic meter of brine extracted the amount of soda ash precipitated in the pond due to temperature change can be estimated as follows:

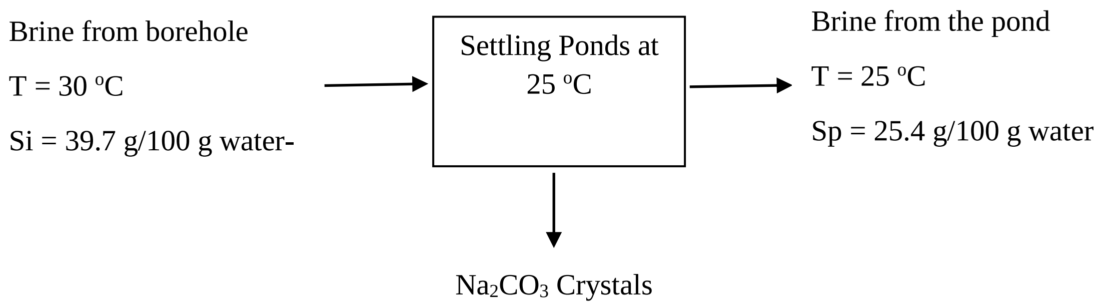



**Figure A.2:** $Na_2CO_3$ balance for settling ponds as brine temperature changes from 30 to 25ºC

Performing material balance for soda ash:

Precipitated $Na_2CO_3$ = 39.7 – 25.4

= 14.3 g $Na_2CO_3$/100 g of water

= 143 g $Na_2CO_3$/l of water

Using concentration data, 1 litre of feed solution has a weight of 1,200 g.

Therefore, amount of free water is approximately

- 942.57 g of water/l of feed solution
- or 942.57 ml of water/l of feed solution
- or 1 litre of water/1.06 litres of feed solution
- or 942.57 g of water/1,200 g of feed solution
- or 1 g of water/1.27 g of feed solution

This gives amount of precipitated $Na_2CO_3$ as 143 g $Na_2CO_3$ /1.06 litre of feed brine, which is;

= 134.9 kg $Na_2CO_3$ /$m^3$ of brine

Feed solution at 30 ºC has 39.7 g $Na_2CO_3$ per 100 ml water, which gives 397g/1.06 l solution or 374.5 kg $Na_2CO_3$/ $m^3$ of feed solution, which gives the recovery rate as:

Recovery = 134.9/374.5

= 36.02 % wt/wt

Therefore, it can be estimated that settling ponds will produce 134.9 kg of crude soda ash per every cubic meter of brine extracted from boreholes. This soda ash can be harvested and refined in the plant or sold as is

**Soda Ash Recovery Process by Carbonation**

Saturated brine from settling ponds at ambient temperature of 25 $^{o}$C will be filtered to remove suspended matters in a drum filter or centrifuge followed by carbon filtration to remove odour and colour. Filtered brine will be stored in feed tanks in the plant.

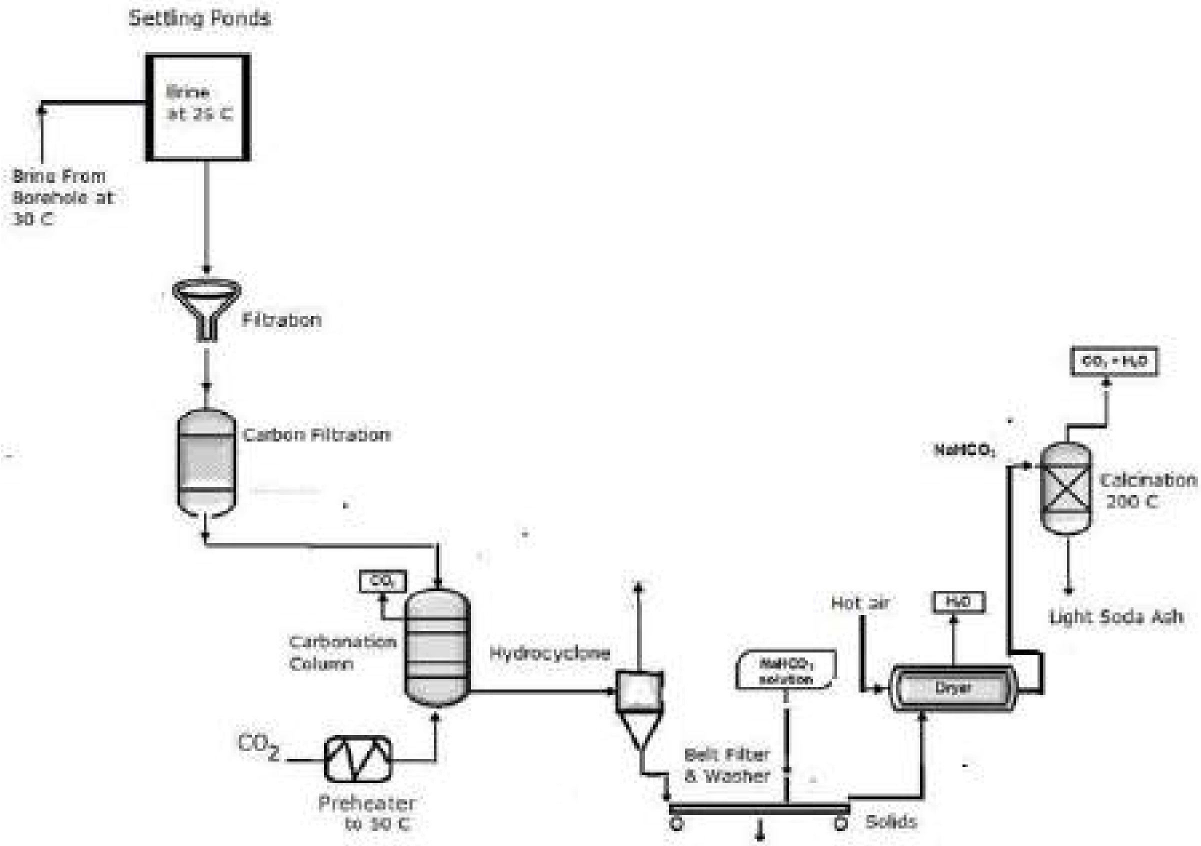



**Figure A.3:** Carbonation process layout

From the feed tank brine will be preheated to 50$^{o}$C then pumped to the carbonation tower, where the chemical reaction will take place. Carbonation reaction will take place at around 50$^{o}$C. The governing chemical reaction equation is:

$$Na_2CO_3 + H_2O + CO_2 => 2NaHCO_3$$

Properties of streams entering and leaving the carbonation column are as follows:

**Table A.3:** Data for streams entering and leaving the carbonation reactor

| Stream | Temperature °C | Concentration (kg/ $m^3$ Solution) | | Solubility (g/ 100 ml of water) | |
|---|---|---|---|---|---|
| | | $Na_2CO_3$ | $NaHCO_3$ | $Na_2CO_3$ | $NaHCO_3$ |
| Feed* | 25 | 239.5 | 17.93 | 25.4 | 1.9 |
| Reactor | 50 | | | | |
| Separator | 30 | | | 39.7** | 11.1** |
| $CO_2$ | 50 | | | | |

* Data from this study BH5

** Solubility at saturation point (literature value).

During carbonation process, $NaHCO_3$ will be precipitated leaving saturated solution of $NaHCO_3$ with solubility of 11.1g of $NaHCO_3$ in 100 ml water (during separation at 30 °C). This is the limiting point for precipitation, beyond that there is no recovery. It is considered that all $Na_2CO_3$ will be reacted.

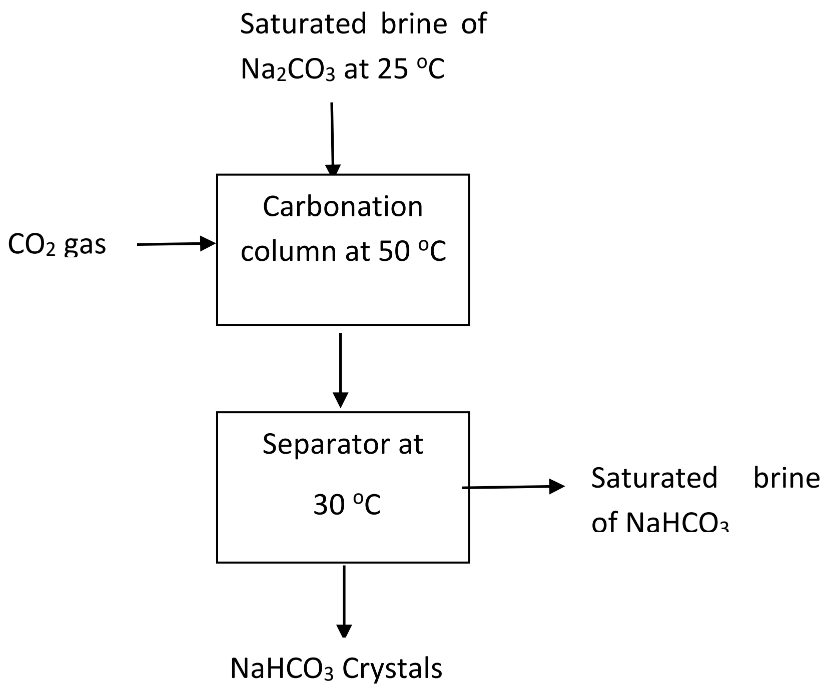



**Figure A.4:** Material balance for carbonation column and separator.

For simplicity, let the basis be 1 $m^3$ of feed brine (1,000 l). This is equivalent to:

Balance will be done for the $Na^+$in $Na_2CO_3$ in the feed stream:

- $Na^+$ in $Na_2CO_3$ is 46/106 = 43.39 %wt/wt
- Na+ in $NaHCO_3$ is 23/84. = 27.38 %wt/wt

The governing chemical reaction equation is:

$Na_2CO_3 + H_2O + CO_2 => 2NaHCO_3$

Balance for $Na^+$ in $Na_2CO_3$ using brine data from borehole BH5 is;

$Na^+$ in the inlet stream = $Na^+$ in crystals + $Na^+$ in output stream

239.5 * 0.4339 = 103.9 kg $Na^+/m^3$ of feed brine

At exit from the separator, saturation point at 30°C has the solubility of $NaHCO_3$ as 11.1 g/100 ml of water or 111 g/l of water. Therefore, the amount of $Na^+$ in the outlet solution after separation will be:

$Na^+$ = 23*111/84 = 30.4 g/ l of water.

Feed stream has 942.6 ml water/1,000 ml of solution (From **Table 14-2**), considering that there is no loss of free water, therefore $Na^+$ in $NaHCO_3$ from reacted $Na_2CO_3$ is:

30.4/1.06 = 28.66 kg $Na^+/m^3$ of feed brine

This gives the amount of $Na^+$ recovered as $NaHCO_3$ crystals from $Na_2CO_3$as:

103.9 – 28.66 = 75.24 kg $Na^+/m^3$ of feed brine

Therefore, the amount of $NaHCO_3$ recovered is:

= 84*75.24/23

= 274.8 kg $NaHCO_3/m^3$ of feed brine.

(Equivalent amount in $Na_2CO_3$ is = 274.8*106/168 = 173.4 kg $Na_2CO_3/m^3$ of feed brine.

Giving the conversion as 173.4/239.5 in feed solution = 72.4 % wt/wt)

The percent yield (i.e., amount of $Na_2CO_3$ converted to $NaHCO_3$ crystals).

= 75.24/103.9

= 72.4% per $m^3$ of feed brine

**Required Amount of Carbon Dioxide**

Mount of $CO_2$required is given by mole balance as:

I mole $CO_2$reacts with one mole of $Na_2CO3$

That is, 44 g-mole reacts with 106 g-mole $Na_2CO_3$ to produces 168 g-mole of $NaHCO_3$

Therefore, amount of $CO_2$required to react all 239.5 kg of $Na_2CO_3$in 1 $m^3$ of feed brine is given by:

` Amount of $CO_2$ required = 44*239.5/106

= 99.4 kg $CO_2$ /$m^3$ of feed brine.

**Recovery of Na2CO3 by Evaporation Process (Crystallisation)**

Data from the borehole number 5 give the concentration of $Cl^-$ as 31,391.42 mg/l. Assuming that all this chloride is from the NaCl only, then the concentration of NaCl is given as;

$C_{NaCl}$ = 58.5*31,391/35.5

= 51,715 mg NaCl/l of solution

= 51.715 g NaCl/1itre of solution

In this evaporation process at 100 °C (normally ranging 60 – 100 °C) the limiting point is the concentration of NaCl. The evaporation process to recover $Na_2CO_3$ will continue until the level of NaCl in the crystalliser reaches the saturation point at crystallization temperature. Thus, taking the material balance for NaCl only as illustrated in Figures A.5 and A.6 below to determine amount of water to be removed

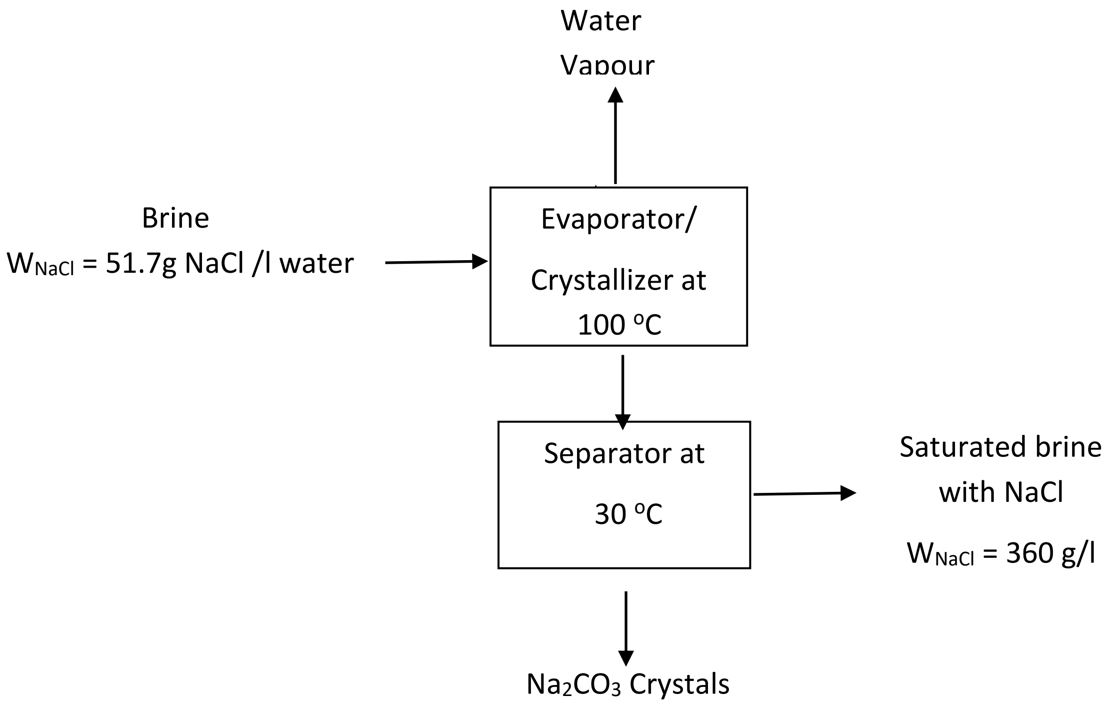



**Figure A.5:** Material balance for a crystalliser with NaCl concentration as a limiting factor

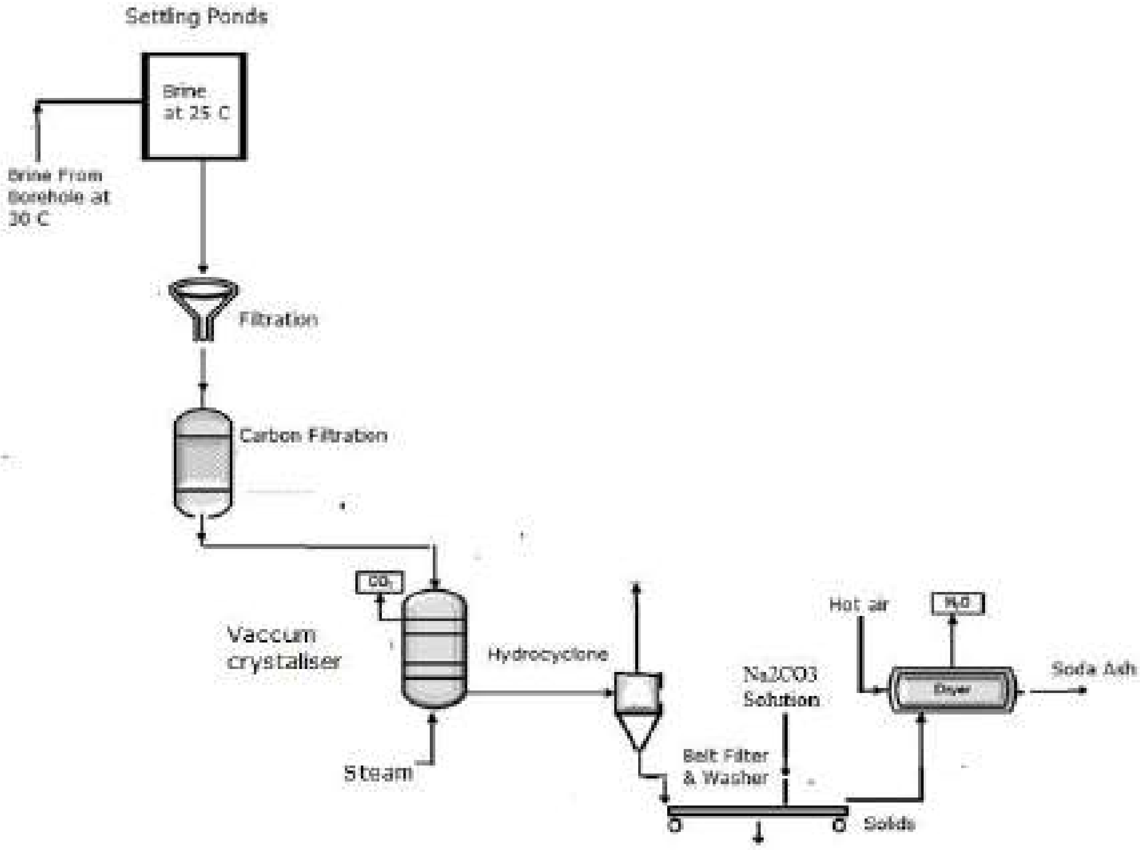



**Figure A.6:** Process flow diagram for recovery of soda ash by crystallisation method

Let the basis be 1 $m^3$ of feed brine at 25 $^oC$. The solubility of NaCl at 30 $^oC$ is 36.09 g/100 ml of water. NaCl balance gives:

$$51.7 \text{ kg} = \text{Water}_{out} * 360.9 \text{ kg/m}^3$$

$$\text{Water}_{out} = 51.7/360$$

$$= 0.143 \text{ m}^3 \text{ in the exit stream.}$$

Therefore, amount of water to be evaporated is given by:

Amount of water in the feed stream – amount of water in the discharge stream

0.9426 – 0.143 = 0.80 $m^3$ of water evaporated/ per $m^3$ of feed solution.

This is the amount of water per cubic meter of feed to be evaporated before NaCl starts crystallizing out.

### Required Amount of Energy

As a rule of thumb, 1 kg of steam evaporates I kg of water at each stage of multiple evaporators.
For a single stage crystalliser, total energy required to evaporate the calculated amount of water is given as:

$$Q_{evap} = M_{water} * h_{fg}$$

Where $h_{fg}$ is the enthalpy of evaporation at 100 °C = 2,256 kJ/kg

$Q_{evap}$ = 800 * 2,256

= 1,804,800kJ per $m^3$ of feed solution

For a two-stage evaporation, amount of energy required can be reduced by 50%.

If coal is to be used for heat generation, and the calorific value of coal is taken as 33,600

kJ/kg required amount of coal would be;

Wcoal = 1,804.800/33,600

= 53.71 kg coal per $m^3$ of feed solution (for a single stage).

NOTE: this is the value if no energy recovery is used in multiple effect evaporators through reduction of boiling points using vacuum process (steam ejector) for a four-stage system amount of coal required is:

= 13.4 kg of coal/$m^3$ of feed solution for a four-stage system

Therefore, the amount of $Na_2CO_3$ recovered by losing 800 kg of water for every $m^3$ of feed solution is calculated as shown in figure A.7 below;

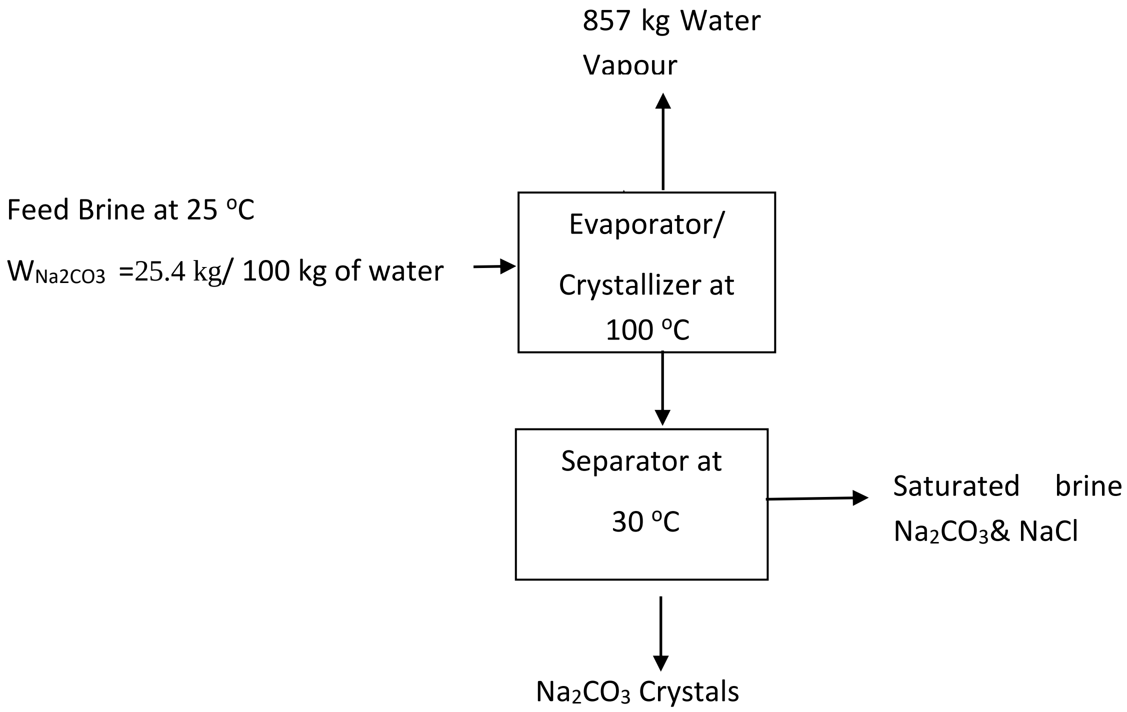



**Figure A.7:** Block diagram for material balance for recovery of $Na_2CO_3$ by crystallisation.

At steady state operation for every cubic meter of feed brine, 143 litres of water in the discharge stream saturated in both NaCl and $Na_2CO_3$ salts will be discharged

The concentration of $Na_2CO_3$ in feed stream is 239.5 g/litre of feed solution or 25.4 kg /100 litres of water and the discharge stream after separation at 30$^oC$ concentration of $Na_2CO_3$ is 39.7 kg/ 100 litres of water (from Table A.1).

Using the basis of 1 $m^3$of feed solution to the crystallizer, $Na_2CO_3$ balance give:

239.5 kg = $W_{solidNa2CO3}$ + 143 * 1.06 *0.397

Wsolid=179.3 kg $Na_2CO_3/m^3$ of feed brine

Therefore, the maximum amount of $Na_2CO_3$ which can recovered without taking out NaCl is 179.3 kg per cubic metre of saturated brine ($Na_2CO_3$) in the feed.

This gives the recovery percentage as:

Recovery = 179.3/239.5

= 74.8 %wt/wt.

**Table A.4:** Summary of input requirements per cubic meter of brine feed for production of 500,000 tonnes/yr of $Na_2CO_3$.

| S/n | Process | Amount of $Na_2CO_3$ in feed stream to process | Amount Recovered (kg $Na_2CO_3$/$m^3$ of brine) by: Solar Evaporation Process (crude product) | Carbonation Process | Evaporative Crystallization Process | Yield | Amount of $CO_2$ required | Amount of Coal required*** | Amount of Steam required | *Amount of Wash water required (3 stage) | **Amount of drying air |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (kg $Na_2CO_3$/ $m^3$ of brine) | (kg/ $m^3$ of feed brine) | (kg/ $m^3$ of feed brine) | (kg/ $m^3$ of feed brine) | (%) | (kg/ $m^3$ of feed brine) | (kg/ $m^3$ of feed brine) | (Tons/ $m^3$ feed brine) | ($m^3$/ $m^3$ feed brine) | ($m^3$ air/ $m^3$ feed brine) |
| 1 | Brine from borehole cooling & Solar evaporation (30 -> 25ºC) | 374.5 | 134.9 | | | 36.0 | | | | | |
| 2 | Carbonation Process | 239.5 | | 173.4 | | 72.4 | 99.4 | | | 23.1 | 86.0 |
| 3 | Crystallization process | 239.5 | | | 179.3 | 74.9 | | 13.4 | 0.80 | 23.9 | 88.9 |

**Table A.5:** Summary of input requirements for production of 500,000tonnes/yr of $Na_2CO_3$ (volume of feed solution in $m^3$ is used as a basis).

| | | **$Na_2CO_3$** | **Solar Evaporation Process (crude product)** | **Carbonation Process** | **Evaporative Crystallization Process** | | **Amount of $CO_2$ required** | **Amount of Coal required*** ** | **Amount of Steam required** | ***Amount of Wash water required (3 stage)** | ****Amount of drying air** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **(tonnes)** | **($m^3$ of feed brine)** | **($m^3$ of feed brine)** | **($m^3$ of feed brine)** | **(%)** | **(kg)** | **(kg)** | **(tonnes)** | **($m^3$)** | **($m^3$)** |
| **Required amounts of brine, drying steam and air for production of 500,000 t/yr. of $Na_2CO_3$ by Solar Evaporation process** | | | | | | | | | | | |
| 5 | Per year (300 days) | 500,000 | 3,706,449 | | | | | | 53,333 | 66,667 | 247,939,335 |
| 6 | Per day (24 hrs) | | 12,355 | | | | | | 178 | 222 | 826,464 |
| 7 | Per hr | | 515 | | | | | | 7.4 | 9.3 | 34,436 |
| **Required amounts of brine, $CO_2$, coal, drying steam and air for production of 500,000 tonnes/yr. of $Na_2CO_3$ by carbonation process** | | | | | | | | | | | |
| 5 | Per year (300 days) | 500,000 | | 2,883,506 | | | 286,620,530 | 3,581,000 | 53,333 | 66,666 | 247,939,334 |
| 6 | Per day (24 hrs) | | | 9,612 | | | 955,402 | 12,000 | 178 | 222 | 826,464 |
| 7. | Per hr | | | 401 | | | 39,808 | 500 | 7.4 | 9.3 | 34,436 |
| **Required amounts of brine, coal, evaporation steam and drying air for production of 500,000 tonnes/yr. of $Na_2CO_3$ by evaporative crystallization process** | | | | | | | | | | | |
| 5 | Per year (300 days) | 500,000 | | | 2,788,622 | | | 37,367,540 | 2,230,897 | 66,666 | 247,939,334 |
| 6 | Per day (24 hrs) | | | | 9,295 | | | 124,559 | 7,436 | 222 | 826,464 |
| 7 | Per hr | | | | 387.3 | | | 5,189.94 | 309 | 9.3 | 34,436 |

* Amount of wash water in 3 stages = Amount of wet solid*0.4/3 (assuming solids voidage is 40%).

** Amount of drying air = Amount of wash water *0.2/(120*1.011) (assuming filtration removes 80% of water and drying air is at 120°C).

*** Expressed as equivalent $Na_2CO_3$. Actual $NaHCO_3$ is 274.8 kg.

**** Four stages multiple-effect evaporators.

+ 90% will be recycled

**Comparison of Processes**

Comparing the three processes, it can be concluded that the carbonation process will be the most economical process in terms of energy requirements and capital investment. The quality of the final product from the solar pond will require reprocessing by either carbonation process or by evaporative crystallisation to obtain the industrial quality product. Comparing the yield from the carbonation process and crystallization process 72.4% versus 74.9, respectively it does not warranty to choose crystallisation process for Engaruka brine.

## APPENDIX 2: Chemical Analysis of Brine Samples

Ministry of Water
Mwanza Zonal Water Quality Laboratory
Analytical Report

SADCAS
TEST-5 0011

Lab Ref: 8291/MZWQL 001-010/2019
Client Ref: 0
Client name: Prof Abdulkarim Mruma
Sampled: 21/10/2019-31/10/2019
Received: 8/11/2019
Reported: 10/1/2020

Samples number: 10
Pages: 3
Type of Samples: SODA WATER
BRINE GROUND WATER
Fax:
eReport:
Email:

Copy:

Notes:

Authorised: ______________
Technical Signatory

Head of Laboratory

*The results in the following analytical report pertain to the samples provided to the laboratory for preparation and/or analysis as requested by the client.*
*MZWQL General Conditions of Service apply*
*This report may not be reproduced except in full, without written permission of the Laboratory*

Off Shinyanga Road, Mwanza, P.O. Box 271, Mwanza, Tanzania.
t +255 (0)28 2500 582 f +255 (0) 28 2500 582

MZWQL-QF 7.8.1 | Prepared: Staff | Effective date: September 2019
Rev 000 | Approved: HL | page 1 of 3

Lab Ref 8291/MZWQL 001-0100/2019
Client Ref #
Client name Prof Abdulkarim Mruma
Reported 10/1/2020
Type of Samples SODA WATER
Status FINAL
Page 2 of 3

**MZWQL-QF 7.8.1**
Prepared: Staff
Approved: HL
Effective date: September 2019

| Sample | Density | Viscosity | Sulphate as $SO_4$ * | Potassium as $K^+$ | Sodium as $Na+$ | Chloride as $Cl^-$ | Fluoride as F- | Total Phosphorus |
|---|---|---|---|---|---|---|---|---|
| Lake | 1.01 | 0.90 | 402.69 | 40 | 920 | 923.17 | 5.12 | 2.72 |
| Spring | 1.01 | 0.78 | 99.72 | 50 | 1070 | 140.6 | 0.83 | 0.53 |
| CBR1 | 1.21 | 1.80 | 3139.43 | 520 | 5830 | 53.75 | 600.52 | 2.78 |
| CBR2 | 1.23 | 1.56 | 6399.4 | 510 | 6550 | 42.43 | 745.19 | <D.L |
| BH 5 | 1.16 | 1.33 | 13858.09 | 970 | 6530 | 31.39 | 388.97 | <D.L |
| BHU 1 | 1.19 | 1.59 | 5352.12 | 490 | 5600 | 86.95 | 212.66 | 1.94 |
| BH 13 | 1.2 | 1.68 | 8349.38 | 580 | 6220 | 29.23 | 362.8 | 0.4 |
| BHU 12 | 1.2 | 1.68 | 10672.8 | 760 | 6770 | 15.79 | 365.84 | 0.32 |
| BHU 2 | 1.15 | 1.65 | 8393.43 | 1150 | 6400 | 26.412 | 455.86 | 0.16 |
| BH 6 | 1.24 | 1.34 | 19318.4 | 850 | 5940 | 48.09 | 346.33 | 0.04 |
| Method Code | MZWQL-WI-7.2.011 | MZWQL-WI-7.2.008 | MZWQL-WI-7.2.017 | MZWQL-WI-7.047 | MZWQL-WI-7.8.022 | MZWQL-WI-7.2.012 | MZWQL-WI-7.2.009 | MZWQL-WI-7.2.017 |
| Units | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l |
| Detection Limit | 0.73 | 0.431 | 0.328 | 0.01 | 0.01 | 0.112 | 0.431 | 0.328 |
| REFERENCE | APHA | APHA | APHA | APHA | APHA | APHA | APHA | APHA |

- not analysed | – element not determined | I.S. insufficient sample | L.N.R. late (S) Subcontracted * Accredited parameter

Authorised ____________
Technical Signatory

Head of Laboratory 10/01/2020

Lab Ref: B281/MZWQL 001-010/2019
Client Ref: 6
Client name: Prof Abdulkarim Miyuma
Reported: 10/1/2020
Type of Samples: SODA WATER
Status: FINAL
Page: 3 of 3

MZWQL-QF 7.8.1
Prepared: Staff
Approved: HL
Effective date September 2019

| Sample | Total Hardness as CaCO3 | Total alkalinity as CaCO3 | $HCO_3^-$ alkalinity as CaCO3 | $CO_3^{2-}$ alkalinity as CaCO3 | $NaHCO_3$ | $Na_2CO_3$ | Total Organic Carbon (TOC) | Nitrate as $NO_3^-$ |
|---|---|---|---|---|---|---|---|---|
| Lake | 5.2 | 1123.5 | 223.5 | 900 | 187.7 | 954 | 13.95 | 5.42 |
| Spring | 66 | 153.5 | 73.5 | 80 | 61.7 | 85 | 7.92 | 0.78 |
| CBR1 | 60 | 292350 | 86350 | 204 | 74214.9 | 216 | 80.46 | 4.55 |
| CBR2 | 680 | 230350 | 36350 | 194000 | 30534.0 | 205640 | 12.64 | 3.76 |
| BH 5 | 475 | 247350 | 21350 | 226000 | 17934.0 | 239560 | 22.62 | 94.8 |
| BHU1 | 108 | 200350 | 30350 | 170000 | 25494.0 | 180200 | 13.24 | 2.85 |
| BH 13 | 196 | 194350 | 22350 | 172000 | 18774.0 | 182320 | 30.59 | 75.3 |
| BHU12 | 740 | 252700 | 20700 | 232000 | 17388.0 | 245920 | 10.95 | 3.23 |
| BHU2 | 100 | 137870 | 19070 | 118800 | 16018.8 | 125928 | 24.31 | 80.56 |
| BH 6 | 152 | 237080 | 14080 | 222400 | 12331.2 | 235744.0 | 26.35 | 29.79 |
| Method Code | MZWQL-WI-7.2.010 | MZWQL-WI-7.2.008 | MZWQL-WI-7.2.008 | MZWQL-WI-7.2.008 | MZWQL/WI 7.2.023 | MZWQL/WI 7.2.17 | MZWQL/WI 7.2.034 | MZWQL-WI-7.2.005 |
| Units | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l | mg/l |
| Detection Limit | 1.211 | 3.0 | 3.0 | 3.0 | 0.01 | 0.72 | 0.03 | 1.0 |
| REFERENCE | APHA | APHA | APHA | APHA | APHA | APHA | APHA | APHA |

- not analysed | -- element not determined | I.S. insufficient sample | L.N.R. listed not received (S) Subcontracted

Authorised ........ Technical Signatory

Head of Laboratory

10/01/2020

**APPENDIX 3: Concentration of Ions in The Brines From Twelve Boreholes (Bh 5 – Bh 16).**

| S/N | Parameter | Units | BH 5 | BH 6 | BH 7 | BH 8 | BH 9 | BH 10 |
|---|---|---|---|---|---|---|---|---|
| 1 | pH | | 10.34 | 10.35 | 10.58 | 10.66 | 10.53 | 10.61 |
| 2 | Sodium | mg/l | 138,058.0 | 128,420.0 | 129,943.2 | 119,750.0 | 139,900.0 | 128,680.0 |
| 3 | Potassium | mg/l | 1,192.00 | 912.00 | 1,288.50 | 1,154.50 | 1,309.00 | 1,335.00 |
| 4 | Calcium | mg/l | 53.00 | 52.00 | 72.00 | 52.00 | 56.00 | 52.00 |
| 5 | Magnesium | mg/l | 5.67 | 3.87 | 5.04 | 2.67 | 7.30 | 2.22 |
| 6 | Iron | mg/l | 0.02 | 0.97 | 1.37 | 0.07 | 1.03 | 0.42 |
| 7 | Carbonate | mg/l | 128,000 | 118,000 | 120,000.0 | 110,000 | 130,000 | 119,340 |
| 8 | Bicarbonate | mg/l | 9,000 | 9,500.0 | 9,000.0 | 8,500.0 | 11,000.0 | 9,000.0 |
| 9 | Chloride | mg/l | 56,723 | 53,000.0 | 53,689.0 | 49,908.0 | 56,000.0 | 52,564.0 |
| 10 | Sulphate | mg/l | 64.00 | 279.00 | 250.00 | 320.00 | 276.00 | 220.00 |
| 11 | Fluoride | mg/l | 0.80 | 0.80 | 0.80 | 0.80 | 1.30 | 0.80 |
| 12 | Phosphate | mg/l | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| 13 | EC | mS/cm | 113.70 | 119.30 | 118.10 | 122.80 | 117.80 | 121.00 |
| 14 | **TDS** | **g/l** | **321.61** | **310.17** | **314.25** | **289.69** | **338.55** | **311.19** |

| S/N | Parameter | Units | BH 11 | BH 12 | BH 13 | BH 14 | BH 15 | BH 16 |
|---|---|---|---|---|---|---|---|---|
| 1 | pH | | 10.21 | 10.35 | 10.34 | 10.55 | 10.50 | 10.51 |
| 2 | Sodium | mg/l | 139,490.0 | 120,003.0 | 130,000.0 | 118,905.0 | 119,790.0 | 120,638.0 |
| 3 | Potassium | mg/l | 139,490.0 | 120,003.0 | 130,000.0 | 118,905.0 | 119,790.0 | 120,638.0 |
| 4 | Calcium | mg/l | 897.00 | 867.00 | 901.00 | 829.00 | 967.00 | 1,215.00 |
| 5 | Magnesium | mg/l | 50.00 | 52.00 | 54.00 | 56.00 | 60.00 | 54.00 |
| 6 | Iron | mg/l | 7.86 | 7.23 | 8.25 | 5.10 | 4.10 | 23.25 |
| 7 | Carbonate | mg/l | 1.09 | 0.01 | 1.98 | 2.16 | 1.15 | 0.89 |
| 8 | Bicarbonate | mg/l | 129,674.0 | 110,000.0 | 119,870.0 | 109,050.0 | 109,500.0 | 110,000.0 |
| 9 | Chloride | mg/l | 10,200.0 | 11,000.0 | 9,000.0 | 8,700.0 | 8,601.0 | 8,900.0 |
| 10 | Sulphate | mg/l | 56,007.0 | 48,796.0 | 53,549.0 | 49,450.0 | 50,456.0 | 51,230.0 |
| 11 | Fluoride | mg/l | 40.00 | 74.00 | 267.00 | 180.00 | 180.00 | 220.00 |
| 12 | Phosphate | mg/l | 1.15 | 1.15 | 0.80 | 0.80 | 0.80 | 0.80 |
| 13 | EC | mS/cm | 116.80 | 118.90 | 119.90 | 104.60 | 104.60 | 121.00 |
| 14 | **TDS** | **g/l** | **336.37** | **290.80** | **313.65** | **287.18** | **289.56** | **292.28** |

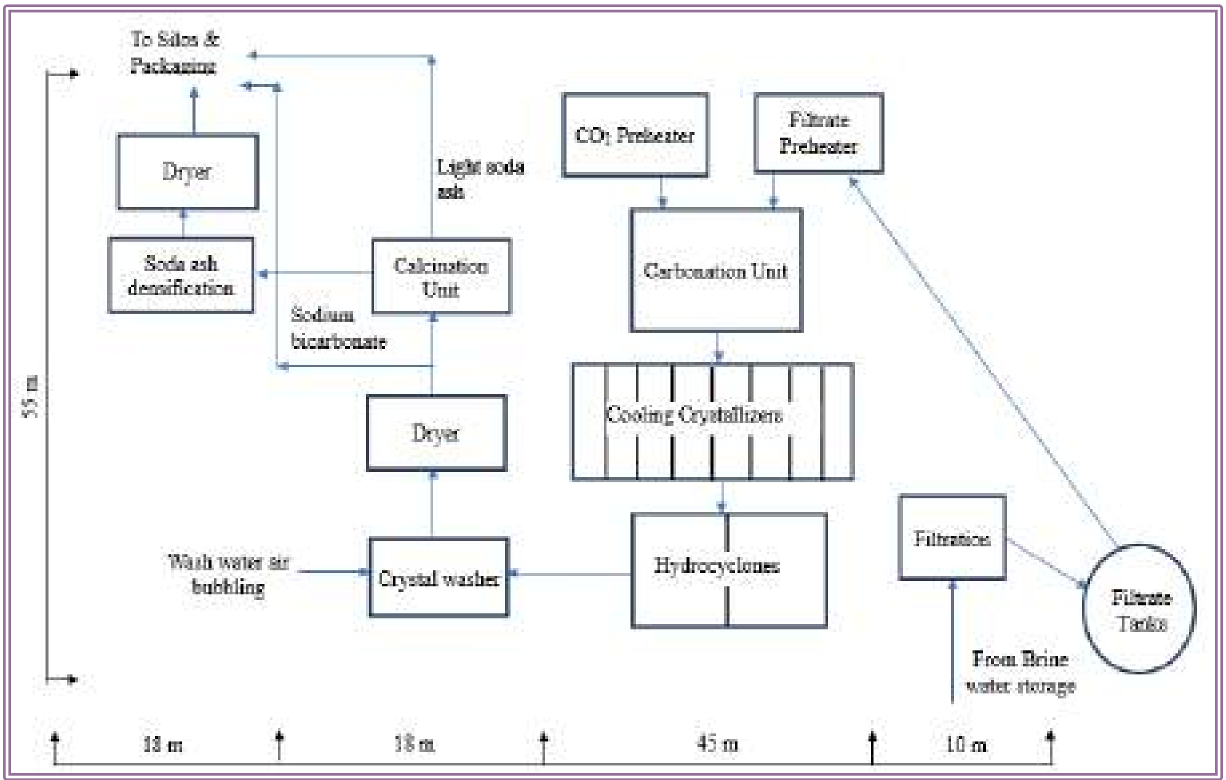
**Source:** C.Z. Kaaya, (2013) Final Report on Second Phase on Borehole Drilling for the Assessment of Soda Ash Deposits in Engaruka Basin in Arusha Region

# NATIONAL DEVELOPMENT CORPORATION

# "TECHNO-ECONOMIC STUDY FOR SODA ASH PROJECT AT ENGARUKA IN MONDULI DISTRICT, ARUSHA REGION, TANZANIA"

## VOLUME IV

## PROJECT ENGINEERING DESIGN




**Prepared by:**
**Tanzania Industrial Research and Development Organization**

**May 2021**

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## EXECUTIVE SUMMARY

### Objectives of Volume IV

This Volume covers Item 3.7 of the Terms of Reference for Engaruka Soda Ash Plant, namely Project Engineering Design. The objectives to be fulfilled were assessment of Plant and machinery for production of soda ash. This includes selection and sizing of process equipment, designing pumping system and storage ponds, as well as specifying steam and power generation system.

### Plant Design and Operating Capacities

The plant with rated/operating capacity of 500,000 tonnes of soda ash per year has been designed. However, in order to cater for wear, flow variance, calculation errors and other safety reasons, the plant is designed and costed for a design capacity of 550,000 tonnes per year (10% in excess of the rated capacity). The plant has been designed to produce three products in the proportions in brackets, namely sodium bicarbonate (10%), light soda ash (20%) and dense soda ash (70%). The project will be generating steam and subsequently 15 MW of electricity using a coal fired boiler. As the market grows the plant will be upgraded to produce 1,000,000 tonnes per year.

### Quality of Products

The purity of the sodium bicarbonate produced is 99.6%, while light soda ash has a purity of 99.6% and the dense soda ash has a purity of 99.4%. All the products meet minimum international market purity of 99.2%.

### Soda Ash Processing Facilities

Specifications for all the major equipment and machinery required for the soda ash plant have been given. This Volume also gives a list of potential equipment suppliers as well as complete soda ash plant vendors. The estimated cost of major pieces of equipment for the soda ash plant is USD 49,517,850. The total direct fixed cost (including piping, insulation, installation, etc.) is as shown in the table below.

### Electrical Power Distribution and Control System

Units required for ensuring availability of electricity in the plant have been identified and specifications given. It covers transformers, cables and similar items which will be necessary for tapping electricity from the existing 33 kV Manyara-Loliondo grid line and distributing the same in the project area. The total costs for the electrical power distribution and a standby generator are shown in the table below. In addition, some extra cost will be incurred if a dedicated 33 kV line will be built to avoid potential challenges of the existing line being overloaded due to other economic activities. Furthermore, a list of potential suppliers of the proposed electrical items is provided.

### Brine Pumping System and Storage

The number of boreholes required to meet plant demand will depend on further exploration drilling and pumping test work results. The brine from the production boreholes will pumped to collection tanks. The brine will then be pumped to three (3) storage/settling ponds using centrifugal pump. These storage/settling ponds will have a capacity for holding water enough to supply the plant for about 30 days. Specifications for the required submersible pumps and potential suppliers are given. Design for the collection tanks and storage ponds is given. The ponds will facilitate settling of mud from the boreholes, which can be scrapped off as the layer increases. Clear water from the ponds is then pumped to the plant. Due to solar evaporation, there might be crystallization of soda ash which will be harvested as crude soda ash. The total cost for the pumping from the boreholes to holding tanks in the plant is shown in the table below.

**Steam Plant and Power Generation System**

The Steam plant and power generation have been handled together since they are closely related. Specifications for coal quality, coal storage, boiler, turbine and other major items for steam and power generation are provided. The cost for this component of the project is shown in the table below.

**Mobile Equipment**

Construction and operation of the project requires some mobile equipment. These have been specified and their potential sources listed in the appropriate section of this report. The cost of mobile equipment has been estimated as shown in the table below.

Capital cost estimates for the plant and brine pumping

| **Cost Item** | **Value (USD)** |
|---|---:|
| Plant Fixed capital | 197,714,871 |
| Electrical Power Distribution | 950,604 |
| Dedicated 33 kV line | 40,369,093 |
| Steam and Power Generation | 61,151,250 |
| Standby Diesel Generator | 201,250 |
| Brine Pumping | 6,188,071 |
| Mobile Equipment | 676,770 |
| **Grand Total** | **307,251,909** |

**Safety and Environmental Concerns**

In addition to the specified items of ToR, the report provides a sketchy information on safety and environment issues including material safety datasheet and Hazard and Operability (HAZOP) analysis.

**Plant Layout**

A preliminary equipment layout in the factory which covers at least 1.3 acres is provided. In addition, the layout of the whole industrial area which covers about 9 acres is also provided.

**Project Implementation Period**

Implementation of the project requires detailed design of the machinery, fabrication of the units, design and construction of foundations for the machinery, installation of the machinery, design and construction of factory buildings and other plant accessories, testing of the facilities as well as commissioning of the plant. These are best handled if the plant is tendered as a turnkey project. Since most of the units will be tailor-made, implementation of these activities is estimated to take about 30 months to be completed.

**Recommendation**

The design presented in this Volume is a preliminary one; it is a front-end engineering design (FEED). The actual plant will require a detailed design of the plant and machinery, fabrication of the major units, design and construction of foundations for the major units, installation of all units and accessories, testing and commissioning of the plant. It is recommended to implement these activities as a turnkey project.

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## LIST OF FIGURES



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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AAC | All Aluminium Conductor |
| ABC | Aerial Bundle Conductors |
| AC | Alternating Currency |
| ACSR | Aluminium Conductor Steel Reinforced |
| CBR | California Bearing Ratio |
| CFC | Contractor's Fee and Contingency |
| CIF | Cost, Insurance and Freight |
| DFC | Direct Fixed Capital Costs |
| DFT | Density Functional Theory |
| EAC | East African Community |
| EIR | Environmental Impact Report |
| EPC | Engineering, Procurement, Construction |
| EPCI | Engineering, Procurement, Construction and Installation |
| EWURA | Energy and Water Utilities Regulatory Authority |
| FEED | Front End Engineering Design |
| FID | Final Investment Decision |
| FOB | Free On Board |
| GAC | Granular Activated Carbon |
| GCLA | Government Chemist Laboratory Agency |
| HDPE | High Density Polyethylene |
| HPT | High Pressure Turbine |
| HT | High Tension |
| IPT | Intermediate Pressure Turbine |
| LHS | Left Hand Side |
| LPT | Low Pressure Turbine |
| LV | Low Voltage |
| MCCB | Moulded Case Circuit Breaker |
| MDD | Maximum Dry Density |
| MSDS | Material Safety Data Sheet |
| NDC | National Development Corporation |
| NEMC | National Environment Management Council |
| OMS | Optimal Moisture Content |
| OSHA | Occupational Safety and Health Authority |
| PBH | Production Borehole |
| PC | Equipment Purchase Cost |
| PVC | Polyvinyl Chloride |
| RHS | Right Hand Side |
| SADC | Southern Africa Development Corporation |
| SWA | Steel Wire Armoured |
| TANESCO | Tanzania Electric Supply Company |
| TBS | Tanzania Bureau of Standards |
| TIC | Tanzania Investment Centre |

| | |
|---|---|
| TIRDO | Tanzania Industrial Research and Development Organisation |
| TOC | Total Organic Compounds |
| ToR | Terms of Reference |
| TPC | Total Plant Cost |
| TPDC | Total Plant Direct Costs |
| TPIC | Total Plant Indirect Costs |
| TSS | Total Suspended Solids |
| VES | Vertical Electrical Soundings |
| XLPE | Cross-Linked Polyethylene |

CHAPTER ONE

# 1 INTRODUCTION

## 1.1 Background

The National Development Corporation (NDC) is carrying out techno-economic study for establishment of economically, environmentally and socially sound soda ash plant at Engaruka in Arusha region, including associated infrastructure. Based on the Market Study (Volume II), the planned plant should have an initial production capacity of 500,000 tonnes of soda ash per year which will expand production to 1,000,000 tonnes per year as the market grows. However, as reported in Volume I (Appraisal of the Brine Resources), the available raw material can support higher production capacity up to one million tonnes per year.

This Volume serves primarily to present the plant and machinery specifications, electricity supply and distribution as well as pumping system. It also provides the associated investment cost.

**CHAPTER TWO**

# 2 OBJECTIVES OF THE VOLUME

## 2.1. Terms of Reference

This Volume is limited to assessing the following issues:

### 2.1.1. Plant and machinery

This includes:

i) Soda ash processing plant facilities
ii) Flue gas desulphurization (FGD) unit
iii) Carbonation unit
iv) Crystallization unit
v) Filtration
vi) Packaging unit
vii) Coal handling and storage system
viii) Detailed investment cost estimate of plant and machinery

Note that the process technology proposed (Volume III) does not include a NaCl salt plant due to its low concentration in the brine. Thus, salt plant unit and auxiliaries are not considered in this Volume. It should be noted further that items (ii) and (vii) are covered under (power supply system).

### 2.1.2. Electrical power distribution and control systems

This includes:

i) Transformers and circuit breakers
ii) Motor control systems
iii) Plant control systems
iv) Main distribution boards
v) Capacitor banks
vi) Detailed investment cost estimates of electrical power distribution and control systems

### 2.1.3. Brine pumping system and storage

This includes:

i) Location of extraction wells/boreholes as per mathematical model
ii) Extraction wells/boreholes network design
iii) Construction of extraction wells
iv) Settling ponds construction/establishment
v) Piping and pumping system and storage
vi) Detailed investment cost estimated of pumping system

Note that due to low concentration of NaCl in the brine as reported in Volume I (Appraisal of the Brine Resources), the process technology proposed in Volume III (Soda Ash Technological Assessment) does not include solar ponds for its concentration and hence harvesting. However, solar ponds are replaced by settling-cum-storage ponds. Due to solar evaporation and wind draft, there will be some crystallization of soda ash which will be harvested by racking and sold as crude soda ash.

2.1.4. Power supply system

This includes:

i) Design of power supply system
ii) Construction of power supply system including power supply auxiliaries
iii) Investment cost estimate of power supply system

2.1.5. Steam plant

This includes:

i) Steam Plant and auxiliaries (water treatment plant, ash handling system, water storage tanks, bag filters, main fans)
ii) Power plant and auxiliaries (turbine system, substation, condenser, control system)
iii) Emergency power supply system
iv) Detailed investment cost estimated of steam plant

2.1.6. Mobile equipment

This includes:

i) Salt harvesting, stockpiling and feeding equipment
ii) Settling pond maintenance equipment
iii) Material handling equipment
iv) Plant vehicles
v) Detailed capital cost estimates of mobile equipment

Note that due to low concentration of NaCl in the brine as reported in Volume I (Appraisal of the Brine Resources), the process technology proposed in Volume III (Soda Ash Technological Assessment) does not include solar ponds for its concentration and hence harvesting. However, solar ponds are replaced by settling-cum-storage ponds.

## 2.2. Approach and Methodology

2.2.1. General approach

To implement this assignment, the general approach focused on three main activities:

i) Plant site visits to assess the site characteristics, raw material and utilities sourcing locations in relation to the plant site;
ii) Analysis of information obtained from the Client and various Consultant Teams to establish the appropriateness/suitability of the raw material in relation to the technology options recommended;
iii) Desk studies to develop project engineering design and detailed investment cost estimates of plant and Machinery; Electrical Power Distribution and Control System; Brine Pumping System and Storage; Power Supply System; Steam Plant and Mobile equipment.

### 2.3. Technical Approach

The information obtained from the different sources for all items mentioned in Section 2.1 was synthesized and analysed with assistance of different software including Excel 2019, SuperPro Designer version 10, and F-Chart. Using the mentioned software, Front End Engineering Design (FEED) was established.  This includes process flow diagrams, major equipment specifications as well as investment cost estimates.

Conceptual framework for a project can take the form shown in Figure 2-1, where engineering design is part of the activities taking place towards the end of the project implementation.

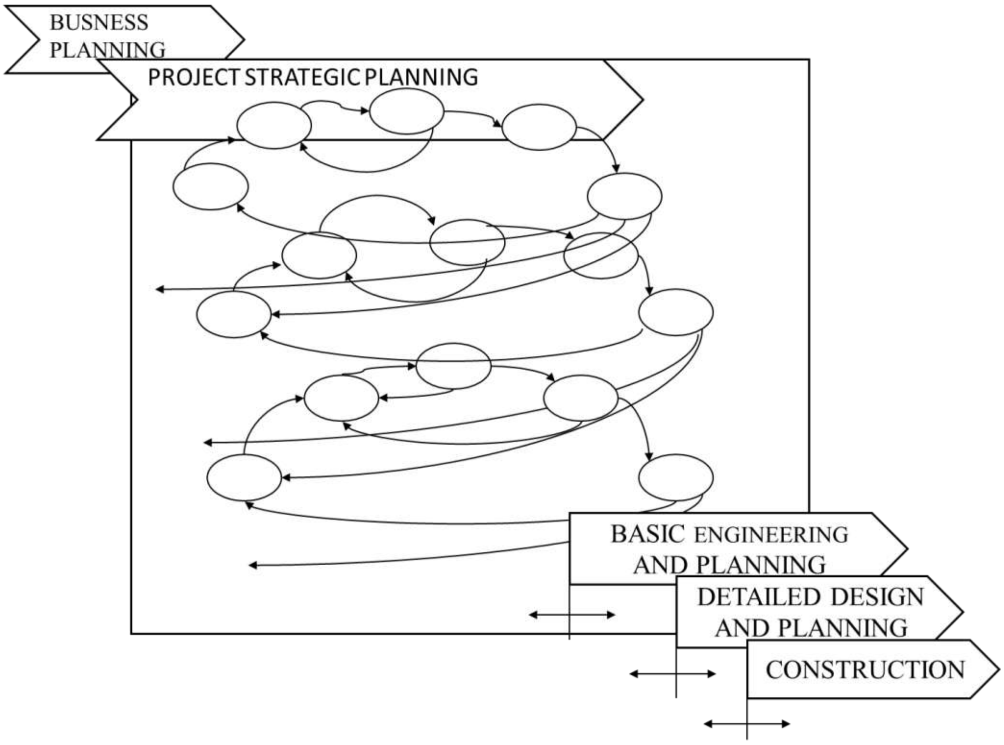


Figure 2-1: Project decision stages

The evaluation of the strategies, and thus the investment decision, starts with the feasibility study or conceptual study. If the feasibility study is rated positive, the evaluation will continue by the Front-End Engineering Design (FEED).

FEED is an engineering design approach used to control project expenses and thoroughly plan a project before a fix bid quote is submitted. It may also be referred to as Pre-Project Planning (PPP).

The FEED focuses on the technical requirements as well as rough investment cost for the project. The FEED can be divided into separate packages covering different portions of the project. The FEED package is used as the basis for bidding the Execution Phase Contracts (EPC, EPCI, etc.) and is used as the design basis.

A good FEED will reflect all of the client's project-specific requirements and avoid significant changes during the execution phase. FEED contracts usually take around 1 year to complete for larger-sized projects. During the FEED phase there is close communication between Project Owners and Operators and the Engineering Contractor to work up the project-specific requirements.

A positive evaluation in conclusion of the FEED does not means that the Final Investment Decision (FID) will follow suit as there are other non-engineering components, including legal and anticipated risks, that needs to be evaluated and the best option is what will be implemented.

Implementation of the project can follow different approaches, the major ones being:

i) Engineering procurement and construction contract (EPC), sometimes called turnkey projects (Wallace, 1984). In this approach the client may seek tenders based on a performance specification and then have no input into the design, other than if variations are instructed. In that respect the contractor takes more risk. Generally, EPC contracts are used on engineering and infrastructure projects, or industrial projects, where the aesthetics of design might be considered less important to the client than performance and cost certainty.
ii) Design and build contracts. It involves a single contract for the design and construction of the project. Here the client may produce an outline design upon which tenders are sought.

A turnkey project or contract as described by Duncan Wallace (1984) is “a contract where the essential design emanates from, or is supplied by, the Contractor and not the owner, so that the legal responsibility for the design, suitability and performance of the work after completion will be made to rest with the contractor”. 'Turnkey' is treated as merely signifying the Contractor is responsible for the design.

So, in short EPC is a contract comprising Engineering, Procurement, and Construction and a turnkey project is a contract comprising Engineering, Procurement, and Construction. However, the two concepts differ as follows:

i) In EPC, the client will provide basic engineering to a contractor and the latter shall perform detailed design based on a received basic design.
ii) In Turnkey Project, the client will only provide certain technical specifications of the project and it is the responsibility of the contractor to prepare the basic and detailed design of the project.
iii) In Turnkey Project, the contractor is responsible to perform construction and commissioning, start-up, and takeover of the plant to the client, but in EPC, it may be the responsibility of another third party to do commissioning and start-up.

A primary benefit of a turnkey contract is that the solution is ready to use as soon as the project is completed. The client also normally does not pay for the solution until it is finished and this is recommended for this project.

# CHAPTER THREE

# 3 PLANT AND MACHINERY

## 3.1. Availability of Raw Materials

The findings of the Market Study indicate that the local and even East African Community regional market demand for soda ash is not very large, implying that large production capacity will aim at export market. However, the report cautioned of stiff competition in the international market with producers and suppliers which are well established. Since there is already one supplier in East African Community (EAC), which is Tata Chemical Magadi Company in Kenya and one supplier in South African Development Corporation (SADC) region, which is Botswana Ash Pty. it is, therefore, recommended to start with a smaller production capacity of 500,000 tonnes of soda ash per annum. The plant can be expanded to accommodate higher production capacity as the market grows.

As reported in Volume I (Appraisal of the Brine Resources) and echoed in Volume III (Soda Ash Technological Assessment), the six boreholes tested have brine with high concentration of sodium carbonate (average of 202 g/L at 25℃) and sodium bicarbonate (average of 18 g/L at 25℃) and negligible concentration of other salts. The two salts make up 40 to 87% of the total dissolved solids in the brine solution.

Extraction of this resource will be done by pumping the brine from the aquifer through production boreholes. This method will minimize contamination to the brine during extraction as well as avoid environmental destruction which might be experienced if open pit method will be used to extract sodium bicarbonate which is in the solid, crystalline structures.

According to Volume I (Appraisal of the Brine Resources) and Volume III (Soda Ash Technological Assessment), the resource is enough to sustain the proposed production capacity of 500,000 tonnes per year and subsequent expansion to 1,000,000 tonnes per years.

The use of standard equipment in a process plant, whenever possible, will reduce costs. However, reactors, columns and other vessels are usually designed as special items for a given project. Design factors are applied in process design to give some tolerance in the design. For example, the process stream average flows calculated from material balances are usually increased by a factor, typically 10 per cent, to give some flexibility in process operation. The 10% factor, as applied in this work, will set the maximum flows for equipment, instrumentation, and piping design (Sinnott, 2005). Thus, the sizing and costing of the proposed plant has a design capacity of 550,000 tonnes per year.

### 3.2.1. Quality of raw material

The type of technology chosen and the number of unit operations involved depends on the quality of raw materials. Based on the soda ash concentration reported, Solar ponds system design may not be required, instead brine storage / settling ponds will be required. These will capture the slurry from the boreholes. Clear solution will then be pumped to the production plant.

### 3.2.2. Appropriateness of technology chosen

Market Study shows that there is a clear market for dense and light soda ash, with the former dominating the market. Several alternatives for producing dense soda ash have been discussed thoroughly in Process Technology Study. There are two main approaches for production of dense soda ash as shown in the block flow diagram (BFD) in **Error! Reference source not found.**. The first approach is the evaporation process which employs evaporators followed by crystallizers. The second approach is the carbonation process which produces sodium bicarbonate and later light soda ash, which can be processed further to dense soda ash. The first approach is more energy intensive and more expensive, hence opted out. The carbonation technology is similar to that of Botswana Ash Pty (Botash) shown in **Error! Reference source not found.**. The technology is less energy intensive and is more flexible in terms of supply of soda ash and sodium bicarbonate.

In absence of a clear market share, the plant is designed assuming dense soda ash takes almost 70% of the market share, light soda ash (20%) and sodium bicarbonate (10%). Thus, the plant will produce, at minimum 350,000 tonnes per year of dense soda ash, 100,000 tonnes per year of light soda ash and 50,000 tonnes per year of sodium bicarbonate (also referred to as baking soda). However, the plant can produce 100% of either product, if that is what is needed in the market.

The quality of Magadi soda ash from Kenya is 95% pure, whereas the synthetic one obtained from China and other exporting countries vary from 99.2% to 99.5% pure. Impurities found in Magadi soda ash are NaF (2.4%w/w), NaCl (0.3%w/w) and $Na_2SO_4$ (0.3%w/w). These are also expected to be in our product but in smaller proportions. About 90%w/w of the Magadi soda ash has particle size of 0.125 mm. Since our brine solution is richer in soda ash than that in Botswana and Kenya, the Engaruka soda ash plant is designed to meet a minimum quality of 99.2% $Na_2CO_3$ purity.

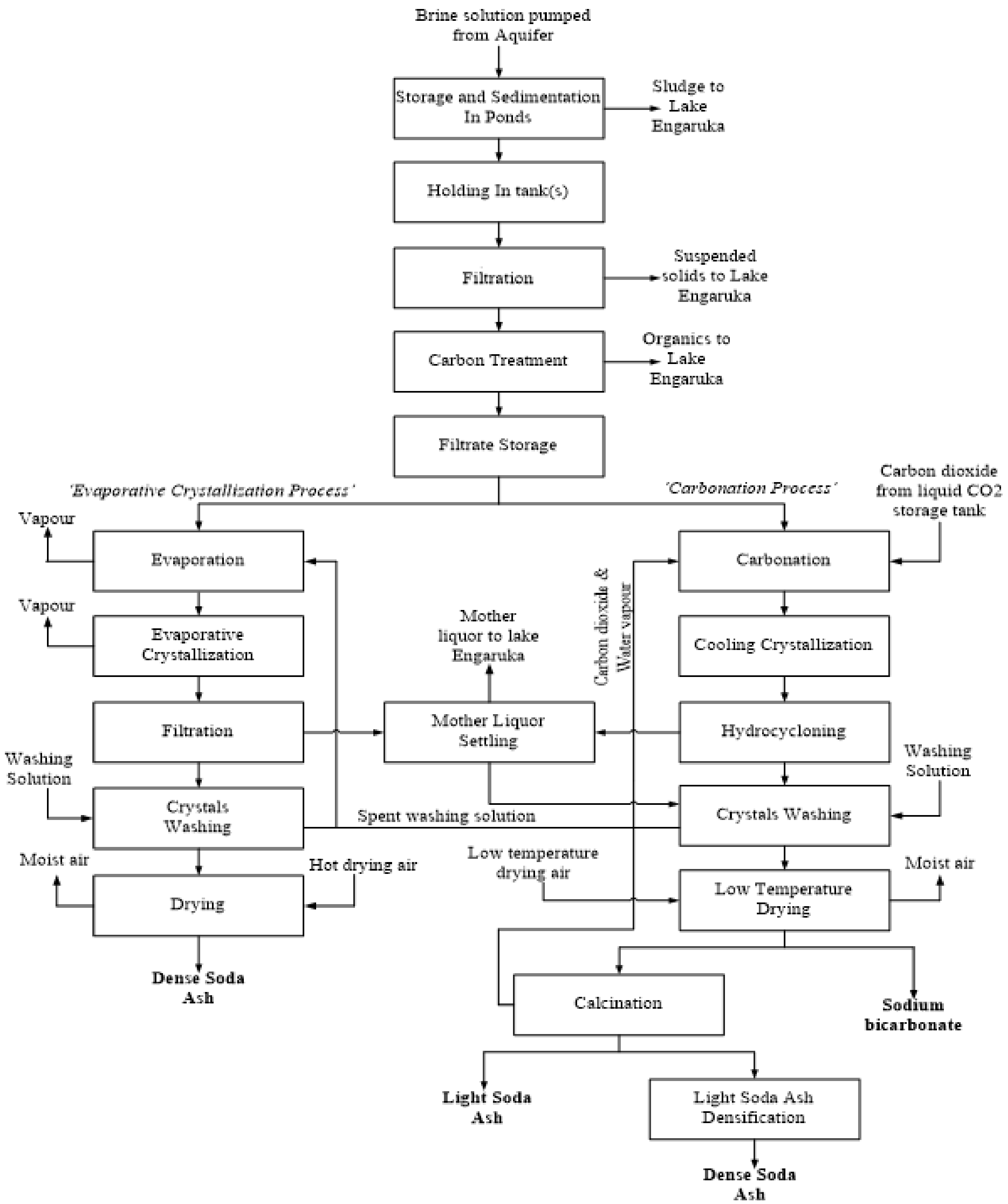


Figure 3-1: Process flow diagram with two approaches
(LHS: Evaporation crystallization process, RHS: Carbonation process)

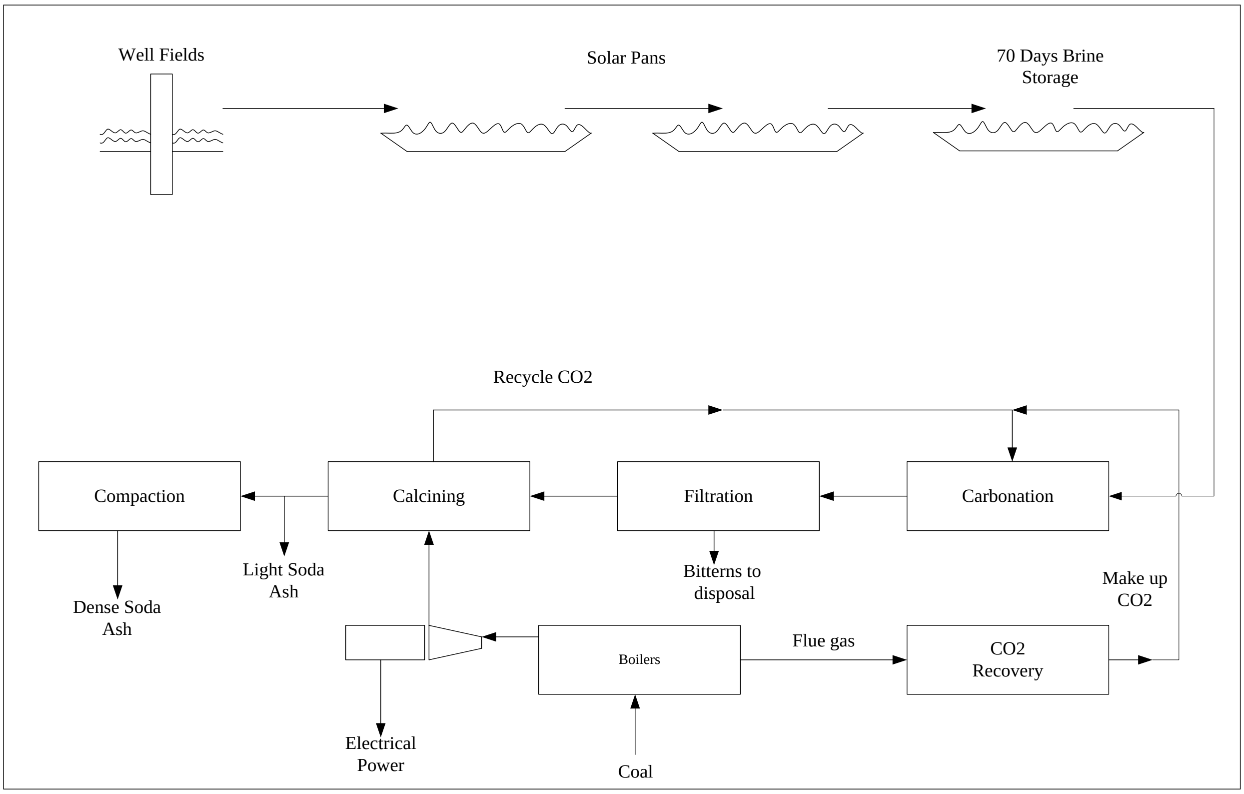


Figure 3-2: Production process flow diagram for soda ash by Botash
Source: Adapted from Botswana Ash Pty website (www.botash.bw)

### 3.2. Plant Equipment and Machinery

Soda ash production machinery can be supplied as a complete plant or as independent equipment/machinery. The more practised approach is supply of a complete plant. Complete soda ash production plants are normally supplied as a turnkey project.

There are several companies, which can supply soda ash plant as turnkey projects, some of which are shown in **Error! Reference source not found.**. The table shows that the higher the plant capacity the lower the investment cost. The table also shows that capital investment per tonne for synthetic soda ash is higher than that of natural soda ash. Experience from soda ash plant suppliers show that plant capacity of less than 200,000 tonnes per year of natural soda ash will be uneconomical, whereas for synthetic soda ash an economical plant could be as small as 30,000 tonnes per year.

Table 3-1: Soda ash plant suppliers and costs

| S/N | Complete Plant Supplier | Production capacity [tonnes] | Plant cost [million USD] | Plant cost per tonne [USD] | Remarks | Source of Information |
|---|---|---|---|---|---|---|
| 1 | Citic Pacific Ltd,<br>32nd Floor, CITIC Tower 1 Tim Mei Avenue Central, Hong Kong, China<br>Telephone： +852 2820 2111<br>Email： contact@citic.com<br>www.citic.com)<br><br>JC «Uzkimyosanoat», State Joint-Stock Company Uzkimyosanoat (holding company for chemical industry)<br>100011, Tashkent city, Uzbekistan. Navoiy st., 38.<br>Tel: (99878) 140-74-08<br>Email: uzkimyosanoat@uks.uz, info@uzkimyosanoat.uz<br>(www.uzkimyosanoat.uz/en/) | 100,000 | 100 | 1,000 | Installed in Uzbekistan's Kungrad Soda Plant (using NaCl and Limestone raw materials)<br>Solvay process | www.uzkimyosanoat.uz/en/ |
| 2 | Sumy Frunze NPO<br>Joint Stock Company "Sumy Machine-Building Science-and-Production Association"<br>58, Gorkogo Str., Sumy, 40004, Ukraine<br>Tel: +38 (0542) 686-333 | 50,000 to 200,000 | | | Solvay process | http://www.frunze.com.ua/en/ |

| S/N | Complete Plant Supplier | Production capacity [tonnes] | Plant cost [million USD] | Plant cost per tonne [USD] | Remarks | Source of Information |
|---|---|---|---|---|---|---|
| | Email: info@snpo.ua (http://www.frunze.com.ua/en/) | | | | | |
| 3 | Chemieanlagenbau Chemnitz GmbH (CAC)<br>Augustusburger Strasse 34<br>09111 Chemnitz, Germany<br>PF 23 02 41/D-09055<br>Tel: +49 371 68990<br>Email: info@cac-chem.de<br>(https://www.cac-chem.de/en/desktopdefault.aspx/tabid-2/) | 110,000 | | | Turnkey crystallization plant installed for Ciech Soda Deutschland GmbH & Co.KG, Stassfurt, Poland (2018) https://ciechgroup.com/en/ciech-group/ciech-group-companies/ciech-soda-deutschland/ | https://www.cac-chem.de/en/desktopdefault.aspx/tabid-2/ |
| 4 | Larsen & Toubro ECC Division (https://www.lntecc.com/home.html), Jacobs H&G Ltd, Mumbai (https://www.niir.org/directory/contact/6077/jacobs-h-g-ltd-mumbai-maharashtra-india.html),<br>Akzo Nobel Engineering (https://www.akzonobel.com/en/vacancy-job-family/engineering) | 365,000 (upgrading to this capacity) | 98 | 268.50 | Installed in Kenya's Tata Chemicals Magadi Co. (natural soda ash production) | https://www.akzonobel.com/en/vacancy-job-family/engineering |
| 5 | Asia Chemical Engineering Co. Ltd, China (www.yatai.cn)<br>(Synthetic soda ash production) | 30,000 | 30 | 1,000 | FOB | Enquiry from Asia Chemical Engineering company, China<br>Xiang Hongyue<br>asia2@yatai.cn |
| | | 200,000 | 164 | 820 | FOB | |
| | | 1,000,000 | 347 | 347 | FOB | |

| S/N | Complete Plant Supplier | Production capacity [tonnes] | Plant cost [million USD] | Plant cost per tonne [USD] | Remarks | Source of Information |
|---|---|---|---|---|---|---|
| 6 | Veolia Water Technologies North America, Fax: (815) 609-2044, (www.veoliawatertech.com , hpd.info@veolia.com ) (Natural soda ash production) | 200,000 | 50 | 250 | Not including freight charges | Enquiry from Veolia company, USA stephen.heal@veolia.com |
| | | 500,000 | 75 | 150 | | |
| 7 | Undisclosed<br><br>(Natural soda ash production and sodium chloride salt recovery) | 300,000 Soda ash | 65<br>(P736 million) | 68 | Installed in Botswana (Botswana Ash Pty) in 1991.<br>Infrastructure development in township needed additional P100 million. | www.botash.bw |
| | | 650,000 Sodium chloride | | | | |
| 8 | Arabian Gulf<br>(synthetic soda ash) | 200,000 | 166 | 830 | Complete plant including installation<br>1992 estimate<br>Cost Index 1992: 392.2<br>Cost Index 2020: 541 | (Wagialla, et al., 1992) |
| 9 | Kazan Soda Electric Uretim A.S., Turkey<br>(Natural soda ash – solution mining) | 2,500,000 soda ash | 1,500 | 555.6 | Built by Ciner Group between 2015 and 2017 by China. Production started in 2018.<br>Produces 99.8% pure soda ash | https://www.kazansoda.com/en/ |
| | | 200,000 bicarbonate | | | | |

### 3.3. Soda Ash Packaging

Worldwide soda ash is supplied to wholesalers or agents in different packaging sizes ranging from 25 kg bags to 32 tonne bulk tankers as shown in **Error! Reference source not found.**. Sodium bicarbonate, is also available in similar packages. However, the products are also available in smaller packages for retailers. Packaging requirements dictate the packaging technology to be used. Thus, the Engaruka soda ash plant has been designed to accommodate wholesaler kind of packaging arrangement, i.e., 50 kg bags and bulk tankers.

Table 3-2: Soda ash packaging

| **Tata Chemicals Magadi Ltd.** | **Botswana Ash Pty** | | **Ciech Soda Deutchland GmBH, Poland** |
|---|---|---|---|
| Dense Soda Ash | Dense Soda Ash | Light Soda Ash | Dense & Light |
| Bulk shipload up to approximately 15,000 tonnes per vessel | 32 tonnes bulk pneumatic tankers | | |
| 1 tonne block bottomed woven polypropylene bags | 1 tonne bulk bags | | 1 tonne bulk bags |
| 50 kg woven polypropylene bags with inner polythene liner | 50 kg bags (shrink-wrapped and palletized) | 50 kg bags (shrink-wrapped and palletized) | |
| | 25 kg bags (shrink-wrapped and palletized) | | 25 kg bags |
| *Source:* (Tata, 2019) | *Source: Botash South Africa (https://www.botash.co.za/products/soda-ash/)* | | *Source:* https://ciechgroup.com/en/ciech-group/ciech-group-companies/ciech-soda-deutschland/ |

The production capacity of the soda ash plant is a constant figure, but the market in which it operates is in constant change. When the economy grows, soda ash and baking soda consumption grows even faster and more of it is needed in the market, sometimes more than the local plant can produce. When the economy shrinks, consumption of the product is likely to reduce, which might necessitate managing high inventory. There are two ways to do this - trade and distribution.

Soda ash, like cement trade basically consists of bringing together a producer and a user (all over the world) and arranging for all requirements to get the product from one to the other. It is a highly specialised profession. It requires a detailed knowledge of the global markets, a technical knowledge of soda ash and sodium bicarbonate quality and consistence of quality. It requires knowledge of the technical aspects, the logistics and the economics of the transportation and terminal issues. In addition, it requires experience in the politics, trials and tribulations that go with the business. With these aspects in mind, the plant is not expected to own a product warehouse outside the plant location, neither a large storage facility as the product will be going straight to consumers through sales agents. The details of soda ash market are covered in Volume I of this.

## 3.4. Description of the Soda Ash Plant

Using the carbonation technology, three products can be obtained from the brine solution as the raw material. These products are dense soda ash, light soda ash and sodium bicarbonate. The technology proposed enables the plant to produce all the three products at the same time during operation as these products share most of the equipment.

Starting with brine pumping from the aquifer, the technology is comprised of operations shown in block flow diagram (BFD) in **Error! Reference source not found.**. These are:

i) Brine Storage and Sedimentation in Ponds
ii) Holding in Tank(s)
iii) Rotary Vacuum Filtration
iv) Activated Carbon Filtration
v) Brine Filtrate Storage
vi) Brine Filtrate Pre-heating
vii) Carbonation Reaction
viii) Cooling Crystallization
ix) Hydrocyclone Separation
x) Crystals Washing
xi) Low Temperature Drying
xii) Sodium Bicarbonate Calcination
xiii) Densification of Soda Ash
xiv) Products Storage and Packaging

The process flow diagram (Appendix 1) shows arrangement of the equipment and flow of material in the production process as outlined below.

### 3.4.1. Brine water holding tanks

These are designed to act as a reservoir for the storage of clear brine solution pumped from the sedimentation ponds. They will be the first part of the plant which ensures stable supply of clarified brine solution to the downstream processes plant. There will be two tanks which will be fed at a total rate of 459.34 tonnes/hr. The holding tanks will be capable of accommodating 5,500 $m^3$ of brine each and this is equivalent to an amount of brine required by the plant for about 30 hours of operation. Therefore, the storage will ensure the supply of brine and avoid the unnecessary shutdown or stoppage of the plant due to either scheduled or unscheduled maintenance in the brine pumping section.

### 3.4.2. Filtration process

*Rotary vacuum filtration*

It is at this stage where the suspended solids remaining in the solution after sedimentation in ponds will be removed. This will be achieved using a rotary vacuum drum filter. The filter consists of a rotating drum covered with the filtering screen or cloth on the surface. During operation, the drum is submerged in a trough containing the brine solution with suspended solids to be filtered. The drum surface is divided into several chambers which are connected to the axial section of the drum linked to the vacuum sources especially vacuum pumps.

During the rotation of the drum, vacuum sucks both the suspended solids and the liquid part of the formed slurry. The liquid part passes as the filtrate and the solids remain on the surface and build up a cake which is scrapped before the drum re-enters the trough.

The rotary drum filter cross section is divided into three sections during operation based on the vacuum level. These sections are the low vacuum section, high vacuum section and no vacuum section. The low vacuum section is for forming and building a cake on the filtering surface and is applied within a trough where a drum is submerged. The high vacuum section dries the washed cake before being scrapped. Before entering the high vacuum section, a cake is sprayed with water to allow leaching of the soluble substances retained in the cake. The no vacuum section is where the cake is scrapped from the surface and it is just after the high vacuum section.

Filtration process will be achieved by three (3) rotary vacuum drum filters, operating in parallel, and each having a filtration area of about 110.61 $m^2$. Troughs will be fed with brine at a total rate of 459.34 tonnes/hr and cake will be collected from all the troughs at the rate of 0.082 tonnes/hr. Since there will be a very thin layer of cake produced over the production period, cake washing will not be necessary. The developed cake can be scraped off during scheduled annual maintenance.

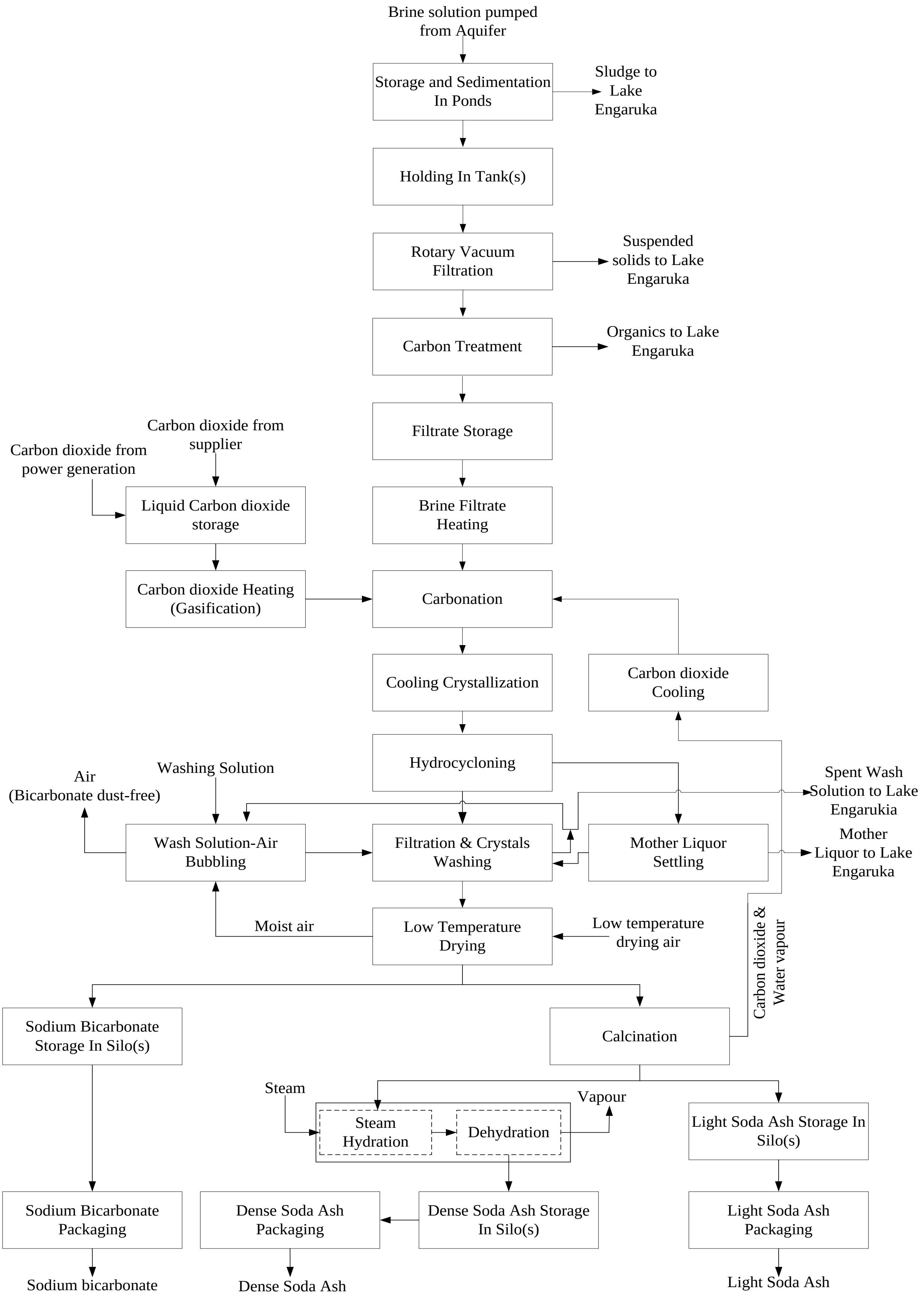


Figure 3-3: The carbonation technology for production of soda ash and sodium bicarbonate

***Activated carbon filtration***

After removing suspended solids using the rotary filter, filtrate is passed through activated carbon beds in order to remove dissolved organic matters contained in the brine through adsorption process. The average concentration of total organic compounds (TOC) in brine is 10.67 mg/litre (Volume I - Appraisal of the Brine Resources). The organics in brine are removed because they impart unwanted colour and smell to the final product (Madima, 2009). The organics left in brine might also affect the process performance by causing foaming in processes involving brine heating.

This adsorption process will be taking place in Granular Activated Carbon (GAC) adsorption filter beds. There will be four activated carbon filters and the total feed rate of brine into all filters will be 459.26 tonnes/hour. The beds will be flashed regularly to remove any bound organics after adsorption to allow for the bed regeneration. The water required for this action will be fed at a rate of 117.22 tonnes/hr and the spent wash water stream will be discharged at the rate of 144.90 tonnes/hr. The spent wash solution stream contains water, dissolved organics and traces of some components like sodium carbonate and sodium bicarbonate left during adsorption.

***Filtrate storage***

The filtered brine which is free of organic carbon will be stored in tanks to facilitate smooth pumping of brine into carbonation column via a heating facility. This filtrate will be stored in two tanks each capable of holding 5,500 $m^3$ of brine. This amount of brine can be consumed in about 24 hours of plant operation. This means that in case of problems in the brine pumping from the ponds, these tanks combined with the raw brine holding tanks will enable the plant to continue operating for about 60 hours uninterrupted.

***Brine filtrate heating***

Carbonation feed preheating is necessary because it facilitates the reaction to take place easily just after introducing the reagents into the reactor. This is achieved using a heat exchanger. The suitable temperature for carbonation reaction is about 50℃ to 120℃ (Sih, et al., 1979). Thus, the brine from the filtrate tank, which is at ambient temperature, is preheated to 50$^o$C before entering the carbonation reactor.

Brine heating also increases the solubility of dissolved solutes which prevents crystallization in the carbonation reactor allowing for appreciably high conversion degree. During this process, brine is heated to reaction temperature or near the reaction temperature using a low-pressure steam. The heating steam temperature is recommended to be less than 200℃ to avoid calcination of sodium bicarbonate into sodium carbonate which occurs above this temperature. For this operation, steam will be supplied at 152℃.

### 3.4.3. Carbonation process

During carbonation process, carbon dioxide is bubbled to the brine solution. The sodium carbonate present in the brine solution is converted into sodium bicarbonate based on the reaction given in Equation 3-1.

$$Na_2CO_3 + H_2O + CO_2 \longrightarrow 2NaHCO_3 \qquad \text{Equation 3-1}$$

During carbonation process, the produced $NaHCO_3$ starts to precipitate once the solution concentration becomes saturated at about 149 g/l at a temperature of around 50℃ as per solubility trends shown in **Error! Reference source not found.**. The carbonation process is designed to take place in a bubbling column reactor where $CO_2$ will be reacted with the filtered brine. Carbon dioxide for this process will be outsourced from a supplier and stored in a liquid $CO_2$ storage facility during process plant start-up. As production continues, enough $CO_2$ will be produced during calcination of $NaHCO_3$ into $Na_2CO_3$, which will be recycled to the carbonation reactor, hence reducing the amount of $CO_2$ to be outsourced. The temperature of $CO_2$ produced during calcination is lowered before recycling it into the reactor in order to avoid the excessive temperature rise during reaction which results into sodium bicarbonate calcination into sodium carbonate. More $CO_2$ could be supplied from the flue gases of the coal fuelled power plant which is expected to be part of the soda ash process plant.

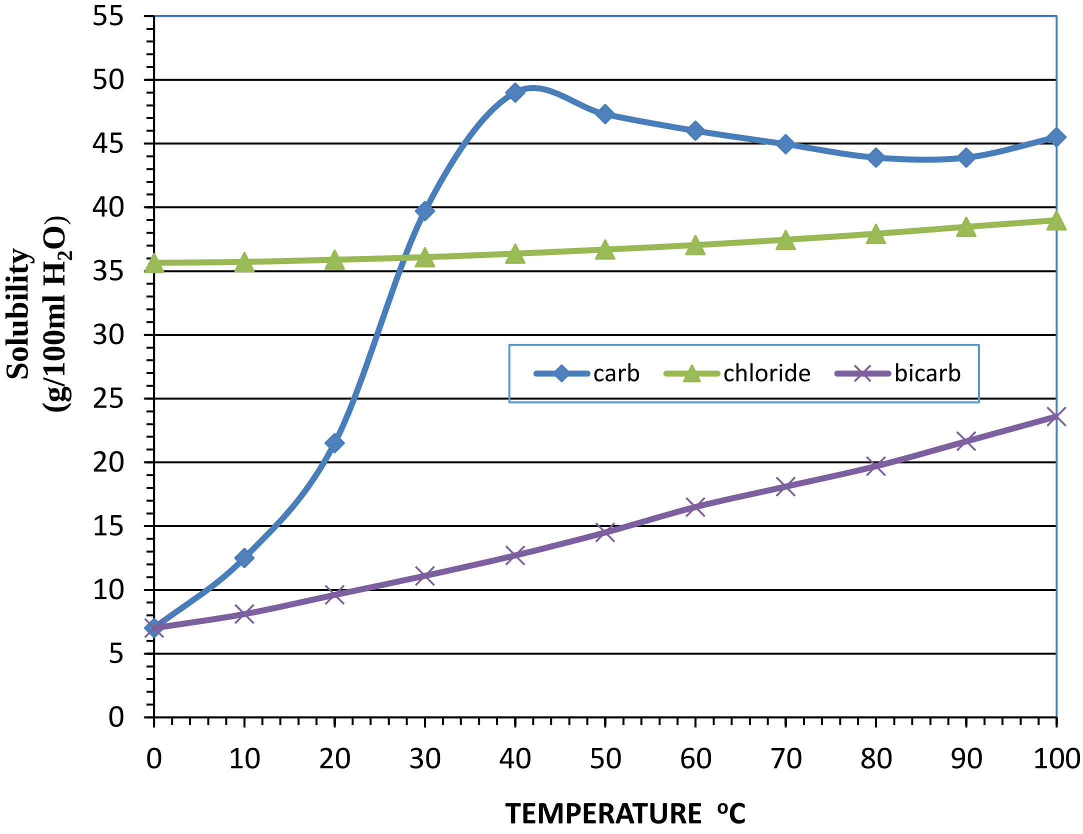


Figure 3-4: Solubility curves of sodium carbonate, sodium chloride and sodium bicarbonate.

The brine will be fed into the carbonation reactor at a rate of 431.58 tonnes/hr and $CO_2$ will be bubbled at a rate of 35.25 tonnes/hr to produce $NaHCO_3$ as per the reaction in Equation 3-2 where half of the product mixture is recycled back into the reactor to allow for more recovery. The amount of $NaHCO_3$ slurry crystals formed will be at a rate 958.15 tonnes/hr.

### 3.4.4. Crystal separation and washing process

***Cooling crystallization***

The carbonation process product is a slurry at a temperature of about 53.4℃ and at this temperature it is saturated with $NaHCO_3$ at about 151 g/L as per **Error! Reference source not found.**. To recover more crystals, the slurry is introduced into cooling crystallizer(s) where its temperature is lowered to about 25℃. At this temperature the slurry is saturated with $NaHCO_3$ at about 100 g/L and this allows for more crystals' recovery compared to the carbonation temperature saturation concentration.

Cooling crystallization will be taking place in seven (7) identical crystallizers working in parallel with a capacity of 149.06 $m^3$ each. The total feed rate of slurry into the crystallizers will be 479.08 tonnes/hr. Chilled water at a temperature of 10℃ will be used as a cooling medium for the process.

*Hydrocyclone separation*

Hydrocycloning involves the separation of precipitated $NaHCO_3$ crystals with the mother liquor by the influence of centrifugal force. This takes place in a hydrocyclone. During operation, a slurry is pumped into a hydrocyclone where it enters tangentially and by the influence of a centripetal force, the crystals are thrown outwards to the hydrocyclone wall then fall down as an underflow. Mother liquor leaves through an overflow outlet which is an upper section of hydrocyclone and thereafter it will be directed to Lake Engaruka so that it improves the brine recharge rate in the aquifer.

A hydrocyclone will be fed with slurry at a rate of 479.08 tonnes/hour and thereafter, separation will give an underflow at the rate of 129.45 tonnes/hour and an overflow at the rate of 349.63 tonnes/hour. The crystals make about 85% composition by mass of the underflow while the overflow is saturated with $NaHCO_3$ at about 100 g/L at 25℃.

*Crystals washing*

This process involves removing the mother liquor retained with crystals during hydrocycloning stage. It will be achieved by a belt washer of three stages. Crystals washing requires wash solution that is saturated with $NaHCO_3$ at 25℃ which is about 100 g/L to prevent crystals dissolution during the process, while dissolving other solutes contained in the mother liquor retained with crystals after separation.

During the process, the washer is fed with crystals at a rate of 129.45 tonnes/hr, while wash solution will be charged into a washer at the rate of 24.14 tonnes/hr. The resulting spent wash solution stream will be leaving at a rate of 39.46 tonnes/hour. This will be directed to the settling tank to capture any solids before discharging it to Lake Engaruka.

### 3.4.5. Low temperature drying of sodium bicarbonate

Because $NaHCO_3$ is one of the final products, washed crystals discharged from the belt washer will be dried at low temperature. Low temperature drying air will be used for that process. In a normal practice the temperature should be below 200℃ to prevent calcination of sodium bicarbonate into sodium carbonate. The recommended air temperature should be slightly above the boiling point of water.

Drying of $NaHCO_3$ will be achieved using a fluidized bed due to its high efficiency compared to other types of solid dryers (Davich, 1990). In this process, drying air will be entering at a temperature of 110℃. Drying air will be steam-heated and before heating, it will be filtered to remove any foreign matters that can contaminate the crystals. For this case, steam for air heating will be at a temperature of about 152℃. About 10% of the dryer output equivalent to 11.09 tonnes/hr will be taken to the sodium bicarbonate storage silos as a final product.

### 3.4.6. Calcination Process

Calcination process is a thermal decomposition of $NaHCO_3$ crystals according to Equation 3-2 into low density $Na_2CO_3$ known as light soda ash.

$$2NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_2O \qquad \text{Equation 3-2}$$

The calcination process is designed to take place in a rotary calciner in which $NaHCO_3$ crystals will be subjected to a temperature of at least 200°C to decompose the $NaHCO_3$ into soda ash, carbon dioxide and water.

The rotary calciner will be fed with $NaHCO_3$ crystals from the dryer at a rate of 99.80 tonnes/hr. Light soda ash will be produced at a rate of 62.59 tonnes/hr. About 22.2% of this product which is equivalent to 13.89 tonnes/hr will be taken directly to the light soda ash storage silos as a final product. The remaining amount will be pneumatically transported to the densification unit to convert the light soda ash into dense soda ash.

### 3.4.7. Soda ash densification

Light soda ash is used for production of detergents, chemicals, soaps, textile, paper, food, casting industry, and oil refineries. Dense soda ash is preferred for all kinds of glass manufacture like flat glass, float glass, container glass, etc. But, coarse dense soda with selected granulation containing thicker fraction is mainly used for the production of detergents.

Soda ash densification is a process of increasing the bulk density of light soda ash. Different technologies can be used for this purpose and amongst those technologies there is densification by compaction, densification by steam hydration, and densification by fusion and grinding. For this process densification by steam hydration will preferably be used.

***Densification by compaction***

Compaction increases the density of light soda ash by compressing the crystals together to form pellets or compacts/blocks or just by compressing the crystals using a continuous roller system. Both of these technologies reduce the voidage of the light soda ash and this ultimately increases it bulk density.

Soda ash obtained by compacting light soda ash has lower density and different granulation than the regular dense grade. It might be unique or better suited for certain processes and applications.

***Densification by steam hydration***

Soda ash densification by steam hydration is a process of increasing the bulk density of the light soda ash to make it dense by hydrating it with steam. Light soda ash crystals are hydrated first with steam followed by dehydration of the crystals. The allowable temperature of steam during hydration process is 70-120℃ but it is preferable to operate at 112℃ as this temperature has always confirmed the better results (Gancy, 1967). During hydration process the amount of steam to be used is recommended to be 20-25% w/w of the expected hydration product (Gancy, 1967). After hydration the mixture is dehydrated to remove the hydration water by heating it to a temperature slightly above the boiling point. The hydrating steam is also used as a heating medium for this case and therefore the temperature for dehydration is also 112℃.

The light soda ash hydration by steam and dehydration processes are both designed to be performed by a rotary calciner having two zones, that is, steaming zone for hydration and calcining zone for dehydration.

The steam hydration and dehydration unit, will be fed with light soda ash at a rate of 48.69 tonnes/hr and steam will be supplied at the rate of 14.14 tonne/hr whereas the dense soda ash will be produced at the rate of 48.71 tonnes/hr. The soda ash product produced as a result of densification by steam hydration method is dust free compared to other densification methods like fusion and grinding method. The method increases the density of light soda ash by 5-17%.

### 3.4.8. Products storage and packaging

The produced products will be stored in silos before packing them in bags ready to be loaded in trucks. There will be a total of six (6) silos for storage of the three products where each product will need two (2) silos. The storage capacity of dense soda ash silos is 11,795 $m^3$ each, the ones for light soda ash is 4,196 $m^3$ each and those for sodium bicarbonate is 3,349 $m^3$ each.

There will be one packaging unit for each product and each product will be bagged in 50 kg bags. The production rate per hour of operation for dense soda ash, light soda ash and sodium bicarbonate will be 974 bags, 278 bags and 222 bags, respectively. After packaging, the bags will be directly loaded in trucks ready for dispatch. The packaging facility is also capable of filling the products into 30 tonnes+ bulk trucks or containers.

### 3.4.9. Product quality

The processing plant produces three products simultaneously or as required by the market. The purity of the sodium bicarbonate produced is 99.6%, while light soda ash has a purity of 99.6% and the dense soda ash has a purity of 99.4%. All the products meet minimum international market purity of 99.2%.

### 3.4.10. Equipment specifications and capital cost

Most of the equipment for this soda ash plant, like all other large production facilities, will be tailor made to suit the proposed production conditions and volume. Equipment specifications were established with assistance from SuperPro Designer software. The direct fixed capital

(DFC – see **Error! Reference source not found.**) was estimated using cost correlations to estimate the purchase cost of all major process equipment and appropriate chemical and process engineering cost factors with respect to purchase cost to generate estimates for all other cost elements. The capital cost elements are outlined below.

i) **Equipment Purchase Cost (PC):** this is the vendor's selling price of major equipment. It is free-on-board (FOB) cost as it excludes items such as taxes, insurance, delivery and installation. The cost of equipment is typically estimated based on average of costs from different vendors worldwide (such as those in **Error! Reference source not found.**) coupled with correlations for scaling up or down.
ii) **Installation Cost:** this cost item refers to the in-place construction of equipment at the new plant site and includes the cost of foundations, slabs, supports, and local equipment services. For this preliminary economic analysis, the installation cost of equipment is estimated by multiplying the corresponding purchase cost by a suitable factor. In absence of a national cost factor, the generally recommended Chemical and process engineering factor of 0.29 was used.
iii) **Process Piping Cost:** this cost item incorporates the cost of process fluid piping that connects the equipment, as well as connections to the main utility headers and vents. Included are valves, piping supports, insulation, and other items associated with equipment piping. In this preliminary economic analysis, this cost was estimated by multiplying PC by the recommended process plant design factor of 0.35.
iv) **Instrumentation Cost:** this cost item includes the costs of transmitters and controllers (with all required wiring and tubing for installation), field and control room terminal panels, alarms and enunciators, indicating instruments both in the field and in the control room, on-stream analysers, control computers and local data-processing units, and control room display graphics. In this preliminary economic analysis, this cost was estimated by multiplying PC by the recommended process plant design factor of 0.40.
v) **Insulation Cost:** this cost item includes the cost of insulation and painting, which is usually included in the cost of installation and piping. Where low or high temperatures are used, insulation cost can become unusually high. An insulation surcharge is recommended for such plants. For this preliminary economic analysis, this cost was estimated by multiplying PC by the recommended process plant design factor of 0.03.
vi) **Electrical Cost:** this cost item refers to the cost of electrical facilities. These includes motor switch gear and control centres, wiring and conduit, bus bars, area lighting and emergency power supply unit (standby generator). The standby generator is costed under Electrical power distribution (Chapter Four) For this preliminary economic analysis, this cost was estimated by multiplying PC by the recommended process plant design factor of 0.10.
vii) **Auxiliary Facilities Cost:** this cost item includes the cost of satellite process-oriented service facilities that are vital to the proper operation of the battery limits plant. An example of an auxiliary facility is a steam plant. For this preliminary

economic analysis, this cost is covered under Chapter Six (Steam and Power Generation).

viii) **Engineering:** this cost item includes the preparation of design books that document the whole process (e.g., the design of equipment, specification sheets for equipment, instruments, auxiliaries, etc., the design of control logic and computer software, the preparation of drawings) and other engineering-related costs. For this preliminary economic analysis, this cost was estimated by multiplying Total plant direct costs (TPDC) by a suitable plant design factor of 0.25.

ix) **Construction:** this cost item includes the costs associated with the organization of the total construction effort. They do not include the cost of construction labour because that is incorporated in direct cost items that involve construction. For this preliminary economic analysis, this cost was estimated by multiplying TPDC by a suitable plant design factor of 0.35.

x) **Contractor's Fee:** this is the contractor's profit. It should be added even if a corporation does its own construction, because the construction division is expected to show a profit. For this preliminary economic analysis, this cost was estimated by multiplying Total plant costs (TPC) by a suitable plant design factor of 0.05.

xi) **Contingency:** the more speculative a process is, the more likely it is that key elements have been overlooked during the project's early stages. This cost attempts to compensate for missing elements. However, even advanced-stage estimates will include a contingency to account for unexpected problems during construction, such as strikes, delays, and unusually high price fluctuations. For this preliminary economic analysis, this cost was estimated by multiplying TPC by a suitable plant design factor of 0.10.

Based on the above definitions, the total DFC of an investment is calculated as the sum of TPC and CFC as shown in **Error! Reference source not found.**.

Table 3-3: Equipment vendors/manufacturers

| | **Company** | **Address** | **Telephone, Email** | **Products** |
|---|---|---|---|---|
| 1. | Charles Thompson Ltd | Glasshouse Road, Kilnhurst, Mexborough, South Yorkshire, S64 5TD, UK | Tel: +44 1709 580411<br>Email: info@Charles-Thompson.co.uk<br>www.charles-thompson.co.uk | Nutsche Filter-dryers Pressure vessels, Heat exchangers, Packaged process systems |
| 2. | Inox-Tech Inc. | 453 North Main Str, #302 Southington, CT 06489, USA | Tel: +1 450 638 5441<br>Email: info@inox-tech.com<br>www.inox-tech.com | Stainless tanks, reactors, silos, pressure vessels, mixed tank reactors |
| 3. | De Dietrich | P. O. Box 345, | Tel: +1 908 317 2585 | Reactor vessels |

| | Company | Address | Telephone, Email | Products |
|---|---|---|---|---|
| | (USA) Inc | 2333 US Highway 22 West Union, NJ 07083, USA | Email: craig.compoli@DDPSInc.com sales@DDSInc.com www.ddpsinc.com | |
| 4. | Perry Videx, Inc. | 25 Hainesport – Mt Laurel Road, Hainesport, New Jersey 08036, USA | Tel: +1 609 267 1600 Email: perryvidex@perryvidex.com www.perryvidex.com | Centrifuges, dryers, Reactors, Tanks, Heat exchangers |
| 5. | Weihai Haiwang Hydrocyclone Co., Ltd. | No. 95, Huihe Road, Weihai City, Shandong Province, China | Tel: +86-631-5621553 Email: kevin@haiwangtec.com Tel: +86 631 5779116/ +86 18763140706 sales@haiwangtec.com Website: http://en.wh-hw.com | Hydrocyclone for separating solid crystals |

The list of major equipment and associated costs is shown in **Error! Reference source not found.**. The table also provides detailed specifications of the equipment including physical dimensions, capacity and wattage among others. The estimated equipment costs are around USD 49,517,850. The direct capital estimates summary breakdown given in **Error! Reference source not found.** is USD 197,714,871. **Error! Reference source not found.** shows the summary of material costs while **Error! Reference source not found.** presents the required consumables and **Error! Reference source not found.** shows the cost of utilities.

Since the equipment are tailor-made, and they need different supporting structures like buildings/sheds and foundations, it needs long time to accomplish the project. Based on Chemical Engineering Plant design rules of thumb, considering the time required for detailed engineering design, fabrication, installation and commissioning of the process equipment and machinery, design and construction of supporting structures as well as preparation of the necessary accessories to the plant, like access roads, it is estimated that the whole factory project will take about 30 months (**Error! Reference source not found.**).

Table 3-4: Soda ash by carbonation plant major equipment specification and cost as of July 2020

| | Name | Description/Type | Design Capacity | | Dimensions | | Design Pressure | Material of Construction | Quantity | Unit Cost | FOB Cost | CIF Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Value | Units | L/ H (m) | W/ D (m) | (bar) | | | (USD) | (USD) | (USD) |
| 1 | R-101 | Carbonation Reactor | 1,029,605 | L | 20.5 H | 8.2 D | 1.52 | SS316 | 1 | 3,849,000 | 3,849,000 | 4,426,350 |
| 2 | R-102 | Calcination Reactor | 109,019 | L | 14.2 H | 3.16 D | 1.52 | SS316 | 1 | 1,357,000 | 1,357,000 | 1,560,550 |
| 3 | V-101 | Brine Holding Tank | 5,500,000 | L | 16.5H | 20.6 D | 1.52 | SS316 | 2 | 197,000 | 394,000 | 453,100 |
| 4 | R-103 | Steam Hydration Unit | 31,709 | L | 6.36 H | 2.54 D | 1.52 | SS316 | 1 | 899,000 | 899,000 | 1,033,850 |
| 5 | R-104 | Dehydration Unit | 34,354 | L | 6.5H | 2.6 D | 1.52 | SS316 | 1 | 920,000 | 920,000 | 1,058,000 |
| 6 | PC-101 | Pneumatic Conveyor | 76,505 | kg/h | 30 | 0.285 | pipe | CS | 1 | 100,000 | 100,000 | 115,000 |
| 7 | RVF-101 | Rotary Vacuum Filter | 111 | $m^2$ | Filter area | | | CS | 3 | 270,000 | 810,000 | 931,500 |
| 8 | V-102 | $CO_2$ Storage Tank | 120,000 | L | 11.12 H | 3.71 D | 1.52 | SS316 | 1 | 315,000 | 315,000 | 362,250 |
| 9 | CY-101 | Hydrocyclone | 465,508 | L/h | | | | CS | 1 | 24,000 | 24,000 | 27,600 |
| 10 | WSH-101 | Washer (Bulk Flow) | 155,283 | kg/h | | | | CS | 1 | 79,000 | 79,000 | 90,850 |
| 11 | HX-101 | Heat Exchanger | 1.5 | $m^2$ | HX-Area | | | CS | 1 | 10,000 | 10,000 | 11,500 |
| 12 | PM-101 | Centrifugal Pump | 16.4 | kW | | | | SS316 | 1 | 63,000 | 63,000 | 72,450 |
| 13 | PM-102 | Centrifugal Pump | 18.7 | kW | | | | SS316 | 1 | 67,000 | 67,000 | 77,050 |
| 14 | V-103 | Brine Filtrate Tank | 5,500,000 | L | 16.5 H | 20.61 D | 1.52 | SS316 | 2 | 197,000 | 394,000 | 453,100 |
| 15 | PM-103 | Centrifugal Pump | 17.5 | kW | | | | SS316 | 1 | 65,000 | 65,000 | 74,750 |
| 16 | PM-104 | Centrifugal Pump | 37.3 | kW | | | | SS316 | 1 | 88,000 | 88,000 | 101,200 |
| 17 | SC-101 | Screw Conveyor | 15 | m | Pipe | 0.4367 D | | CS | 1 | 92,000 | 92,000 | 105,800 |
| 18 | PC-102 | Pneumatic Conveyor | 25 | m | Pipe | 0.2513 D | | CS | 1 | 86,000 | 86,000 | 98,900 |
| 19 | BC-101 | Belt Conveyor | 15 | m | Belt | 0.7911 D | | CS | 1 | 78,000 | 78,000 | 89,700 |
| 20 | GAC-101 | GAC Adsorption Column | 47,121 | L | 6.4 H | 3.13 D | | CS | 4 | 404,000 | 1,616,000 | 1,858,400 |
| 21 | PM-105 | Centrifugal Pump | 17.5 | kW | | | | SS316 | 1 | 65,000 | 65,000 | 74,750 |
| 22 | HX-102 | Heat Exchanger | 75 | m2 | HX-Area | | | CS | 1 | 102,000 | 102,000 | 117,300 |
| 23 | V-104 | Fresh Water Tank | 25,611 | L | 6.65 H | 2.22 D | | SS316 | 1 | 162,000 | 162,000 | 186,300 |
| 24 | PM-106 | Centrifugal Pump | 0.9 | kW | | | | SS316 | 1 | 18,000 | 18,000 | 20,700 |

| | Name | Description/Type | Design Capacity | | Dimensions | | Design Pressure | Material of Construction | Quantity | Unit Cost | FOB Cost | CIF Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Value | Units | L/ H (m) | W/ D (m) | (bar) | | | (USD) | (USD) | (USD) |
| 25 | FBDR-101 | Fluidized Bed Dryer | 38,813 | L | 17.12 H | 1.71 D | | SS316 | 1 | 213,000 | 213,000 | 244,950 |
| 26 | HX-104 | Heat Exchanger | 71.4 | $m^2$ | HX-Area | | | CS | 1 | 100,000 | 100,000 | 115,000 |
| 27 | PC-103 | Pneumatic Conveyor | 50 | m | | 0.2938 | | CS | 1 | 103,000 | 103,000 | 118,450 |
| 28 | BC-102 | Belt Conveyor | 15 | m | | 0.0678 | | CS | 1 | 66,000 | 66,000 | 75,900 |
| 29 | BC-103 | Belt Conveyor | 35 | m | | 0.0849 | | CS | 1 | 113,000 | 113,000 | 129,950 |
| 30 | BC-104 | Belt Conveyor | 25 | m | | 0.02977 | | CS | 1 | 89,000 | 89,000 | 102,350 |
| 31 | PM-107 | Centrifugal Pump | 5.7 | kW | | | | SS316 | 1 | 39,000 | 39,000 | 44,850 |
| 32 | HX-105 | Heat Exchanger | 62 | m2 | HX-Area | | | CS | 1 | 92,000 | 92,000 | 105,800 |
| 33 | CR-101 | Crystallizer | 149,058 | L | 10.3 H | 4.12 D | 1.52 | SS316 | 7 | 1,538,000 | 10,766,000 | 12,380,900 |
| 34 | SL-101 | Dense Soda Ash Silo | 11,795,257 | L | 36 H | 25 D | 1.11 | Concrete | 2 | 2,623,000 | 5,246,000 | 6,032,900 |
| 35 | BE-101 | Bucket Elevator | 36 | m | 36 H | 0.1*0.15 | | CS | 1 | 40,000 | 40,000 | 46,000 |
| 36 | SL-102 | Light Soda Ash Silo | 4,196,088 | L | 45.82 | 15.27 D | 1.11 | Concrete | 2 | 1,228,000 | 2,456,000 | 2,824,400 |
| 37 | BE-102 | Bucket Elevator | 28 | m | 28 H | 0.1*0.15 | | CS | 1 | 36,000 | 36,000 | 41,400 |
| 38 | SL-103 | Bicarbonate Silo | 3,348,576 | L | 42.5 H | 14.17 | 1.11 | Concrete | 2 | 1,073,000 | 2,146,000 | 2,467,900 |
| 39 | BE-103 | Bucket Elevator | 26 | m | 50 H | 0.1*15 | | CS | 1 | 34,000 | 34,000 | 39,100 |
| 40 | AF-101 | Air Filter | 164,570,489 | L/h | | | | CS | 1 | 632,000 | 632,000 | 726,800 |
| 41 | M-101 | Centrifugal Fan | 164,570,489 | L/h | | | | CS | 1 | 42,000 | 42,000 | 48,300 |
| 42 | HX-103 | Heat Exchanger | 40 | $m^2$ | HX-Area | | | CS | 1 | 71,000 | 71,000 | 81,650 |
| 43 | SC-102 | Screw Conveyor | 14 | m | | | | | 1 | 112,000 | 112,000 | 128,800 |
| 44 | SC-103 | Screw Conveyor | 10 | m | | | | | 1 | 44,000 | 44,000 | 50,600 |
| 45 | SC-104 | Screw Conveyor | 9 | m | | | | | 1 | 31,000 | 31,000 | 35,650 |
| 46 | V-105 | Receiver Tank | 769,222 | L | 13 H | 8.7 D | | | 1 | 184,000 | 184,000 | 211,600 |
| 47 | V-106 | Receiver Tank | 79,017 | L | 9.7 H | 3.22 D | | | 1 | 140,000 | 140,000 | 161,000 |
| | | Unlisted Equipment | | | | | | | 1 | 8,611,000 | 8,611,000 | 9,902,650 |
| | | | | | | | | | | **TOTAL** | **43,059,000** | **49,517,850** |

Note: D = Diameter, H = Height, L = Length, W = Width

Table 3-5: Fixed capital estimate summary, in USD, as of July 2020

| **A. Total Plant Direct Cost (TPDC) (physical cost)** | | | **% of PC** |
|---|---|---|---|
| 1 | Equipment Purchase Cost (PC) | 49,517,850 | |
| 2 | Installation | 14,360,177 | 29 |
| 3 | Process Piping | 17,331,248 | 35 |
| 4 | Instrumentation | 19,807,140 | 40 |
| 5 | Insulation | 1,485,536 | 3 |
| 6 | Electrical | 4,951,785 | 10 |
| | **TPDC** | **107,453,735** | |
| **B. Total Plant Indirect Cost (TPIC)** | | | **% of TPDC** |
| 7 | Engineering | 26,863,434 | 25 |
| 8 | Construction | 37,608,807 | 35 |
| | **TPIC** | **64,472,241** | |
| **C. Total Plant Cost (TPC = TPDC+TPIC)** | | | |
| 9 | **TPC** | **171,925,975** | |
| **D. Contractor's Fee & Contingency (CFC)** | | | **% of TPC** |
| 10 | Contractor’s fee | 8,596,299 | 5 |
| 11 | Contingency =10%TPC | 17,192,598 | 10 |
| | **CFC = 11+12** | **25,788,896** | |
| **E. Direct Fixed Capital Cost (DFC = TPC+CFC)** | | | |
| 12 | **DFC** | **197,714,871** | |

Table 3-6: Materials cost (2020 prices) – process summary

| **Bulk Material** | **Annual Amount** | **Ref. Units** | **Unit Cost** | **Annual Cost** | |
|---|---|---|---|---|---|
| | | | **[USD]** | **[USD]** | **(%)** |
| Air | 1,164,828,862 | kg | 0 | 0 | 0 |
| Brine from settling tanks | 3,307,260,960 | kg | 0 | 0 | 0 |
| Carbon Dioxide | 8,640,000 | kg | 1.25 | 10,800,000 | 81.88 |
| $CO_2$ Recovery | 125,985,384 | kg | 0 | 0 | 0 |
| $NaHCO_3$ | 15,798,960 | kg | 0 | 0 | 0 |
| Water | 1,103,755,240 | kg | 0.000723 | 798,015 | 6.05 |
| Discrete Material - (Empty bag) | 10,611,078 | bags | 0.15 | 1,591,662 | 12.07 |
| **Total** | | | | **13,189,677** | **100.00** |

Table 3-7: Various consumables costs (2020 prices) – process summary

| Consumable | Units Cost | Annual Amount | Ref. Units | Annual Cost |
|---|---|---|---|---|
| | [USD] | | | [USD] |
| GAC Packing (L) | 4.00 | 9,613 | 4 | 38,452 |
| **TOTAL** | | | | **38,452** |

Table 3-8: Utilities cost (2020 prices) - process summary

| Utility | Ref. Units | Annual Amount | Unit Cost | Annual Cost | |
|---|---|---|---|---|---|
| | | | [USD] | [USD] | [%] |
| Standard Power | kW-h | 4,739,092 | 0.1 | 473,909 | 1.87 |
| Steam | MT | 288,944 | 12 | 3,467,328 | 13.69 |
| Steam (High Pressure) | MT | 242,306 | 20 | 4,846,120 | 19.14 |
| Chilled Water | MT | 41,280,045 | 0.4 | 16,512,018 | 65.20 |
| $CaCl_2$ Brine | MT | 100,045 | 0.25 | 25,011 | 0.10 |
| **TOTAL** | | | | **25,324,386** | **100.00** |

Table 3-9: Project time valuation

| S/N | Time Parameter | Description/Time | Unit |
|---|---|---|---|
| 1 | Year of Analysis | 2020 | N/A |
| 2 | Construction Period | 30 | Months |
| 3 | Start-up Period | 4 | Months |
| 4 | Project life time | 20 | Years |

# CHAPTER FOUR

## 4 ELECTRICAL POWER DISTRIBUTION AND CONTROL SYSTEM

### 4.1. Overhead High Tension (HT) Line

Survey needs to be carried out for High Tension (HT) 33 kV overhead line route from nearby existing TANESCO line to the proposed soda ash plant substation and extension of the 11 kV HT overhead line from substation to boreholes distribution transformers and to storage ponds at site. The output of the survey shall be a complete working drawing for the HT overhead line route from tapping point to substation power transformer and from substation to all distribution transformers at site. The estimated provisional route length for the 33 kV overhead line is 20 km and for the 11 kV overhead line is 17 km.

The design proposes to construct a three phase 33 kV overhead line by tapping from existing TANESCO line including poles, Aluminium Conductor Steel Reinforced (ACSR) 100 $mm^2$, insulators, HT Cables, drop out fuses, Surge Arrestors, Metering unit, Termination Kits with lugs, crossarms, connectors, post insulators, pin insulators, tension insulators, and all necessary accessories for the medium voltage line. The overhead line starts from the tapping point of TANESCO line to receiving power transformer substation. The construction shall include the civil works associated with the construction of the line. **Error! Reference source not found.** shows the overhead line layout.

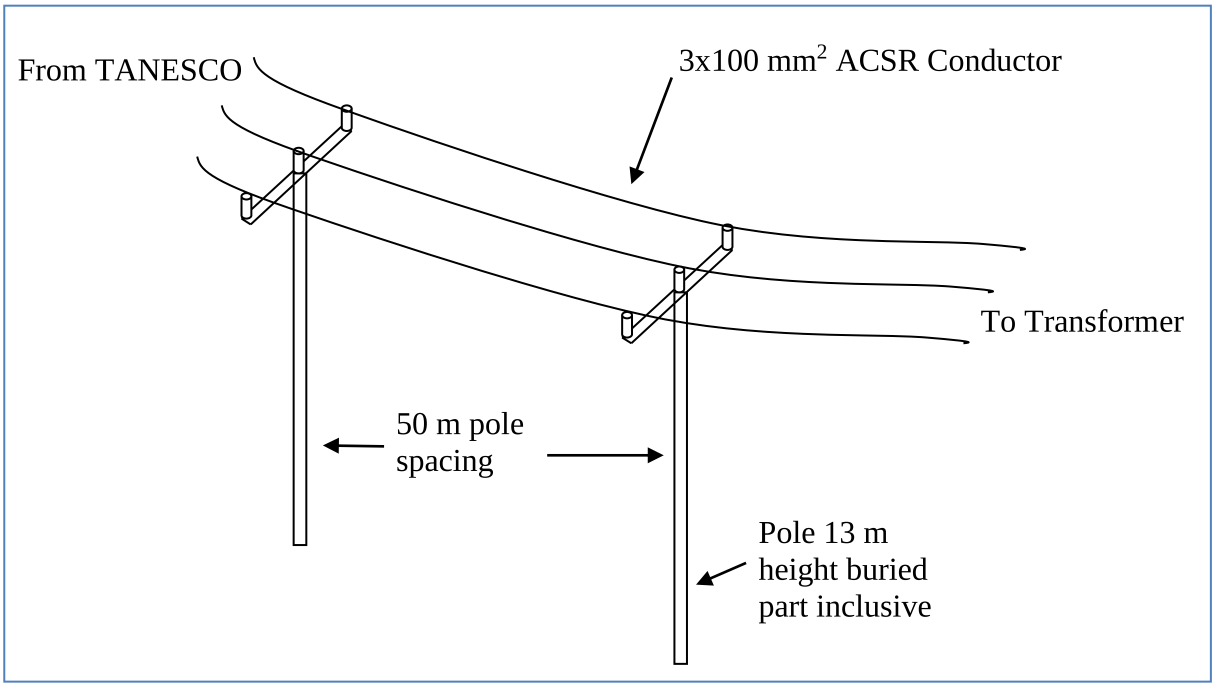


Figure 4-1: HT Overhead line

The outdoor HT metering unit and the installed indoor metering panel with all other accessories in compliance to TANESCO shall be part of the line at the substation.

It is required to construct a three phase 11 kV overhead line from power transformer at site substation including poles, Aluminium Conductor Steel Reinforced (ACSR) 80 $mm^2$, insulators, HT Cable, drop out fuses, Surge Arrestors, Termination Kits with lugs, crossarms, connectors, post insulators, pin insulators, tension insulators, and all necessary accessories for the medium voltage line. The overhead line includes from substation to all the distribution transformers at the site. Pole spacing for 11 kV line is 50 m as shown in **Error! Reference source not found.**. The 11 kV line uses 80 $mm^2$ ACSR conductor while the 33 kV line uses 100 $mm^2$ ACSR conductor. The construction includes all civil works associated with the construction of the line. The estimated provisional route length is 17 km.

The connection from circuit breakers to the overhead line 11 kV outgoing feeders is by 3 core XLPE HT insulated cable. At the site there is 33 kV overhead line, 11 kV overhead line and the 400 V overhead lines.

The alternative to tapping the overhead line of 33 kV from the public line is to construct a separate feeder of 33 kV overhead line from TANESCO substation to the proposed soda ash plant substation. The alternative design shall have longer route length than the line obtained by tapping from the public line. Also, the separate feeder shall need a medium voltage circuit breaker at the origin of the feeder at TANESCO substation.

### 4.2. Availability of Material

The alternative to the 11 kV overhead line which is local sub-transmission at the site is 6.6 kV overhead lines. The decision depends on the availability of overhead line equipment that use 6.6 kV including distribution transformers.

### 4.3. Overhead Low Voltage (LV) Line

Survey needs to be carried out for LV with Aerial bundled conductors (ABC) overhead line route from each distribution transformer to all pumps. The output of the survey is a working drawing of the overhead line route from distribution transformer to all pumps. The estimated provisional route length is 3.5 km. The survey shall be carried out for LV with Aerial bundled conductors (ABC) overhead line route from distribution transformers to boreholes, distribution transformers to pond and distribution transformer to plant. The output of the survey is a working drawing of the overhead line route from distribution transformer to all borehole pumps.

The Low Voltage (LV) overhead line from distribution transformers to boreholes overhead line includes 4x95 $mm^2$ Aerial bundled conductors (ABC) XLPE insulated, with wooden poles, hooks, and all connecting accessories is used to connect power from the distribution transformer to pumps.

The 4C x 70 $mm^2$ XLPE armoured Cu cable Cu/XLPE/SWA/PVC including all necessary accessories and cable routes, cable lugs, is used to connect power from end of LV overhead line to pump switchboard and to the borehole pumps as shown in **Error! Reference source not found.**.

The 4C x 35 $mm^2$ XLPE armoured Cu cable Cu/XLPE/SWA/PVC including all necessary accessories and cable routes, cable lugs, is used to connect from the end of LV overhead line to pump switchboard and to the pumps at pond.

In order to take power from the distribution transformer and supply to loads the Low Voltage (LV) overhead line from transformer to boreholes power points is used as shown in **Error! Reference source not found.**. The overhead line includes 4x95 $mm^2$ Aerial bundled conductors (ABC) XLPE insulated, three kilometres (3 km), wooden poles; the spacing form one pole to another is 25 m. Three current carrying conductors are ABC) XLPE insulated, the fourth which is neutral is the ACSR conductor.

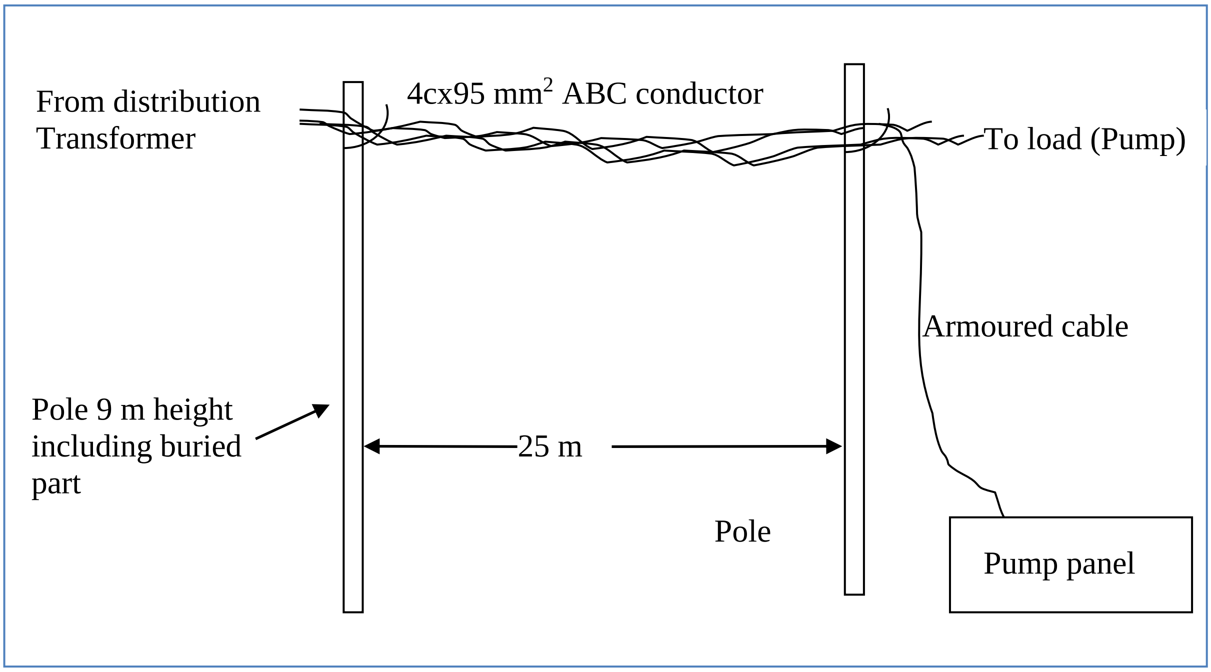


Figure 4-2: ABC conductor, pole and armoured cable

The construction of complete power house to accommodate operator’s office, switchgears, power monitoring centre is taken into considerations. The design included the Electrical installation of the administration building and all associated buildings at the soda ash plant site. The calculated load of the 340.86 kW at the proposed soda ash plant needs the transformer rating of 500 kVA, this transformer does not include transformers for pumps. At the soda ash plant, it is proposed to use the standby Generator of 500 kVA, 400 V, 50 Hz, 1500 rpm, Specifications as Caterpillar, three phase standby diesel engine generator set, complete with automatic change over switch, sound canopy and all necessary accessories and connecting kits. The supply and installation of the generator shall include generator plinth and shelter.

The alternative to the ABC conductors is to use the AAC conductors but the use of AAC conductors shall need additional accessories such as shackle insulators, D-iron and bolts. The construction of the LV line with AAC involves drilling of four holes on pole to mount the bolts, shackle insulators and D-iron. The design recommends the use of ABC conductors.

### 4.4. Substation, Transformers and Circuit Breakers

A power transformer with 1250 kVA, delta star, 33 kV/11 kV, 50 Hz, for receiving substation, is designed to supply the whole site and this is the receiving power transformer. The output of the power transformer should allow synchronizing with the thermal power plant, at proposed soda ash plant location power station. Also, the output of power transformer is connecting to overhead line of 11 kV for local transmission at the site, the 11 kV overhead line starts from the synchronised outgoing busbars.

The design proposes the construction of a complete operating thermal power plant to supply power at the site. The thermal power plant capacity shall be capable to supply power in parallel with TANESCO and also when TANESCO mains fail the thermal power plant should supply the required power. The construction of thermal power plant includes civil works, building works and all the works associated with the construction of the thermal power plant. Capacity of the thermal power plant shall be determined based on the power requirements for full operation of the soda ash site.

It is needed to construct the system for interconnection and synchronization between the TANESCO substation at the factory and the thermal power plant at the factory. The interconnection includes supply and installation of the power interconnection equipment, bus bars, supply and installation of synchronization panels and all the associated materials and accessories to allow power interconnection and synchronization.

One (1) medium voltage substation receives overhead line TANESCO power, gives output of voltage the same as that of TANESCO but at 11 kV. Substation should receive power from thermal power station. Substation should supply the output at medium voltage HT of 11 kV depending on the TANESCO voltage level.

Six (6) 11 kV Vacuum Circuit Breakers for Alternating Current (AC), Floor rolling, withdrawable version, are used to connect between synchronized output of TANESCO and power station and outgoing 11 kV feeder to distribution transformers.

Six (6) distribution transformers with 100 kVA, delta star, 11 kV/0.4 kV, 50 Hz, pole mounted, shall be installed for power supply to pumps at the pond in order to supply power to PBH1, PBH2, PBH3, PBH4, PBH6 and PBH7. The distribution transformers are connected from the 11 kV overhead local distribution line. One (1) distribution transformer with 100 kVA, delta star, 11 kV/0.4 kV, 50 Hz, pole mounted shall be installed for power supply to the pumps at the pond where there are 4 pumps. The distribution transformers are connected from the 11 kV overhead local distribution line.

One (1) distribution transformer with 500 kVA, delta star, 11 kV/0.4 kV, 50 Hz, ground mounted, on concrete base, block wall shelter, at proposed soda ash plant location is used to supply power at the soda ash plant location. One (1) Generator of 500 kVA, 400 V, 50 Hz, 1500 rpm, three phase standby diesel engine generator set at the soda ash plant, is not connected to pumps.

### 4.5. Motor Control Systems

At each pump location there is a Low Voltage (LV) panel, metal, water proof, outdoor standard, vertical standing fixed to concrete base, with MCCBs, and contactors for supplying power and control of the pump, pump control box and outdoor panel on concrete base for each borehole pump. Rating of MCCB must correspond to the current rating of the motor and cable size connecting to the motor. Each pump shall have the motor starters, and this is for all pumps.

### 4.6. Plant Control Systems

The electrical control system for the soda ash plant is part of the plant specifications and cost.

### 4.7. Main Distribution Boards

There will be a 1000 A, three-phase changeover switch at the soda ash plant. Minimum OFF-time between transfers from the sources is 20 ms. The LV panel at soda ash plant receives power from the 500 kVA distribution transformer and the 500 kVA standby generator in order to supply to the plant.

### 4.8. Capacitor Banks

The construction of the substation shall include the capacitor banks for voltage improvement at the site. The size of capacitor banks shall be determined based on the prevailing conditions of load and voltage

### 4.9. Detailed Investment Cost Estimates

Investment cost for the electric power distribution network is given in **Error! Reference source not found.**. Considering that once the plant is fully operational and other economic activities have been started by residents along the existing 33 kV line, the electric supply line might be overloaded. In that scenario, a separate investment cost for a dedicated 33 kV line is presented in

. **Error! Reference source not found.** shows the potential suppliers of electrical materials and equipment.

Table 4-1: Power distribution investment cost

| S/N | Description | Unit | Qty | Rate [USD] | Amount [USD] |
|---|---|---|---|---|---|
| 1. | Liaise with TANESCO for compliance and advise of the overhead high tension (HT) and Low Voltage (LV) work including metering units for power connection | item | 1 | 1,300 | 1,300 |
| 2. | Carry out survey for High Tension (HT) overhead line route from nearby existing TANESCO line to the proposed soda ash plant substation and extension to boreholes distribution transformers and to storage ponds at site. Allow for drawing of the HT overhead line route from tapping point to substation power transformer and from substation to all distribution transformer at site. | item | 1 | 1,300 | 1,300 |
| 3. | Construct a three phase 33 kV overhead line by tapping from existing TANESCO line including poles, Aluminium Conductor Steel Reinforced (ACSR) 100 $mm^2$, insulators, HT Cables, drop out fuses, Surge Arrestors, Metering unit, Termination Kits with lugs, cross arms, connectors, and all necessary accessories for the medium voltage line. The overhead line includes from tapping point of TANESCO line to receiving power transformer substation. Allow for all civil works associated with the construction of the line. Detailed specifications and scope to be issued by TANESCO. | km | 20 | 10,403 | 208,060 |
| 4. | Supply and install outdoor HT metering unit including wiring and all accessories. Specifications as ABB. | No | 1 | 3,000 | 3,000 |
| 5. | Supply and install indoor metering panel including wiring and all accessories. Specifications as ABB. | No | 1 | 3,000 | 3,000 |
| 6. | Construct a three phase 11 kV overhead line from power transformer substation including poles, Aluminium Conductor Steel Reinforced (ACSR) 80sq.mm, insulators, HT Cable, drop out fuses, Surge Arrestors, Termination Kits with lugs, crossarms, connectors, and all necessary accessories for the medium voltage line. The overhead line includes from substation to all the distribution transformers at the site. Allow for all civil works associated with the construction of the line. | km | 17 | 10,403 | 176,851 |
| 7. | Supply, install, earth and set to work a power transformer with 1250 kVA, delta star, 33 kV/11 kV, 50 Hz, for receiving substation, the output of the power transformer should allow synchronizing with the thermal power plant, at proposed soda ash plant location. Transformer Specifications as ABB. | No | 1 | 33,000 | 33,000 |
| 8. | Interconnection and synchronization between the TANESCO substation at the factory and the thermal power plant at the factory. The interconnection includes supply and installation of the power interconnection equipment, busbars, supply and installation of synchronization panels and all the associated materials and accessories to allow power interconnection and synchronization. Subject to the detailed design | item | 1 | 22,000 | 22,000 |
| 9. | Supply materials and construct a medium voltage substation to allow receiving overhead TANESCO power, give | item | 1 | 22,000 | 22,000 |

| S/N | Description | Unit | Qty | Rate [USD] | Amount [USD] |
|---|---|---|---|---|---|
| | output of voltage the same as that of TANESCO. Substation should receive power from thermal power station. Substation should supply the output at medium voltage HT of 33 kV or 11 kV depending on the TANESCO voltage level. Subject to the detailed design. | | | | |
| 10. | 11 kV Vacuum Circuit Breaker for Alternating Current (AC). Floor rolling, Withdrawable version. To connect between synchronized output of TANESCO and power station and outgoing 11 kV feeder to distribution transformers. Specifications as Schneider. | No | 6 | 3,500 | 21,000 |
| 11. | Supply and install 3core XLPE HT insulated cable from circuit breakers to the overhead line 11 kV outgoing feeders. | m | 120 | 135 | 16,200 |
| 12. | Supply, install, earth and set to work a distribution transformer with 500 kVA, delta star, 11 kV/0.4 kV, 50 Hz, ground mounted, on concrete base, block wall shelter, at proposed soda ash plant location. Specifications as ABB. | No | 1 | 16,385 | 16,385 |
| 13. | Carry out survey for LV with Aerial bundled conductors (ABC) overhead line route from11 kV overhead line to each distribution transformer. Allow for drawing of the overhead line route from distribution transformer to all pumps. | item | 1 | 1,300 | 1,300 |
| 14. | Supply and install the Low Voltage (LV) overhead line from distribution transformers to boreholes. The overhead line includes 4x95 $mm^2$ Aerial bundled conductors (ABC) XLPE insulated, wooden poles, hooks, and all connecting accessories. Allow for power connection to all borehole pumps armoured cable receiving point. | km | 3.5 | 10,403 | 36,411 |
| 15. | Supply install, terminate, connect a 4C x 70 $mm^2$ XLPE Armoured Cu cable Cu/XLPE/SWA/PVC including all necessary accessories and cable routes, cable lugs, from end of LV overhead line to pump switchboard and to the borehole pumps. | m | 2400 | 65 | 156,000 |
| 16. | Supply install, terminate, connect a 4C x 35 $mm^2$ XLPE Armoured Cu cable Cu/XLPE/SWA/PVC including all necessary accessories and cable routes, cable lugs, from the end of LV overhead line to pump switchboard and to the pumps at pond. | m | 1200 | 20 | 23,400 |
| 17. | Supply and install LV panels, metal, water proof, outdoor standard, vertical standing fixed to concrete base, with MCCBs, contactors, for supplying power and control of the pump, outdoor panel on concrete base for each borehole pump. Rating of MCCB must correspond to the current rating of the motor and cable size connecting to the motor. | No | 10 | 3,468 | 34,680 |
| 18. | Supply and install complete motor starters for all pumps. Details and specifications of the motor starters shall be | No | 10 | 1,734 | 17,340 |

| S/N | Description | Unit | Qty | Rate [USD] | Amount [USD] |
|---|---|---|---|---|---|
| | provided. | | | | |
| 19. | Supply, install, earth and set to work a distribution transformer with 100 kVA, delta star, 11 kV/0.4 kV, 50 Hz, pole mounted, for power supply to pumps at the pond. Specifications as ABB. | No | 6 | 13,004 | 78,024 |
| 20. | Supply, install, earth and set to work a distribution transformer with 100 kVA, delta star, 11 kV/0.4 kV, 50 Hz, pole mounted, for power supply to the pumps at the pond. Specifications as ABB. | No | 1 | 13,004 | 13,004 |
| 21. | Carry out survey for LV with Aerial bundled conductors (ABC) overhead line route from distribution transformers to boreholes, distribution transformers to pond and distribution transformer to plant. Allow for drawing of the overhead line route from distribution transformer to all borehole pumps. | item | 1 | 1,300 | 1,300 |
| 22. | Supply and install the Low Voltage (LV) overhead line from transformer to boreholes power point. The overhead line includes 4x95 $mm^2$ Aerial bundled conductors (ABC) XLPE insulated, wooden poles, hooks, and all connecting accessories. Allow for power connection to all borehole pumps receiving armoured cable such as East African Cables. | km | 3 | 10,403 | 31,209 |
| 23. | Construction of complete power house to accommodate operator’s office, switchgears, power monitoring centre. | item | 1 | 21,673 | 21,673 |
| 24. | Allow for Electrical installation of the administration building and all associated buildings at the soda ash plant site. | item | 1 | 0 | 0 |
| 25. | 1000 A, three-phase changeover switch for scanner switching. Minimum OFF-time between transfer from the sources is 20 ms. Specifications as ABB. | No | 1 | 2,167 | 2,167 |
| 26. | Supply and install LV panel at soda ash plant. Subject to detailed specifications. Specifications as ABB. | No | 1 | 10,000 | 10,000 |
| | **Subtotal Power distribution** | | | | **950,604** |
| | | | | | |
| 27. | Generator 500 kVA, 400 V, 50 Hz, 1500 rpm, three phase standby diesel engine generator set, complete with automatic change over switch, sound canopy and all necessary accessories and connecting kits. Provide generator, shelter. Specifications as Caterpillar. | No | 1 | 201,250 | 201,250 |
| | **Total Power Generation and Distribution Cost** | | | | **1,155,854** |

Table 4-2: Investment cost of a dedicated 33 kV line

| S/N | Description | Unit | Qty | Rate [USD] | Amount [USD] |
|---|---|---|---|---|---|
| 1. | All equipment must be brand new. | | | | |
| 2. | Manufacturer data sheets must be provided before procurement. | | | | |
| 3. | Every work and equipment are subjected to approval before implementation. | | | | |
| 4. | Liaise with TANESCO for compliance and advise of the overhead high tension (HT) and Low Voltage (LV) work including metering units for power connection | item | 1 | 1,300 | 1,300 |
| 5. | Carry out survey for High Tension (HT) overhead line route from nearby existing TANESCO substation to the proposed soda ash plant substation and extension to boreholes distribution transformers and to storage ponds at site. Allow for drawing of the HT overhead line route from TANESCO substation to Soda Ash plant substation power transformer and from Soda Ash plant substation to all distribution transformer at site. Submit an AutoCAD Drawing with coordinates. The line route shall adapt the route of permanent road. | item | 1 | 1,300 | 1,300 |
| 6. | Construct a three phase 33kV overhead line by connecting from TANESCO substation to the Soda Ash plat including poles, Aluminium Conductor Steel Reinforced (ACSR) 100 $mm^2$, insulators, HT Cables, drop out fuses, Surge Arrestors, sectional poles, corner poles, staring poles, Metering unit, Termination Kits with lugs, cross arms, connectors, and all necessary accessories for the medium voltage line. The overhead line includes from TANESCO substation to receiving power transformer substation. Allow for all civil works associated with the construction of the line. Pole height 13 meters, spacing between poles 50 meters. Detailed specifications and scope to be issued by utility company. | km | 31 | 10,403 | 322,493 |
| 7. | Supply and install at TANESCO substation the feeder metering unit include wiring, instrumentation, current transformers (CT), potential transformers (PT) and all | item | 1 | 8,000 | 8,000 |

| S/N | Description | Unit | Qty | Rate [USD] | Amount [USD] |
|---|---|---|---|---|---|
| | accessories. Specifications as ABB/ Siemens. | | | | |
| 8. | Supply and install all the protection relays for the outgoing feeder such as distance protection, earth protection and overload protection including the current transformer (CT), potential transformer (PT). Specifications as Siemens. | item | 1 | 10,000 | 10,000 |
| 9. | Supply and install all the measurement system to the circuit breaker and the battery charger at substation. | item | 1 | 5,000 | 5,000 |
| 10. | Supply and install all the protection system to the circuit breaker and the battery charger at substation. | item | 1 | 5,000 | 5,000 |
| 11. | Supply and install all the busbar links to allow for installation of the circuit breaker at TANESCO substation. | item | 1 | 8,000 | 8,000 |
| 12. | All preliminary works for installation of the circuit breaker and associated components and accessories at TANESCO substation. | item | 1 | 8,000 | 8,000 |
| 13. | 33kV SF6 Circuit Breaker for Alternating Current (AC). Current at least 630A at TANESCO substation. To connect to the outgoing feeder of the overhead line, the circuit works as the origin of the 33 kV overhead line going to the soda ash plant. Confirm the TANESCO voltage before purchase of the circuit breaker. Confirm with TANESCO the required protection and measuring system before purchase of the system components. Specifications as Schneider. *(Source: TANESCO)* | item | 1 | 40,000,000 | 40,000,000 |
| | **Total Cost for Construction of a three phase 33kV line** | | | | **40,369,093** |

Table 4-3: Electrical materials vendors

| | Material Description | Manufacturer | Vendor Details | Unit | Estimated cost [USD] |
|---|---|---|---|---|---|
| 1 | Aluminium Conductor Steel Reinforced (ACSR) Electrical cables | East African Cables(T) Ltd | Saidi Shehondo-Sales Officer<br>Tel: +255 786 312 001,<br>Email: Sshehondo@eacables.com | km | 10,403 |
| 2 | Aerial Bundled Conductors (ABC) overhead | | | km | 10,403 |
| 3 | Armoured Electrical cables | | | m | 15 to174 |
| 4 | Single core Electrical installation cables 1.5 $mm^2$, 2.5 $mm^2$,4 $mm^2$, 6 $mm^2$ | | | roll | 20 to 65 |
| 5 | Armoured Electrical cables | METSEC | Milan K Doshi,<br>Tel: +254 703 030 000 / 500<br>Email:<br>finance.doshi@tz.doshigroup.com | m | 15 to174 |
| 6 | Electrical panels | ABB | Michael Otonya, Sales officer<br>Tel: +255 754 271 617 | No | 4,400 to 12,000 |
| 7 | Power Transformer | | | No | 50,000 to 65,000 |
| 8 | Electrical panels | Schneider Electric | Nairobi -Kenya, contact expert<br>Tel: +254 703 069 115/<br>+254 703 069 116<br>Email:<br>customercare.eastafr@se.com | No | 4,400 to 12,000 |
| 9 | Switchgear | | | No | |
| 10 | Electrical Distribution Boards | Hager | Kaizer - Local Agent<br>Tel: +255 789 909 090 | No | |
| 11 | Distribution Transformer | Tanelec Ltd | Adili Mwangoka - Sales Engineer<br>Tel: +255 789 644 315/<br>+255 765 644 315 | No | 6,000 to 22,000 |
| 12 | 25 mm heavy duty PVC conduits | Tronic | Mr. Samir, Manager<br>Tel: +255 756 472 700<br>Cash Sales Store,<br>Tel: +255 (0) 222133549 | No | 1.5 |
| 13 | 20 mm heavy duty PVC conduits | | | No | 1 |
| 14 | galvanized metal square box single | | | No | 0.5 |
| 15 | galvanized metal square box twin | | | No | 1 |
| 16 | Light fixtures | | | No | |
| 17 | Cable tray | | | m | |
| 18 | Light switches | Legrand | INDELEC LTD<br>Tel: +255 (0) 222119734/2122706 | No | |
| 19 | Sockets outlets | | | No | |
| 20 | Three phase industrial | | | | |

| | Material Description | Manufacturer | Vendor Details | Unit | Estimated cost [USD] |
|---|---|---|---|---|---|
| | plugs and sockets 5-pin | | | | |
| 21 | Light fixtures | Thorn | Thorn Power Kenya Ltd, Nairobi Tel: +(254) 722-503-129 | | |
| 22 | Cable tray | MEM | | | |
| 23 | Electrical poles | Local supplier | Availability dependent | | |
| 24 | Diesel generator | Caterpillar local dealer | Availability dependent | No | 220,000 |

## CHAPTER FIVE

# 5 BRINE PUMPING SYSTEM AND STORAGE

## 5.1. Extraction Method of the Brine from Aquifer

Based on Volume I (Appraisal of the Brine Resources), the Trona at Engaruka basin contains high concentration of carbonates and bicarbonates of sodium and other salts. Sodium bicarbonate is in the solid, well crystalline form which can be mined by open pit method. But due to presence of three underground aquifers which host saturated brine with high concentration of sodium carbonate (averaged at 202 g/L) and sodium bicarbonate (averaged at 18 g/L), extraction of this resource will be done by pumping the brine from the aquifer through production boreholes.

The production boreholes will be drilled to intersect the three identified brine aquifers, and submersible pump will be used to pump the brine from the production boreholes. This method will minimize contamination to the brine during extraction as well as avoid environmental destruction which might be experienced if open pit method will be used.

## 5.2. Determination of Pumping Rate and Number of Production Boreholes

According to Volume I (Appraisal of Brine Resources) further reverse circulation exploration boreholes will be drilled for assessment of aquifer properties. The same boreholes will later be used as production boreholes. The production requirement from these boreholes depends on the soda ash plant requirement.

The soda ash plant will need to process 2,883,506 $m^3$ per year of brine in order to produce 500,000 tonnes of soda ash during its initial phase. This amount was used as a baseline to estimate annual volume of brine required to be pumped from a single production borehole. The amount of brine required to be pumped from the production boreholes was derived from volume requirements by the soda ash plant plus about 5% excess to account for losses due to evaporation, leakage and seepage. The calculated brine production required during initial phase is shown in **Error! Reference source not found.**. Since the operation will be running for 300 days per year, the average pumping rate from individual production boreholes will be 105 $m^3$/hr.

Table 5-1: Brine production requirement

| **Description** | **Amount** | **Unit** |
|---|---|---|
| Brine required by plant | 2,883,506 | $m^3$/year |
| Brine to be pumped from Production Boreholes | 3,031,656 | $m^3$/year |
| Required brine production rate | 421 | $m^3$/hour |

### 5.3. Submersible Pump Selection

Since brine solution in the aquifer is found at in-situ temperature of about 34ºC, alkaline (pH >10) and contains some solid particles, the submersible pump to be used for this particular operation should meet the following criteria;

i) High chemical resistance
ii) High mechanical strength
iii) High corrosion resistance
iv) Good thermal properties
v) Has superior impact strength
vi) Good abrasion and cut-through resistance

A deep well salt water lifting submersible pump capable to operate in high elevation difference will be needed. The wet side of the pump have to be coated with material that meet the mentioned criteria. The diameter of the pump to be used will be limited to the borehole diameter proposed in Volume I (Appraisal of the Brine Resources). It was recommended that 16-inch cased diameter production boreholes should be used for exploration prior to production. Horizontal pumping distance from individual production boreholes will vary depending on the proposed location of the production boreholes with respect to the location of the brine solution collection tanks. The submersible pump to be used will operate in conditions shown on **Error! Reference source not found.**.

Table 5-2: Submersible pump operating conditions

| Description | Value | Unit |
|---|---|---|
| Viscosity Index of the brine solution | 0.0016 | kg/ms |
| Cased production borehole diameter | >10 | in |
| Pumping rate | 105 | $m^3$/hr |

The total dynamic head of the submersible pump will depend on the depth of the production boreholes, the elevation difference between the collar of the individual borehole and location of the collection tanks as well as the friction head loss of the pipe transporting the brine from the borehole to the tanks. It was not possible to determine the total dynamic head of the submersible pump due to the fact that the vertical extent of the aquifer was not well established and hence it is difficult to determine the depth of the production boreholes which will intersect all the aquifers.

Using the submersible pump operating condition shown in **Error! Reference source not found.** and calculated total dynamic head, consultation was made with manufacturers, suppliers and dealers of pumps. **Error! Reference source not found.** shows the specifications and cost of a submersible pump that can operate in such conditions at maximum head available.

Table 5-3: Specifications and cost of the deep well submersible pumps

| | **Manufacturer** | **KSB Pumps & Valves (South Africa)** |
|---|---|---|
| | Description | Value |
| | **Operating Data** | |
| 1. | Nominal Capacity ($m^3$/hr) | 105 |
| 2. | Nominal Head (m) | 360 |
| 3. | Power consumption at Nominal Capacity (kW) | 175 |
| 4. | Efficiency at Nominal Capacity (%) | 89.9 |
| | **Dimensions** | |
| 5. | Length (mm) | 2004 |
| 6. | Diameter (mm) | 266 |
| | **Material** | |
| 7. | Pump casing | CrNiMo-steel (1.4408) |
| 8. | Impeller | CrNiMo-steel (1.4408) |
| 9. | Pump shaft | CrNiMo-steel (1.4462) |
| 10. | Suction casing | CrNiMo-steel (1.4408) |
| 11. | Non-return valve | CrNiMo-steel (1.4408) |
| 12. | Cast parts motor | CrNiMo-steel (1.4408) |
| 13. | Stator jacket | CrNiMo-steel (1.4571) |
| 14. | Motor Casing | |
| 15. | Motor Tie-in | |
| 16. | Fasteners | |
| | Total Weight (kg) | 744 |
| | **CIF Price (per pump) in USD** | **60,068.70** |

## 5.4. Production Boreholes Pumping System

The brine solution will be pumped from the individual boreholes to collection tanks. The collection tanks will be located in the basin as shown in **Error! Reference source not found.**. Location site for the collection tanks went through analysis of several competing factors, such as the environment, local planning and nature of the topography. Many reasonable potential alternative sites were identified and investigated and undertook realistic assessments of comparative risks. The location of collection tanks was selected based on the following criteria:

i) The area is free of floods and is accessible during rainy season.
ii) It is within the basin area at a position with minimum total pumping distance from the individual proposed borehole locations

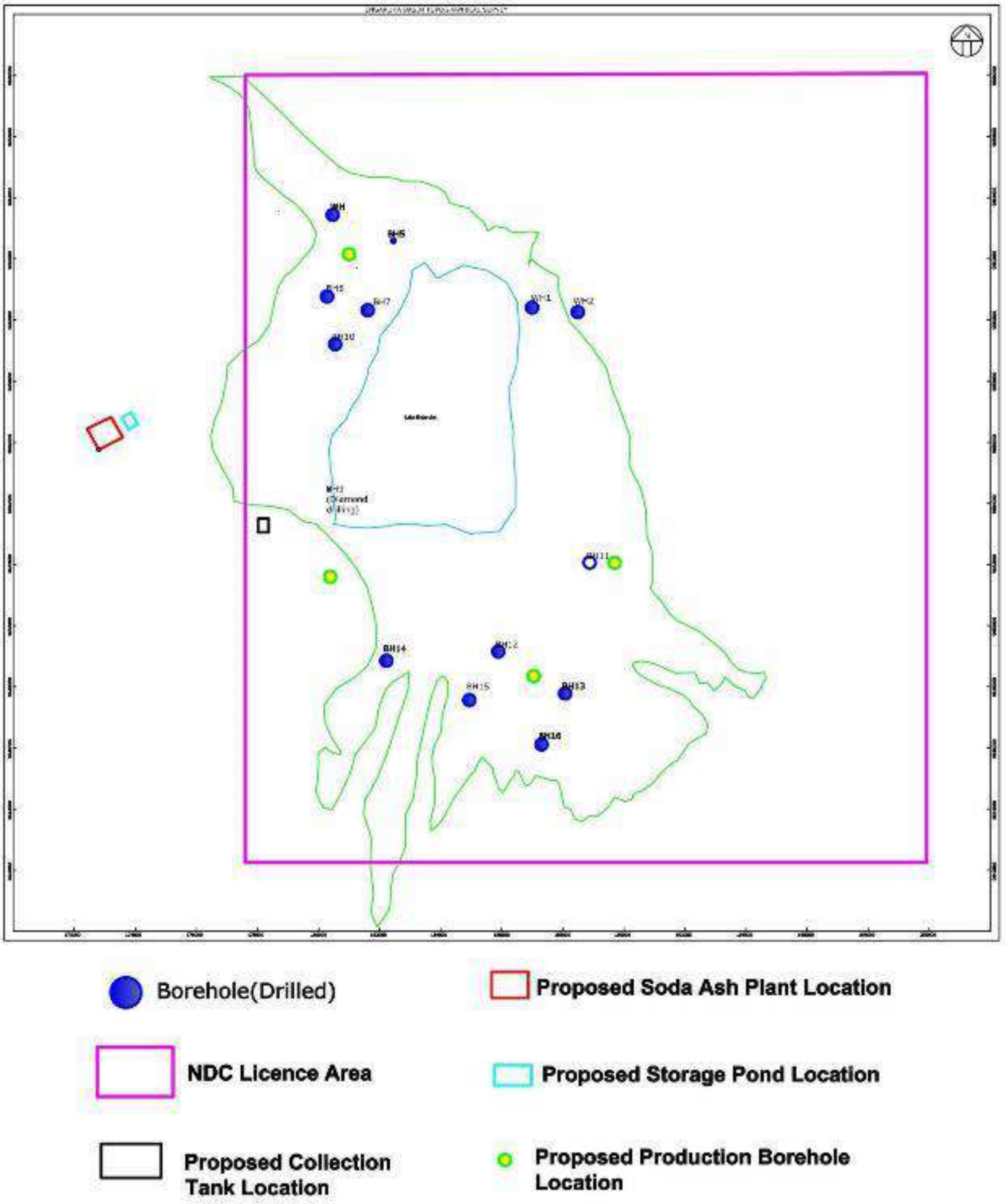


Figure 5-1: Site layout map showing location of project facilities.

Weholite cylindrical collection tanks having a total capacity of 1,000 $m^3$ will be installed at the proposed location. This capacity assures less possibility of dry running of the pump in case all of the submersible pumps are not in operation for a maximum period of 2 hours. The design of the collection tanks manufactured by PLASCO Tanzania Ltd is shown in Appendix 8. The installation of these tanks will need to be carried out by the manufacturer.

A centrifugal pump will be installed to pump brine solution from the collection tanks to the storage pond located at a distance of 5.6 km. In order to achieve equilibrium of flowrate from the production boreholes, the centrifugal pump will have a capacity of 421 $m^3$/hr. This centrifugal pump will operate at a total dynamic head of 88 m which includes a static head of 68 m and a friction head loss of 20 m. The static head was obtained by taking the elevation difference between the collection tanks and the storage pond. The friction head was calculated using Darcy-Weisback formula shown in Equation 5-1, considering pumping in a pipe with specifications shown in **Error! Reference source not found.**.

shows the specifications and cost of the centrifugal pump selected.

$$h_f = \frac{fLV^2}{2gd}$$ Equation 5-1

Table 5-4: Specification of the HDPE pipe for delivery of brine solution from collection tanks to Storage pond (source: PLASCO Ltd, Tanzania)

| **Pipe Category** | **Specifications** | **Unit** |
|---|---|---|
| Pipe type | PN 12.5 PE 100 | |
| Outside Diameter | 400 | mm |
| Minimum Wall thickness | 29.5 | mm |
| Total length required | 5600 | m |
| Unit cost (VAT exclusive) | 118.14 | USD/m |
| Total Costs | 661,584.00 | USD |

Table 5-5: Specifications and Cost of the Centrifugal pump at the collection tanks

| **Description** | **Value** |
|---|---|
| **Operating Data** | |
| Nominal Capacity | 421 $m^3$/hr |
| Nominal Head | 88 m |
| Power consumption at Nominal Capacity | 140 kW |
| Efficiency at Nom. Capacity | 90 % |
| **Dimensions** | |
| Base plate length | 1932 mm |
| Base plate width | 550 mm |
| Height (Base plate + pump) | 685 mm |
| **Material** | |
| Pump casing | CrNiMo-steel (1.4408) |
| Impeller | CrNiMo-steel (1.4408) |
| Pump shaft | CrNiMo-steel (1.4462) |
| Suction casing | CrNiMo-steel (1.4408) |
| **Total Weight** | **1800 kg** |

| CIF Cost (per pump) | USD 82,208.00 |
|---|---|

## 5.5. Construction of Production Boreholes

Based on Volume I (Appraisal of Brine Resource), further geophysical study is needed for establishing the continuation of the stratigraphical sequence at depths beyond 200 m deep. It was also proposed that four (4) Reverse Circulation (RC) boreholes should be drilled for identification of layers of aquifer and their respective aquifer characteristics and later be used as production boreholes. These boreholes will be drilled at 16-inches diameter and cased to 12" diameter. The actual depth of the individual production boreholes will depend on the exploration–drilling results. However, for the purpose of estimating the cost of riser and casing pipes required, the four production boreholes are assumed to be drilled at a depth of 300 m. Additional production boreholes will be determined based on the pumping tests results from the proposed RC exploration boreholes. The spacing of the additional production boreholes will be established once further pumping tests have been carried out. This is because the pumping tests results will establish the cone of depression, which is a necessary information for specifying the spacing of production boreholes.

Non-perforated pipes are proposed to be used to case the production boreholes from surface to a depth that will vary depending on the intersections of the stratigraphy during drilling (intersection point of the first aquifer). For the purpose of estimating length of non-perforated pipes, 40 m overburden thickness was taken because Volume I (Appraisal of Brine Resources) stated consistent aquifer intersections at this depth for logged boreholes. The non-perforated pipes will be followed by perforated pipes for the remaining borehole depth. Both perforated and non-perforated casing pipes will be having internal diameter of 12-inches. The specifications and cost of the casing pipes are shown on **Error! Reference source not found.**.

Table 5-6: Specifications and cost of casing pipes (Source: PLASCO Ltd, Tanzania)

| S/N | Item | Specifications | |
|---|---|---|---|
| 1. | Pipe Category | Non-Perforated | Perforated |
| 2. | Connection Type | C | C |
| 3. | Outside Diameter (mm) | 315 | 315 |
| 4. | Wall thickness (mm) | 14.8 | 14.8 |
| 5. | Thread Depth (mm) | 4.5 | 4.5 |
| 6. | Thread Pitch (mm) | 12.0 | 12.0 |
| 7. | Standard Slot Width (mm) | - | 1.5 – 1.7 |
| 8. | Approx. % open area of screen with STD slot width | - | 7.0 |
| 9. | Length (m0 | 160 | 1,040 |
| 10. | Unit costs (USD/m) VAT exclusive | 57.48 | 64.15 |
| 11. | **Unit costs (USD, VAT Exclusive)** | **9,196.80** | **66,716.00** |

The size of the casing pipes was selected by considering that they should leave annular space between the surface of the drilled borehole and the outer surface of casing pipe. This space will be filled with half inch granite gravels, which will help to trap the sediments that might get into the borehole chamber. It should be noted that, the detail design of the production borehole will require detail information about the aquifer properties to be obtained from further drilling works.

After the production boreholes have been completely drilled and cased, each borehole will be installed with 10-inch diameter submersible pump with outlet connected to 6-inch diameter HDPE riser pipe protruding approximately 1.0 m above the collar of the borehole. The piping system at the collar of the borehole will be divided into two lines as shown in the typical setup in **Error! Reference source not found.**. Line 'A' will be supplying brine solution to collection tanks and line 'B' will act as washout line during pump shutdown and hence helps to avoid crystallization of the brine solution in line 'A'. The washout brine will be discharged to ditch ponds to be constructed nearby the production boreholes. HDPE pipes of 6-inch diameter will be used in line 'B'. Accessories such as Gate valves (labelled 5) will be installed in both lines while Standard tee (labelled 4), Non-return valve (labelled 3), $90^o$ elbow (labelled 1), pressure gauge, and flow meter (labelled 2) will be installed in the borehole outlet. Beyond gate valve 5 in line 'A', an 8-inch diameter HDPE pipes (intermediate pipes) will be connected to supply brine to the collection tanks.

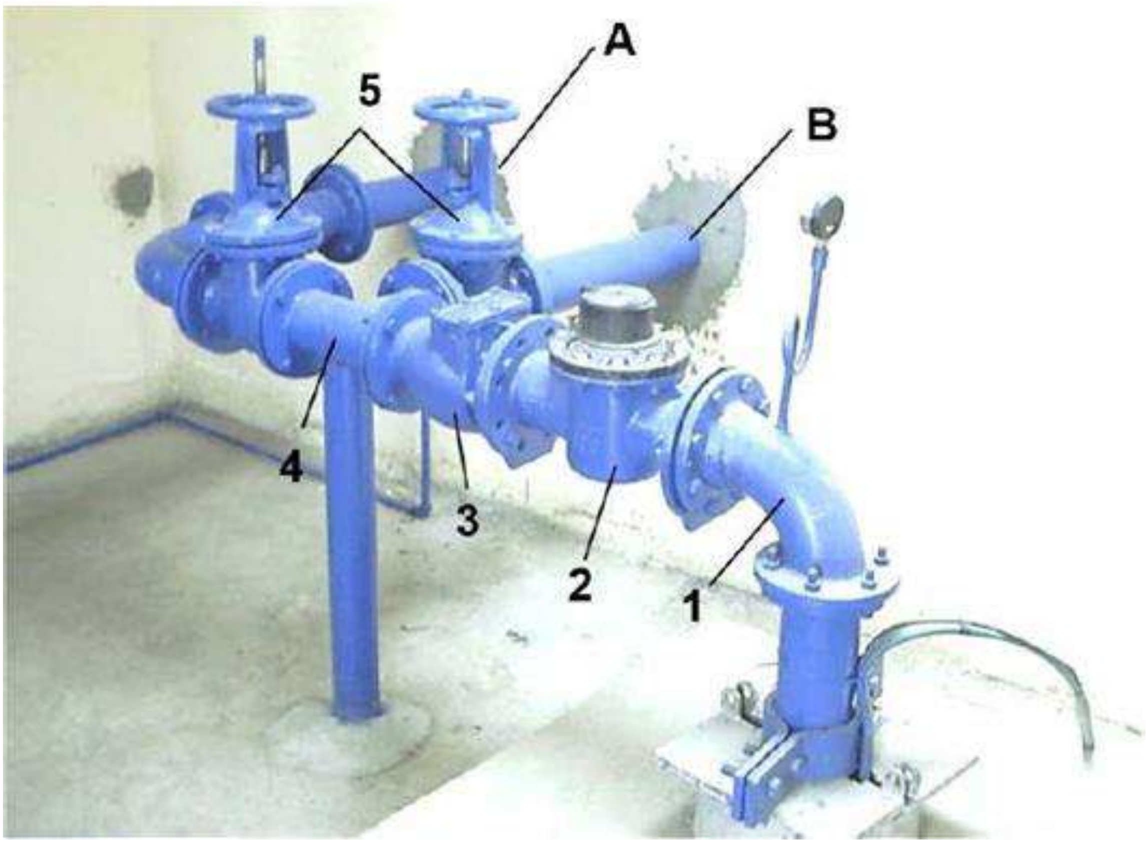

Figure 5-2: Typical production borehole pipeline setup (Arnalich, 2011)

The total length and cost of the HDPE riser pipe will depend on the actual depth of the proposed RC exploration boreholes. HDPE riser pipe to be connected to a 6-inch diameter HDPE intermediate pipe. The length of the intermediate HDPE pipe will depend on the distance from the individual production borehole to the collection tanks but will not exceed

11,570 m. **Error! Reference source not found.** shows specifications and costs of HDPE pipes required for delivering brine solution from the production boreholes to the collection tanks.

Table 5-7: Specifications of HDPE pipes required for delivery brine from production boreholes to storage pond (Source: PLASCO Ltd., Tanzania)

| S/N | Pipe Category | Specifications | Unit | Unit Price [USD/m] | Cost [USD] |
|---|---|---|---|---|---|
| 1. | Riser pipes | | | | |
| | Pipe type | PN 25 PE 100 | | | |
| | Outside Diameter | 160 | mm | | |
| | Min. Wall thickness | 21.9 | mm | | |
| | Total length required | 1,200 | m | 32.79 | 39,348.00 |
| 2. | Intermediate pipes | | | | |
| | Pipe type | PN 12.5 PE 100 | | | |
| | Outside Diameter | 200 | mm | | |
| | Min. Wall thickness | 14.7 | mm | | |
| | Total length required | 33,769 | m | 29.57 | 998,549.33 |
| | Total Costs | | | | 1,037,897.33 |

In addition, a suspended rope capable of lifting up to 1000 kg weight will be needed for anchoring, lowering and retracting the pump within the borehole. The collar of the production boreholes will be reinforced with concrete pad which will facilitate anchoring of the submersible pump and accessories. The active production area will need to be secured to protect illegal access while inactive boreholes will have to be sealed with metal plates.

### 5.6. Site Selection for Storage Pond

Based on Plant site and Township study, the proposed location of soda ash processing plant and storage ponds are on the west of the Engaruka basin. The storage pond location is within the corner coordinates shown in **Error! Reference source not found.**.

Table 5-8: Centre and corner coordinates of the storage pond (UTM ARC 1960)

| Point | Eastings | Northings |
|---|---|---|
| E1 | 178841 | 9657990 |
| E2 | 179186 | 9657990 |
| E3 | 179186 | 9657550 |
| E4 | 178841 | 9657550 |

### 5.7. Design of Storage Ponds

The design of the storage ponds for the Engaruka Soda Ash project was intended to achieve the following main objectives;

i) Collection and storage point of brine solution which will be pumped from different production boreholes.
ii) Sedimentation of the Total Suspended Solids (TSS) available in the brine solution before pumping it to soda ash plant.
iii) Ease of operation and reducing environmental impact due to brine production.

The storage ponds will consist of two partitions that provide three ponds in series. All the three storage ponds will have the same capacity of 110,000 $m^3$ each. This size of the pond was selected to meet a brine supply of 30 days to the soda ash plant when brine production from boreholes is not available. The ponds will be constructed in rectangular shape in order to give longer settlement time of the sediments contained in brine solution. The surface area which will be needed for construction of storage pond is about 149,600 $m^2$.

The pond embankments will be of earth fill type. The foundation of the embankment will be formed by cut-off trench of 2 m deep by 2 m bottom width with side slopes of 1:1. This cut-off trench will be filled with compacted clay and will be the base of the embankment core. The core will be constructed with clay soil and will have a height of 5 m, top width of 2 m and side slopes of 1V:1.5H. The outer part of the embankment will be constructed using the sub-soil material stripped from the foundation. The pond embankment will be constructed at a height of 5.5 m above the stripped surface level. This height will be able to accommodate the thickness of a blanket of clay material to be laid on the upstream side, brine solution depth and 1.0 m freeboard. This freeboard height has been left considering settlement allowance of the embankment and precipitation effect. The 3.5 m wide crest will be left and is sufficient to allow safe access during construction and operation. The inclination of the embankment slope is designed to be 1V:2.5 H on the upstream side and 1V:2H on the downstream side.

Since the ponds are intended for settling of the sediments pumped with brine solution from the collection tanks, the base of the ponds have been designed to allow gravity assistance during mud removal. Therefore, the foundation blanket has a thickness of 1 m at the entrance zone and 1.5 m thickness at the exit zone of each pond. The details of the storage pond designs are shown in sheets 1-6 of Appendix 4.

The flow of brine from one pond to another will be through 2 sets of 14-inch diameter outlet pipes to be constructed in exit of pond 1 and 2. Each set will consist of 3 pipes arranged at spacing of 3.0 m. The first set is positioned to allow free overflow from pond 1 to pond 3. The second set is positioned 2.5 m lower than the first set in order to enable supply of brine solution to plant when there is no supply of brine solution from the collection tanks. The detail arrangement of the sets in the ponds is shown in sheet 3 of Appendix 4. The second set will be operated by using gate valves which will be installed inside the valve chambers shown in Appendix 5. The valve chambers will enable safe access and operation of the gate valves. These chambers will be installed in pond 2 and 3.

### 5.8. Preparation and Construction of Storage Pond

#### 5.8.1. Site clearing

The area to be covered by the embankment should be pegged out prior to commencement of any works. The embankment and the area to be excavated for storage ponds should be cleared and grubbed. Topsoil should be heaped in areas outside of the area to be covered by the storage ponds and all trees, shrubs and roots removed. Topsoil should be placed in layers not exceeding 0.2 m and planted with grass if it is to be left for a considerable time (more than 6 months). This will conserve the integrity of the topsoil. A total area of 340 m wide and 440 m long will be cleared off vegetation, stripped out to a depth of 2 m whereby different layers of soil will be stockpiled separately.

#### 5.8.2. Borrow pit

The material for construction of the embankment, wherever possible should be obtained from the area to be cleared. Otherwise, suitable material to construct the embankment may have to be sourced outside the wetted perimeter of the basin. Great care should be taken when obtaining borrowed materials from steep bank areas that may be prone to instability. When rock is exposed in the excavation area, no attempt should be made to excavate into the rock. All exposed areas of gravel, jointed rock or other porous material in the storage pond surfaces shall be covered with at least 300 mm of compacted clay to ensure water tightness. Therefore, appropriate clay soil will need to be sourced from nearby area for construction pond blanket and embankment core.

#### 5.8.3. Embankment raising and compaction

In order to prevent leaks across the embankment that could lead to pond failures adequate compaction is mandatory. It is important that effective compaction is achieved. This can be undertaken by applying the required compaction effort to high clay content materials. Compaction should be undertaken by using a tamper foot roller, commonly referred to as a sheepsfoot roller. As a rule of thumb to obtain the required compaction effort, the following should be undertaken:

i) All fill material for the embankment should be placed in layers (or lifts) no greater than 150 mm thick.
ii) The largest size particle should not be greater than 1/3$^{rd}$ the height of the lift, that is, 50 mm.
iii) Each layer should be thoroughly compacted before the next layer is placed.
iv) A minimum of 6 passes to achieve the required compaction effort is required.
v) The compaction effort achieved should be on average 98% Standard Maximum Dry Density (MDD) (non-structural fill) as in context to Modified MDD (structural fill).
vi) The minimum compaction effort should be 95% Standard MDD. If the range of compaction effort varies throughout the embankment, then it can lead to the pond embankment settling to different degrees (differential settlement) causing the embankment of the pond to crack. This may ultimately lead to leakage and embankment failure.

vii) The material forming the embankment should be placed with sufficient moisture to ensure proper compaction. The moisture content should be in the range of –1% to + 3% of optimum moisture content (OMC). If the material is too dry, water should be added. If the material is too wet, it should be spread and mixed.

viii) Before each additional 150 mm lift is added to the embankment, the preceding lift should be scarified to ensure that the two lifts are properly joined so that no natural paths for seepage are present that may result in dam failure.

A wheeled scraper or truck should be used for placing the clay on the pond site. The clay should then be spread by the use of the blade on a tamper foot roller or from a bulldozer towing a tamper foot roller (sheepsfoot roller). Vehicles with crawler tracks are not suitable, as high compaction levels are not achieved. Likewise, compaction using a scraper tyre should not be used as the required compaction effort will not be achieved.

### 5.8.4. Compaction testing requirements

During construction, the engineer overseeing the construction activities must ensure geotechnical testing are undertaken, for density tests to ensure that the compaction specifications are met. It is critical that the supervising engineer selects a qualified technician with relevant accreditation for the type of test being undertaken. The technician should also accompany the engineer in their routine inspections. The test certificates need to be included in the Appendix of the Work-as-Executed Report to be submitted to the proponent and the consultant.

Construction of the pond will be carried out based on approved detailed drawings of the proposed designs and specifications issued. It should be noted that slight variation from the assumptions made during design can occur during construction due to some factors such as the change of the ground condition of the area. The site engineer in this regard can provide necessary direction applying modifications on the design to account for the changes during construction stage.

### 5.8.5. Settlement of the embankment

Settlement of soil banks is common and an allowance must be made for settlement of the dam embankment. The embankment may settle to a level where it is overtopped by water and failure may result. Or overtime, settlement may result in the height of the embankment becoming lower than the designed crest height. Loose clay soils can settle in excess of 10% of the dam’s height, but well-constructed and compacted clay dam embankments are not likely to settle more than about 5%. An allowance of 5% of the height of the embankment (along its length) to cater for settlement is necessary.

### 5.8.6. Vegetation

Topsoil should be spread over the exposed surfaces of the embankment to a depth of at least 150 mm and sown with pasture grass to establish a good cover as soon as possible. This will slow runoff that otherwise would promote erosion. Never allow any vegetation larger than pasture grass to become established on or near the embankment. Tree roots, especially deep-rooted trees can cause the core to crack resulting to the failure of the embankment.

### 5.8.7. Quality control and quality assurance

In order to ensure that minimum requirements of the construction are met as per specification in section 5.8.3 above, quality control mechanisms must be put in place. Therefore, sign off by three parties (Proponent, Consultant and Contractor if applicable) must be undertaken at every stage from pegging, clearing and construction to finish. If unsatisfactory work has been done at any stage, no further stage shall be undertaken prior to correcting the situation. The necessary testing as specified in section 5.8.4 above shall be undertaken without any obstruction, any discrepancy must be reported immediately for correction.

## 5.9. Construction Material Requirement

The materials needed for the construction of the embankment of the storage ponds will vary depending on the embankment zones. The construction material will be obtained from the foundation cut after removing and separating a 1 m organic layer. Also, the construction material will be obtained from the vicinity of the construction site. **Error! Reference source not found.** shows type and quantities of material needed for construction of the embankment. The quantity of material (likely sand clay) which will be available from the foundation cut is approximated to be 327,732 bank cubic meters.

Table 5-9: Material requirement for embankment construction

| **Embankment Zone/Source** | **Material Type** | **Compacted Volume [$m^3$]** |
|---|---|---|
| Core and Foundation Blanket | Clean Clay Soil | 110,138 |
| Shell | Weathered Clay | 282,769 |
| Riprap Filter | Gravel | 1,634 |
| Riprap | Cobbles and Boulders<br>< 500 mm diameter | 10,878 |
| Internal Drainage | Sand/Gravel | 12,259 |

In addition, the material for construction will need to be tested for the purpose of determining their suitability for the construction of the pond embankment. Some of the tests to be conducted include particle size distribution, index properties, density of soil, triaxial shear strength test, direct shear strength test, soil permeability, compaction characteristics and CBR (California Bearing Ratio). The suitable material for construction will be recommended by the civil engineer who will be supervising the construction. He/she will recommend the construction material based on laboratory test results.

## 5.10. Storage Ponds Pumping and Piping System Design

A centrifugal pump is proposed to be used to pump the brine solution from the storage ponds to a holding tank located at the soda ash plant. This type of pump is commonly used to induce flow or raise a liquid from a low level to a high level. The biggest advantage of using centrifugal pump for pumping the brine solution from storage ponds to holding tanks is its ability to adjust the flow rates over a wide range by changing the impeller speed or diameter. Increase of flow rate is likely to happen in this project especially when the amount of brine solution to be pumped will need to be increased to fulfil any increase of market demand of soda ash in the future. Increase in impeller diameter will require more power to run the pump, however, the amount of additional power will depend on the weight of the material used to manufacture the impeller (Matlakala, et al., 2019).

In order to meet production of 500,000 tonnes of soda ash per annum, a pumping requirement of 383 $m^3$ of brine solution per hour is required. The centrifugal pump will operate at a total dynamic head of 21 m which includes a static head of 20 m and a friction head loss of 1 m. The static head was obtained by taking the elevation difference between the holding tanks at the soda ash plant and the storage pond. The friction head was calculated using Darcy-Weisback formula shown in Equation 5-1, considering pumping in a pipe with specifications shown in **Error! Reference source not found.**.

Table 5-10: HDPE pipe specification (Source: PLASCO Ltd, Tanzania)

| **Pipe Category** | **Specifications** | **Unit** |
|---|---|---|
| Pipe type | PN 12.5 PE 100 | |
| Outside Diameter | 400 | mm |
| Minimum Wall thickness | 29.4 | mm |
| Total length required | 300 | m |
| Unit cost | 118.14 | USD/m |
| Total Costs | 35,442.00 | USD |

Based on these operating conditions (flow rate of 383 $m^3$/hr and total dynamic head of 21 m), a pumping system consisting of two pumps was considered. In this system, a single pump capable of delivering 383 $m^3$/hr over the head of 21 m will be used while a pump of the same capacity will be installed in parallel as a standby pump. When the operating pump goes off due to any fault, the standby pump will switch on automatically in order to avoid delays in production. In the discharge side of each pump, a gate valve will be installed to limit backflow to the pump when it is not operating. **Error! Reference source not found.** shows the principle of operation of parallel pump configuration proposed in this system.

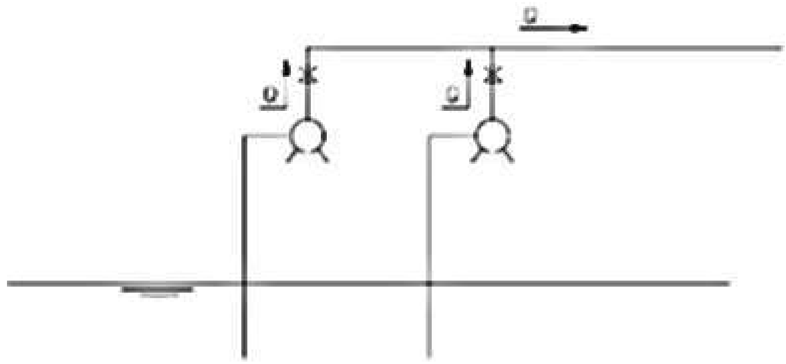

Figure 5-3: Typical configuration of parallel centrifugal pump system

The operating conditions of this system were used to inquire technical specifications of the available pumps in the market from manufacturers, suppliers and dealers. Appendix 3, shows characteristics curves of the pump capable of operating in this system. It should be noted that the specified pump will need to be operated at 2258 rpm in order to meet the head and flow rate required. Specifications and costs of the centrifugal pump at the storage ponds are summarized in **Error! Reference source not found.**.

Table 5-11: Specifications and costs of the surface centrifugal pumps at the storage ponds

| **Description** | **Value** |
|---|---|
| **Operating Data** | |
| Nominal Capacity | 383 $m^3$/hr |
| Nominal Head | 21 m |
| Power consumption at Nominal Capacity | 45 kW |
| Efficiency at Nom. Capacity | 76 % |
| **Dimensions** | |
| Base plate length | 1932 mm |
| Base plate width | 550 mm |
| Height (Base plate + pump) | 685 mm |
| **Material** | |
| Pump casing | CrNiMo-steel (1.4408) |
| Impeller | CrNiMo-steel (1.4408) |
| Pump shaft | CrNiMo-steel (1.4462) |
| Suction casing | CrNiMo-steel (1.4408) |
| **Total Weight** | **1,800 kg** |
| **CIF Cost (per pump)** | **USD 41,607.00** |

In this system a discharge manifold will be connected to the pumps at its receiving end and to the 16-inch diameter HDPE transport pipe at its discharge end. The 16-inch diameter HDPE transport pipe having a total distance of about 300 m will deliver brine solution to the holding tanks located at soda ash plant. A control panel controlling both pumps will be fitted which contains a pumping controller, a variable frequency drive, circuit breakers and fuses. The control panel and the pumps will be installed inside the pump house.

### 5.10.1. Installation of the centrifugal pump and piping

During installation of the pump and pipes, the following key issues should be observed;

i) Based on the size and weight of the centrifugal pump, the foundation should be well designed and constructed. The design of the foundation will need to be prepared by a qualified person and he/she should ensure the design is well implemented during construction.
ii) Once the construction of the foundation is completed, the pump should be properly aligned and anchored on the foundation. For security reason, it is proposed that the pump should be well secured in a well-ventilated room.
iii) The pipes should be laid on the excavated trench and left uncovered for easy repair in case of any leakage. The trench will be excavated at 1.0 m depth and 1.0 m width. Appropriate fittings should be used in connecting the pipes. The piping connections should be checked to verify that they are not subjected to stresses or strains prior being connected to the pump. Re-aligning the pipe connections if required.

In general, the flow of brine solution from boreholes to soda ash plant will comprises submersible pump to be installed in the production boreholes, piping network, storage ponds and centrifugal pump. **Error! Reference source not found.** shows the flow of brine solution from boreholes to soda ash plant.

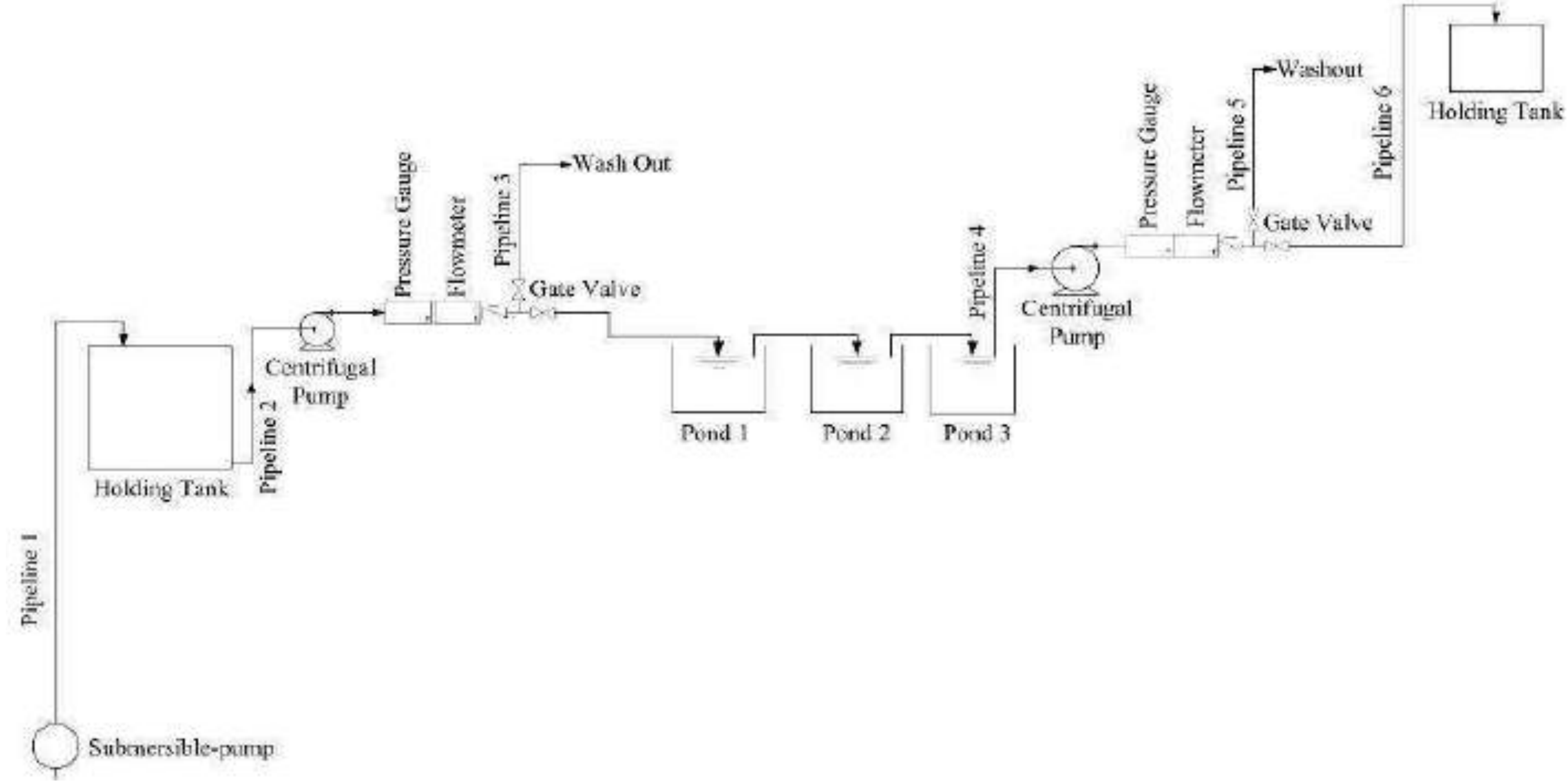

Figure 5-4: General flow sheet showing the flow of brine solution from boreholes to soda ash plant

## 5.11. Operation and Maintenance

The operation of ponds is such that pond 1 will allow overflow of brine to pond 2 and overflow from pond 2 will get into pond 3 through free flow. The flow direction of the brine in the three ponds is shown in sheet 1 of Appendix 4.

The balance of brine solution in the three storage ponds considers inflow due to pumping from collection tanks and precipitation while outflows consider pumping of brine solution to the soda ash plant, leakage, seepage and evaporation. In order to achieve steady state operation of the ponds, the submersible pumps in the boreholes and the centrifugal pump at the collection tanks will be required to operate under variable frequency drive condition, whereby flow from the boreholes should range between 383 – 421 $m^3$/hr depending on the season. During wet season, whereby precipitation ranges between 119 – 223 mm per month (November to December and March to April) (Meteovista, 2020), warrant lower pumping values from boreholes. During dry season, where evaporation rate averaged at 1,800-2,000 mm per annum (Dagg, et al., 2009), warrant higher pumping rates from boreholes.

Based on the reported Total Suspended Solids (TSS) in the brine solution which is averaged to be 700 mg/L (Volume I - Appraisal of the Brine Resources), it is calculated that the rate of accumulation of sediments in the ponds will be 6 tonnes per day. It is assumed that, large quantity of sediments will settle in pond 1 based on the fact that the size of the pond will allow the particles to have sufficient residence time enough for particles to settle. It is calculated that the settling of the sediments will be in the ratio of 60% in pond 1, 30% in pond 2 and the remaining 10% in pond 3.

It is suggested that, maintenance of pond should be done when the depth of the brine solution has reached 2.5 m measured on the inlet side of the settling zone provided that the freeboard is maintained close to 1 m during operation. At this depth, the height of the sediment sludge will be about 1 m. It is also critical to monitor this depth through periodic measurement as it relates to the quantity of sediments in the settling pond. Accumulation of sediments in the settling ponds decreases the brine storage volume as the sediment height expenses the brine solution depth.

Based on the calculated sediment settling distribution ratio among the three storage ponds, it is calculated that pond 1 will require pumping out of settled sediments after 34 years. However, at this period pond 2 and 3 will not require such maintenance as the amount of sediment will still be low. Removal of sediments from the ponds will be carried out by using a movable slurry pump. It is recommended to use a self-priming slurry pump shown in **Error! Reference source not found.**. This pump will enable the suction hose to be lowered to the target slurry at the bottom of the pond, while stationing the pump at the crest of the pond embankment. The sludge removal process will require agitation of the settled sediments before being pumped.

Figure 5-5: A self-priming slurry pump (Eddy Pump Corporation, 2020)

In addition, it should be noted that the selected freeboard height of 1 m should be maintained during operational life of the storage pond in order to manage excess water that may be caused by the extreme precipitation event.

### 5.12. Investment Cost Estimates

The investment costs estimate for the brine extraction system include costs for pond construction, pumping system and auxiliary facilities. The potential suppliers of submersible and centrifugal pumps with their contact information are listed in **Error! Reference source not found.**. The pond construction costs include equipment hiring costs, field and laboratory tests, and outsourced embankment construction material. The pond construction costs are detailed in **Error! Reference source not found.**. The investment costs of the brine pumping system consist of purchase costs of pumps, pipes and fittings as detailed in **Error! Reference source not found.**. The potential suppliers of submersible and centrifugal pumps with their contact information are listed in **Error! Reference source not found.**. The auxiliary facilities include the fuel bay, centrifugal pump house, submersible pump collar protection structures and the overhead crane are detailed in **Error! Reference source not found.**. The total investment costs for the brine extraction system are approximated at **USD 6,188,071.19** based on July 2020 prices as summarized in **Error! Reference source not found.**. Note that all costs are exclusive of local taxes.

Table 5-12: Potential Suppliers of Pumps

| S/N | Company Name | Category | Address | Contacts |
|---|---|---|---|---|
| 1 | TERAL DMCC | Manufacturer | 1806-002, BB1, Mazaya Business Avenue<br>Jumeirah Lake Towers, Dubai, PO Box 414781, UAE<br>+971(0)43699039, sales.me@teralasia.com,<br>Website: www.teral.net | pankaj.attarde@teralasia.com<br>Mobile: +971 (0) 551184953 |
| 2 | KSB Pumps and Valves Limited | Manufacturer | KSB Kenya<br>Address<br>Units A2 & B3, Prabhaki Industrial Park<br>Baba Dogo Road, Ruaraka<br>00621 Nairobi<br>Website: www.ksb.com | Ian.Black@ksb.com<br>Tel: +254 234 9308<br>Mobile: +254 705 984 088 |
| 3 | Flowserve Flow Solutions Group | Manufacturer | Unit 1, 12 Director Road, Spartan Ext. 2, Kempton Park, 1620, South Africa<br>Website: www.flowserve.com | BKabue@Flowserve.com<br>Tel: +27 (0)11 923 7323 (direct)<br>Tel: +27 (0)11 923 7300 (switchboard)<br>Mobile: +27 (0)79 893 2674<br>Fax: +27 (0)11 974 5190 |
| 4 | EBARA Pumps Europe SpA | Manufacturer | Torri di confine, 2/1 int. c - I - 36053 Gambellara (Vicenza)<br>Website: http://www.ebaraeurope.com/ | carlo_milesini@ebaraeurope.com<br>Tel: +39 0444 706811<br>Mobile: +39 345 1302031 |
| 5 | EVMA Company Limited | Dealer of DESMI pumps | P. O. Box 36216<br>Garden Road, Amani lane<br>Plot 401, Off Garden Road<br>Mikocheni A<br>Dar es Salaam, Tanzania | jndossi@evma.co.tz<br>Mobile: +255 713 242453 |
| 6 | MerryWater Limited | Dealer | MerryWater House<br>Bagamoyo Road<br>P. O. Box 7472<br>Dar-es-Salaam Tanzania | damian@merrywater.de<br>Mobile: +255 713 337424 or /and +255 788 457968 |

Table 5-13: Pond Construction costs

| | Sn | Item | Unit | Qty | Rate [USD] | Amount [USD] | Suppliers | Contacts |
|---|---|---|---|---|---|---|---|---|
| **1** | | **EQUIPMENT HIRING** | | | | | | |
| | 1.1 | Mobilization and Demobilization (Excavator, Dozer, Compactor, Drill rig & Wheel loader) | Ls | 5 | 1,200.00 | 6,000.00 | Elerai Construction Co. Ltd | P. O. Box 7026, Arusha - Tanzania Mobile: +255 784 511144 or +255 754 511144 Email: info@eleraiconstruction.co.tz |
| | 1.2 | Mobilization and Demobilization of Trucks | Ls | 3 | 434.00 | 1,302.00 | | |
| | 1.3 | Equipment Hiring (exclusive fuel charge) | | | | 0 | | |
| | | Excavator 1.68 CMB Bucket | hr | 3,310 | 68.04 | 225,212.40 | | |
| | | Power Angle Tilt Dozer | hr | 18,010 | 59.83 | 1,077,538.30 | | |
| | | Sheep Foot Roller Compactor | hr | 770 | 282.61 | 217,609.70 | | |
| | | Wheel loader 4.4 CBM Bucket | hr | 1,330 | 304.35 | 404,785.50 | | |
| | | Trucks 10 tons | hr | 4,600 | 16.30 | 74,980.00 | | |
| | | Motor Grader | hr | 168 | 43.48 | 7,304.64 | | |
| | | Light Vehicle (4 WD Land Cruiser Hardtop) | daily | 10 | 130.43 | 1,304.30 | | |
| | | RC Drill | borehole | 6 | 35,000.00 | 210,000.00 | JNM Mining Services Ltd | P. O. Box 11940, DSM - Tanzania Email: jmwakabage@jnm-tz.com Mobile: +255 755 440278 or +255 784 440278 |
| | 1.4 | Dayworks - Labour Only | | | | 0 | | |
| | | Mobile crane operator | daily | 30 | 21.74 | 652.20 | Elerai Construction Co. Ltd | |
| | | Fuel and Lube Truck operator | daily | 30 | 13.04 | 391.20 | | |
| | | Water bowser operator | daily | 30 | 13.04 | 391.20 | | |
| | | **SUB TOTAL (VAT exclusive)** | | | | **2,227,471.44** | | |
| | | | | | | | | |
| **2** | | **FIELD AND LABORATORY TESTS** | | | | | | |

| | Sn | Item | Unit | Qty | Rate [USD] | Amount [USD] | Suppliers | Contacts |
|---|---|---|---|---|---|---|---|---|
| | 2.1 | Compaction test | Nos | 40 | 21.74 | 869.60 | BICO,<br><br>DIT | Bureau for Industrial Cooperation, College of Engineering and Technology,<br>University of Dar-es-Salaam. P. O. Box 35131, Dar es Salaam - TANZANIA.<br>Tel: + 255 (22) 2410113; Gen. 2410501-9; Ext. 2964.<br>Fax: + 255 (22) 2410114<br>E-mail: bico@udsm.ac.tz<br><br>Dar Es Salaam Institute of Technology, Civil & Building Engineering Department, Soil and Materials Laboratory,<br>Tel: +255 (0) 22 – 2151709<br>E-mail: computer@dit.ac.tz |
| | 2.2 | Combined sieve analysis | Nos | 10 | 32.61 | 326.10 | | |
| | 2.3 | Atterberg Limits | Nos | 10 | 30.00 | 300.00 | | |
| | 2.4 | Specific gravity | Nos | 10 | 19.57 | 195.70 | | |
| | 2.5 | Unit weight of soil | Nos | 10 | 10.87 | 108.70 | | |
| | 2.6 | Natural moisture content (NMC) | Nos | 10 | 5.48 | 54.80 | | |
| | 2.7 | Permeability test | Nos | 10 | 28.70 | 287.00 | | |
| | 2.8 | Oedometer test | Nos | 10 | 32.61 | 326.10 | | |
| | 2.9 | Triaxial | Nos | 10 | 39.13 | 391.30 | | |
| | 2.10 | UCS of rock sample | Nos | 10 | 21.74 | 217.40 | | |
| | 2.11 | Proctor and CBR for trial pit samples | Nos | 10 | 71.74 | 717.40 | | |
| | | **SUB TOTAL (VAT exclusive)** | | | | **3794.10** | | |
| | | | | | | | | |
| **3** | | **EMBANKMENT CONSTRUCTION MATERIAL** | | | | | | |
| | 3.1 | Drainage filter (gravel) | c. $m^3$ | 12,259 | 43.48 | 533,021.32 | | |
| | 3.2 | Riprap (boulders) | c. $m^3$ | 10,878 | 56.52 | 614,824.56 | | |
| | 3.3 | Grass seeding- channel slopes | $m^2$ | 19,188 | 0.22 | 4,221.36 | | |
| | | **SUB TOTAL** | | | | **1,152,067.24** | | |
| | | | | | | | | |
| | | **TOTAL COSTS** | | | | **3,383,332.78** | | |

Table 5-14: Pumps and piping costs

| Sn | | Item | Unit | Qnty | Rate [USD] | Amount [USD] | Suppliers | Contacts |
|---|---|---|---|---|---|---|---|---|
| **1** | | **Pumps** | | | | | | |
| | 1.1 | Centrifugal pump at the collection tank | Ls | 2 | 82,208.00 | 164,416.00 | KSB Pumps & Valves Ltd | P. O. Box 2286-00621 |
| | 1.2 | Centrifugal pump at the storage pond | Ls | 2 | 41,607.00 | 83,214.00 | | Village Market |
| | | **SUB TOTAL (CIF)** | | | | **247,630.00** | | |
| | | | | | | | | |
| **2** | | **Pipes** | | | | | | |
| | 2.1 | HDPE 200mm PN12.5 - 12mtrs PE100 | m | 33,769 | 29.57 | 998,549.33 | PLASCO Ltd | Plasco Limited Mbozi Road, Changombe Area, P. O. Box 19956, Dar-es-Salaam, Tanzania. Tel. +255 22 2199822; Mobile: +255 766 104 403/ +255 769 756 495 |
| | 2.2 | HDPE 400mm PN12.5 - 12mtrs PE100 | m | 5,900 | 118.14 | 697,026.00 | PLASCO Ltd | |
| | 2.3 | HDPE 160mm PN25 - 6mtrs PE100 | m | 1,200 | 32.79 | 39,348.00 | PLASCO Ltd | |
| | 2.4 | Casing Pipe - Non-Perforated | m | 160 | 57.48 | 9,196.80 | PLASCO Ltd | |
| | 2.5 | Casing Pipe - Perforated | m | 1,040 | 64.15 | 66,716.00 | PLASCO Ltd | |
| | 2.6 | Valve chambers & accessories | Ls | 6 | 10,666.50 | 63,998.97 | PLASCO Ltd | |
| | 2.7 | Transport (Dar to Mto wa Mbu) | trips | 18 | 1,521.74 | 27,391.30 | PLASCO Ltd | |
| | 2.8 | Mto wa Mbu to Engaruka Site | | 18 | 113.04 | 2,034.78 | Local Transporter | |
| | | **SUB TOTAL (VAT exclusive)** | | | | **1,904,261.19** | | |
| | | | | | | | | |
| **3** | | **Fittings** | | | | | | |
| | 3.1 | Mobilisation/Demobilisation per trip | Ls | 1 | 1,239.13 | 1,239.13 | PLASCO Ltd | |
| | 3.2 | Site Welding of HDPE Pipes | Ls | 1 | 184,782.61 | 184,782.61 | PLASCO Ltd | |
| | | **SUB TOTAL (VAT exclusive)** | | | | **186,021.74** | | |
| | | | | | | | | |
| | | **TOTAL COST OF PUMPING SYSTEM** | | | | **2,337,912.93** | | |

Table 5-15: Investment costs of Auxiliary Facilities

| Sn | | Item | Unit | Qnty | Rate [USD] | Amount [USD] | Suppliers | Contacts |
|---|---|---|---|---|---|---|---|---|
| 1 | | **Fuel Bay** | | | | | | |
| | 1.1 | Construction and Installation Costs | Ls | 1 | 95,652.17 | 95,652.17 | Combined Engineering Systems | P. O. Box 4705, Dar es Salaam, Email: – crkazwala@gmail.com Tel: +255 753 744326 |
| | 1.2 | 54 $m^3$ fuel tanks | Ls | 2 | 21,739.13 | 43,478.26 | | |
| | 1.3 | Offloading pump | Ls | 1 | 9,000.00 | 9,000.00 | | |
| | 1.4 | Dispersing pump | Ls | 1 | 7,826.09 | 7,826.09 | | |
| | | | | | | 0 | | |
| 2 | | Weholite cylindrical collection tanks | Ls | 1 | 260,781.00 | 260,781.00 | | |
| 3 | | Centrifugal pump House | Ls | 1 | 6,521.74 | 6,522.74 | Local Contractors | |
| 4 | | Submersible pump protection structures | Ls | 6 | 3,260.87 | 19,565.22 | Local Contractors | |
| 5 | | Overhead Crane (10 tons lifting capacity) for Soda Ash Plant | Ls | 1 | 24,000.00 | 24,000.00 | Henan Mine Crane Co., Ltd | No. 18 Changnao Industrial Park, Changyuan, Xinxiang, Henan, China. Tel: +86 371 69102788. Email: info@hnminecrane.com |
| | | **SUB TOTAL (VAT exclusive)** | | | | **466,825.48** | | |

Table 5-16: Summary of Brine Pumping Costs

| Item | Source | Cost (USD) |
|---|---|---|
| | | |
| Pond Construction | Table 5-13 | **3,383,332.78** |
| Pumps and Piping | Table 5-14 | **2,337,912.93** |
| Auxiliary Facilities | Table 5-15 | **466,825.48** |
| **Total** | | **6,188,071.19** |

# CHAPTER SIX

# 6 STEAM AND POWER SUPPLY SYSTEM

## 6.1. Introduction

A well designed, operated and maintained boiler house is the heart of an efficient steam plant. However, a number of obstacles can prevent this ideal. The boiler house and its contents are sometimes viewed as little more than a necessary inconvenience and even in today's energy conscious environment, accurate steam flow measurement and the correct allocation of costs to the various users, is not universal. This can mean that efficiency improvements and cost-saving projects related to the boiler house may be difficult to justify to the end user.

It is important to remember that the steam boiler is a pressurised vessel containing scalding hot water and steam at more than 100°C, and its design and operation are covered by a number of complex standards and regulations.

Almost two third of electricity requirement of the world is fulfilled by thermal power plants (Daware, 2015). In these power stations, steam is produced by burning some fossil fuel (e.g., coal) and then used to run a steam turbine. Thus, a thermal power station may sometimes be called as a Steam Power Station. After the steam passes through the steam turbine, it is condensed in a condenser and again fed back into the boiler to become steam. This is known as ranking cycle.

The primary boiler fuels are coal, oil, natural gas, and wood biomass. Wood biomass cannot be an option for consideration in Engaruka project because it will contribute in deforestation. Oil is also not a good option because Tanzania is importing all its petroleum oil products.

Natural gas is a good candidate as boiler fuel because Tanzania has 57.54 tcf of natural gas reserve which can be harnessed and be utilized in big projects for generating steam and power. This gas is found in the Indian ocean and along its coast. The challenge in utilizing the gas is the distribution network, as it has to be distributed through pipeline. So far there is distribution network in only three regions of Dar es Salaam, Pwani na Mtwara (Kalemani, 2020) and it will take long time before most of the country is covered because of the high capital cost involved. Thus, Engaruka project cannot be based on natural gas boiler firing and hence steam and power generation.

Tanzania is producing more than 434,485 tonnes of coal per year (Biteko, 2020), 99% of which comes from Ngaka Mines and Kambas Mining Investment in Ruvuma region. Ngaka mines has the capacity to produce more as the market demands. Distribution of coal is not as complicated as that of natural gas. It is thus plausible to plan to use coal from Ngaka mines for firing steam boiler for Engaruka project.

## 6.2. Layout and Working of a Thermal Power Plant

A simplified layout of a thermal power station is shown in **Error! Reference source not found.** and explained below.

**Coal:** Fuel to be used in this thermal power plant will be coal since it is abundantly available in Tanzania. Coal will be transported from Ngaka coal mines to the generating station. The quality of the coal is as shown in **Error! Reference source not found.**. The fuel will be stored in both 'dead storage' and ‘live storage’. Dead storage is generally a 40 days backup coal storage which is used when coal supply is unavailable, whereas ‘live storage’ is a raw coal bunker in boiler house. The coal will be cleaned in a magnetic cleaner to filter out any metallic particles present which may cause wear and tear in the equipment. In order to improve efficiency of the boiler, coal from live storage is first crushed into small particles and then taken into pulveriser to make it in powdered form. The ash produced after the combustion of coal is taken out of the boiler furnace and then properly disposed. Periodic removal of ash from the boiler furnace is necessary to enhance combustion.

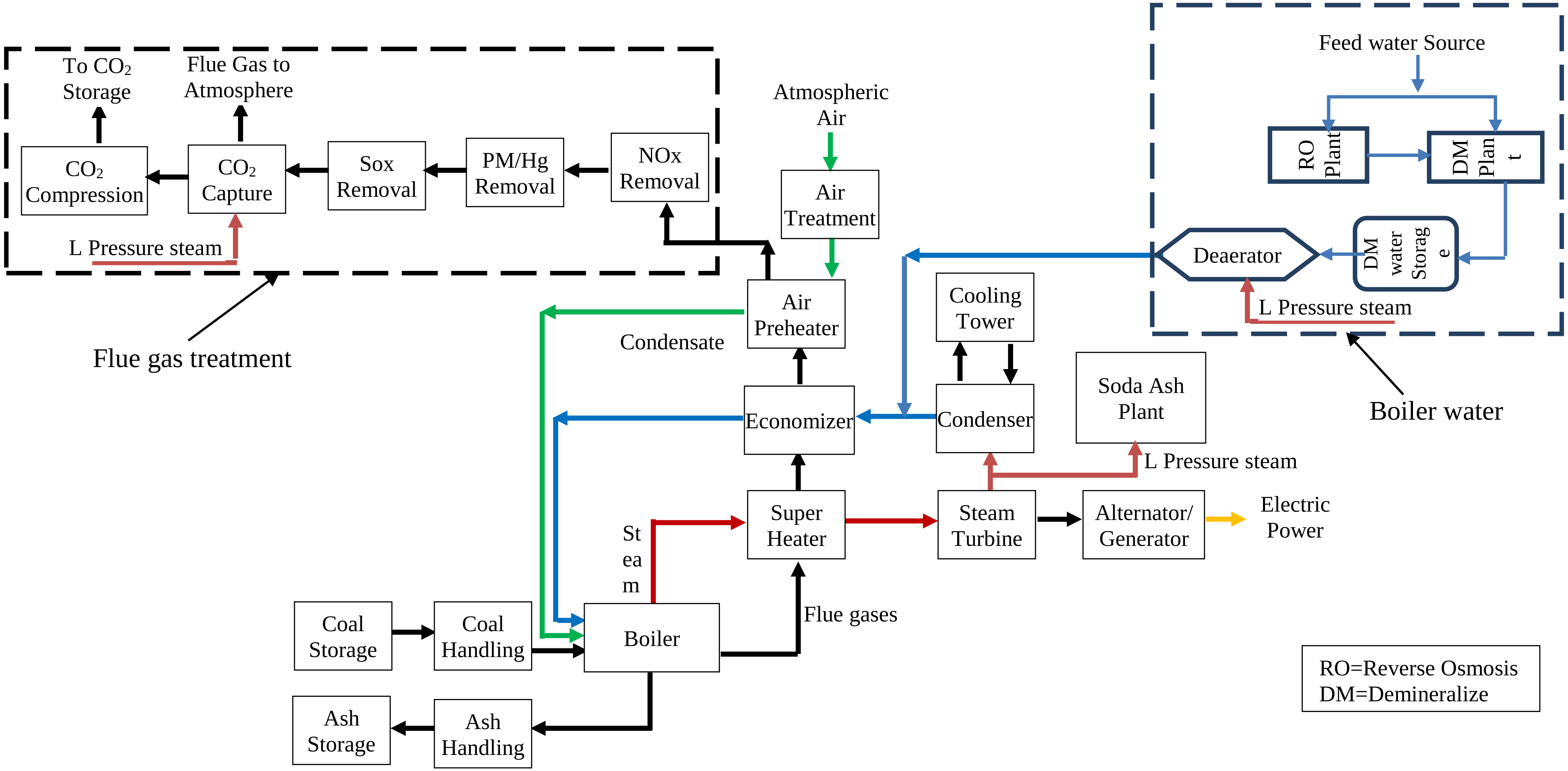


Figure 6-1: Coal fired power plant flow diagram

Table 6-1: Chemical and thermodynamic properties of coal samples from Ngaka

| S/N | Sample Particular | Sample No | Proximate Analysis (AD) | | | | GCV | Ultimate Analysis | | | Dry Mineral Matter free (dmmf) | | | | | GCV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M% | Ash% | VM% | FC% | kcal/kg | C% | H% | S% | VM% | FC% | C% | H% | S% | kcal/kg |
| | AMQ-01-TANCOAL | IRD/2016/CT/02 | 2.63 | 15.15 | | 82.22 | 6,230 | 65.34 | 3.58 | 1.48 | -1.88 | 101.88 | 80.96 | 4.44 | 1.83 | 7,719 |
| | DPCR-01-TANCOAL | IRD/2016/CT/03 | 3.07 | 15.32 | 25.27 | 56.34 | 6,142 | 69.29 | 3.92 | 1.45 | 29.64 | 70.36 | 86.53 | 4.9 | 1.81 | 7,670 |
| | DPCR-02-TANCOAL | IRD/2016/CT/04 | 2.97 | 23.03 | 27.72 | 46.28 | 6,010 | 69.82 | 3.66 | 0.66 | 35.45 | 64.55 | 97.38 | 5.10 | 0.92 | 8,382 |
| | DPCR-03-TANCOAL | IRD/2016/CT/05 | 2.34 | 23.08 | 31.04 | 43.54 | 6,104 | 69.39 | 3.71 | 2.21 | 39.76 | 60.24 | 96.01 | 5.13 | 3.06 | 8,445 |
| | DPCR-04-TANCOAL | IRD/2016/CT/06 | 2.78 | 27.74 | 25.17 | 44.31 | 6,056 | 68.18 | 3.03 | 2.05 | 33.57 | 66.48 | 102.21 | 4.54 | 3.07 | 9,079 |
| | CPCM-A-TANCOAL | IRD/2016/CT/07 | 1.98 | 33.04 | 22.94 | 41.68 | 4,743 | 49.03 | 3.18 | 4.17 | 31.98 | 68.02 | 80.01 | 5.19 | 6.8 | 7,739 |
| | CPCS-B-TANCOAL | IRD/2016/CT/08 | 3.42 | 20.14 | 27.07 | 49.37 | 5,950 | 66.13 | 5.06 | 1.79 | 33.67 | 66.33 | 88.85 | 6.08 | 2.41 | 7,995 |
| | CPCM-C-TANCOAL | IRD/2016/CT/09 | 3.33 | 14.72 | 26.79 | 55.16 | 6,122 | 68.95 | 3.91 | 1.73 | 31.46 | 68.54 | 85.68 | 4.86 | 2.15 | 7,608 |
| | CPCM-D-TANCOAL | IRD/2016/CT/10 | 2.00 | 43.93 | 21.34 | 32.73 | 3,968 | 43.38 | 2.69 | 0.90 | 34.11 | 65.89 | 87.32 | 5.41 | 1.81 | 7,987 |
| | CPCM-E-TANCOAL | IRD/2016/CT/11 | 2.57 | 17.48 | 24.58 | 55.37 | 6,019 | 66.23 | 3.71 | 0.88 | 29.20 | 70.80 | 84.69 | 4.74 | 1.13 | 7,696 |

**Boiler:** The mixture of pulverized coal and air (usually preheated air) is taken into boiler and then burnt in the combustion zone. On ignition of fuel a large fireball is formed at the centre of the boiler and large amount of heat energy is radiated from it. The heat energy is utilized to convert the water into steam at high temperature and pressure. Steel tubes run along the boiler walls in which water is converted into steam. The flue gases from the boiler make their way through superheater, economizer, air preheater and finally get exhausted to the atmosphere from the chimney.

- **Superheater:** The superheater tubes are hanged at the hottest part of the boiler. The saturated steam produced in the boiler tubes is superheated to about 540°C in the superheater. The superheated high-pressure steam is then fed to the steam turbine.
- **Economizer:** An economizer is essentially a feed water heater which heats the water before supplying to the boiler.
- **Air pre-heater:** The primary air fan takes air from the atmosphere and it is then warmed in the air pre-heater. Pre-heated air is injected with coal in the boiler. The advantage of pre-heating the air is that it improves the coal combustion.

**Steam turbine:** High pressure super-heated steam is fed to the steam turbine which causes turbine blades to rotate. Energy in the steam is converted into mechanical energy in the steam turbine which acts as the prime mover. The pressure and temperature of the steam falls to a lower value and it expands in volume as it passes through the turbine. The exhausted steam (low pressure steam) is partly sent to the plant as process steam where it is further exhausted and condensed. The rest of the steam together with the condensate from the plant is exhausted in the condenser.

**Condenser:** The exhausted steam is condensed in the condenser by means of cold-water circulation. Here, the steam loses its pressure as well as temperature and it is converted back into water. Condensing is essential because, compressing a fluid which is in gaseous state requires a huge amount of energy with respect to the energy required in compressing liquid. Thus, condensing increases efficiency of the cycle.

**Alternator:** The steam turbine is coupled to an alternator. When the turbine rotates the alternator, electrical energy is generated. This generated electrical voltage is then stepped up with the help of a transformer and then transmitted where it is to be utilized.

A practical thermal plant possesses more complicated design and multiple stages of turbine such as High-Pressure Turbine (HPT), Intermediate Pressure Turbine (IPT) and Low-Pressure Turbine (LPT).

### 6.3. Advantages and Disadvantages of a Thermal Power Plant

Advantages:

i) Less initial cost as compared to other generating stations.
ii) It requires less land as compared to hydro power plant.
iii) The fuel (i.e., coal) is cheaper.

iv) The cost of generation is lesser than that of diesel power plants.

Disadvantages:

i) It pollutes the atmosphere due to the production of large amount of smoke. This is one of the causes of global warming.
ii) The overall efficiency of a thermal power station is low (less than 30%).

### 6.4. Efficiency of a Thermal Power Station

A huge amount of heat is lost in various stages of the plant. Major part of heat is lost in the condenser. That is why the efficiency of thermal plants is quite low.

Thermal Efficiency is the ratio of 'heat equivalent of mechanical energy transmitted to the turbine shaft' to the 'heat of coal combustion' as expressed in Equation 6-1.

$$Thermal\ Efficiency = \frac{Heat\ eqv.\ of\ mechanical\ energy\ transmitted\ to\ \ turbine\ shaft}{Heat\ produced\ by\ coal\ combustion} \qquad \text{Equation 6-1}$$

Thermal efficiency of modern thermal power stations is about 30%. It means, if 100 calories of heat are produced by coal combustion, the mechanical energy equivalent of 30 calories will be available at the turbine shaft.

Overall Efficiency is the ratio of 'heat equivalent of electrical output' to the 'heat of coal combustion' as expressed in Equation 6-2.

$$Overall\ Efficiency = \frac{Heat\ equivalent\ of\ electrical\ energy\ output}{Heat\ produced\ by\ coal\ combustion} \qquad \text{Equation 6-2}$$

The overall efficiency of a thermal plant is about 29% (slightly less than the thermal efficiency).

### 6.5. Security of fuel supply

Since coal to be used in the power plant is locally available and the road-rail-road network from Ngaka to Engaruka is well developed, there is assurance of getting good supply of the material. In order to avoid disruptions during operation, the project will maintain good inventory to last for at least two weeks. In addition, when coal is completely not available, one could use biomass like charcoal or firewood.

### 6.6. Fuel storage

The main goal of coal storage is to minimize coal loss and preventing spontaneous combustion. Spontaneous combustion occurs in coal piles when low-temperature oxidation slowly heats up the material to a volatile point. When coal is thoroughly oxidized and the temperature in a pile reaches around 500$^{o}$C, methane in the coal ignites causing trouble for the coal pile and the surroundings.

In order to avoid spontaneous combustion, the stockpile should adhere to principles of proper stockpile management: packing it in horizontal layers, followed by levelling and dozing. In addition, moisture content should be minimized to avoid oxidation, and if possible, the stockpile should be located where there is limited exposure to wind. But if costs allow, stockpiles can be put in a sealed environment, this being the single most effective way to prevent spontaneous combustion problems and ensure compliance with any stringent regulatory requirements.

However, it should be noted that coal will be stored as per requirements of the existing national standard MMDC 3(6486) P3 Coal - Handling, storage and transportation – Code of practice (TBS, 2019). This includes, among others, ensuring:

a) Coal piles are not to be higher than 5 metres and the smallest distance between two adjacent heaps is 5 metres, so that in case of fire approach is available
b) Coal stockpiles are properly compacted to reduce the movement of air for easy oxidation
c) Artificial wind barriers are constructed to minimize the movement of air in the stockpile
d) Steam lines and sewage lines do not run under the coal stockpiles
e) Coal handling facility have effective fire detectors and adequate firefighting measures to combat any fire resulting from coal sources

## 6.7. Boiler types

The objectives of a boiler are:

i) To release the energy in the fuel as efficiently as possible.
ii) To transfer the released energy to the water, and to generate steam as efficiently as possible.
iii) To separate the steam from the water ready for export to the plant, where the energy can be transferred to the process as efficiently as possible.

To maintain proper fuel-air ratio, air flow should also be controlled per the load demand, either by varying the fan speed, by throttling fan inlet vane/damper/blade pitch, or by a combination of damper and speed control. The firing rate demand should be limited by the fuel flow to ensure an adequate air supply for safe combustion of fuel.

To ensure complete combustion of all the fuel, it is always necessary to supply more air than is required by proper fuel-air ratio, which may change due to variations in fuel calorific value, specific gravity, temperature, and other physical properties of either fuel or air. In most boilers, the desired excess air is not constant, but decreases as load is increased. Hence, it is essential to adjust the fuel-air ratio automatically. This is done by programming the $\%O_2$ set point as a function of boiler load.

Boilers have different classifications and come in different designs. Boilers which produce steam at pressures of 80 bar and above are called high pressure boilers, for instance Babcock and Wilcox, and Benson boilers. On the other hand, boilers which produce steam at pressure below 80 bar are called low pressure boilers, for instance Cochran, Cornish, Lancashire and Locomotive boilers. Engaruka project will require a low-pressure boiler.

Fluidized bed combustion (FBC), which originates from the need to burn difficult low-grade fuels of varying quality, makes it possible for in-bed sulphur removal and low NOx emissions (low combustion temperature). Thus, there is no need for special desulphurization or NOx removal equipment (Johnsson, 2007). Fluidized combustion, especially in its pressurized form, should permit coal firing rates for water tube boilers up to 5 – 8 $MW/m^3$ to be obtained.

### 6.8. Cogeneration power plant

Since the project will require both process steam and electricity, it is more convenient to take advantage of the well-established cogeneration technology. For simplicity of presentation, part of the proposed Coal fired power plant flow diagram (**Error! Reference source not found.**) is replaced by **Error! Reference source not found.**. In this case, the energy and steam flows conditions in and out of the boiler have already taken into account the effect of superheater, economizer and air pre heater on the overall performance of the plant.

Given that an FBC system can tolerate a wide distribution of fuel particle size, fuel pre-treatment consists mainly of crushing the fuel. By contrast, in pulverized fuel (PF) boilers fuel pre-treatment requirements are greater, with fuel being pulverized and dried in mills. The fuel feeding system in a pressurized fluidized bed combustion (PFBC) can be either a slurry feeding or a dry feeding system. In the former, coal and additives (e.g., limestone) are mixed with water and then pumped in the combustion chamber; in the latter, coal is pressurized in a lock-hopper system and then transferred to the combustion chamber via a distribution hopper and supply tubes.

Typically, in a slurry feeding system, coal is mixed with 25% water by weight. This type of fuel feeding system is favourable in terms of combustion and is mostly suitable for coals with low ash content. For high ash coals, the amount of water needed relative to the energy content of the fuel is too high, negatively affecting the overall efficiency (Kakaras & Doukelis, 2012).

**Error! Reference source not found.** and **Error! Reference source not found.** summarises the design parameters of the plant, fuel and steam requirements respectively.

The requirement of coal, based on 24 hours operation for 300 days would be 73,440 tonnes per year.

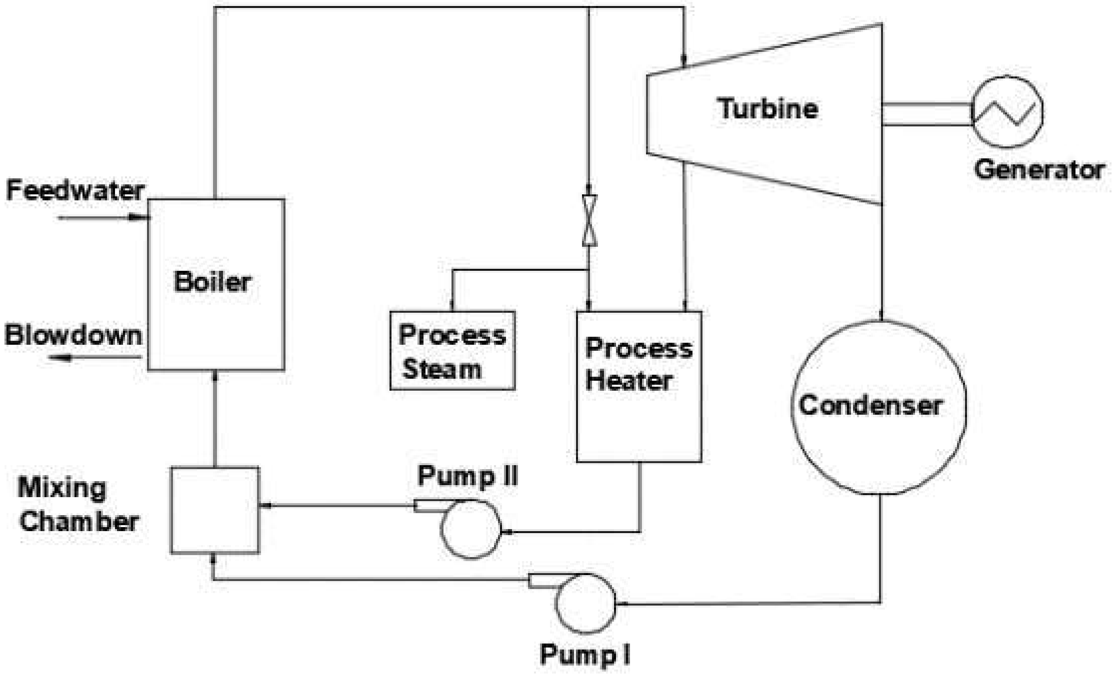


Figure 6-2: Coal fired co-generation power plant flow diagram

Table 6-2: Design parameters for a 15-MW co-generation (pulverized) coal power plant

| **S/N** | **Equipment** | **Pressure [bar]** | | **Temperature [°C]** | | **Mass flowrate [kg/h]** | | **Work [kW]** | |
|---|---|---|---|---|---|---|---|---|---|
| | | In let | Outlet | In let | Outlet | In let | Outlet | In let | Outlet |
| | Boiler | 30 | 30 | - | 500 | - | 130,600 | - | - |
| | Turbine | 30 | 1.013 | 500 | 99.97 | 65,378 | 65,378 | - | 15,000 |
| | Expansion Valve | 30 | 10 | 500 | 250 | 65,222 | 65,222 | - | - |
| | Process Heater | 10 | 10 | 250 | 179.9 | 58,700 | 58,700 | - | - |
| | Process Steam | 10 | - | 250 | - | 6,522 | 0 | - | - |
| | Condenser | 1.103 | 1.013 | 99.97 | 99.97 | 65,378 | 65,378 | | - |
| | Pump I | 1.103 | 30 | 99.97 | 100.2 | 65,378 | 65,378 | 54.93 | - |
| | Pump II | 10 | 30 | 179.9 | 180.3 | 58,700 | 58,700 | 36.76 | - |
| | Mixing Chamber | 30 | 30 | - | 163 | 124,078 | 124,078 | - | - |
| | Make-up water | | | | | 6,522 | | | |

Table 6-3: Steam and fuel requirement of a 15-MW co-generation (pulverized) coal power plant

| | Process Steam [kg/h] | Power Generation [kg/h] | Total [kg/h] | Annual Amount [MT/h] |
|---|---|---|---|---|
| Coal | 10,189 | 10.0 | 10,199 | 10.20 |
| Steam | 73,785 | 65.38 | 73,850 | 73.85 |

In order to validate the estimated coal consumption of the plant, the comparison was made using parameters of different boiler sizes from suppliers. **Error! Reference source not found.** shows the comparison of different boilers sizes. Serial No. 1 to 10 are data from supplier (https://www.sitong-boiler.com) and Serial No. 11 is that of the proposed design. It can be seen that the calculated ratios of coal consumption to steam capacity of 120 is fairly comparable to that of the proposed design of 138.

Table 6-4: Comparison of the Boiler Parameters

| S/N | Steam Capacity (MT/hr) | Coal Consumption(kg/hr) | Coal Consumption/ Steam Capacity | Dimension L*W*H（m） |
|---|---|---|---|---|
| 1 | 2 | 240 | 120 | 5.8×2.35×3.5 |
| 2 | 4 | 480 | 120 | 7.8×2.4×3.6 |
| 3 | 6 | 720 | 120 | 8×3×4.87 |
| 4 | 8 | 960 | 120 | 8.1×3.2×5.7 |
| 5 | 10 | 1,200 | 120 | 8.2×3.5×5.7 |
| 6 | 12 | 1,440 | 120 | 10.6×3.6×5.7 |
| 7 | 15 | 1,830 | 122 | 12.5×3.7×5.8 |
| 8 | 20 | 2,400 | 120 | 13.8×4.2×5.8 |
| 9 | 25 | 3,000 | 120 | 15.6×5×6.135 |
| 10 | 30 | 3,600 | 120 | 17.7×8.5×9.5 |
| 11 | 74 | 10,199 | 138 | - |

### 6.9. Flue gas composition

At 20% excess air supplied for complete coal combustion, the estimated flue gas amount and composition from the cogeneration power plant is as shown in **Error! Reference source not found.**.

Table 6-5: Flue gas composition

| Product | Mass [kg/h] | | | Contribution [%] |
|---|---|---|---|---|
| | Steam | Power | Total | |
| $CO_2$ | 30,585 | 32,660 | 63,244.33 | 21.69 |
| $SO_2$ | 378 | 404 | 781.38 | 0.27 |
| $O_2$ | 5,218 | 5,572 | 10,789.39 | 3.70 |
| $N_2$ | 104,808 | 111,918 | 216,726.00 | 74.34 |
| **Total** | **140,988** | **150,553** | **291,541.00** | **100.00** |

### 6.10. Cost estimate for a 15 MW co-generation power plant

The cost of cogeneration power plant and that of electricity distribution within the project boundaries are shown in **Error! Reference source not found.**.

Table 6-6: Cost estimate for a 15-MW co-generation (pulverized) coal power plant

| S/N | Item | Cost [USD] |
|---|---|---|
| 1 | Earthwork/Civil | 1,655,000 |
| 2 | Structural Steel | 1,158,000 |
| | **Sub-total 1** | **2,813,000** |
| 3 | Mechanical Equipment | |
| | 3.1 Boiler | 5,748,000 |
| | 3.2 Steam Turbine | 1,820,000 |
| | 3.3 Coal Handling | 1,473,000 |
| | 3.4 Ash Handling | 1,521,000 |
| | 3.5 Particulate Removal System | 968,000 |
| | 3.6 Wet Flue Gas Desulfurization (FGD) System | 4,259,000 |
| | 3.7 Selective Catalytic Reduction | 3,021,000 |
| | **Sub-total 2** | **18,810,000** |
| 4 | Electrical | 2,761,000 |
| 5 | Piping | 501,000 |
| 6 | BOP/General Facilities | 15,096,000 |
| | **Sub-total 3** | **18,358,000** |
| 7 | Indirect Costs | 2,533,000 |
| 8 | Engineering and Home Office Costs | 3,129,000 |
| 9 | Project Contingency | 7,532,000 |
| | **Sub-total 4** | **13,194,000** |
| | Total Plant Cost (Sub-total 1+ Sub-total 2+ Sub-total 3 + Sub-total 4) | 53,175,000 |
| | **CIF value** | **61,151,250** |
| | **Total Plant Cost, USD/kWnet** | **4,077** |

# CHAPTER SEVEN

# 7 MOBILE EQUIPMENT

## 7.1. Mobile equipment selection

Mobile equipment at Engaruka Soda Ash project will be used both in the construction and production stages. Construction stage of the project will involve major activities such as stripping of the overburden material, excavation of the embankment foundation, construction of the pond embankment, drilling of the production boreholes, installation of pumps and pipe lines. These major activities will need supporting operations such as material movement, power distribution, equipment maintenance, security etc.

The main operation during production stage will be pumping of brine to the process plant. Other auxiliary operations will be for the purpose of supporting this main operation. Auxiliary operations during production stage will include activities such as pond maintenance, drilling of exploration/production boreholes, soda ash plant and equipment servicing. In order to handle operations in both stages, a number of mobile equipment will be needed as shown in **Error! Reference source not found.**.

Table 7-1: Mobile equipment required during construction and production stage

| S/N | Equipment Type | Specifications | Fleet | Purpose | Stage |
|---|---|---|---|---|---|
| 1. | Bulldozer | Power angle - tiltdozer | 1 | Clearing the construction sites and spreading of earth material during embankment construction. | Construction |
| 2. | Excavator | 3 $m^3$ backhoe bucket excavator | 1 | Excavating the trenches. | Construction |
| 3. | Wheel Loader | 4.4 $m^3$ bucket capacity | 1 | Loading of construction earth material to trucks and during embankment construction. | Construction |
| 4. | Dump truck | 10 tonnes dump truck | 3 | Hauling earth material from different sources. | Construction |
| 5. | Water bowser | 20,000 litres tank capacity | 1 | Water supply and spreading of water for dust suppression and moisture control. | Construction/Production |
| 6. | Compactor (Sheep Foot Roller) | 314 compacted $m^3$/hr. | 1 | Compaction of embankment layers. | Construction |

| S/N | Equipment Type | Specifications | Fleet | Purpose | Stage |
|---|---|---|---|---|---|
| 7. | Drill Rig | Water wells drill rig- 406 mm bit diameter size | 1 | Drilling of production boreholes. | Construction/Production |
| 8. | Mobile crane | Mini Hydraulic 1.5 tonnes Mobile Folding Arm Truck Mounted Crane | 1 | Lifting of heavy loads. Towing trailer mounted equipment. | Construction/Production |
| 9. | Solar Power Lighting plant | 360,000 Lumens Lighting 360 Degree Rotation Compacted and Towable | 2 | Provide light during night operations. | Construction/Production |
| 10. | Fuel and Lube Truck | Diesel fuel capacity of 2000 litres. Oil and coolant product capacity of 500 litres. | 1 | Fuelling machines | Construction/Production |
| 11. | Light Vehicles | 4-wheel Land cruiser- single cabin | 4 | Support movement of supervisors and light tools. | Construction/Production |
| 12. | Mobile Slurry Pump | 3.5 tonnes per hour | 1 | Mud removal | Production |
| 13. | Forklift | 5 tonnes | 1 | Handling of Heavy Unit Loads | Production |

### 7.2. Mobile equipment capitals costs

The capital cost estimates for mobile equipment needed at Engaruka soda ash project comprise of equipment that will be used during production stage. It should be noted that some of equipment may be purchased at the construction stage of the project and will continue to be used during production stage. The mobile equipment that will not be used during production stage will be hired. The estimation of mobile equipment capital cost at CIF value of **USD 676,770**. Details are given in **Error! Reference source not found.**.

Table 7-2: Mobile equipment capital costs

| SN | | ITEM | UNIT | QNTY | RATE [USD] | AMOUNT [USD] | SUPPLIERS | SUPPLIER/MANUFACTURER CONTACTS |
|---|---|---|---|---|---|---|---|---|
| **1** | | **Mobile Equipment** | | | | | | |
| | 1.1 | 20 $m^3$ Water Bowser | Ls | 1 | 152,551 | 152,551 | MSEQ Equipment cc (South Africa) | Tel: +260 011 869 3223<br>Fax: +260 086 672 6804<br>Email: info@mseq.co.za<br>Web: www.mseq.co.za |
| | 1.2 | High lift 3-tonne telescopic boom Truck Mounted Mobile Crane | Ls | 1 | 22,500 | 22,500 | Jinan Sino Truck Sales Co., Ltd | Shandong, China;<br>Web: http://www.sino-truck.cn |
| | 1.3 | Fuel and Lube Truck (8000 L diesel tank & Eight 500 L lubricant tanks) | Ls | 1 | 230,884 | 230,884 | MSEQ Equipment cc (South Africa) | Tel: +260 011 869 3223<br>Fax: + 260 086 672 6804<br>Email: info@mseq.co.za<br>Web: www.mseq.co.za |
| | 1.4 | Forklift | Ls | 1 | 35,000 | 35,000 | Xiamen Interquip Machinery Co., Ltd (China) | Tel: 0592-7820328,<br>Email: overseas@interquip.cn |
| | 1.5 | Light Vehicles (4 WD Pick up) - Single Cabin | Ls | 4 | 31,990 | 127,960 | Milele Motors FZE (UAE) | Phone: +971 43235991,<br>Mobile: +971 50 4996459,<br>Email: info@milelemotors.com |
| | | **SUB TOTAL** | | | | **568,895** | | |
| | | | | | | | | |
| **2** | | **Auxiliary Equipment** | | | | | | |
| | 2.1 | Mobile Solar Power Lighting plant | Ls | 2 | 9,800 | 19,600 | Zhejiang Valiant Power Technology Co., Ltd (China) | Tel: +86 15157059840<br>Email: info@valiantchina.com |
| | 2.3 | Mobile Self-priming slurry pump | Ls | 1 | | | Eddy Pump Corporation (USA) | Tel: +1 619-258-7020<br>Email: Info@eddypump.com<br>Address: 15405 Olde Hwy 80, El Cajon, California 92021, USA |
| | | TOTAL (FOB Price) | | | | 588,495 | | |
| | | **TOTAL (CIF Price)** | | | | **676,770** | | |

# CHAPTER EIGHT

## 8 SAFETY AND ENVIRONMENTAL CONCERNS

### 8.1. Introduction

The criteria for compliance used in the design of the plant are those provided in the World Bank Pollution Prevention and Abatement guidelines, Tanzania Government (NEMC) guidelines and other standards wherever applicable. Evaluation of the burden of the process on the environment has been done with the help of a design software through the Environmental Impact Report (EIR) or a related report and material balances reports.

### 8.2. Emissions and effluents

The project design is based on modern technologies of material handling, process control, solids separation and combustion techniques to minimise the impact on the existing air quality. Also, the water usage and water quality as important issues that affect the local environment have been considered in the design. The management of solid waste generated have been considered as well in the design process.

Coal fired power plant can be one of the sources of air pollution through combustion. The design of powerhouse is equipped with equipment and / or gadgets to control gaseous and particulate emissions to the atmosphere as indicated in Chapter Six of this report.

Coal is handled properly in coal storage area of plant. Dry soda ash is handled in product handling area of the plant by sub-processes of screening, belt conveyors, bucket elevators, screw conveyors, silos and product packaging machines. The material handling equipment is equipped with positive ventilation in accordance with procedures and guidelines established by the American Conference of Governmental Industrial Hygienists. Generally, the plant will use good housekeeping practices to minimise any harmful particulate emissions.

The influence of water use and liquid discharges that would have on local water quality have been considered by the design process. Most of the wastewater from the plant is the crystals wash solution and the bittern (exhausted brine solution). The two streams are dilute solutions of soda ash and other useful salts. It is, therefore, planned to pump them, as is, back to Lake Engaruka to enhance recharging of the boreholes. This arrangement will not have any environmental impact. Other liquid waste from the plant, mainly sewage water, will be combined with wastewater from the township and disposed.

### 8.3. Material safety data sheets (MSDS)

Safety on chemical storage and handling is provided by Material safety data sheets (in Appendix 6). Material safety data sheet is a document that contains information on the potential hazards (health, fire, reactivity and environmental) and how to work safely with the chemical product. It is an essential starting point for the development of a complete health and safety program.

## 8.4. Hazards and operability studies (HAZOP)

In any type of industry, such as petroleum refining, petrochemicals or fertilizer production, specialty chemical manufacturing, or pesticide production, the handling, processing, storing and transferring of huge quantities of materials are inevitable. Some of the products are vulnerable to fires, explosions or toxic release, thus leading to various types of accidents. The consequences of an accident could be catastrophic, which affects capital investment, personnel safety, equipment and the environment.

Industrial accidents can be avoided by proper assessment and management of risk. The process of risk assessment involves not only leadership, but also those who are involved in planning, design, operations, maintenance and safety. It includes managers, engineers, supervisors, operators and laborers. Typically, risk reduction involves the selection and design of proper equipment and machinery for the product in question. It involves selecting suitable piping, instrumentation and controls, electrical aspects, risk assessments and evaluations, safety audits, onsite and offsite disaster management plans, and safety-related training throughout the lifecycle of the plant.

Risk management involves process hazard analysis (PHA) as the first step to commence the process of hazard identification. Many methods exist for conducting PHA, such as:

- What-if checklist,
- Fault tree analysis (FTA),
- Failure mode and effect analysis (FMEA),
- Cause–consequence analysis,
- Event tree analysis (ETA), and
- Hazard and operability analysis (HAZOP).

Of the above, a HAZOP study is a powerful technique for the identification of hazards. It requires that a systematic and comprehensive procedure be followed throughout the study, and it utilizes team efforts of experienced persons in the areas of design, operations, maintenance and safety.

HAZOP is performed by a properly selected, experienced and interdisciplinary team. In order to cover all the potential problems, the Team apply the guide words to process parameters at different locations, called nodes (Baybutt, 2015).

### 8.4.1. Method for carrying out HAZOP

The method is applied to complex 'processes' for which sufficient design information is available, and not likely to change significantly. This range of data should be explicitly identified and taken as the ‘design intent’ basis for the HAZOP study.

For processes plant, the nodes are chosen so that for each a meaningful *design intent* can be specified and they are commonly indicated on piping and instrumentation diagram (P&IDs) and process flow diagram (PFD).

The extent of each node should be appropriate to the complexity of the system and the magnitude of the hazards it might pose. However, it will also need to balance between "too large and complex" (fewer nodes, but the team members may not be able to consider issues within the whole node at once) and "too small and simple" (many trivial and repetitive nodes, each of which has to be reviewed independently and documented).

For each node in turn the HAZOP team uses a list of standardised guide-words and process parameters to identify potential *Deviations* from the design intent. For each deviation, the team identifies feasible *Causes* and likely *Consequences* then decides (with confirmation by subsequent risk analysis where necessary) whether the existing safeguards are sufficient, or whether an *Action* to install an additional safeguard is necessary to reduce the risks to an acceptable level.

### 8.4.2. Guide words and parameters

In order to identify deviations, the team applies (systematically, in order) a set of Guide Words to each node in the process. To prompt discussion, or to ensure completeness, it may also be helpful to explicitly consider appropriate parameters which apply to the design intent. These are general words such as Flow, Temperature, Pressure, Composition. It should be noted, however, Guide Words should be appropriate to the study and neither too specific (limiting ideas and discussion) nor too general (allowing loss of focus). **Error! Reference source not found.** gives an overview of commonly used guide word - parameter pairs and common interpretations of them.

Table 8-1: Standard set of guide words (Sinnott, 2005)

| Guide Word | Meaning | Comment |
|---|---|---|
| NO or NOT | The complete negation of these intentions | No part of the intention is achieved but nothing else happens |
| MORE | Quantitative increases or decreases | These refer to quantities and properties such as flow rates and temperatures, as well as activities like “Heat” and “React” |
| LESS | | |
| AS WELL AS | A qualitative increase | All the design and operating intentions are achieved together with some additional activity |
| PART OF | A qualitative decrease | Only some of the intentions are achieved; some are not |
| REVERSE | The logical opposite of the intention | This is mostly applicable to activities, for example reverse flow or chemical reaction. It can also be applied to substances, e.g. “Poison” instead of “Antidote” or “D” instead of “L” optical isomers |
| OTHER THAN | Complete substitution | No part of the original intention is achieved. Something quite different happens |

Once the causes and effects of any potential hazards have been established, the system being studied can then be modified to improve its safety. The modified design should then be subject to another HAZOP, to ensure that no new problems have been added (Srinivasan & Venkatasubramanian, 1998). Generally, the HAZOP is the most commonly used risk analysis and hazard study in industry (Tyler, 2012); (Fuentes-Bargues, et al., 2016).

Hence, the HAZOP report results generally involves deviations, causes, possible consequences, existing safeguards and corresponding recommendations (Jang & Guo, 2016). Tables in Appendix 7 shows the application of HAZOP for a steam boiler. As a limiting factor, two steps of the boiler operation: water flow and pressure respectively were analysed. Both processes have a major impact on boiler operation in this case by Marcos Lucas de Oliveira (2018). As samples, HAZOP analysis is applied to calciner reactor as shown in **Error! Reference source not found.** and to reactors as shown in **Error! Reference source not found.** and **Error! Reference source not found.**.

Table 8-2: HAZOP analysis of calcination reactor

| **Property** | **Guide Word** | **Causes** | **Consequences** | **Recommended Actions** |
|---|---|---|---|---|
| Temperature | More | Poor Material Selection | Reactor Melting | Choose Different Material |
| | Less | Poor Temperature Control | Poor or no Reaction Occurs | Temperature Control to Adjust Feed |
| Composition | Other Than | Wrong Reagent | Possible Reaction | Sample Feed before Inserting |
| | As Well As | Impurity in Reagent | Possible Problem in Reactor | Check the Reactant Composition |

Table 8-3: HAZOP analysis on reactor

| **Guide Word** | **Deviation** | **Causes** | **Consequences** | **Action** |
|---|---|---|---|---|
| NO | No cooling | Cooling water valve malfunction | Temperature increase in reactor | Install high temperature alarm (TAH) |
| REVERSE | Reverse cooling flow | Failure of water source resulting in backward flow | Less cooling, possible runaway reaction | Install check valve |
| MORE | More cooling flow | Control valve failure, operator fails to take action on alarm | Too much cooling, reactor cool | Instruct operators on procedures |
| AS WELL | Reactor | More pressure in | Off-space | Check maintenance |

| Guide Word | Deviation | Causes | Consequences | Action |
|---|---|---|---|---|
| AS | product in coils | reactor | product | procedures and schedules |
| OTHER THAN | Another material besides cooling water | Water source contaminated | May be cooling ineffective and effect on the reaction | If less cooling, TAH will detect. If detected, Isolate water source. Back up water source? |

Table 8-4: HAZOP analysis on a reactor

| Guide word | Deviation | Causes | Consequences | Actions |
|---|---|---|---|---|
| NOT | Not flow flowing into the compressor | Control valve closed | Causing increased pressure in the compressor | Equip with pressure relief valve in the compressor |
| MORE | More pressure in the reactor | Compressor control failure | Tank or reactor will operate at very high pressure | Trigger automatic emergency shut down |
| LESS | Less residence time for the reaction | Valve opening malfunction | Inconsistent initial concentration<br>Less than optimum yield | Periodic maintenance or check up on the valves |
| AS WELL AS | Too high temperature in the reactor (as well as) | Hot stream valve entering reactor failed | Damage the equipment in the reactor as well as valve, pump, sensor and transmitter<br>Product yield not at the optimum quality | Equip the reactor system with fail-open or fail-close valve system |

## CHAPTER NINE

# 9 PLANT LAYOUT

## 9.1. Objectives of Good Plant Layout

Good plant layout comprises of best possible arrangement of the buildings, people, machine and materials for processing a certain product or service. The main objectives of a good plant layout involve minimum material movement, smooth flow of the product in the plant, full utilization of the space of the plant, provision of adequate safety and satisfaction to the plant workers. In addition, it offers sufficient flexibility in the arrangement of the above factors so as to suit the minor future changes, if any and facilitates an effective supervision. Layout helps to integrate all the above factors in such a way that the best compromise and coordination among them is achieved. Furthermore, plant layout aims at minimizing the movements of workers and manufacturing staffs within the plant. It also minimizes waiting time of the semi-finished and finished products.

A good plant layout ensures the work methods and reduced production cycle times is improved and the plant maintenance is much simpler. As such there is increased productivity and better product quality with reduced capital cost. It also facilitates materials to move through the plant at the desired speed with the minimum possible cost.

The material handling technique to be used definitely effects the plant layout and the factory building. A sound low-cost method can be designed and installed only if material handling is considered an integral part of plant layout. The term Plant layout is mainly used to represent the physical arrangement of a plant and different parts of a plant. This includes, but not limited to:

i) Arrangement of machines, equipment and other industrial facilities like receiving and shipping departments,
ii) Stores for raw materials and finished products, including tank farms and warehouses,
iii) Maintenance rooms/workshops,
iv) Fire station and other emergency services,
v) Utilities (steam boilers, compressed air, power generation, refrigeration, transformer stations),
vi) Effluent disposal plant,
vii) Office for general administration,
viii) Canteen and other amenity buildings such as medical centres,
ix) Car parks, and
x) Laboratories for quality control.

According to (Knowles & Thomson, 1944) plant layout deals with:

- Planning and arranging manufacturing machinery, equipment and services for the first time in completely new plants.

- The improvements in layouts already in use in order to introduce new methods and improvements in manufacturing procedure.

Plant layout can be based on

i) Minimum Travel: Operations manager must design layout in such a way that the distance between operations is minimum which in turn helps in avoiding the labour and time wastages there by reducing the cost of material handling.

ii) Sequence: The machines and operations must be arranged sequentially. This principle is effectively attained in product/ line layout.

iii) Usage: The available space needs to be optimally utilized. This principle has wide acceptance in towns and cities where a piece of land is very much expensive.

iv) Compactness: All the significant factors need to be fully integrated and related, producing a well-integrated and final layout.

v) Safety and Satisfaction: The layout must have provisions for safety of workers. It must be planned, based on the comfort and convenience of the workers for making them feel satisfied.

vi) Flexibility: The layout must allow improvements with less difficulty and at minimum cost.

vii) Minimum Investment: The ideal layout must provide savings in fixed capital investment not by ignoring the installation of required facilities but by efficiently and optimally using the available facilities (economies of scale).

When preparing the preliminary site layout, the process units are normally sited first and arranged to give a smooth flow of materials through the various processing steps, from raw material to final product storage. Process units are normally spaced at least 30m apart, greater spacing may be needed for hazardous processes.

The location of the principal ancillary buildings is then arranged to minimize the time spent by personnel in travelling between buildings. Administration offices and laboratories, in which relatively large number of people will be working are normally located far away from potentially hazardous processes. Control rooms will normally be located adjacent to the processing units, if they are not potentially hazardous.

Utility buildings are sited to give the most economical run of pipes to and from the process units. Cooling towers, if used are normally sited so that under the prevailing wind the plume of the condensate spray drifts away from the plant area and adjacent to properties.

The main storage areas are normally placed between the loading and unloading facilities and the process units they serve. Storage tanks containing hazardous materials should be sited at least 70 m from the site boundary. Access road will be needed to each building for construction and operation.

Open structural steel work buildings are normally used for process equipment, whereas closed buildings are only used for process operations that require protection from the weather. The arrangement of the major items of equipment usually follow the sequence given on the process flowsheet with the columns and vessels arranged in rows and the ancillary equipment such as heat exchangers and pumps positioned along the outside.

## 9.2. Types of Layouts

Plant layouts are classified into four major categories namely fixed or position layout, line or product layout, process or functional layout and combination or group layout. Each kind of layouts has its merit, demerits and best suited application.

### 9.2.1. Fixed or position layout

Fixed or position layout is also known as project layout. The fixed layout is as shown in **Error! Reference source not found.**. In this type of layout, the major part of an assembly or material remains at a fixed position. All its accessories, auxiliary material, machinery, equipment needed, tools required and the labour are brought to the fixed site to work. Thus, the product by virtue of its bulk or weight remains at one location. Therefore, the location of the major assembly, semi assembly component and material are not disturbed until the product is ready for dispatch. This layout is suitable when one or a few pieces of an item are to be manufactured and material forming or treating operation requires only tools or simple machines. This layout is highly preferable when the cost of moving the major piece of material is high and the responsibility of product quality by one skilled workman or group of skilled workers is expected. This type of layout is mainly adopted for extremely large items manufactured in very small quantity such as ships, airplanes, boilers, reactors, etc. Thus, the soda ash plant does not fall under this category of layout.

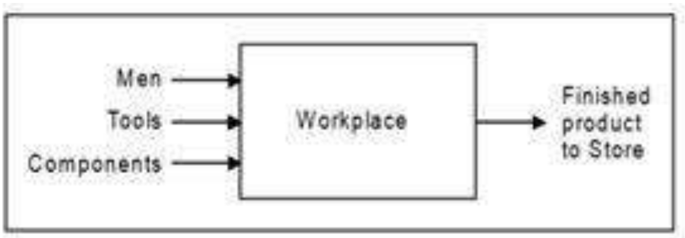


Figure 9-1: Project layout

The main merits of this layout are:

i) highly flexible for varieties of products having intermittent demand as the type of product and the related processes can be easily altered without any change in the layout.
ii) Minimum movement of personnel, material, and tooling during manufacturing process.
iii) The material is drastically reduced.
iv) Highly skilled operators are required to complete the work at one point and responsibility for quality is fixed on one person or the assembly crew.
v) Every personnel of manufacturing team are responsible for quality work for manufacturing the product.

The major demerits of this layout are:

i) The cost of equipment handling is very high.
ii) Labours and equipment are difficult to utilize fully.
iii) It is limited to large items only.

### 9.2.2. Process or functional layout

A process or functional layout is as shown in **Error! Reference source not found.**. In this type of layout arrangements of similar machines, production facilities and manufacturing operations are grouped together according to their functions. Machine tools of one kind are positioned together so that all the similar operations are performed always at the same place e.g., all the lathes may be grouped together for all kinds of turning and threading operations. This type of layout is normally preferred for the industries involved in job order type of production and manufacturing and/or maintenance activities of non- repetitive type. This layout needs not to have to be changed every time of the product or component changes. Also, the breakdown of any machine does not affect the production. This type of layout is highly suitable for batch production.  Thus, some of the operations in soda ash plant might fall under this type of layout.

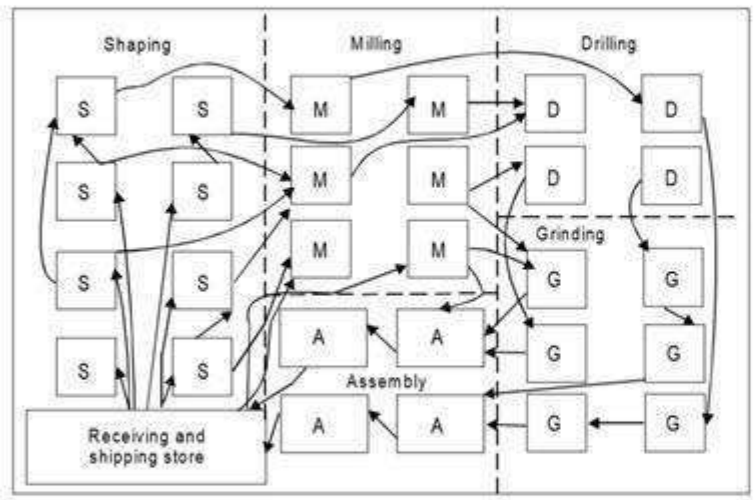


Figure 9-2: Functional layout

The major merits of this layout are:

i) There exists a wide flexibility regarding allotment of work to equipment and workers.
ii) There is a better utilization of the available equipment.
iii) Comparatively less numbers of machines are needed in this layout and hence thus reducing capital investment.
iv) There is an improved product quality, because the supervisors and workers attend to one type of machines and operations.
v) Varieties of jobs coming as different job orders thus make the work more interesting for the workers.

vi) Workers in one section are not affected by the nature of the operations carried out in another section. For example, a lathe operator is not affected by the rays of the welding as the two sections are quite separate.

The major demerits of this layout are:

i) This layout requires more space in comparison to line or product layout for the same amount of production.
ii) Production control becomes relatively difficult in this layout.
iii) Raw material has to travel more which increases material handling and the associated costs.
iv) This layout requires more efficient co-ordination and inspections.
v) Increased material handling cost due to more movement of process raw material to various paths
vi) More material in process remains in queue for further operations.
vii) Requires large in-process inventory.
viii) Completion of same product takes more time.

### 9.2.3. Line or product layout

A line or product layout is as shown in **Error! Reference source not found.**. This layout implies that various operations on raw material are performed in a sequence and the machines are placed along the product flow line, i.e., machines are arranged in the sequence in which the raw material will be operated upon. In this layout raw material starts from one end of production lines and moves from one machine to next along a sequential path.

The layout uses standardized processing operations to achieve smooth, fast, high-volume flow. It is most ideal for production of highly standardized goods or services that allow highly standardized, repetitive processing. In this arrangement the work is divided into a series of standardized tasks, permitting specialization of equipment and division of labour. The large volumes handled by these systems usually make it economical to invest substantial sums of money in equipment and in job design. Most of the operations in the soda ash plant requires this type of layout.

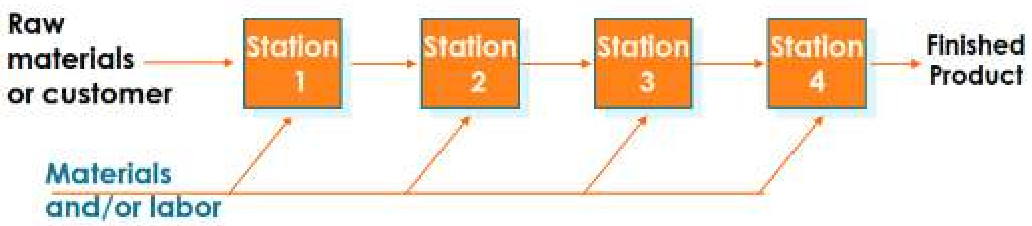


Fig. 9.1: Line layout

Its main merits are

i) It involves smooth and continuous work flow.
ii) It may require less skilled workers
iii) It helps in reducing inventory.

iv) Production time is reduced in this layout.
v) Better coordination, simple production planning and control are achieved in this layout.
vi) For the same amount of production, less space requirements for this layout.
vii) Overall processing time of product is very less.
viii) This layout involves automatic material handling, lesser material movements and hence leads to minimum possible cost of manufacturing.

The major demerits of this layout as compared with process layout are:

i) It is very difficult to increase production beyond the capacities of the production lines.
ii) When single inspector has to look after many machines, inspection becomes difficult
iii) This layout is very less flexible for product change.
iv) The rate or pace rate of working depends upon the output rate of the slowest machine and hence leading to excessive idle time for other machines if the production line is not adequately balanced.
v) Machines being put up along the line, more machines of each type have to be installed for keeping a few as stand by, because if on machine in the line fails, it may lead to shut down of the complete production line. That is why the line or product layout involves heavy capital investments.

### 9.2.4. Combination layout:

**Error! Reference source not found.** shows a typical combination type of layout. It is also known as group layout. A combination of process and product layouts combines the advantages of both types of layouts. Most of the manufacturing sections are arranged in process layout with manufacturing lines occurring here and there scattered wherever the conditions permit. These days, most of manufacturing industries have adopted this kind of layout. In this type of layout, a set of machinery or equipment is grouped together in a section, and so on, so that each set or group of machines or equipment is used to perform similar operations to produce a family of components. A combination layout is possible where an item is being made in different types and sizes. In such cases, machinery and manufacturing equipment are arranged in a process layout but a group of number of similar machines is then arranged in a sequence to manufacture various types and sizes of products. In this layout, it is noted that, no matter the product varies in size and type, the sequence of operations remains same or similar. This layout is suitable when similar activities are performed together thereby avoiding wasteful time in changing from one unrelated activity to the next. It focuses on avoiding unnecessary duplication of an effort. The soda ash production process will essentially be having a combination of layouts.

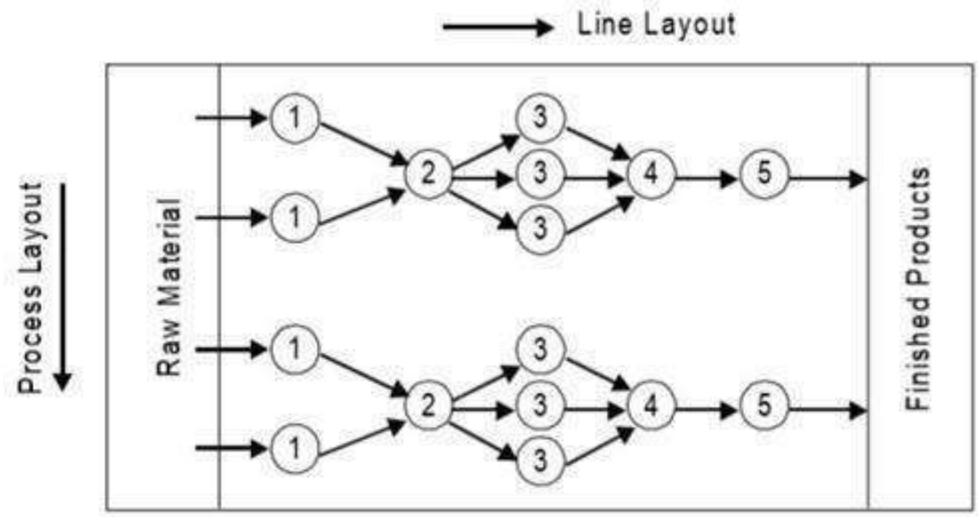

Figure 9-3: Typical combined layout

The merits of this type of layout are:

i) Reduction in cost of machine set-up time and material handling of metal works in a workshop-like setup.
ii) Elimination of excess work-in-process inventory which subsequently allows the reduction in lot size.
iii) Simplification of production planning functions, etc.

The major demerits of this layout are:

i) Change of the existing layout is time consuming and costly.
ii) Inclusion of new components in the existing component requires thorough analysis.
iii) Change of input component mix may likely to change complete layout structure.
iv) Change of batch size may change number of machines.

The production process is sequential, though at some point some processes run in parallel hence combined layout model is most ideal. **Error! Reference source not found.** shows the proposed factory machinery and equipment layout which occupies a minimum of 1.3 acres, while **Error! Reference source not found.** shows the proposed industrial site layout, occupying a minimum of 9 acres. In order to cater for future expansion of the plant, the factory area should be doubled.

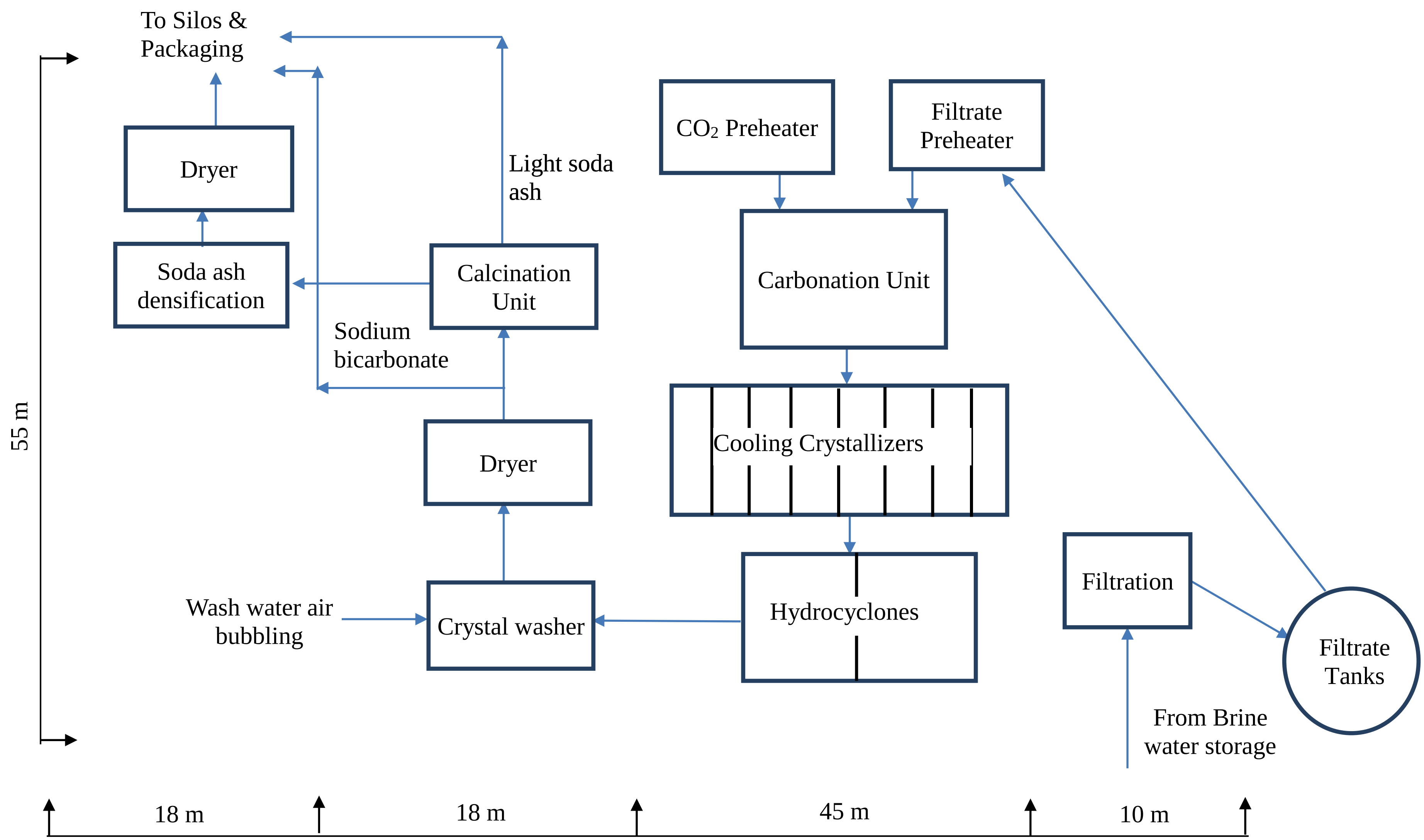


Figure 9-4: Machinery and equipment layout

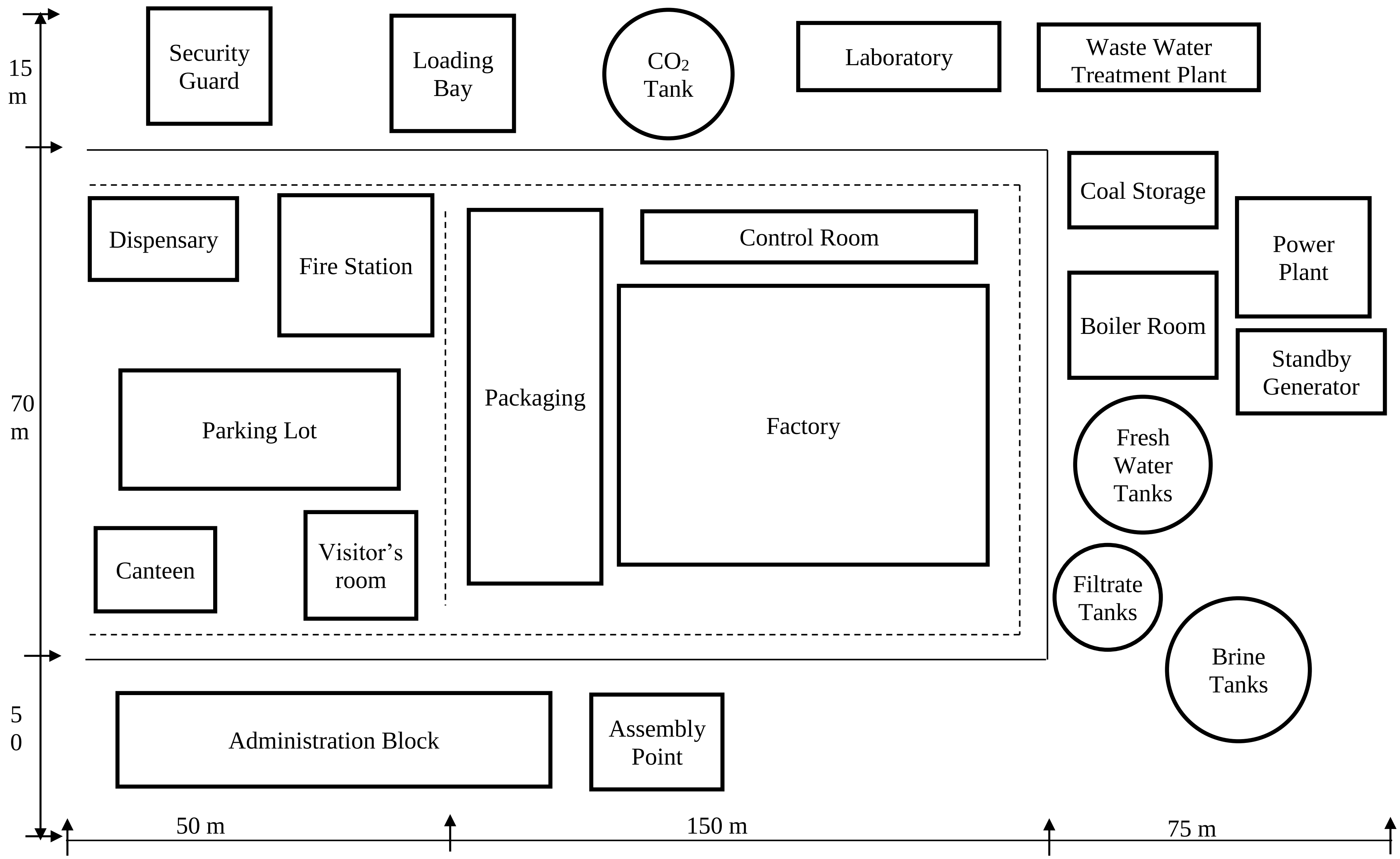


Figure 9-5: Industry site layout

## CHAPTER TEN
## 10 CONCLUSIONS AND RECOMMENDATIONS

### 10.1. Conclusions

#### 10.1.1 Plant design and operating capacity

This Volume covered plant and machinery, electrical power distribution, brine pumping and storage, power generation system, and steam plant for production of 500,000 tonnes of soda ash per year. The plant is designed and costed for a maximum capacity of 550,000 tonnes (10% above operating capacity), for safe operation. The plant has been designed to produce three products in the proportions in brackets, namely sodium bicarbonate (10%), light soda ash (20%) and dense soda ash (70%). The project will be generating 15 MW of electricity using a coal fired boiler.

#### 10.1.2 Product quality

The purity of the sodium bicarbonate produced is 99.6%, while light soda ash has a purity of 99.6% and the dense soda ash has a purity of 99.4%. All the products meet minimum international market purity of 99.2%.

#### 10.1.3 Soda ash processing facilities

Specifications for all the major equipment and machinery required for the soda ash plant have been given. This Volume also gives a list of some potential equipment suppliers as well as complete soda ash plant vendors. The major pieces of equipment and machinery are estimated to cost USD 49,517,850 and the total direct fixed cost (including piping, insulation, installation, etc.) for these equipment and machinery is estimated at USD 197,714,871. Direct material operating costs are estimated at USD 13,189,677 per year while utilities will cost about USD 25,324,386 per year.

#### 10.1.4 Electrical power distribution

The electrical power distribution part provides specifications for items required for ensuring availability of electricity in the plant. It covers transformers, cables and similar items which will be necessary for tapping electricity from the existing 33 kV Manyara-Loliondo grid line and distributing in the project area. The total cost for the requirements is estimated at USD 950,604. In addition, a standby generator is estimated to cost USD 201,250. Furthermore, a list of potential suppliers of such items is provided. Furthermore, consideration was also made for a dedicated 33 kV line from Manyara to the plant, in case the existing Manyara-Loliondo line is overloaded due to other economic activities. This line brings an extra cost of USD 40,369,093.

#### 10.1.5 Brine pumping and storage

The pumping and storage part proposes that the number of production boreholes to meet plant demand will depend on further exploration and pumping test results. The pumped brine from the production boreholes will be collected at the collection tanks where centrifugal pump will be used to pump the brine into storage ponds. The storage will have a capacity for holding brine solution enough to supply the plant for about 30 days. Specifications for the required submersible pumps and potential suppliers are given. Design for the collection tanks and storage ponds have been given. The purpose of the ponds is to allow borehole water to settle so that mud can settle and be scrapped off later as the layer increases. Clear water from the ponds is then pumped to the plant. The total cost for the pumping from the boreholes to holding tanks in the plant is estimated at USD. 6,188,071.

#### 10.1.6 Steam plant and power supply system

The Steam plant and power generation have been handled together since they depend on each other. Specifications for coal quality, coal storage, boiler, turbine and other major items for steam and power generation are provided. This component of the project is estimated to cost USD 61,151,250.

#### 10.1.7 Mobile equipment

Construction and operation of the project requires some mobile equipment. These have been specified and their potential sources listed in the appropriate section of this Volume. The cost of mobile equipment has been estimated at USD 676,770.

The combined cost of the items covered under this Volume as highlighted above is USD 305,435,331 or 345,804,424 if a dedicated 33 kV line will be built.

#### 10.1.8 Hazard and operability study

In addition to the major items of ToR, the report provides a sketchy information on safety and environment issues including material safety datasheet and Hazard and Operability analysis.

#### 10.1.9 Plant layout

This is followed by a proposal on the equipment layout in the factory which covers at least 1.3 acres and the layout of the whole industrial area which covers about 9 acres. The factory area should be doubles in order to cater for future expansion.

### 10.2. Recommendations

The following need to be done before or during implementation of the engineering design.

i) Geotechnical study of the surface and subsurface in the areas where the plant and other auxiliary infrastructures will be constructed should be conducted. The study should aim at determining all parameters which will facilitate design of foundation of the infrastructures.

ii) Seismic study should be conducted before commencement of construction activities. This study is important for the designing of piping routes and foundation of the infrastructures.

iii) Geotechnical modelling should be conducted to determine the impact of brine extraction from the aquifer to potential ground subsidence. This will incorporate hydrological assessment to factor the impact of water in ground stability response. All this has to be done prior to commencement of brine pumping. Also, during pumping of brine from aquifers, ground monitoring should be done as it has direct impact on the stability of the embankment of the storage ponds and other infrastructures.

iv) More equipment and turnkey project suppliers should be solicited because it was difficult to get an exhaustive list due to Covid-19 effect.

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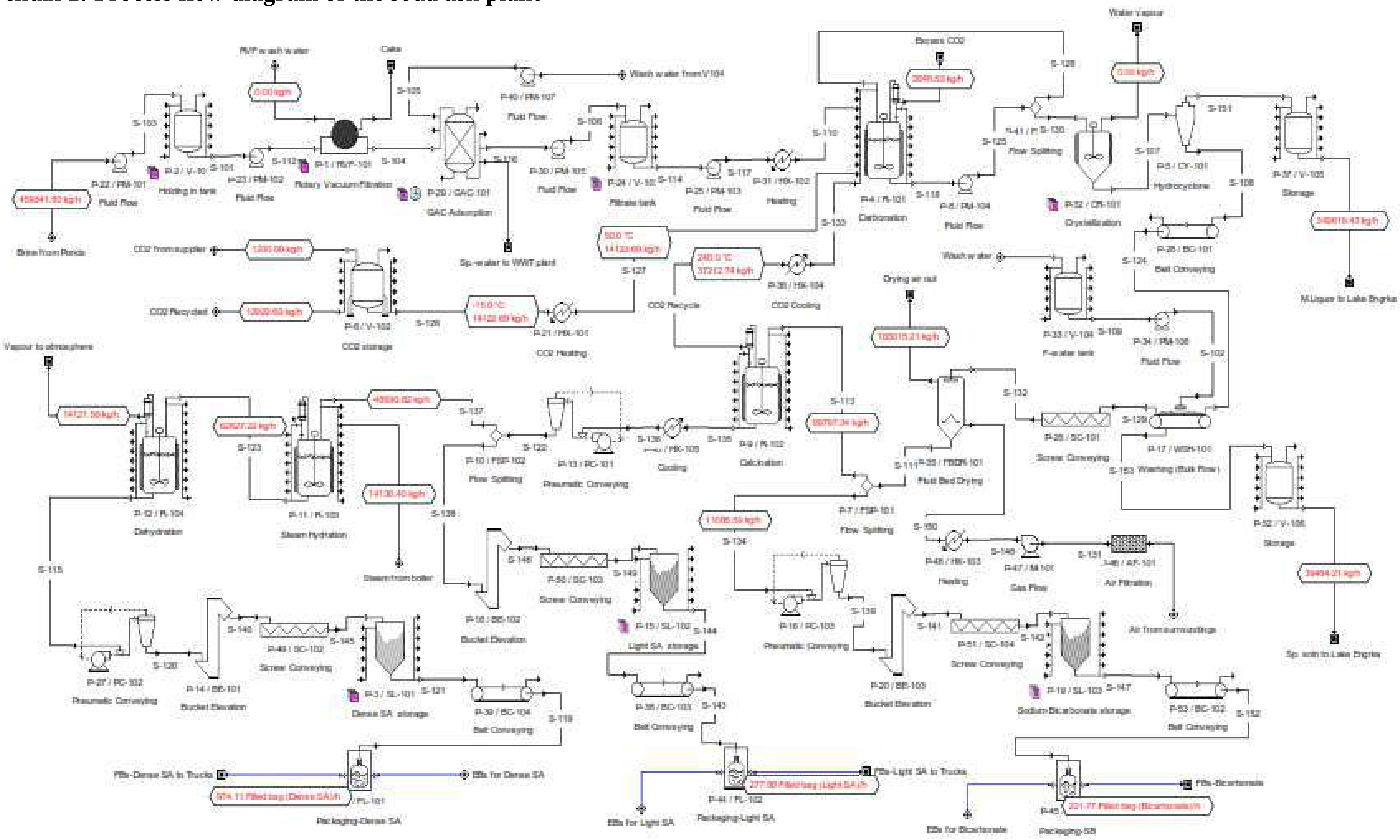
# APPENDICES

## Appendix 1: Process flow diagram of the soda ash plant



**Appendix 2: Characteristics curves of the Centrifugal pump at the collection tanks**

SUBMERSIBLE MOTOR PUMPS
QUOTATION

| | | | |
|---|---|---|---|
| Pos.No. | 1 | QUOTATION NO. | Tanzania |
| Identif. | | | |

| | | |
|---|---|---|
| UNIT: | Pump | UPA S 200-75/10 |
| | Motor | UMA 200D 65/22 |

OPERATING DATA

Medium handled : Well water in "lime-carbonic acid balance" and sand content < 250 g/m³
Installation : vertical
Temperature : 34 °C

| | |
|---|---|
| Nom. Capacity Q | 60,0 m³/h |
| Head (without non return valve) at nom. Capacity | 240,4 m |
| Nom. Head H (after non return valve) at nom. Capacity | 240,0 m |
| Power consumption at pump shaft at nom capacity | 48,3 kW |
| Efficiency pump at nom. Capacity (without non return valve) | 81,4 % |

MOTOR DATA

| | | | |
|---|---|---|---|
| Type of current | AC 3-phase | Starting | direct (parallel cable) |
| Operating voltage t | 400 V | Nom. power rating | 62,0 kW |
| Frequency | 50 Hz | Nom. Current approx. | 124,0 A |
| Motor efficiency | 86,8 % | Nominal speed | 2918 1/min |
| cos. phi | 0,835 | | |

short cable 1xFL 4x10 mm² + 1xFL 3x10 mm²,parallel

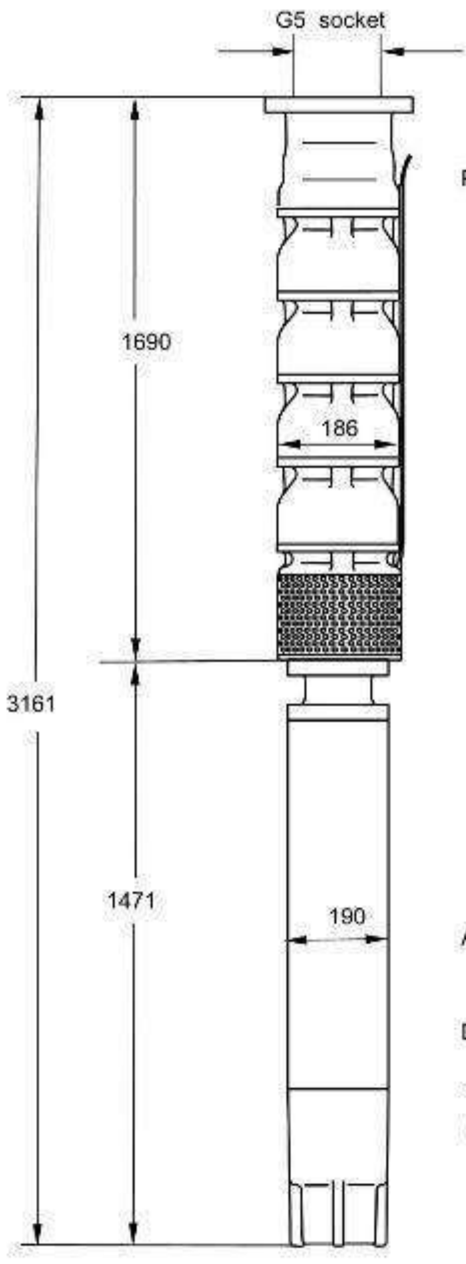
| MATERIALS | C2 / C2 |
|---|---|
| Pump casing | CrNiMo-steel (1.4408) |
| Impeller | CrNiMo-steel (1.4408) |
| Pump shaft | CrNiMo-steel (1.4462) |
| Suction casing | CrNiMo-steel (1.4408) |
| non-return valve | CrNiMo-steel (1.4408) |
| Cast parts motor | CrNiMo-steel (1.4408) |
| Stator jacket | CrNiMo-steel (1.4571) |

DIMENSIONS

| | |
|---|---|
| Length including non-return valve G5 socket | 3161 mm |
| max. outer diameter | 206 mm |
| Total weight net, each unit (pump, motor, cable) | ca. 366 kg |

Model with silicon bearings and metal casing wear rings (wear-resistant design)

page:




Pump with non return valve

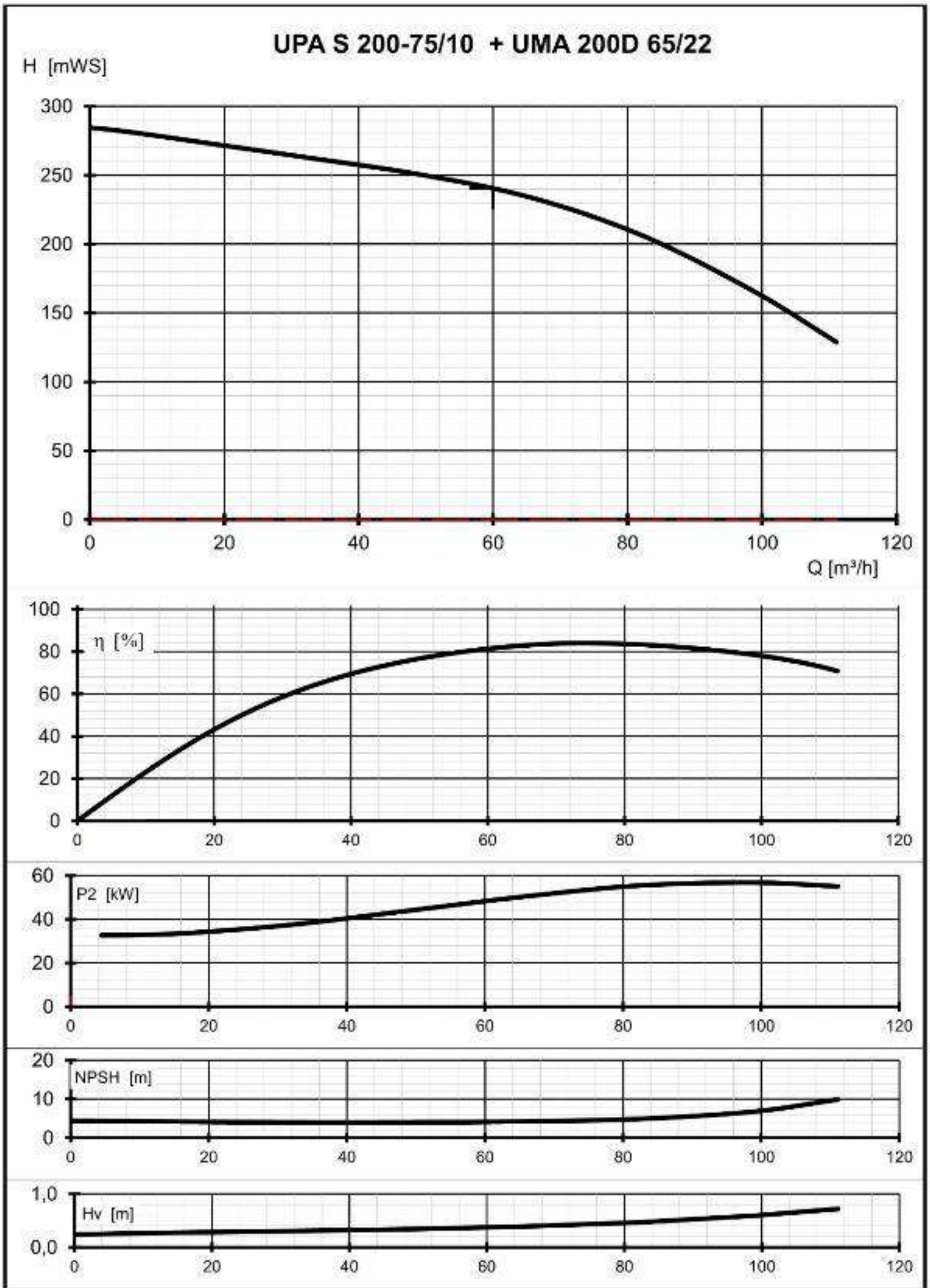
All dimensions in mm

Dmax = 206 mm

Total weight net = ca. 366 kg
(pump, motor, cable)

| | | | | | | |
|---|---|---|---|---|---|---|
| KSB | Type of pump | UPA S 200-75 | Project no. | Tanzania | Dept. | AECS1S513 |
| | Nos of stages | 10 | | | Name | Ledig |
| | type of motor | UMA 200D 65/22 | | | | |
| | | | | | date | 26.06.2020 |

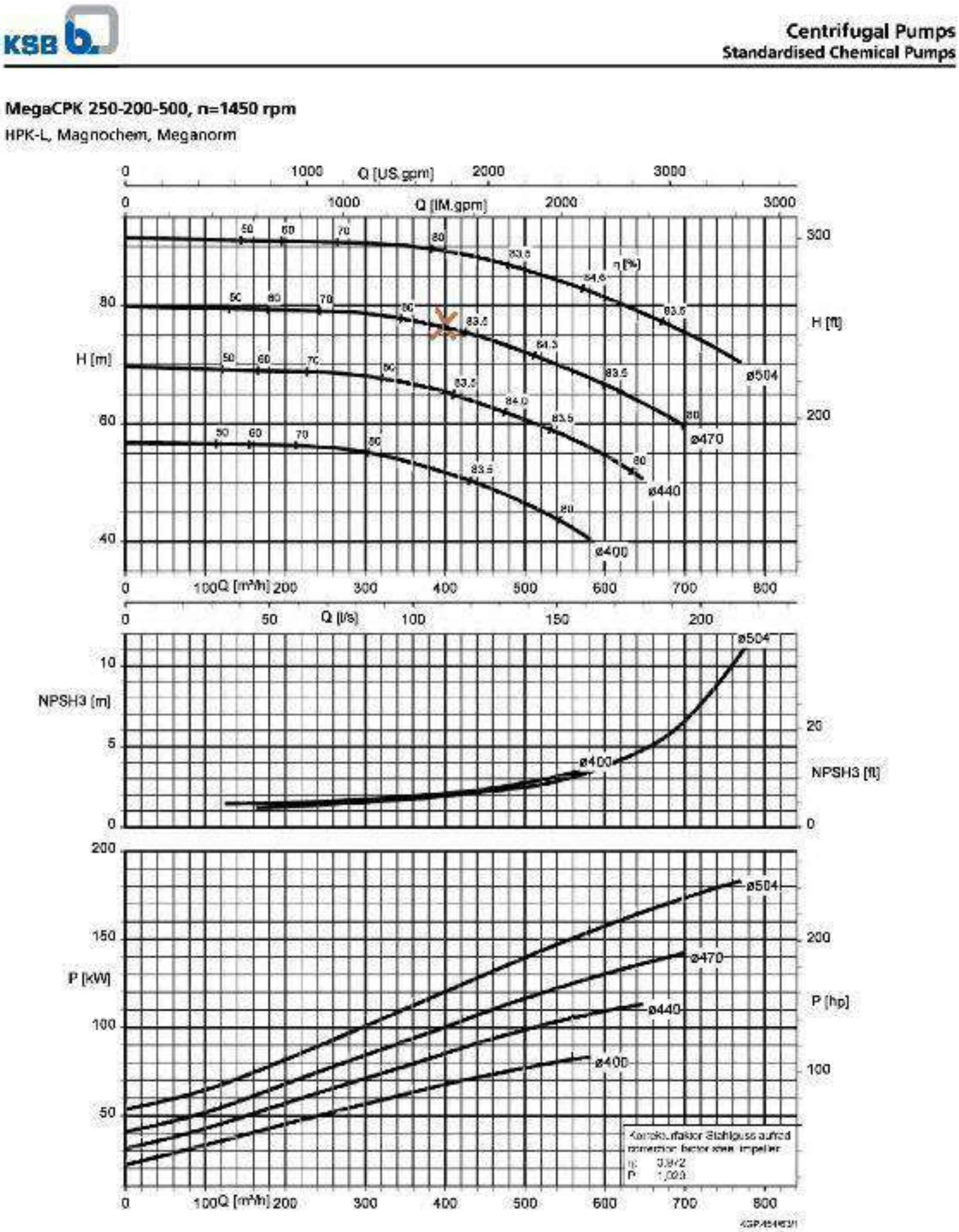
AECS1S513 / Bolct / Version 20-a-29



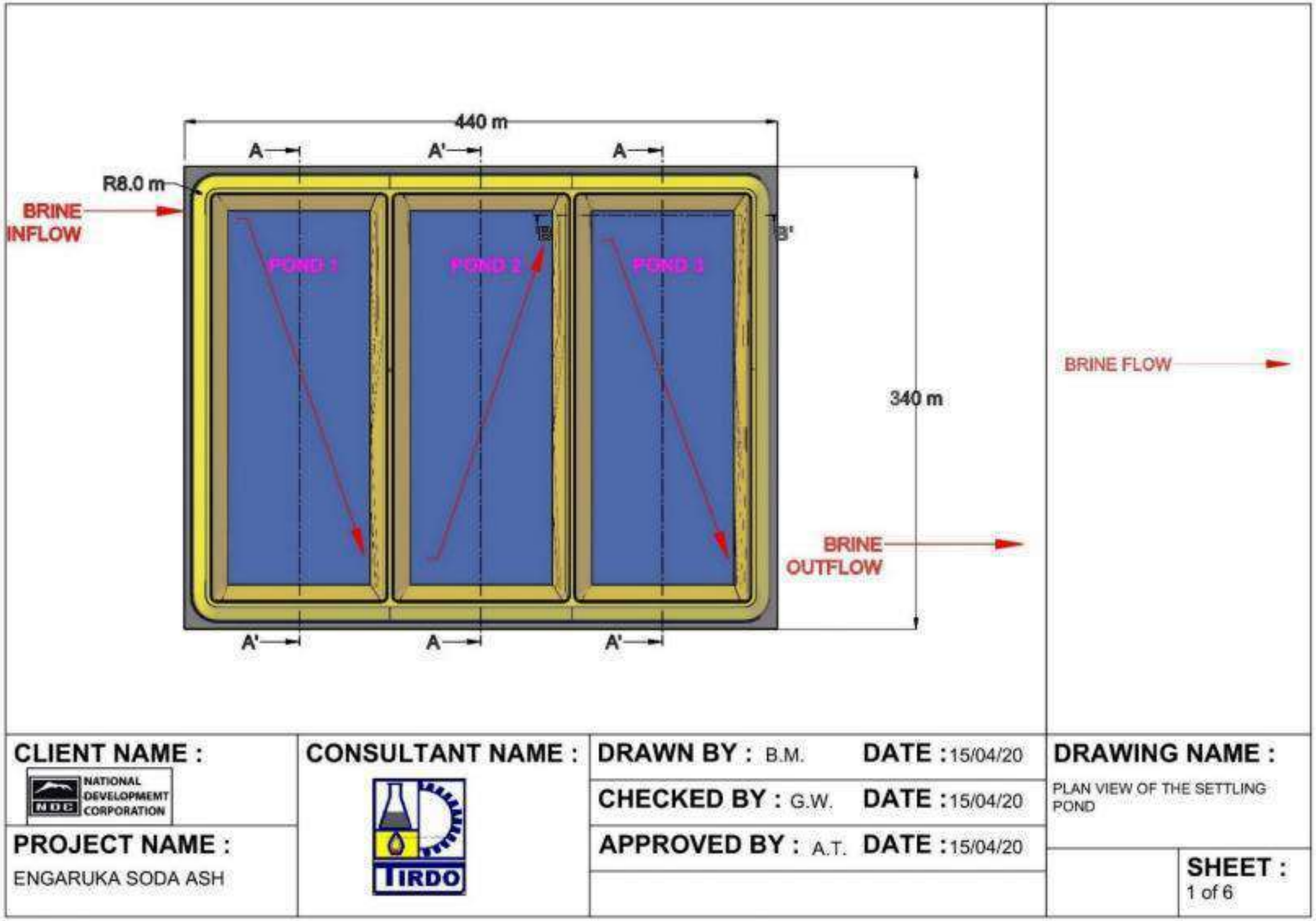

| KSB | Type of pump | UPA S 200-75 | Project no. | Tanzania | Dept. | AECS1S513 |
|---|---|---|---|---|---|---|
| | Nos of stages | 10 | speed [1/min] | 2918 | Name | Ledig |
| | type of motor | UMA 200D 65/22 | rho [kg/dm³] | 1 | | |
| | Offert-curve according ISO 9906 Kl.2B | | impeller ca. 143 / 132 mm | | date | 26.06.2020 |

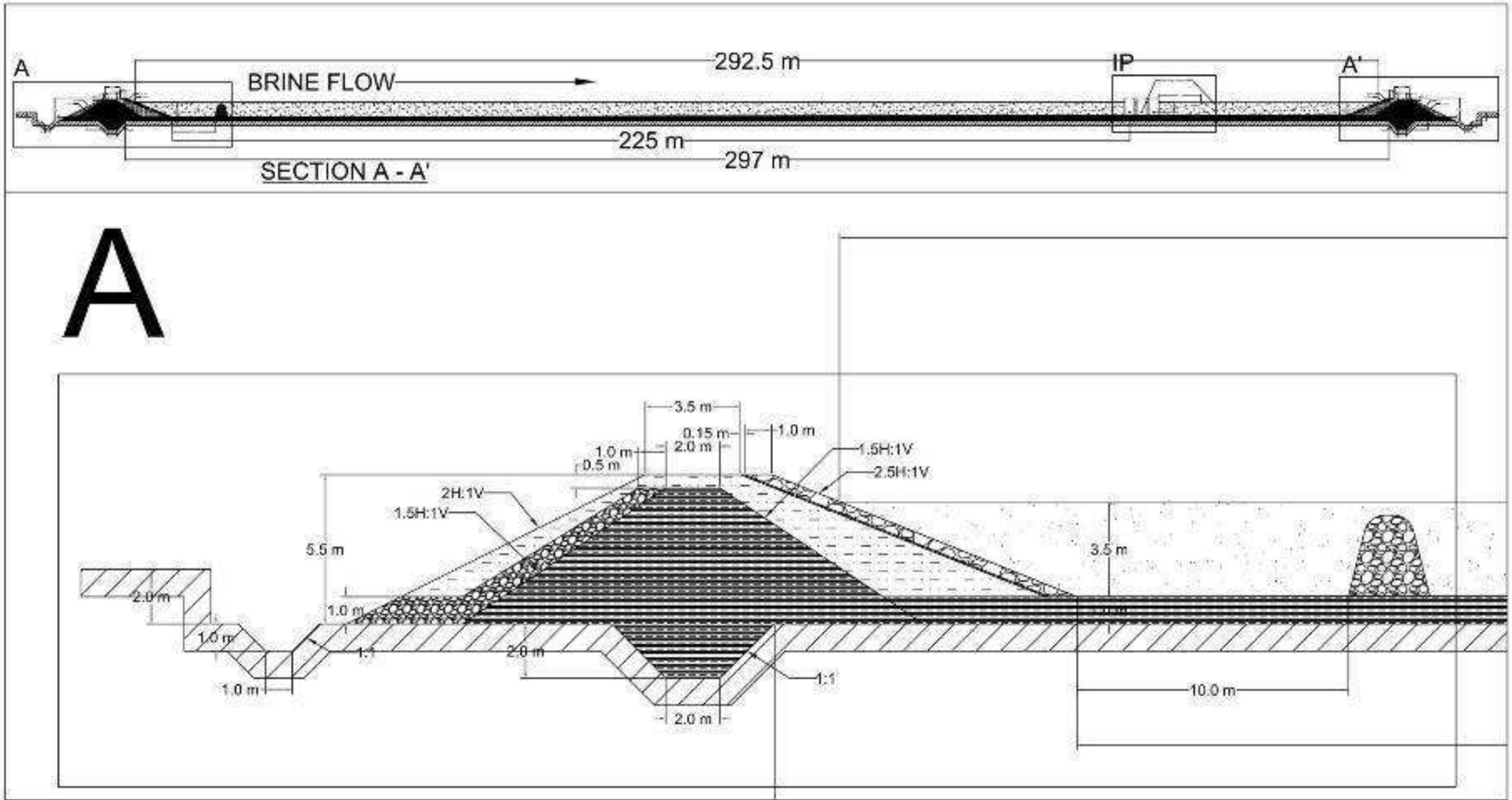
AECS1S513 / Boldt / Version 20 a 29

## Appendix 3: Characteristics curves of centrifugal pumps at the storage ponds



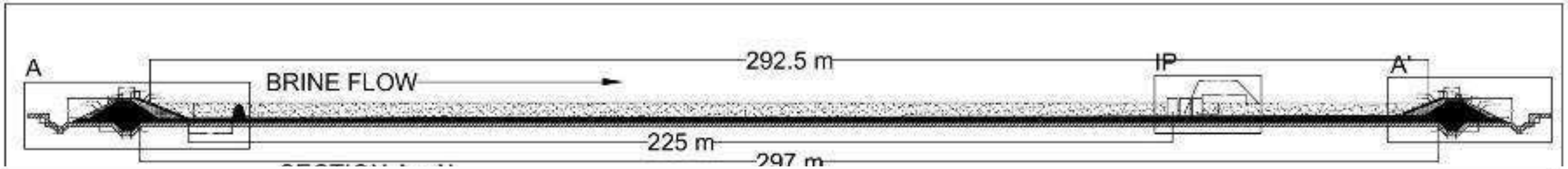
## Appendix 4: Engineering drawings of the pond

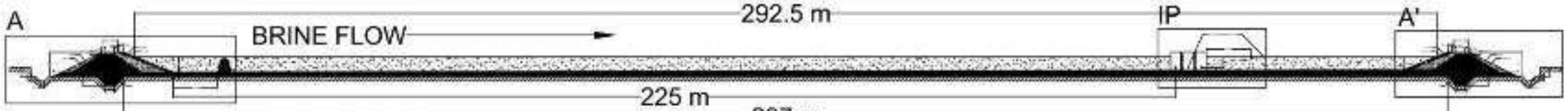




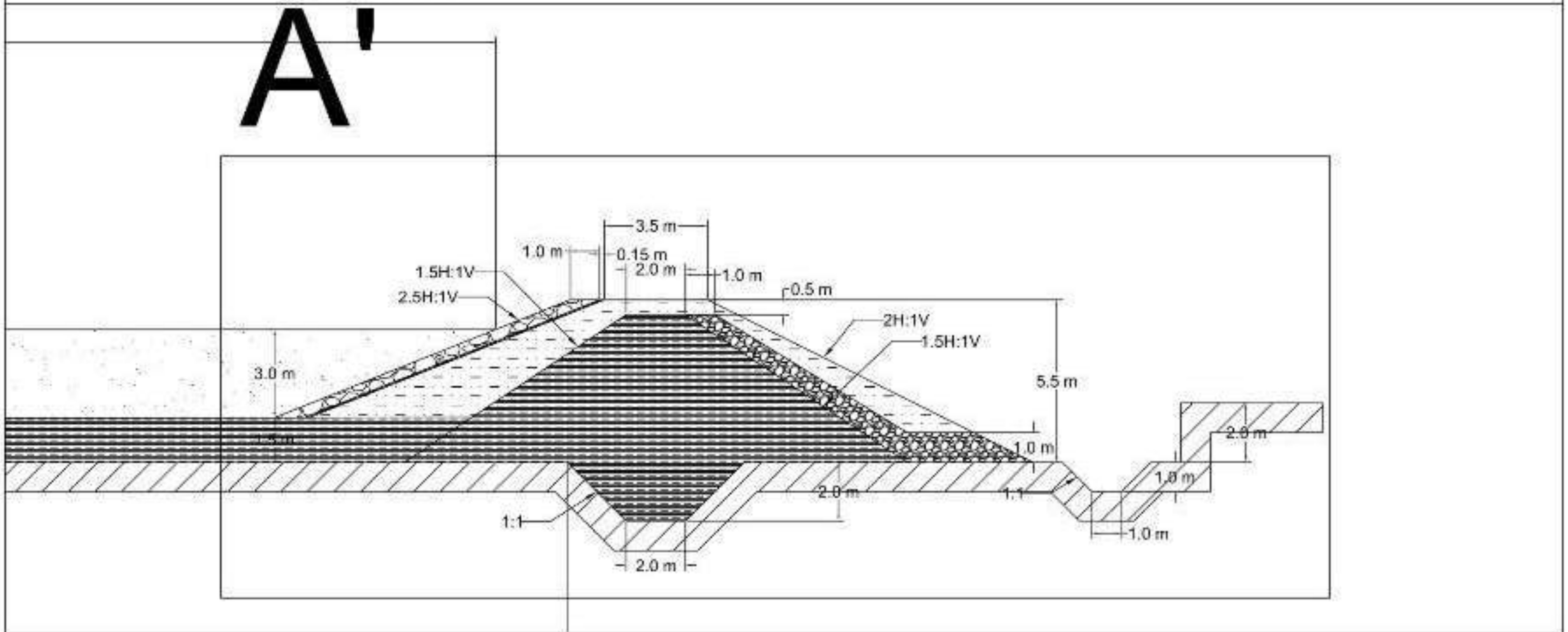

CLEAN CLAY | WEATHERED CLAY | BRINE | GRAVEL | BOULDERS | BEDROCK

| | | | | |
|---|---|---|---|---|
| **CLIENT NAME :** NATIONAL DEVELOPMENT CORPORATION | **CONSULTANT NAME :** TIRDO | **DRAWN BY :** B.M. | **DATE :** 05/04/20 | **DRAWING NAME :** CROSS-SECTION OF SETTLING POND IN THE DIRECTION OF BRINE FLOW SHOWING ENTRANCE ARRANGEMENT |
| | | **CHECKED BY :** G.W. | **DATE :** 05/04/20 | |
| **PROJECT NAME :** ENGARUKA SODA ASH | | **APPROVED BY :** A.T. | **DATE :** 05/04/20 | **SHEET :** 2 of 6 |



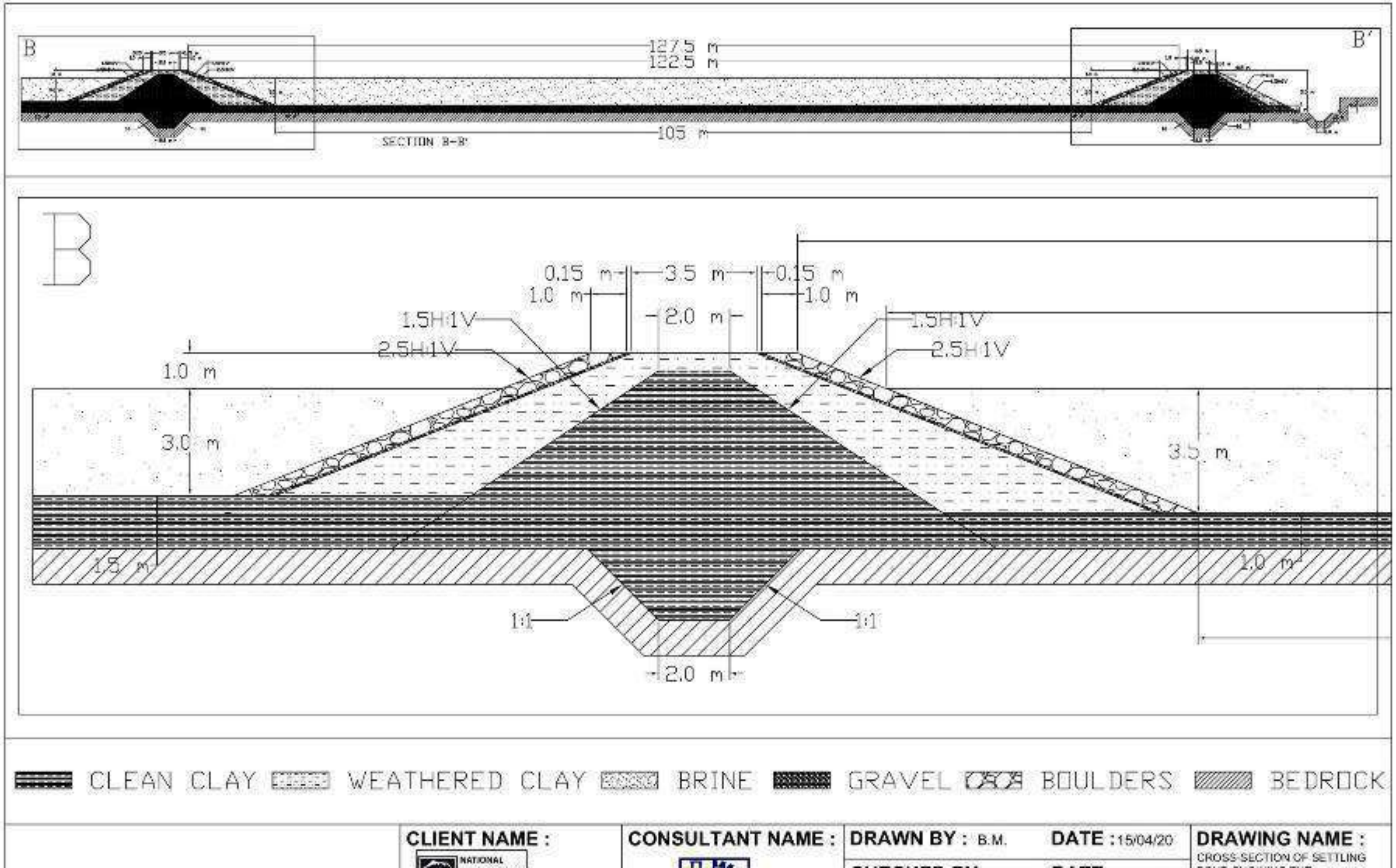

SECTION A - A'

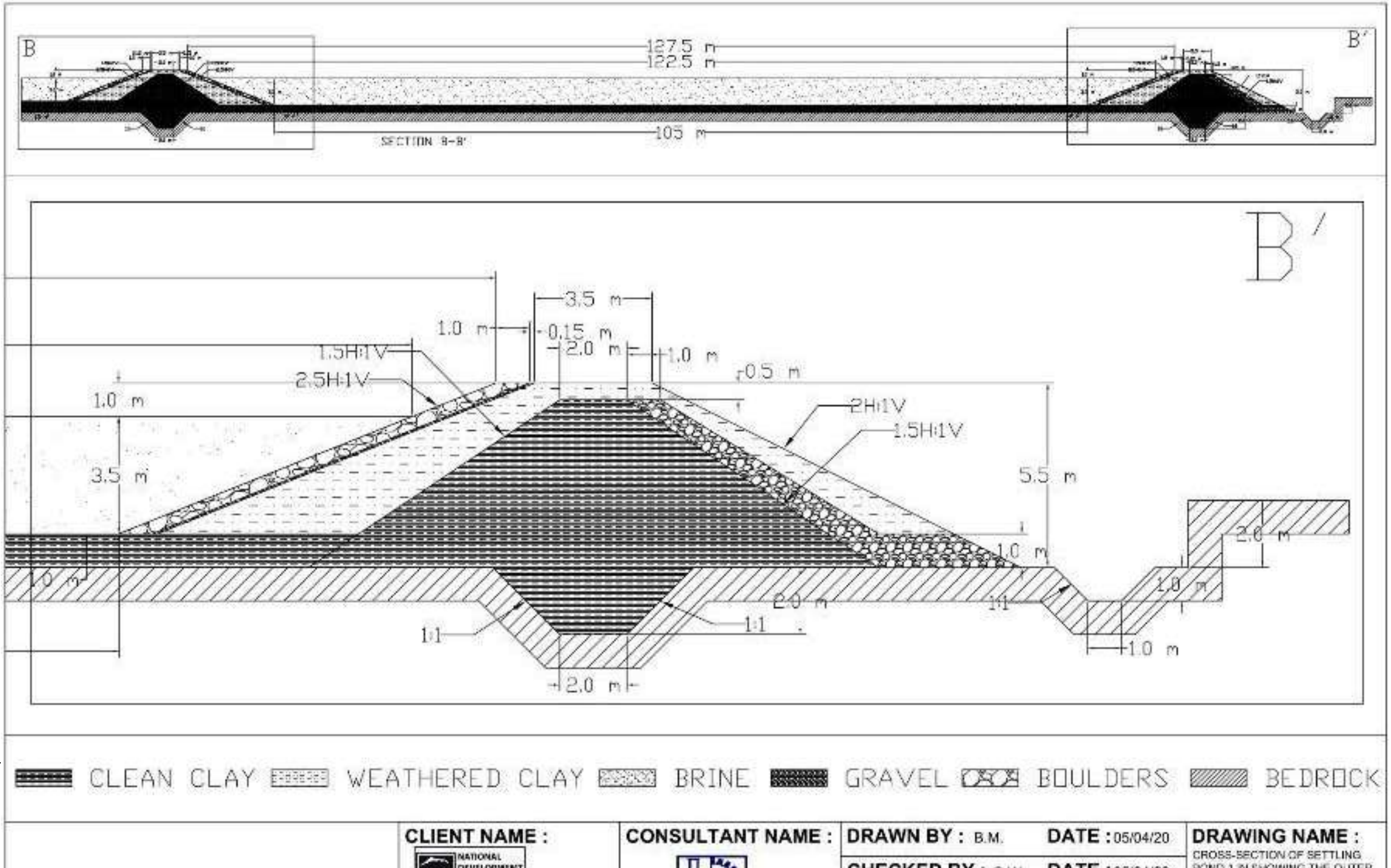



CLEAN CLAY | WEATHERED CLAY | BRINE | GRAVEL | BOULDERS | BEDROCK

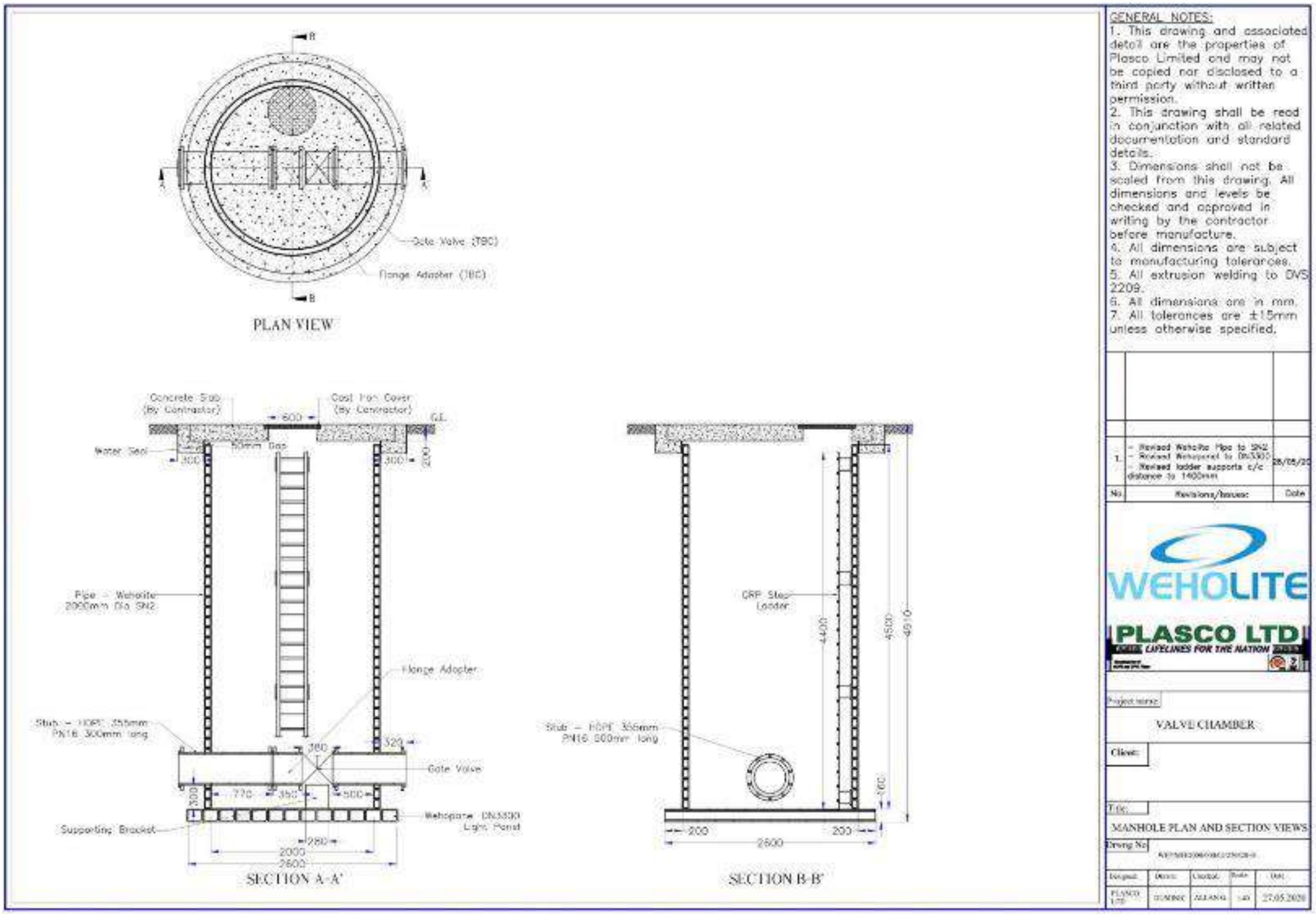


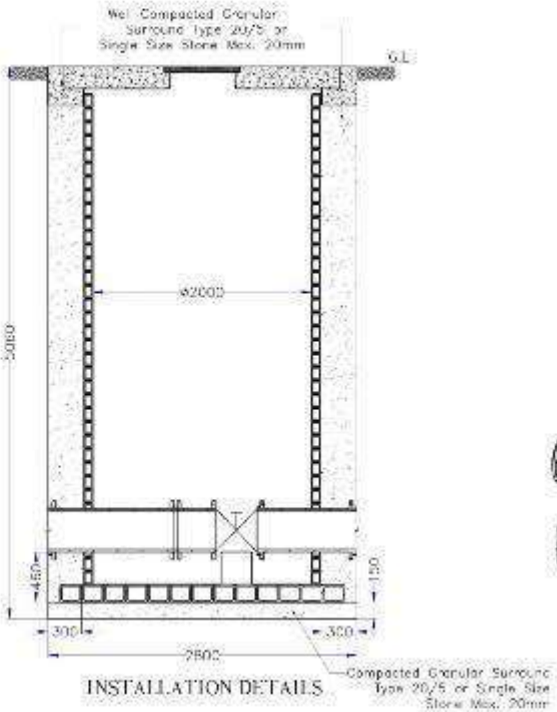
| CLIENT NAME : | CONSULTANT NAME : | DRAWN BY : B.M. | DATE : 15/04/20 | DRAWING NAME : |
|---|---|---|---|---|
| | | | | CROSS-SECTION OF SETTLING |


B
127.5 m
122.5 m
105 m
SECTION B-B'
B'
B
0.15 m
3.5 m
0.15 m
1.0 m
1.0 m
2.0 m
1.5H:1V
2.5H:1V
1.5H:1V
2.5H:1V
1.0 m
3.0 m
3.5 m
1.5 m
1.0 m
1:1
1:1
2.0 m
CLEAN CLAY
WEATHERED CLAY
BRINE
GRAVEL
BOULDERS
BEDROCK
CLIENT NAME :
CONSULTANT NAME :
DRAWN BY : B.M.
DATE : 15/04/20
DRAWING NAME :
CROSS-SECTION OF SETTLING

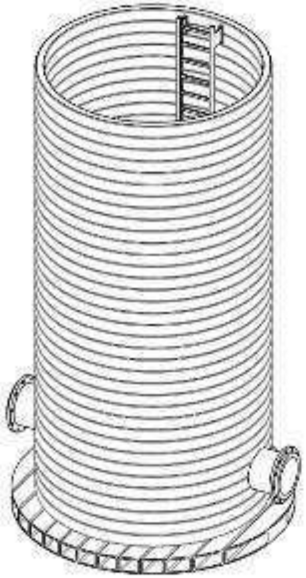

B
B'
127.5 m
122.5 m
105 m
SECTION B-B'
3.5 m
1.0 m
0.15 m
2.0 m
1.0 m
0.5 m
1.5H:1V
2.5H:1V
2H:1V
1.5H:1V
1.0 m
3.5 m
5.5 m
1.0 m
2.0 m
1.0 m
1.0 m
2.0 m
1:1
1:1
1:1
1.0 m
2.0 m
CLEAN CLAY
WEATHERED CLAY
BRINE
GRAVEL
BOULDERS
BEDROCK
CLIENT NAME :
CONSULTANT NAME :
DRAWN BY : B.M.
DATE : 05/04/20
DRAWING NAME :
CROSS-SECTION OF SETTLING

## Appendix 5: Valve chambers

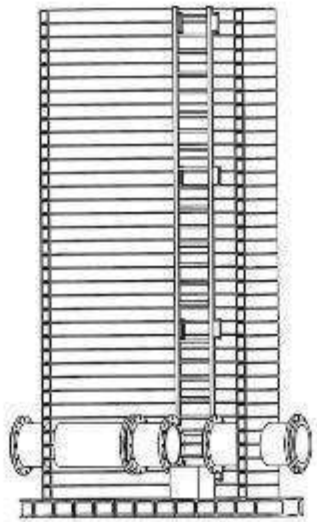





INSTALLATION DETAILS



ISO 1



ISO 2

GENERAL NOTES:

1. This drawing and associated detail are the properties of Plasco Limited and may not be copied nor disclosed to a third party without written permission.
2. This drawing shall be read in conjunction with all related documentation and standard details.
3. Dimensions shall not be scaled from this drawing. All dimensions and levels be checked and approved in writing by the contractor before manufacture.
4. All dimensions are subject to manufacturing tolerances.
5. All extrusion welding to DVS 2209.
6. All dimensions are in mm.
7. All tolerances are ±15mm unless otherwise specified.

| No. | Revisions/Issues | Date |
|---|---|---|
| 1. | - Revised Weholite Pipe to SN2<br>- Revised Wehopanel to DN3300<br>- Revised ladder supports c/c distance to 1400mm | 28/05/20 |

WEHOLITE

PLASCO LTD

LIFELINES FOR THE NATION

Project name: VALVE CHAMBER

Client:

Title: MANHOLE ISOMETRIC VIEWS AND INSTALLATION DETAILS

Drawing No.: [illegible]

| Designed | Drawn | Checked | Scale | Date |
|---|---|---|---|---|
| PLASCO LTD | DOMINIC | [illegible] | [illegible] | 23.05.2020 |

## Appendix 6: Material safety data sheet

ThermoFisher SCIENTIFIC

# SAFETY DATA SHEET

**Creation Date** 15-October-2009 **Revision Date** 18-January-2018 **Revision Number** 7

## 1. Identification

| | |
|---|---|
| **Product Name** | **Sodium carbonate** |
| **Cat No. :** | **BP357-1; S261-10; S263-1; S263-3; S263-10; S263-50; S263-50LC; S263-500; S263-500LC; S495-500** |
| **CAS-No** | 497-19-8 |
| **Synonyms** | Disodium carbonate; Soda ash; Carbonic acid, disodium salt (Anhydrous/Crystalline/Powder/Calcined/Laboratory/Certified ACS/HPLC) |
| **Recommended Use** | Laboratory chemicals. |
| **Uses advised against** | Not for food, drug, pesticide or biocidal product use |

**Details of the supplier of the safety data sheet**

**Company**
**Importer/Distributor**
Fisher Scientific
112 Colonnade Road,
Ottawa, ON K2E 7L6,
Canada
Tel: 1-800-234-7437

**Manufacturer**
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

**Emergency Telephone Number**
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

## 2. Hazard(s) identification

**Classification**

**WHMIS 2015 Classification** Classified as hazardous under the Hazardous Products Regulations (SOR/2015-17)

| | |
|---|---|
| **Serious Eye Damage/Eye Irritation** | Category 2 |

**Label Elements**

**Signal Word**
Warning

**Hazard Statements**
Causes serious eye irritation

Page 1 / 6

**Precautionary Statements**
**Prevention**
Keep only in original container
Wash face, hands and any exposed skin thoroughly after handling
Wear eye/face protection
**Response**
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
Absorb spillage to prevent material damage
**Storage**
Store in a dry place. Store in a closed container
**Disposal**
Dispose of contents/container to an approved waste disposal plant

## 3. Composition/Information on Ingredients

| Component | CAS-No | Weight % |
|---|---|---|
| Sodium carbonate | 497-19-8 | >95 |

## 4. First-aid measures

| | |
|---|---|
| **Eye Contact** | Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention. |
| **Skin Contact** | Wash off immediately with plenty of water for at least 15 minutes. Get medical attention if symptoms occur. |
| **Inhalation** | Move to fresh air. If symptoms arise, call a physician. If not breathing, give artificial respiration. |
| **Ingestion** | Clean mouth with water and drink afterwards plenty of water. Get medical attention if symptoms occur. |
| **Most important symptoms/effects** | None reasonably foreseeable. |
| **Notes to Physician** | Treat symptomatically |

## 5. Fire-fighting measures

| | |
|---|---|
| **Unsuitable Extinguishing Media** | No information available |
| **Flash Point** | Not applicable |
| **Method -** | No information available |
| **Autoignition Temperature** | |
| **Explosion Limits** | |
| **Upper** | No data available |
| **Lower** | No data available |
| **Sensitivity to Mechanical Impact** | No information available |
| **Sensitivity to Static Discharge** | No information available |

**Specific Hazards Arising from the Chemical**
Thermal decomposition can lead to release of irritating gases and vapors.

**Hazardous Combustion Products**
Sodium oxides
**Protective Equipment and Precautions for Firefighters**
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

**NFPA**

| Health | Flammability | Instability | Physical hazards |
|---|---|---|---|
| 2 | 0 | 1 | N/A |

## 6. Accidental release measures

**Personal Precautions** Ensure adequate ventilation. Use personal protective equipment. Avoid dust formation.
**Environmental Precautions** Should not be released into the environment. See Section 12 for additional ecological information.

**Methods for Containment and Clean Up** Sweep up or vacuum up spillage and collect in suitable container for disposal.

## 7. Handling and storage

**Handling** Wear personal protective equipment. Ensure adequate ventilation. Do not get in eyes, on skin, or on clothing. Avoid dust formation. Avoid ingestion and inhalation. Wash hands before breaks and immediately after handling the product.

**Storage** Keep containers tightly closed in a dry, cool and well-ventilated place.

## 8. Exposure controls / personal protection

**Exposure Guidelines** This product does not contain any hazardous materials with occupational exposure limitsestablished by the region specific regulatory bodies.

**Engineering Measures**
Ensure that eyewash stations and safety showers are close to the workstation location. Ensure adequate ventilation, especially in confined areas.
Wherever possible, engineering control measures such as the isolation or enclosure of the process, the introduction of process or equipment changes to minimise release or contact, and the use of properly designed ventilation systems, should be adopted to control hazardous materials at source

**Personal protective equipment**

**Eye Protection** Goggles
**Hand Protection** Wear appropriate protective gloves and clothing to prevent skin exposure.

| Glove material | Breakthrough time | Glove thickness | Glove comments |
|---|---|---|---|
| Natural rubber<br>Nitrile rubber<br>Neoprene<br>PVC | See manufacturers recommendations | - | Splash protection only |

Inspect gloves before use. observe the instructions regarding permeability and breakthrough time which are provided by the supplier of the gloves. (Refer to manufacturer/supplier for information) gloves are suitable for the task: Chemical compatability, Dexterity, Operational conditions, User susceptibility, e.g. sensitisation effects, also take into consideration the specific local conditions under which the product is used, such as the danger of cuts, abrasion. gloves with care avoiding skin contamination.

**Respiratory Protection**

When workers are facing concentrations above the exposure limit they must use appropriate certified respirators. Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
To protect the wearer, respiratory protective equipment must be the correct fit and be used and maintained properly
**Recommended Filter type:** Particulates filter conforming to EN 143

When RPE is used a face piece Fit Test should be conducted

**Environmental exposure controls**
No information available.

**Hygiene Measures**
Handle in accordance with good industrial hygiene and safety practice.

## 9. Physical and chemical properties

| | |
|---|---|
| **Physical State** | Solid |
| **Appearance** | White |
| **Odor** | Odorless |
| **Odor Threshold** | No information available |
| **pH** | 11.3 @ 20°C (10 g/l aq.sol) |
| **Melting Point/Range** | 854 °C / 1569.2 °F |
| **Boiling Point/Range** | 1600 °C / 2912 °F @ 760 mmHg |
| **Flash Point** | Not applicable |
| **Evaporation Rate** | Not applicable |
| **Flammability (solid,gas)** | Not flammable |
| **Flammability or explosive limits** | |
| **Upper** | No data available |
| **Lower** | No data available |
| **Vapor Pressure** | No information available |
| **Vapor Density** | Not applicable |
| **Specific Gravity** | 2.53 |
| **Bulk Density** | 500-800 kg/m³ |
| **Solubility** | Partly soluble in water |
| **Partition coefficient; n-octanol/water** | No data available |
| **Autoignition Temperature** | |
| **Decomposition Temperature** | No information available |
| **Viscosity** | Not applicable |
| **Molecular Formula** | $Na_2CO_3$ |
| **Molecular Weight** | 105.99 |

## 10. Stability and reactivity

| | |
|---|---|
| **Reactive Hazard** | None known, based on information available |
| **Stability** | Stable under normal conditions. |
| **Conditions to Avoid** | Avoid dust formation. Incompatible products. Excess heat. |
| **Incompatible Materials** | Strong oxidizing agents, Strong acids, Fluorine, Metals |
| **Hazardous Decomposition Products** | Sodium oxides |
| **Hazardous Polymerization** | Hazardous polymerization does not occur. |
| **Hazardous Reactions** | None under normal processing. |

## 11. Toxicological information

**Acute Toxicity**

**Product Information**
**Component Information**

| Component | LD50 Oral | LD50 Dermal | LC50 Inhalation |
|---|---|---|---|
| Sodium carbonate | 2800 mg/kg ( Rat ) | > 2000 mg/kg (rabbit) | 2.3 mg/l 2h (Rat) |

**Toxicologically Synergistic Products** No information available

**Delayed and immediate effects as well as chronic effects from short and long-term exposure**

**Irritation** Irritating to eyes and skin

**Sensitization** No information available

**Carcinogenicity** The table below indicates whether each agency has listed any ingredient as a carcinogen.

| Component | CAS-No | IARC | NTP | ACGIH | OSHA | Mexico |
|---|---|---|---|---|---|---|
| Sodium carbonate | 497-19-8 | Not listed | Not listed | Not listed | Not listed | Not listed |

**Mutagenic Effects** No information available

**Reproductive Effects** No information available.

**Developmental Effects** No information available.

**Teratogenicity** No information available.

**STOT - single exposure** None known
**STOT - repeated exposure** None known

**Aspiration hazard** No information available

**Symptoms / effects,both acute and delayed** No information available

**Endocrine Disruptor Information** No information available

**Other Adverse Effects** The toxicological properties have not been fully investigated.

## 12. Ecological information

**Ecotoxicity**
Do not empty into drains. .

| Component | Freshwater Algae | Freshwater Fish | Microtox | Water Flea |
|---|---|---|---|---|
| Sodium carbonate | EC50: = 242 mg/L, 120h (Nitzschia) | Lepomis macrochirus: LC50: 300 mg/L/96h Gambusia affinis: LC50: 740 mg/L/96h | - | EC50: = 265 mg/L, 48h (Daphnia magna) |

**Persistence and Degradability** Soluble in water Persistence is unlikely based on information available.

**Bioaccumulation/ Accumulation** No information available.

**Mobility** Will likely be mobile in the environment due to its water solubility.

## 13. Disposal considerations

**Waste Disposal Methods** Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

## 14. Transport information

**DOT** Not regulated

| | |
|---|---|
| **TDG** | Not regulated |
| **IATA** | Not regulated |
| **IMDG/IMO** | Not regulated |

## 15. Regulatory information

**All of the components in the product are on the following Inventory lists:** X = listed

**International Inventories**

| Component | DSL | NDSL | TSCA | EINECS | ELINCS | NLP | PICCS | ENCS | AICS | IECSC | KECL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sodium carbonate | X | - | X | 207-838-8 | - | | X | X | X | X | X |

**Canada**

SDS in compliance with provisions of information as set out in Canadian Standard - Part 4, Schedule 1 and 2 of the Hazardous Products Regulations (HPR) and meets the requirements of the HPR (Paragraph 13(1)(a) of the Hazardous Products Act (HPA)).

## 16. Other information

| | |
|---|---|
| **Prepared By** | Regulatory Affairs<br>Thermo Fisher Scientific<br>Email: EMSDS.RA@thermofisher.com |
| **Creation Date** | 15-October-2009 |
| **Revision Date** | 18-January-2018 |
| **Print Date** | 18-January-2018 |
| **Revision Summary** | This document has been updated to comply with the requirements of WHMIS 2015 to align with the Globally Harmonised System (GHS) for the Classification and Labelling of Chemicals. |

**Disclaimer**

**The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text**

**End of SDS**

Thermo Fisher
SCIENTIFIC

# SAFETY DATA SHEET

**Creation Date** 29-Jan-2010 **Revision Date** 18-Jan-2018 **Revision Number** 6

## 1. Identification

**Product Name** **Sodium bicarbonate**

**Cat No. :** **S233-3; S233-10; S23310LC; S233-50; S233-300LB; S233-500; S635-3; S637-12; S637-50; S63750LC; S637-212; XXS637GPD350LB; NC1205558; XXS631PET25KG; NC0710541; NC1150577; NC1522424**

**CAS-No** 144-55-8
**Synonyms** Sodium hydrogen carbonate; Sodium acid carbonate; Carbonic acid, monosodium salt (Crystalline/Powder/Certified ACS/USP/FCC/EP/BP/WP/JP)

**Recommended Use** Laboratory chemicals.
**Uses advised against** Food, drug, pesticide or biocidal product use

**Details of the supplier of the safety data sheet**

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

**Emergency Telephone Number**
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

## 2. Hazard(s) identification

**Classification**
This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

**Label Elements**

**Hazards not otherwise classified (HNOC)**
None identified

## 3. Composition/Information on Ingredients

| Component | CAS-No | Weight % |
|---|---|---|
| Sodium bicarbonate | 144-55-8 | >95 |

## 4. First-aid measures

| | |
|---|---|
| **Eye Contact** | Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention. |
| **Skin Contact** | Wash off immediately with plenty of water for at least 15 minutes. Get medical attention immediately if symptoms occur. |
| **Inhalation** | Move to fresh air. Get medical attention immediately if symptoms occur. |
| **Ingestion** | Clean mouth with water and drink afterwards plenty of water. Get medical attention if symptoms occur. |
| **Most important symptoms and effects** | None reasonably foreseeable. |
| **Notes to Physician** | Treat symptomatically |

## 5. Fire-fighting measures

| | |
|---|---|
| **Suitable Extinguishing Media** | Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide. |
| **Unsuitable Extinguishing Media** | No information available |
| **Flash Point** | No information available |
| **Method -** | No information available |
| **Autoignition Temperature** | |
| **Explosion Limits** | |
| **Upper** | No data available |
| **Lower** | No data available |
| **Sensitivity to Mechanical Impact** | No information available |
| **Sensitivity to Static Discharge** | No information available |

**Specific Hazards Arising from the Chemical**
Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes.

**Hazardous Combustion Products**
Sodium oxides
**Protective Equipment and Precautions for Firefighters**
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

| Health | Flammability | Instability | Physical hazards |
|---|---|---|---|
| 0 | 0 | 1 | N/A |

## 6. Accidental release measures

| | |
|---|---|
| **Personal Precautions** | Ensure adequate ventilation. Use personal protective equipment. Avoid dust formation. |
| **Environmental Precautions** | Should not be released into the environment. |
| **Methods for Containment and Clean Up** | Sweep up or vacuum up spillage and collect in suitable container for disposal. Avoid dust formation. |

## 7. Handling and storage

| | |
|---|---|
| **Handling** | Wear personal protective equipment. Ensure adequate ventilation. Avoid ingestion and inhalation. Avoid contact with skin, eyes and clothing. Avoid dust formation. |
| **Storage** | Keep containers tightly closed in a dry, cool and well-ventilated place. |

## 8. Exposure controls / personal protection

| | |
|---|---|
| **Exposure Guidelines** | This product does not contain any hazardous materials with occupational exposure limitsestablished by the region specific regulatory bodies. |
| **Engineering Measures** | Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location. |
| **Personal Protective Equipment** | |
| **Eye/face Protection** | Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. |
| **Skin and body protection** | Wear appropriate protective gloves and clothing to prevent skin exposure. |
| **Respiratory Protection** | No protective equipment is needed under normal use conditions. |
| **Hygiene Measures** | Handle in accordance with good industrial hygiene and safety practice. |

## 9. Physical and chemical properties

| | |
|---|---|
| **Physical State** | Powder Solid |
| **Appearance** | White |
| **Odor** | Odorless |
| **Odor Threshold** | No information available |
| **pH** | 8.3 0.1M aq. solution |
| **Melting Point/Range** | 270 °C / 518 °F |
| **Boiling Point/Range** | No information available |
| **Flash Point** | No information available |
| **Evaporation Rate** | Not applicable |
| **Flammability (solid,gas)** | No information available |
| **Flammability or explosive limits** | |
| **Upper** | No data available |
| **Lower** | No data available |
| **Vapor Pressure** | No information available |
| **Vapor Density** | Not applicable |
| **Specific Gravity** | No information available |
| **Solubility** | Slightly soluble in water |
| **Partition coefficient; n-octanol/water** | No data available |
| **Autoignition Temperature** | |
| **Decomposition Temperature** | > 50°C |
| **Viscosity** | Not applicable |
| **Molecular Formula** | C H Na O3 |
| **Molecular Weight** | 84.01 |

## 10. Stability and reactivity

| | |
|---|---|
| **Reactive Hazard** | None known, based on information available |
| **Stability** | Hygroscopic. |
| **Conditions to Avoid** | Avoid dust formation. Incompatible products. Exposure to moist air or water. Excess heat. Temperatures above 50°C. |
| **Incompatible Materials** | Strong oxidizing agents, Acids |
| **Hazardous Decomposition Products** | Sodium oxides |

**Hazardous Polymerization** Hazardous polymerization does not occur.

**Hazardous Reactions** None under normal processing.

## 11. Toxicological information

Acute Toxicity

**Product Information**
**Component Information**

| Component | LD50 Oral | LD50 Dermal | LC50 Inhalation |
|---|---|---|---|
| Sodium bicarbonate | LD50 = 4220 mg/kg ( Rat ) | Not listed | Not listed |

**Toxicologically Synergistic Products** No information available

**Delayed and immediate effects as well as chronic effects from short and long-term exposure**

**Irritation** No information available

**Sensitization** No information available

**Carcinogenicity** The table below indicates whether each agency has listed any ingredient as a carcinogen.

| Component | CAS-No | IARC | NTP | ACGIH | OSHA | Mexico |
|---|---|---|---|---|---|---|
| Sodium bicarbonate | 144-55-8 | Not listed | Not listed | Not listed | Not listed | Not listed |

**Mutagenic Effects** No information available

**Reproductive Effects** No information available.

**Developmental Effects** No information available.

**Teratogenicity** No information available.

**STOT - single exposure** None known
**STOT - repeated exposure** None known

**Aspiration hazard** No information available

**Symptoms / effects,both acute and delayed** No information available

**Endocrine Disruptor Information** No information available

**Other Adverse Effects** The toxicological properties have not been fully investigated.

## 12. Ecological information

Ecotoxicity

.

| Component | Freshwater Algae | Freshwater Fish | Microtox | Water Flea |
|---|---|---|---|---|
| Sodium bicarbonate | EC50: 650 mg/L/120h | LC50: 8250 - 9000 mg/L, 96h static (Lepomis macrochirus) | - | EC50: 2350 mg/L/48h |

**Persistence and Degradability** Soluble in water Persistence is unlikely based on information available.

**Bioaccumulation/ Accumulation** No information available.

**Mobility** Will likely be mobile in the environment due to its water solubility.

## 13. Disposal considerations

| | |
|---|---|
| **Waste Disposal Methods** | Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification. |

## 14. Transport information

| | |
|---|---|
| DOT | Not regulated |
| TDG | Not regulated |
| IATA | Not regulated |
| IMDG/IMO | Not regulated |

## 15. Regulatory information

**All of the components in the product are on the following Inventory lists:** X = listed

**International Inventories**

| Component | TSCA | DSL | NDSL | EINECS | ELINCS | NLP | PICCS | ENCS | AICS | IECSC | KECL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sodium bicarbonate | X | X | - | 205-633-8 | - | | X | X | X | X | X |

**Legend:**
**X - Listed**
**E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.**
**F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.**
**N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.**
**P - Indicates a commenced PMN substance**
**R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.**
**S - Indicates a substance that is identified in a proposed or final Significant New Use Rule**
**T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.**
**XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).**
**Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.**
**Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.**

**U.S. Federal Regulations**

| | |
|---|---|
| **TSCA 12(b)** | Not applicable |
| **SARA 313** | Not applicable |
| **SARA 311/312 Hazard Categories** | See section 2 for more information |
| **CWA (Clean Water Act)** | Not applicable |
| **Clean Air Act** | Not applicable |

**OSHA** Occupational Safety and Health Administration
Not applicable

| | |
|---|---|
| **CERCLA** | Not applicable |
| **California Proposition 65** | This product does not contain any Proposition 65 chemicals |
| **U.S. State Right-to-Know Regulations** | Not applicable |

**U.S. Department of Transportation**

| | |
|---|---|
| Reportable Quantity (RQ): | N |
| DOT Marine Pollutant | N |

DOT Severe Marine Pollutant N

**U.S. Department of Homeland Security**
This product does not contain any DHS chemicals.

**Other International Regulations**

**Mexico - Grade** No information available

## 16. Other information

| | |
|---|---|
| **Prepared By** | Regulatory Affairs<br>Thermo Fisher Scientific<br>Email: EMSDS.RA@thermofisher.com |
| **Creation Date** | 29-Jan-2010 |
| **Revision Date** | 18-Jan-2018 |
| **Print Date** | 18-Jan-2018 |
| **Revision Summary** | This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). |

**Disclaimer**
**The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text**

**End of SDS**

**Appendix 7: The application of HAZOP for a steam boiler (Marcos, 2018)**

**HAZARDS AND OPERABILITY STUDY (HAZOP) - KNOT 1 - WATER FLOW**

System: HUSM's 01 Boiler

Team: Marcos de Oliveira, Janis Ruppentahl

LEGEND
- Tolerable
- Significant
- Severe

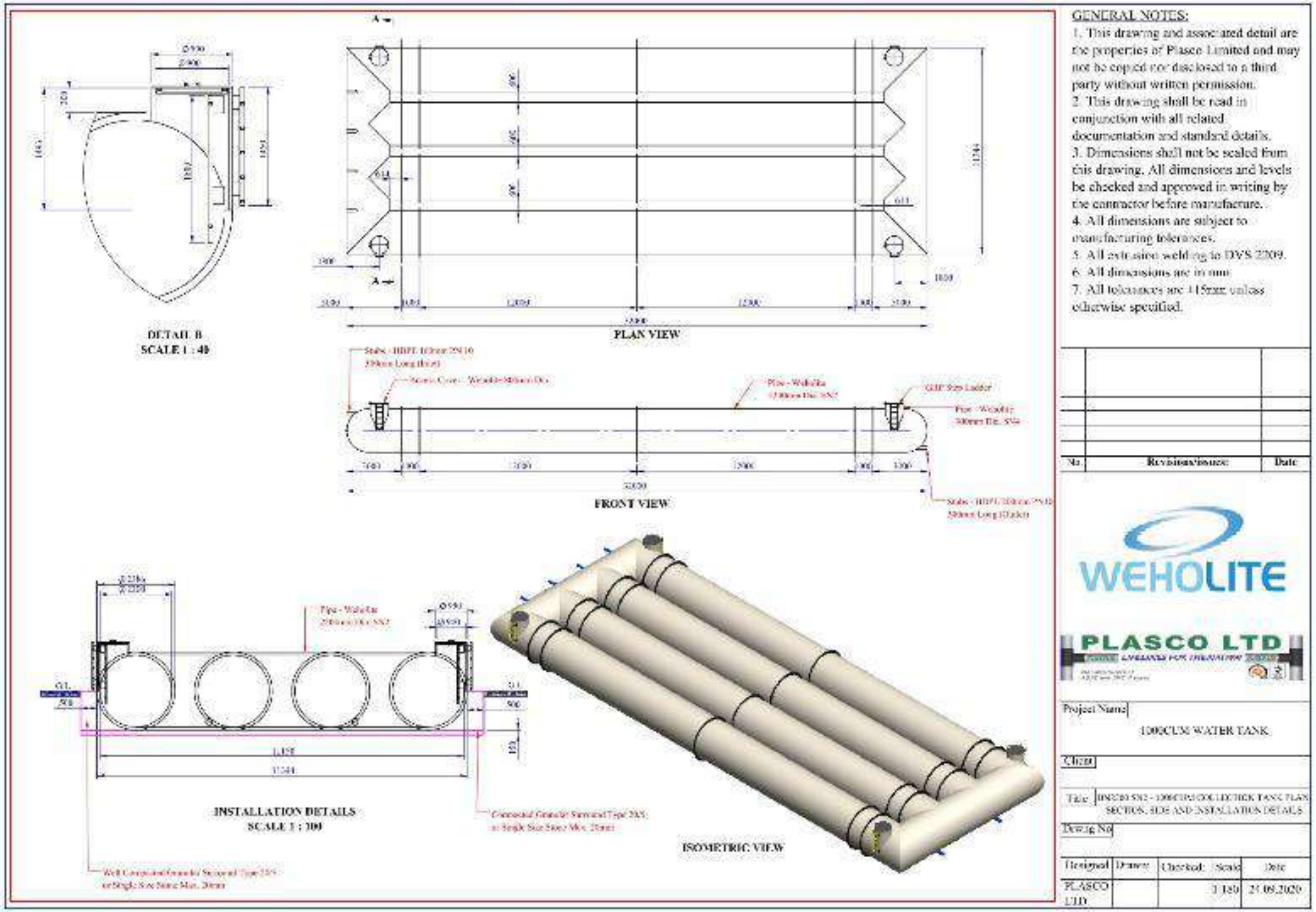
| Project parameter | Guide word | Deviation | Causes | Detections / Safeguards | Consequences | Prob. | Severity | | Magnitude | | Recommendations and observations |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | S | Pr | S | Pr | |
| Flow | More | High Flow | 1. Failure in the pressure switch of the water supply automatic system | Anual calibration and periodic inspection | SECURITY AND HEALTH Explosion of the boiler with consequent injuries to the people<br>PATRIMONY Severe damage in the boiler | 2 | 5 | 2 | 10 | 4 | Elaborate and implement a maintenance plan (preventive and e predictive) of the line and a calibration plan |
| | | | 2. Failure in the boiler's indicator level (float) | Anual calibration and periodic inspection | | 2 | 5 | 2 | 10 | 4 | |
| | | | 3. Steam leakage in the water level | Periodic inspection and corrective maintenance | | 2 | 5 | 2 | 10 | 4 | |
| | | | 4. Electric failure in the pump since there is failure in the pressure switch and level | Periodic inspection and corrective maintenance | | 2 | 5 | 2 | 10 | 4 | |
| Flow | Less | Low Flow | 1. Incrustation in the water pipe | Control of water outflow in the system and monitoring and control the demineralization system avoiding saturation | SECURITY AND HEALTH Temperature increase, emission of black smoke and fire in the boiler<br>PATRIMONY Deformation of the internal piping and of the boiler itself | 5 | 1 | 3 | 5 | 15 | Implementation of an alarm system (andon) of low water level |
| | | | 2. Pump failure (mechanical, electrical, cavitation, etc) | Periodic inspection in the pump | | 3 | 1 | 3 | 3 | 9 | |
| | | | 3. Semi-open valve | Periodic inspection in the valve | | 2 | 1 | 3 | 2 | 6 | |
| | | | 5. Failure in the level | Visual inspection of the level | | 3 | 1 | 3 | 3 | 9 | |
| | | | 6. Failure in the pressure switch | Sound signal for low level of water and visual inspection of the level | | 2 | 1 | 3 | 2 | 6 | |

Source: Authors.

| HAZARDS AND OPERABILITY STUDY (HAZOP) KNOT 2 - STEAM PRESURE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| System: HUSM's 01 Boiler | | | | | Team: Marcos de Oliveira, Janis Ruppentahl | | | | | | |
| Project parameter | Guide word | Deviation | Causes | Detections / Safeguards | Consequences | Prob. | Severity | | Magnitude | | Recommendations and observations |
| | | | | | | | S | Pr | S | Pr | |
| Flow | More | High Pressure | 1. Excess of fuel in the boiler | Boiler and pressure vessel's manometer | SECURITY AND HEALTH<br>Explosion risk<br>PATRIMONY<br>Disconformity in the productive process | 1 | 5 | 3 | 5 | 3 | Elaborate and implement a maintenance plan (preventive and predictive)<br>Substitution of the manual register by an automatic controller<br>Invest in qualification for boilers operators |
| | | | 2. Pressure register closes during the boilers' operation (Possible operator's failure) | Visual Inspection | | 2 | 8 | 3 | 16 | 6 | |
| Flow | Less | Low Pressure | 1. Obstruction or leakage in the oil pipe | Boiler and pressure vessel's manometer | SECURITY AND HEALTH<br>Commitment to the productive process<br>PATRIMONY<br>Expenses with corrective maintenance | 3 | 5 | 4 | 15 | 12 | Elaborate and implement a operating plan (manual) and preventive maintenance schedule<br>Investiment in the boilers's course of operation for the operators |
| | | | 2. Operating failure of the operator during the boiler's pressure control (oil and water) | Visual Inspection | | 3 | 5 | 5 | 15 | 15 | |

Source: Authors.

## Appendix 8: Collection tanks design



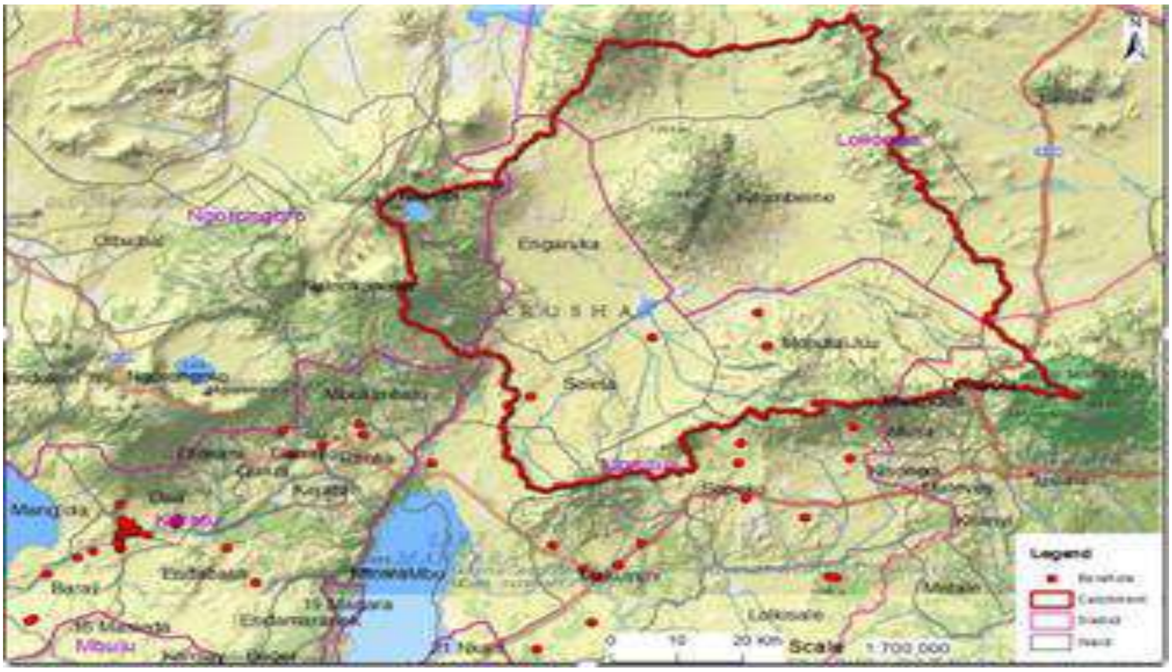
NATIONAL DEVELOPMENT CORPORATION

# TECHNO-ECONOMIC STUDY FOR SODA ASH PROJECT AT ENGARUKA IN MONDULI DISTRICT, ARUSHA REGION, TANZANIA

## VOLUME V

## UTILITIES ASSESSMENT

## PART II: POWER AND FUEL SUPPLY ASSESSMENT





**Prepared by;**

**Tanzania Industrial Research and Development Organization**



**May 2021**

## STUDY TEAM

### Members of the team

| Sn | Name | Position | Organization | Contact |
|---|---|---|---|---|
| 1 | Dr. Lugano Willson | Team Leader | TIRDO | +255 766 771 056 |
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## EXECUTIVE SUMMARY

The Government has planned to develop the resource for economic benefits of the country. Thus, this techno-economic study is being carried to establish the technical feasibility and economic viability of the project. However, among other challenges for this project, is to ascertain availability of plant utilities for plant operation and for the envisaged township. In implementing this study, the Consultant has evaluated the availability of the utilities (Power and Fuel Supply) in the vicinity of the project site.

The objectives to be fulfilled was the Assessment of Availability of Plant Utilities for production of soda ash which includes the following items: (i) To Assess Power Supply; (ii) To assess Fuel Supply for Steam Generation; (iii) To assess Fuel Transportation and Security.

The project power supply will be from the TANESCO National Grid and Steam Turbine Generator. Fuel recommended to be used is coal since it is abundantly available and in good quality for industrial use. Coal will be transported from Ngaka coal mines to the generating station (Engaruka). Unlike gas and oil, it is widely distributed, both geographically and in terms of resource ownership. Its highest reserve, provides energy security to many countries because the supply is considered to last significantly longer than gas or oil. It is predicted that coal will continue to play a very significant role in world primary energy demand well into the future. The locally availability of Coal and well-established road-rail-road network from Ngaka to Engaruka, provides assurance of getting good supply of the material to the project site.

# TABLE OF CONTENT

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## ABBREVIATIONS & ACRONOMY

| | |
|---|---|
| GTZ | Deutsche Gesellschaft für Technische Zusammenarbeit |
| HFO | Heavy Fuel Oil |
| kVA | kilo-volt-ampere |
| NDC | National Development Corporation |
| TANESCO | Tanzania Electric Supply Company |
| TBS | Tanzania Bureau of Standards |
| tcf | trillion cubic feet |
| TGDC | Tanzania Geothermal Development Company |
| TIRDO | Tanzania Industrial Research and Development Organization |
| ToR | Terms of Reference |

## CHAPTER ONE

# 1. INTRODUCTION

## 1.1. Background

The National Development Corporation (NDC) is carrying out techno-economic study for establishment of economically, environmentally and socially sound soda ash plant at Engaruka in Arusha region, including associated infrastructure. Based on the market study, the planned plant should have an initial production capacity of 500,000 tonnes of soda ash per year which will expand production to 1,000,000 tonnes per year as the market grows. However, as reported in the appraisal of brine resource, the available raw material can support higher production capacity up to one million tonnes per year.

This study is meant to inform the government on the appropriate and most economical technology for the same. The techno-economic study will also provide a bankable feasibility study for mobilization of the required resources (human, technology, financial) for the project. It is against this background TIRDO was invited as a Consultant to provide expertise in this. This study addresses one component of the Terms of reference (ToR), namely Assessment of Availability of Plant Utilities specifically Power and Fuel supply.

## 1.2. OBJECTIVE

According to the Terms of References the objectives to be fulfilled was the Assessment of Availability of Plant Utilities for production of soda ash which includes;

### 1.2.1. Power Supply:

- Power requirements estimates (plant, township, etc.);
- Evaluate/analyze power sources options (captive power using coal/gas or grid connection) and recommend the most cost-effective source;
- If the supply is from the grid, provide the nearest point for connection from the power utility including appropriate voltage level.

### 1.2.2. Fuel Supply

- Evaluate/analyze fuel sources options (coal, gas, HFO, etc.) for steam generation including its cost;
- Determine the most effective way on how the fuel will be transported and distributed to the plant site.

**CHAPTER TWO**

# 2. APPROACH AND METHODOLOGY

## 2.1. General approach

To implement this assignment, the general approach focused on:

i) Analysis of information obtained from the Client, various Consultant Teams and other Government organizations to establish the appropriateness/suitability of the power and fuel sources recommended;
ii) Desk studies to establish the Power Supply and Fuel Supply for Steam Generation, Transportation and Security.
iii) Desk studies to establish Fuel Transportation and Security

CHAPTER THREE

# 3. ASSESSMENT OF AVAILABILITY OF PLANT UTILITIES

The Government has planned to develop the resource for economic benefits of the country. Thus, this techno-economic study is being carried to establish the technical feasibility and economic viability of the project. However, among other challenges for this project, is to ascertain availability of plant utilities for plant operation and for the envisaged township. In implementing this study, the Consultant has evaluated the availability of the utilities in the vicinity of the project site.

## 3.1. Power Supply

The project power supply will be from the TANESCO National Grid and steam turbine generator (thermal power plant). The project machinery and equipment need a supply of electricity from a transformer rating of 33 kVA which will be tapped from the existing 33 kVA Manyara-Loliondo grid line and distributing the same in the project area. The estimated provisional route length for the 33 kV overhead line is 20 km. The alternative to tapping the overhead line of 33 kV from the public line is to construct a separate feeder of 33 kV overhead line from TANESCO substation to the proposed soda ash plant substation. The alternative design shall have longer route length than the line obtained by tapping from the public line.

There is a possibility of using geothermal energy as one of the energy options for developing 10MW power plant capacity through Tanzania Geothermal Development Company Limited (TGDC). TGDC has already done preliminary assessment of geothermal aspects located in Arusha region mainly Natron and Meru geothermal area. Natron geothermal prospect is closer to the area envisaged for the Soda Ash Plant. However detailed geoscientific studies have to be conducted to confirm capacity of the resources. A letter from TGDC with details on modality of executing the project including cost estimates for 10MW power plant capacity is attached in Appendix 1.

## 3.2. Fuel Supply for Steam Generation

The primary boiler fuels are coal, oil, natural gas, and wood biomass. Wood biomass cannot be an option for consideration in Engaruka project because it will contribute in deforestation. Oil is also a good option because Tanzania is importing all its petroleum oil products. The challenge with oil has to be imported and it is becoming more and more expensive as reserve reduce and import increase.

Natural gas is a good candidate as boiler fuel because Tanzania has 57.54 tcf of natural gas reserve which can be harnessed and be utilized in big projects for generating steam and power. This gas is found in the Indian Ocean and along its coast. The challenge in utilizing the gas is the distribution network, as it has to be distributed through pipeline. So far there is distribution network in only three regions of Dar es Salaam, Pwani and Mtwara (Africa-energy-portal, 2019) and it will take long time before most of the country is covered because of the high capital cost involved. Thus, Engaruka project cannot be based on natural gas boiler firing and hence steam and power generation.

Coal reserves are an abundant resource in Tanzania. Tanzania coal reserves are estimated at about 1,200 million tonnes of which 304 million tones are proven (GTZ, 2007). Tanzania is producing more than 400,000 tonnes of coal per year as shown in Table 3-1, 99% of which comes from Ngaka Mines and Kambas Mining Investment in Ruvuma region. Ngaka mines has the capacity to produce more as the market demands. Distribution of coal is not as complicated as that of natural gas. It is thus plausible to plan to use coal from Ngaka mines for firing steam boiler for Engaruka project.

Figure 3-1: Ngaka Coal Mine (The Citizen magazine, 2017)

Table 3-1: Coal Production trends in Tanzania from Financial year 2016/17 to 2019/20

| Year | Weight (Tonne) |
|---|---|
| 2016/17 | 419,541.50 |
| 2017/18 | 595,352.00 |
| 2018/19 | 799,628.41 |
| 2019/20 | 644,831.35 |

(***Source: www.tumemadini.go.tz)***

Coal is the most widely available fossil fuel energy resource. Unlike gas and oil, it is widely distributed, both geographically and in terms of resource ownership. Its abundance provides energy security to many countries because its supply will last significantly longer than gas or oil. It is predicted that coal will continue to play a very significant role in world primary energy demand well into the future.

Energy produced from coal fired plants is cheaper and more affordable than other energy sources. Since coal is abundant, it is definitely cheap to produce power using this fuel. Moreover, it is not expensive to extract and mine from coal deposits. It has many important uses worldwide because it provides around 90% of the energy consumed by manufacturing plants around the world. The most significant uses of coal are in steam & electricity generation, steel production, cement manufacturing and as a liquid fuel.

Fuel to be used in this thermal power plant is recommended to be coal since it is abundantly available in Tanzania (as shown in fuel selection criteria Table 3-2). Coal will be transported from Ngaka coal mines to the generating station. The Coal combustion properties is as shown in Table 3-3. The fuel will be stored in both 'dead storage' and ‘live storage’. Dead storage is generally 40 days backup coal storage which is used when coal supply is unavailable, whereas ‘live storage’ is a raw coal bunker in boiler house. The coal will be cleaned in a magnetic cleaner to filter out any metallic particles present which may cause wear and tear in the equipment. In order to improve efficiency of the boiler, coal from live storage is first crushed into small particles and then taken into a pulverizer to make it in powdered form. The ash produced after the combustion of coal is taken out of the boiler furnace and then properly disposed. Periodic removal of ash from the boiler furnace is necessary to enhance combustion.

Coal fired power plant can be one of the sources of air pollution through combustion. The design of powerhouse must be equipped with equipment and / or gadgets to control gaseous and particulate emissions to the atmosphere.

Table 3-2: Fuel Ranking Criteria

| **Type of Fuel** | **FUEL RANKING CRITERIA** | | | | **Total Weight** | **Order of Selection** |
|---|---|---|---|---|---|---|
| | **Invest ment cost** | **Availa bility** | **Means of transportatio n and distribution** | **Environmental management complexity** | | |
| Wood biomass | 0.4 | 0.2 | 0.35 | 0.05 | 1 | 2 |
| Natural gas | 0.2 | 0.15 | 0.05 | 0.5 | 0.9 | 3 |
| Coal | 0.3 | 0.6 | 0.5 | 0.2 | 1.6 | 1 |
| Oil | 0.1 | 0.05 | 0.1 | 0.25 | 0.5 | 4 |
| **Total Weight** | 1 | 1 | 1 | 1 | | |

In Tanzania, the Coal combustion properties has been analyses by Tanzania Industrial Research and Development Organization (TIRDO) and fall within acceptable range:

Table 3-3: Combustion properties for Tanzania coal (Source TIRDO)

| **Description** | **Ash (%)** | **Moisture (%)** | **Volatile Matter (%)** | **Gross Calorific Value (Kcal/Kg)** | **Sulphur (%)** |
|---|---|---|---|---|---|
| Tanzania Coal | 14-34 | 1 - 10 | 35< | 3500 - 6800 | 0.2-1 |
| TBS Coal Standard | 40< | 10< | 30< | 4000 - 5500 | 1< |

### 3.3. Fuel Transportation and Security

The rail option is the most economical and cost effective. Since there was no direct rail connectivity between Engaruka to the coal production mines, road-rail-road routes will be applied. The locally availability of Coal and well-established road-rail-road network from Ngaka to Engaruka, provides assurance of getting good supply of the material. In addition, when coal is completely not available, one could use criteria number 2 which is biomass like firewood (as shown in table 4-1 above).

### 3.4. Fuel Storage

The main goal of coal storage is to minimize coal loss and preventing spontaneous combustion. Spontaneous combustion occurs in coal piles when low-temperature oxidation slowly heats up the material to a volatile point. When coal is thoroughly oxidized and the temperature in a pile reaches around $500^oC$, methane in the coal ignites causing trouble for the coal pile and the surroundings.

In order to avoid spontaneous combustion, the stockpile should adhere to principles of proper stockpile management: packing it in horizontal layers, followed by levelling and dozing. In addition, moisture content should be minimized to avoid oxidation, and if possible, the stockpile should be located where there is limited exposure to wind. But if costs allow, stockpiles can be put in a sealed environment, this being the single most effective way to prevent spontaneous combustion problems and ensure compliance with any stringent regulatory requirements.

It should be noted that coal will be stored as per requirements of the existing national standard MMDC 3(6486) P3 Coal - Handling, storage and transportation – Code of practice (TBS, 2019).

## CHAPTER FOUR

## 4. CONCLUSION AND RECOMMENDATION

The study covered Assessment of Availability of Plant Utilities for production of soda ash which includes the following items: (i) To Assess Power Supply; (ii) To assess Fuel Supply for Steam Generation; (iii) To assess Fuel Transportation and Security

The project power supply will be from the TANESCO National Grid and Steam Turbine Generator. Fuel recommended to be used is coal since it is abundantly available and in good quality for industrial use. Coal will be transported from Ngaka coal mines to the generating station (Engaruka). Unlike gas and oil, it is widely distributed, both geographically and in terms of resource ownership. Its highest reserve, provides energy security to many countries because the supply is considered to last significantly longer than gas or oil. It is predicted that coal will continue to play a very significant role in world primary energy demand well into the future. The locally availability of Coal and well-established road-rail-road network from Ngaka to Engaruka, provides assurance of getting good supply of the material.

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## APPENDIX

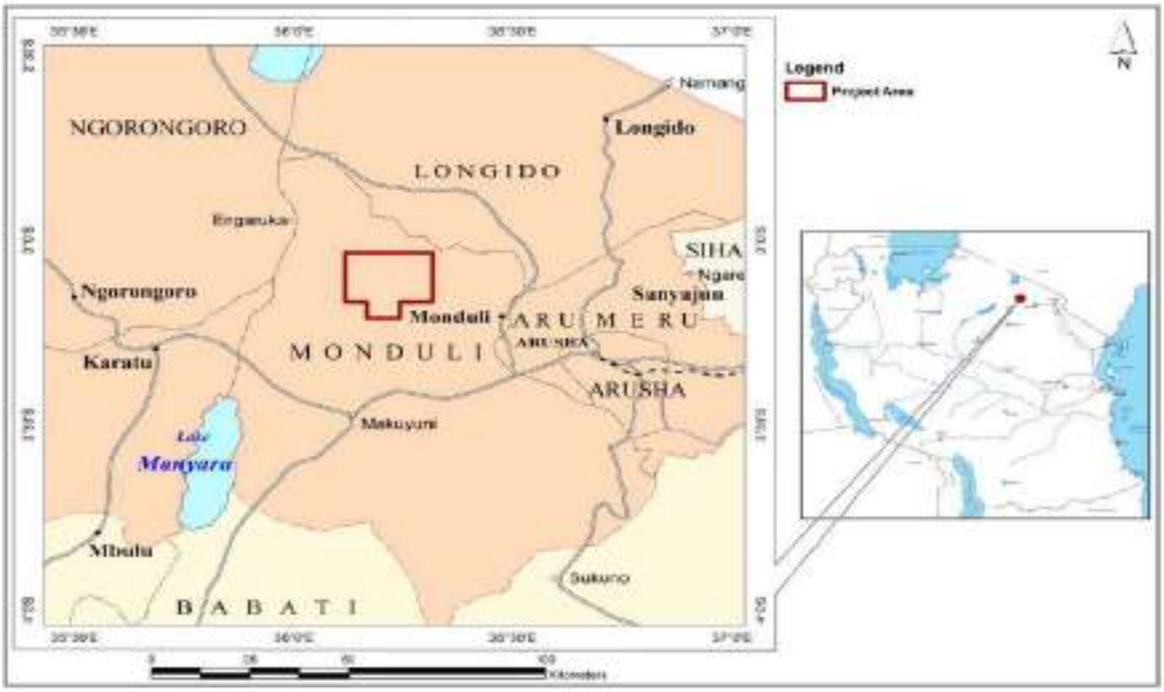
Letter from TGDC with details on modality of executing the project including cost estimates for 10MW power plant capacity

## NATIONAL DEVELOPMENT CORPORATION

# "TECHNO-ECONOMIC STUDY FOR SODA ASH PROJECT AT ENGARUKA IN MONDULI DISTRICT, ARUSHA REGION, TANZANIA"

### VOLUME VI

### PLANT AND TOWNSHIP SITES SELECTION AND INFRASTRUCTURES DESIGN




**Prepared By:**
**Tanzania Industrial Research and Development Organization**

**May 2021**

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## EXECUTIVE SUMMARY

This study covers item 3.5, 3.7.8, and 3.7.9 of the terms of reference for Engaruka Soda Ash Plant, namely plant Site, plant buildings and covered sheds and township and infrastructure.

The objectives to be fulfilled were assessment of most suitable area for the development of Plant buildings as well to township buildings of soda ash project. The study includes selecting the most scoring criteria among three selected options which are Plant Site options and township options

The criteria for selecting the most suitable township and plant site includes ecological factor, assessment of physical outlook of soil degradation; flooding history for project area, geological situation of the area, infrastructure construction cost reports from other professions for instance technology report, environment reports, natural resources reports and engineering reports.

Regarding to ToR, three layouts for township were designed in different location but the most scoring point was selected as the most suitable area, found close to the edge of project area.

Architectural designing for plant site building are much based on layout and dimensions found in ToR, includes arrangement of factory buildings, administration buildings, changing rooms, packaging building, security building, control rooms, boiler building, loading bay building, coal store buildings, power plant building, generator building, laboratory building, fire building and dispensary building.

The total bill of quantity (BOQ) for plant buildings are of **USD 7,835,317.** This estimated based on standard of AQRB Board of Tanzania. This includes all buildings and Industrial water ponds.

Township buildings were designed based on arts of township layout and historical background of project area. Project area is commonly located in rift valley regions on which the most preferable buildings are single storey buildings. Designing residents building were taken into consideration regarding to the plant managerial staff. The building categories in township are; building type **A** has 10houses for top managements, building type B has 20 houses for middle Supervisors, building Type C has 50 for Artesian. On the other hand, Village house has been proposed for official guests.

In the proposed area, different social services have been considered such as community health center, community church, community nursery and primary school, community shopping center (local market), community function hall, police post, recreational area like swimming pool, pray ground and community open garden. The existence of these social services favors the establishment of the TOR plant.

After feasibility study and architectural designing of township buildings the bill of quantities (BOQ) are estimated to total amount of **USD. 4,368,634.** Thi**s** BOQ includes all township facilities and buildings.

To the most selected suitable area for plant site and township buildings, it is recommended to the establishment of new roads connections which join main roads (Mto wa Mbu to Engaruka Village) about 30Km before reaching Engaruka village center, lastly this alternative road it is more economical since save about 35Km rotation of the existing road.

Finally, it is recommended that, the government should invite other stakeholders specializing in Real Estate development such as NHC and TBA to invest in the proposed township in order to attract more investors, this means Investor may concentrate with main activities while resident’s buildings and other community facilities can be under NHC or TBA. The village has to undergo resettlement plan in order to accommodate newly established social services.

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## ABREVIATION & ACRONOMY

| | | |
|---|---|---|
| AHP. | - | Analytic hierarchical process |
| AQRB | - | Architect& Quantity Surveyors Registration Board |
| BOQ. | - | Bill of Quantity |
| DELPHI. | - | Decision making methodology |
| ESIA | - | Environmental Social and Impact Assessment |
| NDC | - | National Development Corporation |
| NHC | - | National Housing |
| PROMETHE. | - | Preference ranking organization method for enrichment evaluation |
| TBA | - | Tanzania Building Agency |
| TIRDO | - | Tanzania Industrial Research and Development Organization |
| ToR | - | Term of Reference |

# CHAPTER ONE

# 1. SELECTING SUITABLE PLANT AND TOWNSHIP SITES

## 1.1. Introduction

The National Development Corporation (NDC) is carrying out techno-economic study for establishment of economically, environmentally and socially sound soda ash plant at Engaruka district in Tanzania, including associated infrastructure. Based on the market study (Chapter 1), the planned plant should have an initial production capacity of 500,000 tons of soda ash per year which will expand production to 1,000,000 tons per year as the market grows. However as reported in the appraisal of brine resource (Chapter 2), the available raw materials can support higher production capacity up to one million tons per year.

This study is meant to inform the government on the appropriate and most economical technology for the same. The techno-economic study will also provide a bankable feasibility study for mobilization of the required resources (human, technology, financial) for the project. It is against this background TIRDO was invited as a Consultant to provide expertise in this.

This Chapter addresses one component of the Terms of reference (ToR), namely Township and Plant Site.

## 1.2. Objectives

### 1.2.1. Terms of reference

According to the ToR, the scope of this Chapter is limited to assessing the following issues:

**A. Plant Site**

This includes:

- ⇨ Propose relevant criteria for selecting the most suitable plant site including accessibility and proximity to raw materials, water sources market centers, environmental issues (cost of environmental protection), site preparation work (cost of earthworks), etc.
- ⇨ Select various suitable plant sites and come up with at least three (3) options for detailed evaluation;
- ⇨ Basing on the proposed criteria, select the most suitable plant site.

**B. Plant Buildings and covered sheds**

This includes:

- ⇨ Plant buildings and cover sheds;
- ⇨ Offices;
- ⇨ Workshops;
- ⇨ Stores (spare and finished products);
- ⇨ Operator rooms (e.g. changing rooms etc.);

- ⇨ Other service buildings (canteen, training, administrative blocks, etc.);
- ⇨ Detailed investment cost estimates.

### C. Township and Infrastructure

This includes:

- ⇨ Proposing relevant criteria for selecting most suitable area for establishment of township within vicinity of the plant area.
- ⇨ Selecting various suitable township sites and come up with at least three (3) options for detailed evaluation and recommend the most suitable;
- ⇨ Preparing a layout plan of the township facilities and infrastructure (housing, roads, health center, schools, police post, shopping center, playgrounds, local authority offices, recreation areas, etc.);
- ⇨ To estimate investment Cost.

## 1.3. Approach and methodology

To implement this project, the general approach focused on the following activities:

i. Visiting the site to assess characteristics, raw materials and utilities sourcing locations in relation to the plant site;
ii. Analyzing information obtained from the Client and various Consultant teams to establish the appropriateness/suitability of the raw materials in relation to the technology options recommended;
iii. Developing project Maps, Architectural design of Buildings and detailed investment cost.

# CHAPTER TWO

# 2. PLANT SITE

## 2.1. Overview

A Plant site is a certain tract of land upon which the plant is located. Selecting a site for plant is far more than deciding where the new corporate headquarters should be built.

The selection of plant site involves a number of factors such as financial issues, environmental study, Health and safety requirements, ecological factors and physical nature of soil. The study use physical grounds verifications on landscaping and terrains, picking coordinates helps analyzing the suitable plant site area through spatial data analysis.

## 2.2. Methodology applied on selecting Plant Site

Different techniques and discussion with different professional expertise like environmental experts. Geologist (Resources Experts) Business Markets Study, Technology Engineers have been used for selecting effective site for plant site building using suitable constraints and criteria. Also, joint consideration of multiple alternatives and evaluation criteria in assessment several object procedures are adopted these involve tangible and intangible criteria. Three integrated decision-making methodology is applying to DELPHI Analytic Hierarchical process (AHP) and preference ranking organization method for enrichment evaluation (PROMETHE). Through modified DEPHI help on selecting the most influential Criteria by few professional experts engaged in the project.

### 2.2.1. Data Collection

The Hand-held GPS is employed for the collection of geographic data during field navigation.

Geographical Datum used during data collection is Arc1960 Zone 37 South. The exercises involve taking corner point by GPS which helps preparation of m shape file. Data obtained from field investigation survey used as a road map on preparation of town designing on which the architectural drawings have to follow in, the position of many features which were mainly footpath, mountains, lake, Drilled Boreholes were collected. The positions of these features were plotted on a base map consisting of the concession boundary, roads, and survey controls.

### 2.2.2. Criteria for Plant Site Selection

**General Overview of selecting the most suitable area includes;**

- ⇨ **General Water Flows surveys**

  The study focusses on a details historical water flows of the area from the upwards hills to the low level is vital, since the area comprises both upland and low land. details analysis was deployed to avoid the shortcoming upon construction of the plant sites buildings. The survey content is generally as follows.

- ⇨ **Survey of rainfall drainage stream**

  The area is not getting enough rainfall throughout the year as a results Rivers are seasonal flowing during rainfall time. The River drainage system are dry with no flow of water during dry season, historical information from the indigenous was vital on getting real information.

- **Historical flood surveys**

  The study was taken into consideration by looking those areas affected by floods on the rainfall season, different area lefts with flooding mark. Different discussion with villagers gave us a straight point knowing flooding area during rainfall season. Through this survey helps on deciding where to select suitable plant site area.

- **Water conveyance line surveys**

  The study also looks on topographical and geological conditions along the water drainage patterns. Unfavorable landforms such as landslides, collapse and large spans of aqueducts shall be specifically evaluated. Selecting a straight river section, focusing on bridges, ancient monuments, bends, and river meandering, to check the traces of flood marks.

- **Transportation Facility:**

  Looking on the easiness reaching to the plant site by minimizing cost of construction for bridges, roads and railway connections, is economical vital finding the alternative roads which may minimize construction cost during infrastructure development.

- **Expected plant expansion**

  Future expansion of the mining activities is necessary to be taken into consideration on selecting the suitable area by looking geological map exploration survey report, helps to select the best area which has no effect on the future plant mining expansions.

- **Physical nature of soil:**

  Physical soil observation was a serious cases investigation, here the soil was not tested on the laboratory but just by observing by eyes whereby other piece of land has soil erosion and degradations on which is not suitable for the development of plant sites.

- **Ecological Factor:**

  Through different consultation from environment experts and ESIA reports helps on studying the ecological of wild animal in the corridor as the results helps on deciding the best place of establishing plants sites with minimal ecological effects.

Best Scoring Chart for Selecting Suitable Plant Site

Table 2.1: Show the average total scoring of suitable plant site from different Project stakeholder

| SN | Criteria | Site I | Site II | Site III | Total Scoring from different Project stakeholder |
|---|---|---|---|---|---|
| 1 | Closeness to the site and Raw material | 0.5 | 0.3 | 0.2 | 1 |
| 2 | Fresh Water sources | 0.4 | 0.3 | 0.3 | 1 |
| 3 | health and Safety | 0.5 | 0.3 | 0.2 | 1 |
| 4 | Energy Availability | 0.4 | 0.3 | 0.3 | 1 |
| 5 | Waste Disposal | 0.4 | 0.3 | 0.3 | 1 |
| 6 | Geographical terrain | 0.4 | 0.4 | 0.3 | 1 |
| 7 | Transportation Facility | 0.4 | 0.3 | 0.3 | 1 |
| 8 | Expected expansion | 0.4 | 0.3 | 0.3 | 1 |
| 9 | Site Accessibility | 0.5 | 0.25 | 0.25 | 1 |
| 10 | Physical nature of soil | 0.3 | 0.3 | 0.35 | 1 |
| 11 | Ecological Factor | 0.4 | 0.4 | 0.2 | 1 |
| 12 | Rain Water Effect (Flood) | 0.35 | 0.35 | 0.3 | 1 |
| | TOTAL | 4.95 | 3.8 | 3.3 | 1 |

### 2.2.3. Three Suitable Plant Site

The results obtained from the study are presented in the following sub-sections. The results of each of the stages have been presented.

The assessment came out with three options for the plant Sites with their corresponding Township Sites, due to the slope terrain of the project area, two sites have been found besides the project area.

The technology report requires 9ha for plant site, but this report propose 20Ha per for plant site which is around two times of proposed size, where by the remain area can be used for future uses

### 2.2.4. Plant Site I

This Plant site is located 15Km from Engaruka town center (South West) and 10 Km from the center of Engaruka Lake (South West). The area can accommodate proposed 50Acres (20Ha) for Plant Site. The area is identified as plant site number One, having total scoring points from other different stakeholders (Resources expert, Environmental Expert, Transport and Logistic, Expertise Market Study, Technology Study Expertise) of 4.95 points. Here are the Coordinates of Corner Points and its Elevations above Sea Level

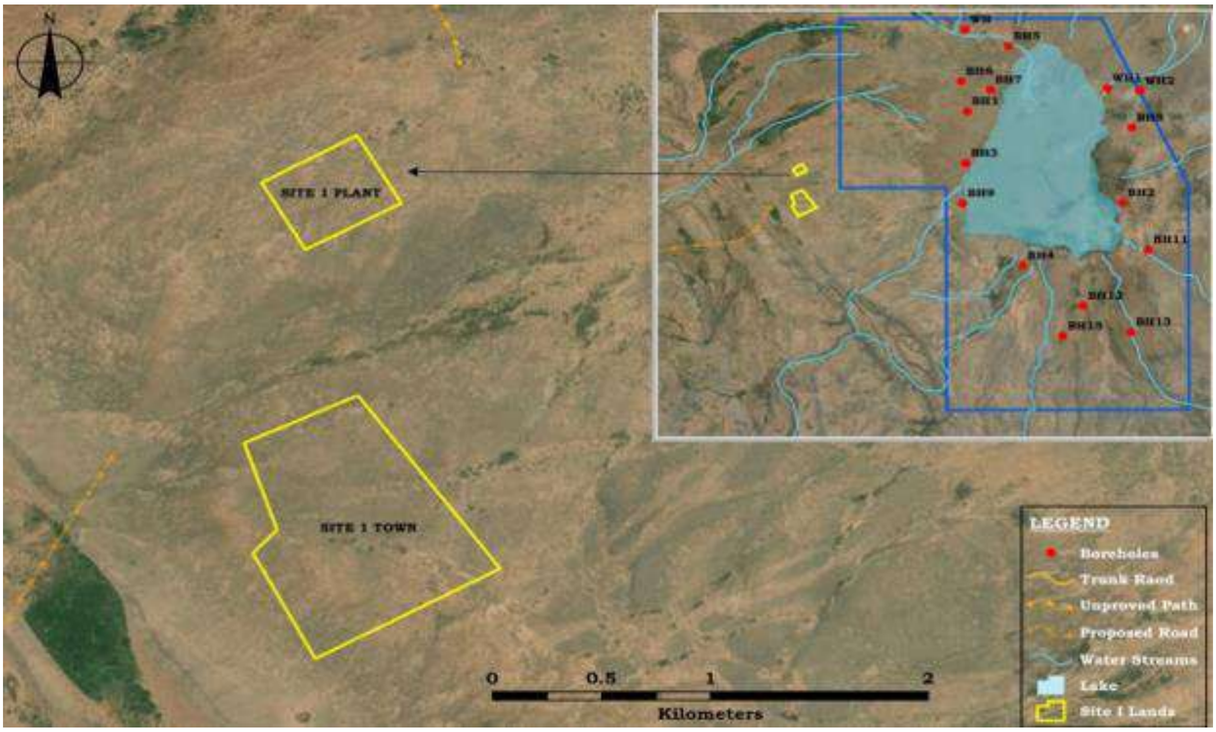


Figure 2.1: Plant Site I

Table 2.2: ShowCoordinates of Corner Points and Elevations Above Sea Level

| NAME | EASTINGS COORDNATES | NORTHINGS COORDNATES | ELEVATION METERS |
|---|---|---|---|
| Point A | **173588.36** | **9656164.04** | **787.6032** |
| Point B | **172797.02** | **9655756.58** | **804.672** |
| Point C | **172417.53** | **9656441.36** | **797.052** |
| Point D | **173206.93** | **9656819.94** | **788.2128** |

### 2.2.5. Plant Site II

The Area can accommodate proposed 50Acres (20Ha) for Plant Site, found just at the edge of project boundary west side about 15Km from Engaruka village Centre. The area has scoring points of 3.8 from other suggestion of project expertise for instance; Resources experts, environment expertise, Transport expertise, Technology expertise and Market expertise. Project area has minimal flooding effect history, free from rivers drainage system, free from soil degradation and good land for future expansion.

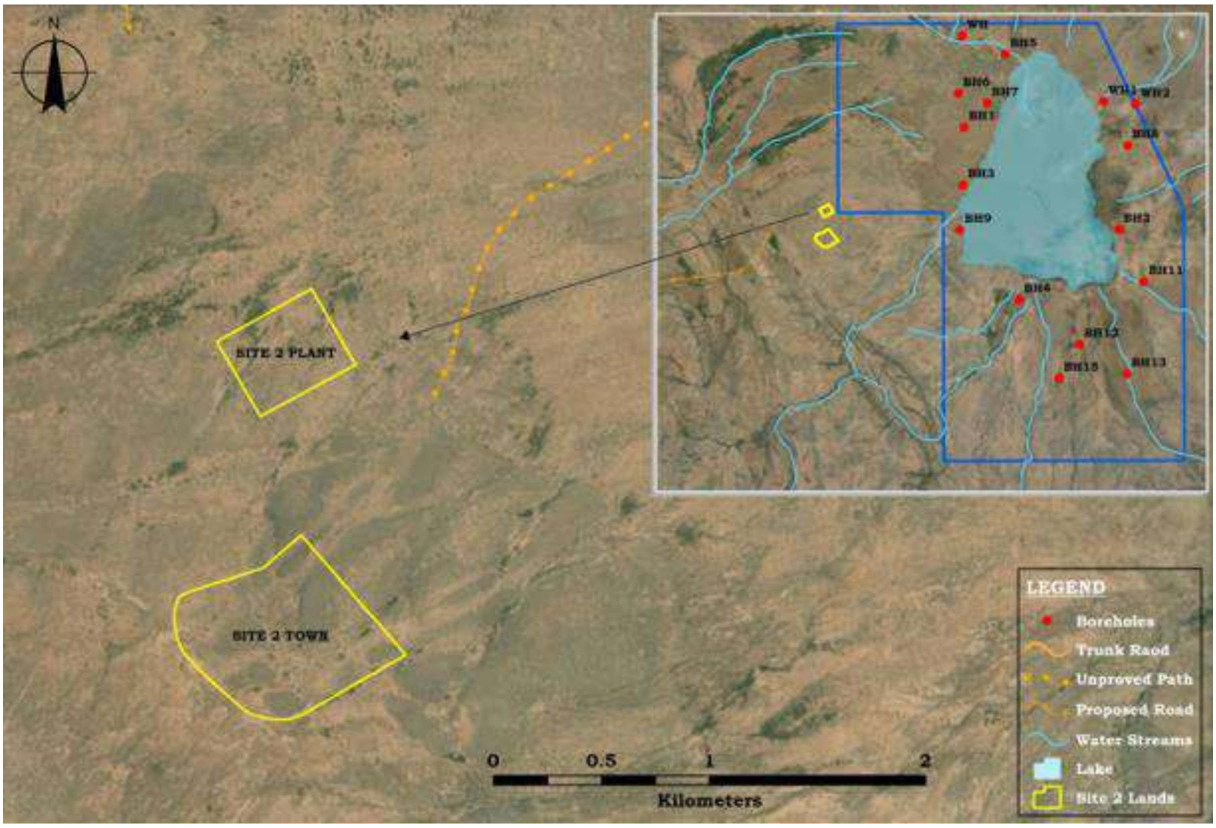


Figure 2.2: Plant Site II

The Datum coordinates used are of ARC 1960 zone of 37s and all coordinates was taken by RTK GPS. This area is recommended as option plant site number Two. With corresponding coordinates XY format.

Table 2.3: ShowCoordinates of Corner Points and Elevations Above Sea Level

| NAME | EASTINGS COORDNATES | NORTHINGS COORDNATES | ELEVATION METERS |
|---|---|---|---|
| Point A | **174411.77** | **9655842.15** | **779.3736** |
| Point A | **173910.38** | **9655502.19** | **795.2232** |
| Point A | **174996.43** | **9655041.25** | **784.5552** |
| Point A | **175091.11** | **9655130.25** | **777.8496** |

### 2.2.6. Plant Site III

The Plant site is located 13Km from Engaruka town center and 2Km from Engaruka Lake. Plant site has total area coverage 50 Acres (20Ha)

The area is identified as Plant site number three having total scoring points of 3.3 from other different project stakeholders professional and natives. The area is free from flooding history, free from water drainage streams and swamp area as shown in the map legend bellow marked with faint blue stream in the map, this plant site found a nearly boreholes number 6, which make difficult access to other Boreholes

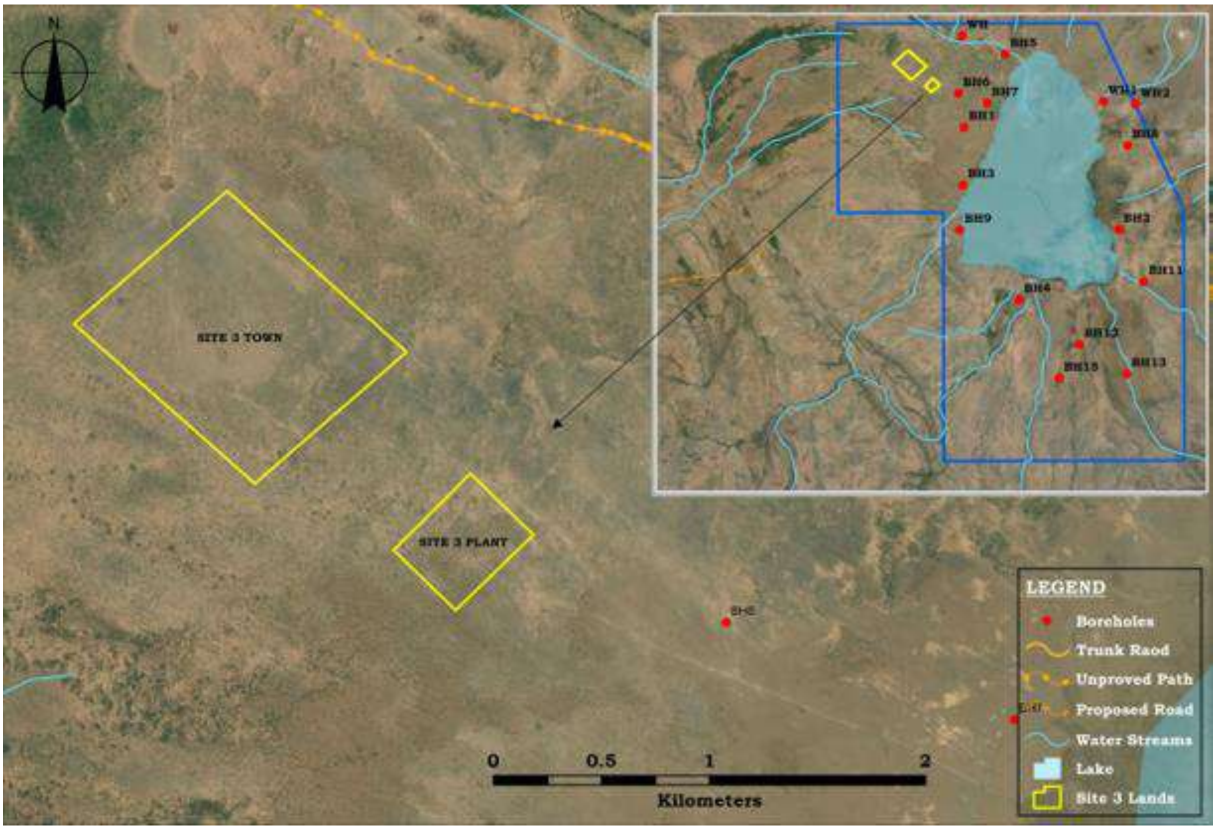


Figure 2.3: Plant Site III

Generally, the area is easily accessible to the connections of the main roads from Mto wa Mbu to Engaruka Village.
The Site has some disadvantage like; -

- The site has interaction with movement of wild animal which may bring ecological effect.
- It's hard to expand the site since it found nearly the boreholes location.

Here down are the Coordinates of the Site Location under the Datum of UTM ARC 1960 zone 37s.

Table 2.4: ShowCoordinates of Corner Points and Elevations Above Sea Level

| NAME | EASTINGS COORDNATES | LONGITUDE COORDNATES | ELEVATION METERS |
|---|---|---|---|
| **Point A** | 179713.93 | 9660911.02 | 729.6912 |
| **Point A** | 180166.22 | 9661257.07 | 721.4616 |
| **Point A** | 180075.54 | 9661547.79 | 726.0336 |
| **Point A** | 179930.58 | 9661840.78 | 728.472 |

### 2.2.7. Most Suitable Plant Site

The option of Plant site number one is the most suitable area regarding to scoring criteria from different factors of investigation on ground those factors include, ecology factor, resources factor, accessibility to plant site, market study, transport and logistic. The option site I has a total 4.95 points over the whole three selected criteria, which make it to be the best location for plant site overall sites.

But this site may require new access road since the current used path are now well advised to be developed as option to reach this area

The area is free from flooding history, free from water drainage streams and swamp area as shown in the map legend bellow marked with faint blue stream in the map, plant site found at Centre of all boreholes and makes easily accessible to whole boreholes found with the project area. Generally, the area is easily accessible to the connections of the main roads from Mto wa Mbu to Engaruka Village. Plant site has a minimal animal ecological effect. Also, it has extra land for future expansion.

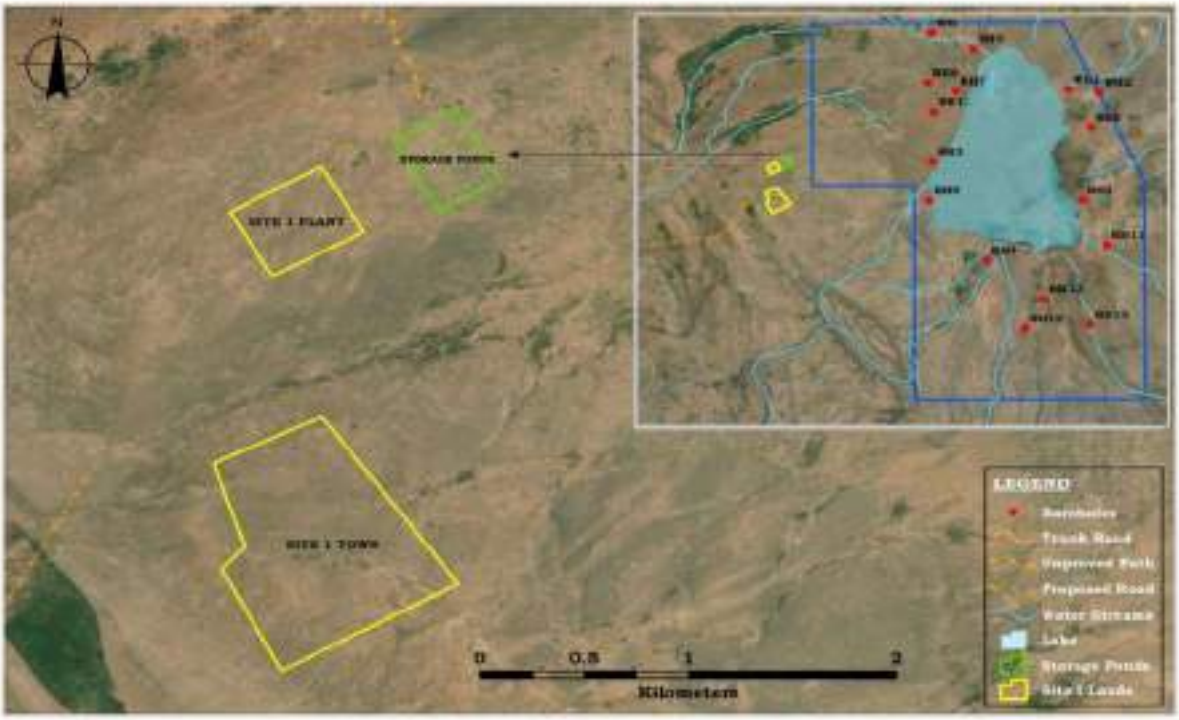


Figure 2.4: Suitable Plant site with Ponds Site

But this site may require new access road since the current used path are now well advised to be developed as option to reach this area

Since this Plant Site I is the suitable overall mapped Plant sites, even the storage Ponds area was selected nearly this Plant site

Here down are the Coordinates of the Storage Pond Site Location under the Datum of UTM ARC 1960 zone 37s.

Table 2.5: Show Coordinates of Corner Points and Elevations Above Sea Level

| POINT | EASTINGS COORDINATE | NORTHINGS COORDINATE | ELEVATION METERS |
|---|---|---|---|
| CENTRE | **173819** | **9656701** | **782.1168** |
| E1 | **173562** | **9656810** | **784.86** |
| E2 | **173863** | **9656977** | **780.5928** |
| E3 | **174077** | **9656593** | **776.9352** |
| E4 | **173775** | **9656425** | **782.1168** |

### 2.2.8. Plant Buildings

Designing of plant buildings focus on layout designed by technology team, the architectural drawings are drawn based on the dimensions obtained from technology report. Three plant sites were observed, preferable option site number one as the most suitable area for plant site buildings development. All plant sites options found at Engaruka Chini Village.

Plant site buildings include:

i. Factory
ii. Administration Block
iii. Changing Room
iv. Packaging Block
v. Loading Bay
vi. Canteen
vii. Fire Block
viii. Boiler Block
ix. Coal Store
x. Power Plant
xi. Control Room
xii. Security Block
xiii. Dispensary
xiv. Visitors Room
xv. Generator Room
xvi. Laboratory

Plant sites buildings layout is deployed to show different buildings arrangement.

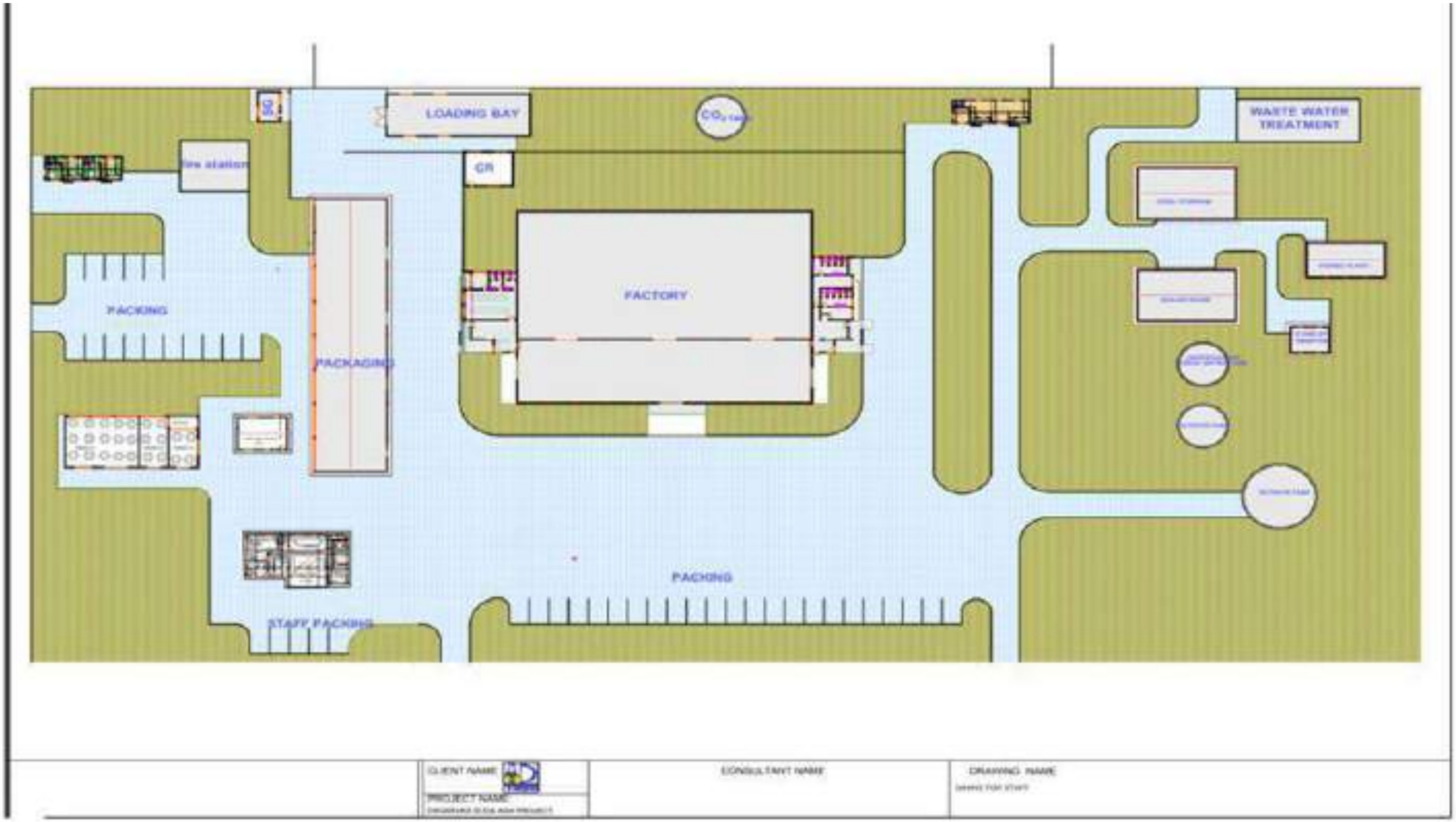


Figure 2.5: Plant sites buildings layout

Figure 2.6: General view images of plant buildings

Over view general images for plant site in three dimensions look after development of architectural designing

### 2.2.9. Investment Cost Estimates for Plant Buildings

The estimates for investment cost for plant site has been taken I regarding to the buildings arranged in plant area with correspondents to their cost. The details cost estimates is attached as appendix in this report.

Table 2.6 Show investment cost estimates for plant buildings

| **Name** | **Cost in USD** |
|---|---|
| Factory Building | 1,170,968 |
| Canteen | 312,258 |
| Administration Block | 560,882 |
| Changing Room | 106,774 |
| Dispensary | 22,452 |
| Laboratory | 21,677 |
| Security House | 6,865 |
| Fire Block | 21,677 |
| Packaging Block | 40,688 |
| Loading Bay | 84,151 |
| Control Room | 18,065 |
| Coal Store | 20,645 |
| Boiler Room | 20,645 |
| Power Plant | 11,011 |
| Industrial Paving area (63,552sqm) | 546,237 |
| Visitors House | 16,989 |
| Generator Room | 5,161 |
| Industrial Water Pond | 4,774,193 |
| Plant site wall fence | 94,624 |
| **TOTAL PLANT BUILDING INVESTMENT COST IN USD** | **7,835,317** |

# CHAPTER THREE

## 3. TOWNSHIP SITE

### 3.1. Township and Infrastructure:

Planning in Tanzania is a statutory function practiced in accordance to the Town and Country Planning Ordinance (Cap 378) of 1956, revised in 1961 and recently reviewed to give way to two legislations including Urban Planning and Land Use Planning. The main guiding policy in this endeavor is the National Human Settlements Development Policy of 2000. This provides legal responsibility for preparing detailed plans in advance of development.

Planning is divided into two aspects which are general planning and detailed planning, detailed planning is further subdivided in detailed planning for new areas, detailed planning for urban renewal as well as detailed planning for regularization

**The followings are the general advantages of Township planning for a new area**

- **To guide urban growth and development,**
  Without planning town develop in mushrooming or squatter having poor service for example infrastructure like roads, sanitation, drainage, water, and electricity, these might result to pollution and general chaos of social and economic development. Hence threaten the health and welfare of the urban residents

- **Coordinate development and ensure efficient and effective use of land**
  Detail planning guides the use and development of land and buildings in an area, alignment of roads and other physical infrastructures, location of community facilities and amenities

- **Reduce land use conflict**
  Carrying detailed planning, allocation of land uses is located in the way that compatible and incompatible use are placed separately by considering the function and use of the space, for example nursery school and market these are two land use which do not complement to each other, hence in planning should be placed separately, because market play a role of some sort of noise and movement of people which reduce convenient to the nursery school which require some sort of silence

- **Enhance Diversity, workability, connectivity**

  Mixed housing and a broad range of housing types, sizes and price levels within the planning area, can encourage people of diverse ages, cultures, races, and income levels to interact, strengthening the personal and civic bonds essential to a livable community. Facilities and services that enhance daily living found within the walking distance. And hierarchies of interconnected networks of streets reduce the number and length of automobile trips and encourage walking

#### 3.1.1. Criteria of selecting suitable Township

Consideration for selecting township is same as was applied on plant site, since the area required for development of buildings is for plant workers during production time. The following are selected criteria:

- **Historical flood surveys:**
  Flooding historical background on selecting township, here involves serious survey project area as well to the edge boundary of the project area. Finally, we come with suitable place for development of township which is almost 1Km far from selected Plant site area.

- **Water conveyance line surveys**

Since the area has many river streams which used to allow flow of water during rainfall season, therefore selecting suitable township are much involves on avoid township on water catchment area. We advise to select the area which is free from water conveyance line.

- **Transportation Facility:**
  Based on different reports from Market study and infrastructures historical background developed in Monduli district, our team comes with the possible area which will minimizes infrastructure cost to join the main report road from Mto wa Mbu to Engaruka.
- **Physical nature of soil:**
  Soil was not tested on the laboratory but just physical observation like historical land degradation and soil erosion, effect on volcanic eruption was enough helping on making decision of where to select for township development.
- **Ecological Factor**
  Consultation from environment experts and passing through ESIA reports helps to identify the areas which are free from hunting blocks, animal movement corridor, area which is free from effect of biodiversity, free from polluting Lake Engaruka, during plant production.

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Table 3.1: Show average of selected three Criteria rate of selecting the suitable Township

| SN | Criteria for selecting suitable township and plant site location | Site I | Site II | Site III | Total scoring point from different project stakeholders and natives |
|---|---|---|---|---|---|
| 1 | Closeness to the site and Raw material | 0.5 | 0.3 | 0.2 | 1 |
| 2 | Fresh Water sources | 0.4 | 0.3 | 0.3 | 1 |
| 3 | health and Safety | 0.5 | 0.3 | 0.2 | 1 |
| 4 | Energy Availability | 0.4 | 0.3 | 0.3 | 1 |
| 5 | Waste Disposal | 0.4 | 0.3 | 0.3 | 1 |
| 6 | Geographical terrain | 0.4 | 0.4 | 0.3 | 1 |
| 7 | Transportation Facility | 0.4 | 0.3 | 0.3 | 1 |
| 8 | Expected expansion | 0.4 | 0.3 | 0.3 | 1 |
| 9 | Site Accessibility | 0.5 | 0.25 | 0.25 | 1 |
| 10 | Physical nature of soil | 0.3 | 0.3 | 0.35 | 1 |
| 11 | Ecological Factor | 0.4 | 0.4 | 0.2 | 1 |
| 12 | Rain Water Effect (Flood) | 0.35 | 0.35 | 0.3 | 1 |
| | **TOTAL** | **4.95** | **3.8** | **3.3** | **1** |

### 3.1.2. Layout for Township Facilities and Infrastructure

The study involves selecting three suitable areas for township development by their criteria rating from option one, two and three.

### 3.1.3. Township Site 1

The site is covering 222 Acres of Land. This site was selected as site option III for Township location after having total scoring of 4.8 points out of 5point for selecting suitable area for township development.

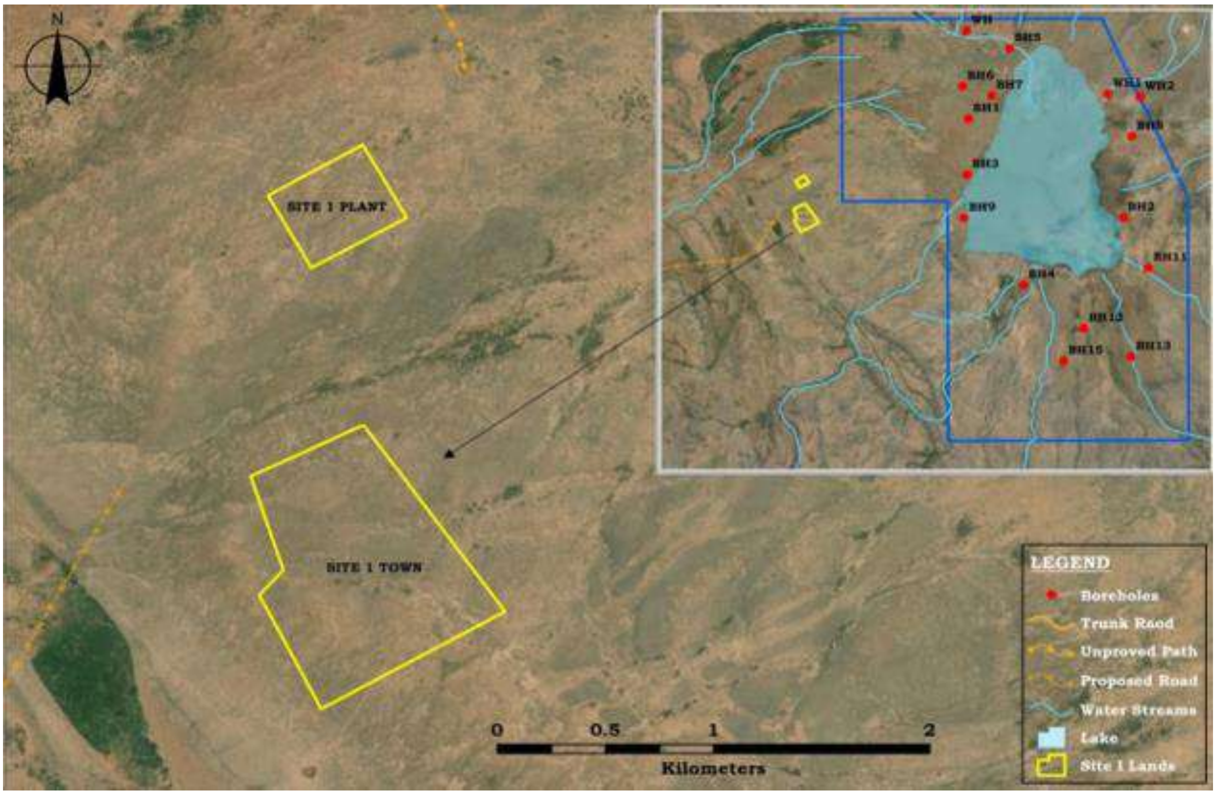



Figure 3.1: Township 1

Datum coordinates ARC1960 Zone 37s was taken, which helps to identify township boundaries and develop conceptualization of idea through putting all necessary requirements information's for township under Tanzanian legislation for township.

Table 3.2: Show Coordinates of Corner Points and Elevations Above Sea Level

| NAME | EASTINGS COORDNATES | NORTHINGS COORDNATES | ELEVATION METERS |
|---|---|---|---|
| Site 3 Town | **177862.64** | **9661930.33** | **739.4448** |
| Site 3 Town | **178564.76** | **9662540.45** | **736.092** |
| Site 3 Town | **177734.06** | **9663286.38** | **742.7976** |
| Site 3 Town | **177024.93** | **9662671.19** | **743.712** |

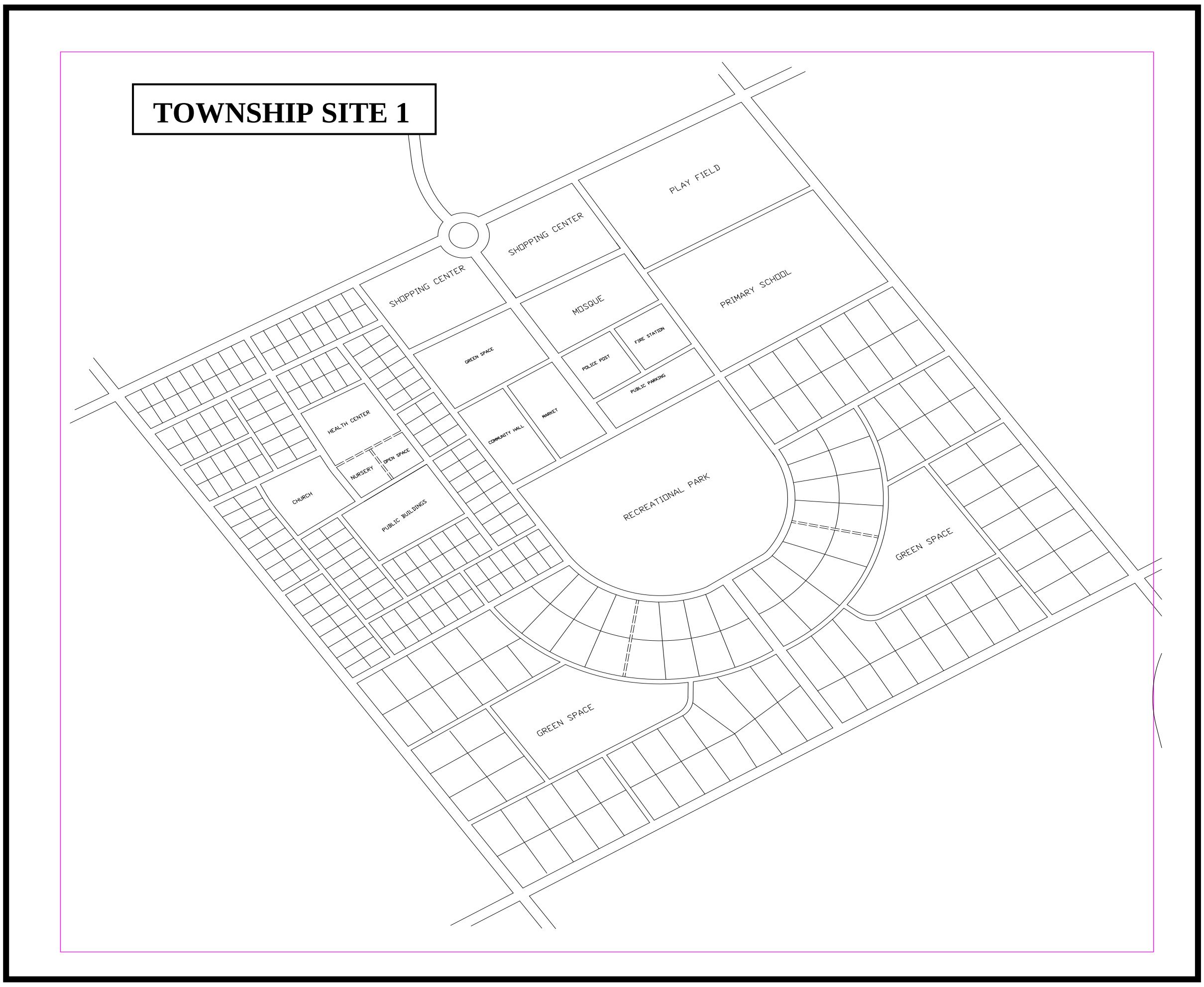



Figure 3.2: Township 1 Planning Layout

### 3.1.4. Site II for Township

The site has 150 Acres coverage. This site was selected as site option II for township location after having total scoring of 3.8 points out of limit of 5point for selecting suitable area for township development.

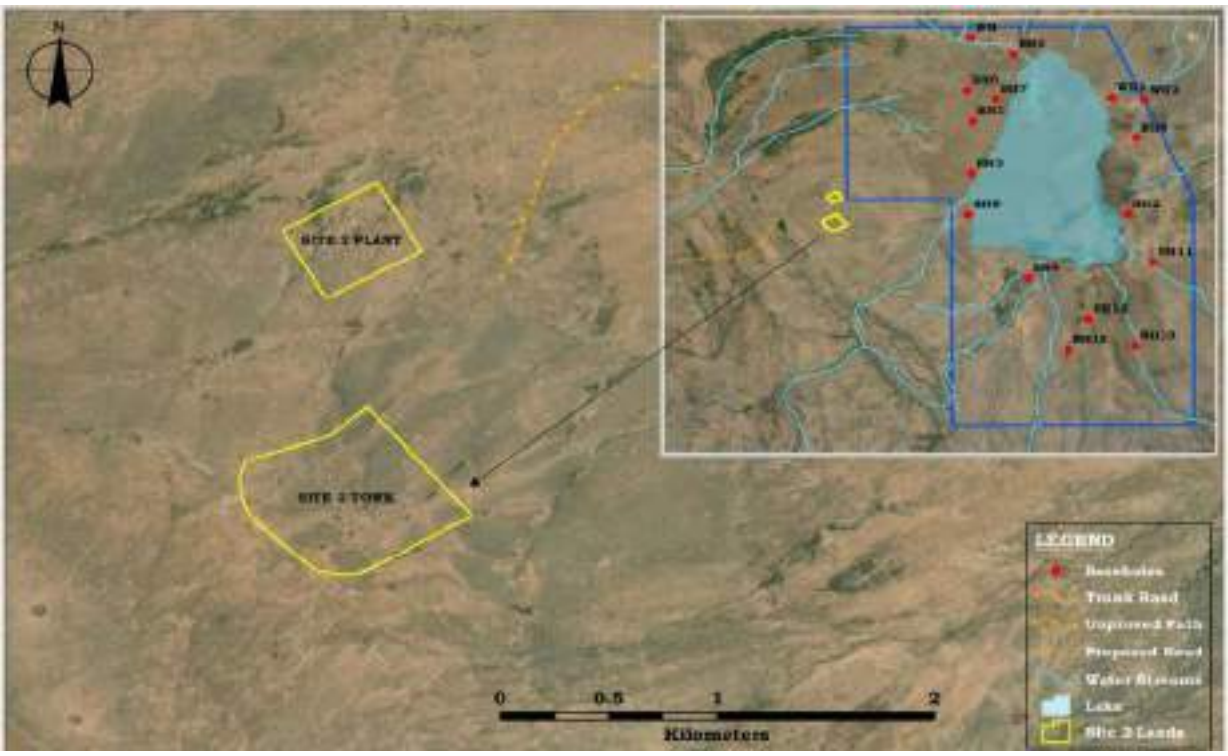


Figure 3.3: Township **2**

Coordinates was taken under Datum of ARC1960 Zone 37s, which helps to identify township boundaries and develop conceptualization of idea through putting all necessary requirements information's for township under Tanzanian legislation for township. The following below are coordinates executed.

Table 3.3: ShowCoordinates of Corner Points and Elevations Above Sea Level

| NAME | EASTINGS COORDNATES | NORTHINGS COORDNATES | ELEVATION METERS |
|---|---|---|---|
| Point A | **174168.40** | **9654813.91** | **809.8536** |
| Point A | **174652.37** | **9654258.24** | **807.72** |
| Point A | **174176.77** | **9653981.64** | **818.0832** |
| Point A | **173934.48** | **9653983.29** | **822.0456** |
| Point A | **173995.06** | **9654661.74** | **815.0352** |
| Point A | **173601.32** | **9654523.34** | **820.2168** |
| Point A | **173648.63** | **9654237.96** | **821.1312** |
| Point A | **173616.95** | **9654280.10** | **821.1312** |

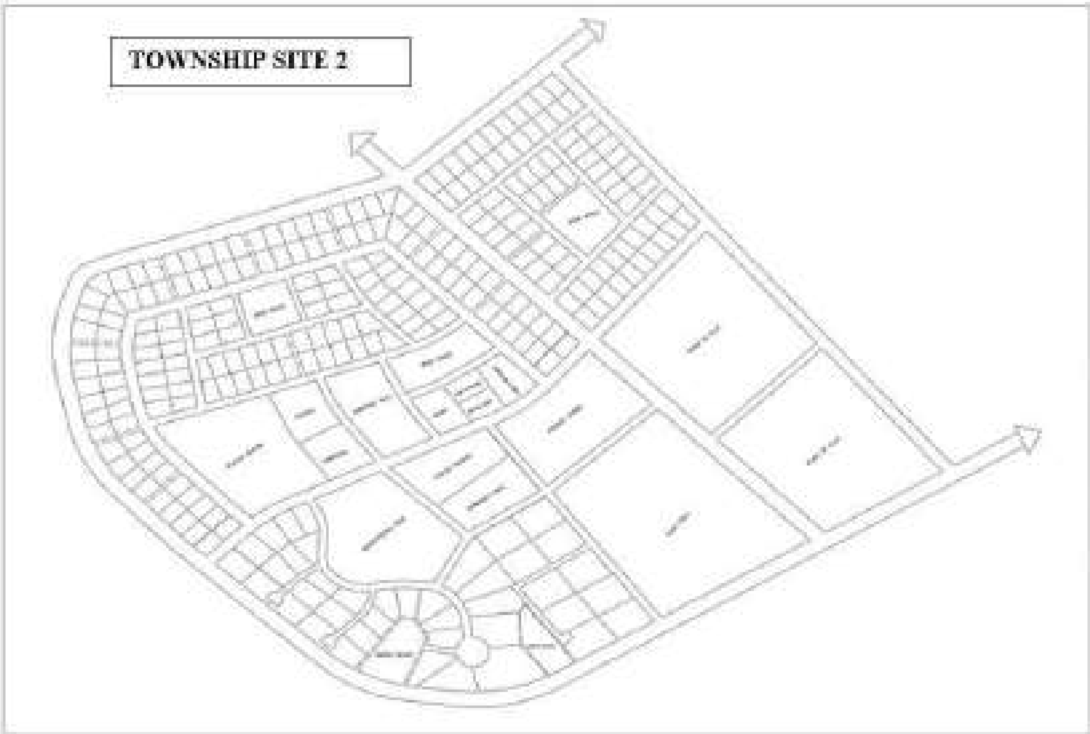


Figure 3.4: Township planning, layout number 2

### 3.1.5. Site III for Township

The site has 255 Acres coverage. This site was selected as site option III for Township location after having total scoring of 3.3 points out of 5points for selecting suitable area for township development,

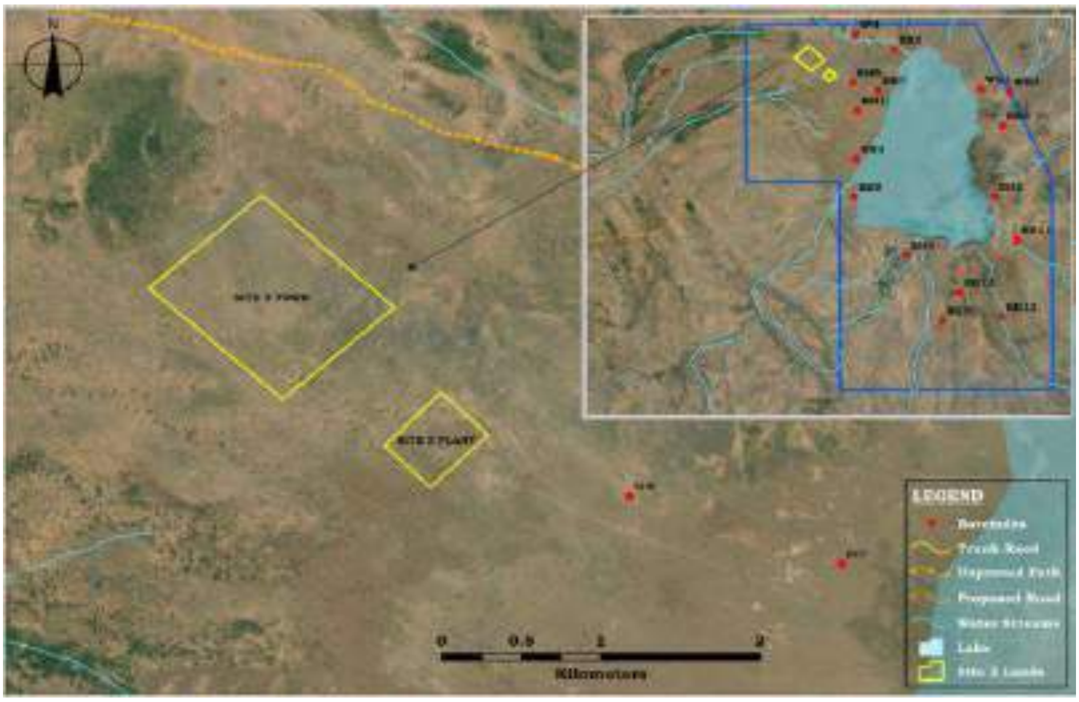


Figure 3.5: Township Site 3

Datum coordinates ARC1960 Zone 37s was taken, which helps to identify township boundaries and develop conceptualization idea through putting all necessary requirements information's for township under Tanzanian legislation for township

Table 3.4: Show Coordinates of Corner Points and Elevations Above Sea Level for township site No.3

| NAME | EASTINGS COORDNATES | NORTHINGS COORDNATES | ELEVATION METERS |
|---|---|---|---|
| Point A | **172711.76** | **9654080.42** | **837.8952** |
| Point A | **173561.05** | **9654548.40** | **820.8264** |
| Point A | **172906.83** | **9655444.58** | **805.2816** |
| Point A | **172385.30** | **9655196.97** | **821.1312** |
| Point A | **172424.82** | **9654627.07** | **831.7992** |
| Point A | **172536.43** | **9654746.94** | **830.2752** |

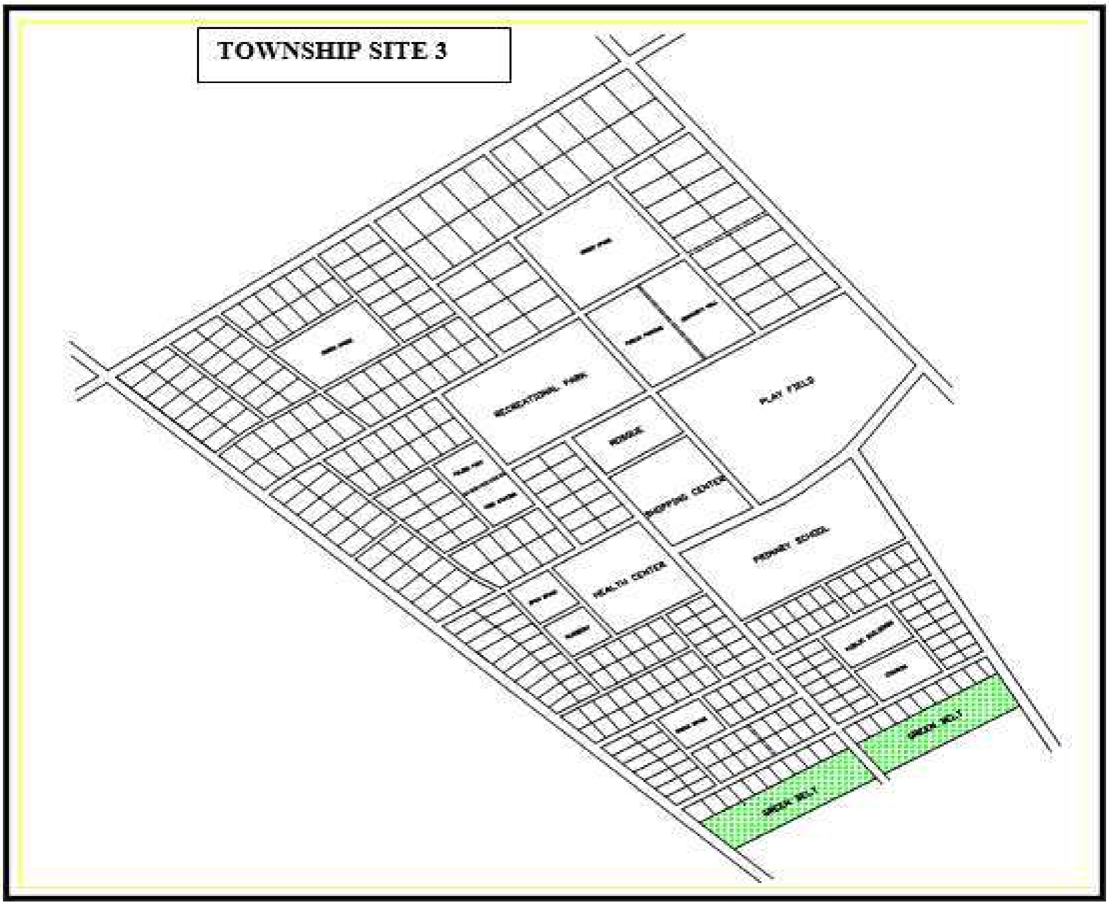



Figure 3.6: Township 3 Planning Layout

### 3.1.6. Three Dimension Overview of Township

General overview of township layout in three dimensions showing different features incorporated in township which includes; Housing residence, play grounds, Recreational area and Community services. This done through by designing each feature with its own designing and incorporate in general town planning drawings.

Figure 3.7: General view of township planning

Figure 3.8: General view of some buildings in township planning

### 3.1.7. Investment Cost Estimates

Township involves designing of different building facilities which is supposed to be accommodated in town the following are the list of building s and their correspondent Cost.

Table 3.5: Investment cost estimates for township buildings

| **Cost for Township** | | |
|---|---|---|
| **S/N** | **Name** | **Cost in USD** |
| 1 | Community function hall | 45,847 |
| 2 | Type C-Residential Building (**USD 37,251**per house, Proposed 50house | 1,862,550 |
| 3 | Type B-Residential Building (**USD 40,343** per House, Proposed 20House | 806,860 |
| 4 | Type A-Residential Building (**USD 43,430** per House) Proposed 10House | 434,300 |
| 5 | Villa houses for quests | 262,177 |
| 6 | Health Centre | 95,674 |
| 7 | Public garden area (21000sqm) | 219,807 |
| 8 | Swimming Pool 50mx25m Inter Standard | 289,699 |
| 9 | Play Ground (Basket cost, football, valley ball& netball | 69,269 |
| 10 | Project wall fence | 282,452 |
| | TOTAL TOWN INVESTMENT COST | **4,368,634** |

## CHAPTER FOUR

## 4. RECOMMENDATION

### 4.1.Access Road (Proposal)

During site survey is advised to use alternative road which is about 10km from Plant site to the connection of Main road from Mto wa Mbu to Engaruka Village. Existing road rotation from Mto wa Mbu to proposed Plant site is about 71km with many rivers drainage system but the newly proposed alternative has 41km with a minimum rivers drainage System.

Below is well elaborated insert Map for Plant site with both existing rotation road to plant site and alternative proposed to alternative road which is identified on the legend key map.

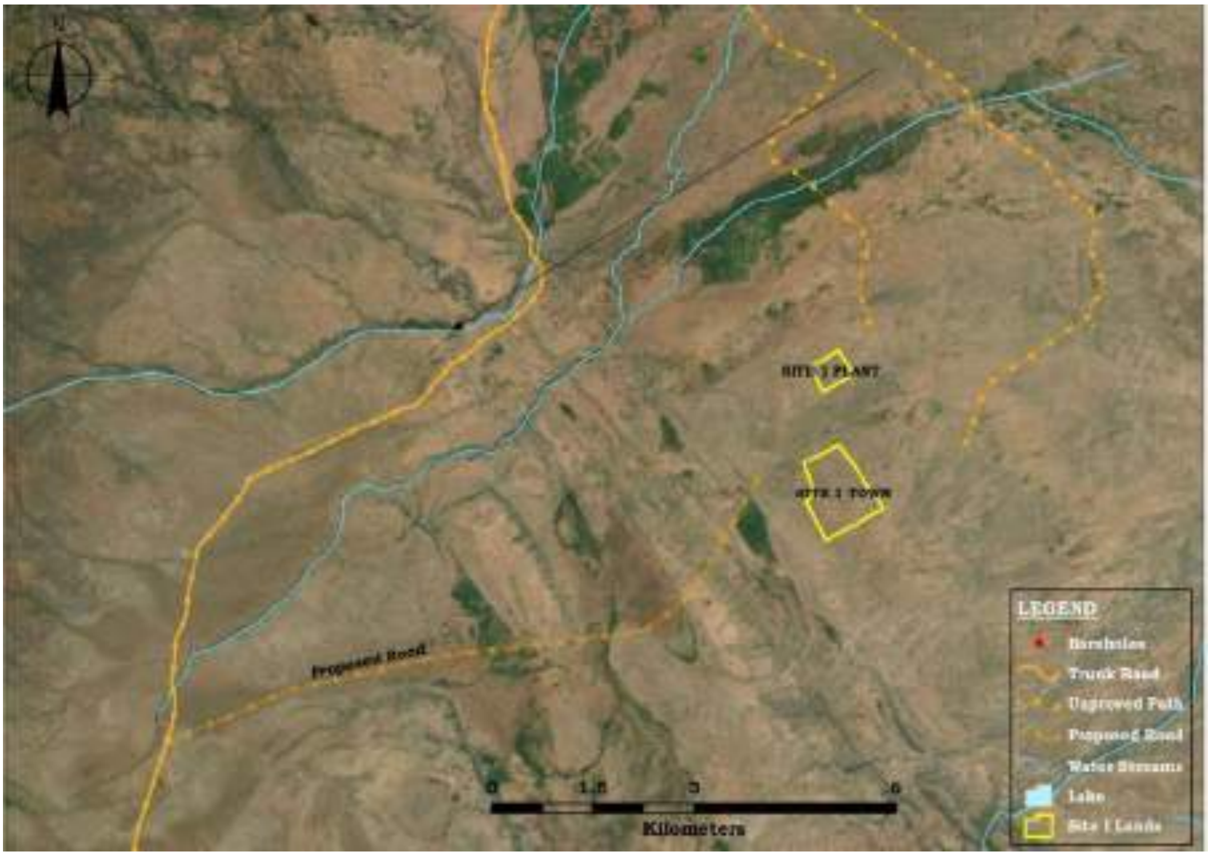



Figure 4.1: Proposed Road Location

**NOTE**: The Government is advised to invites other real estate's stakeholder like NHC and TBA to concentrate with development of township residential property which will be leased to plant workers and investor to concentrate with core activities.

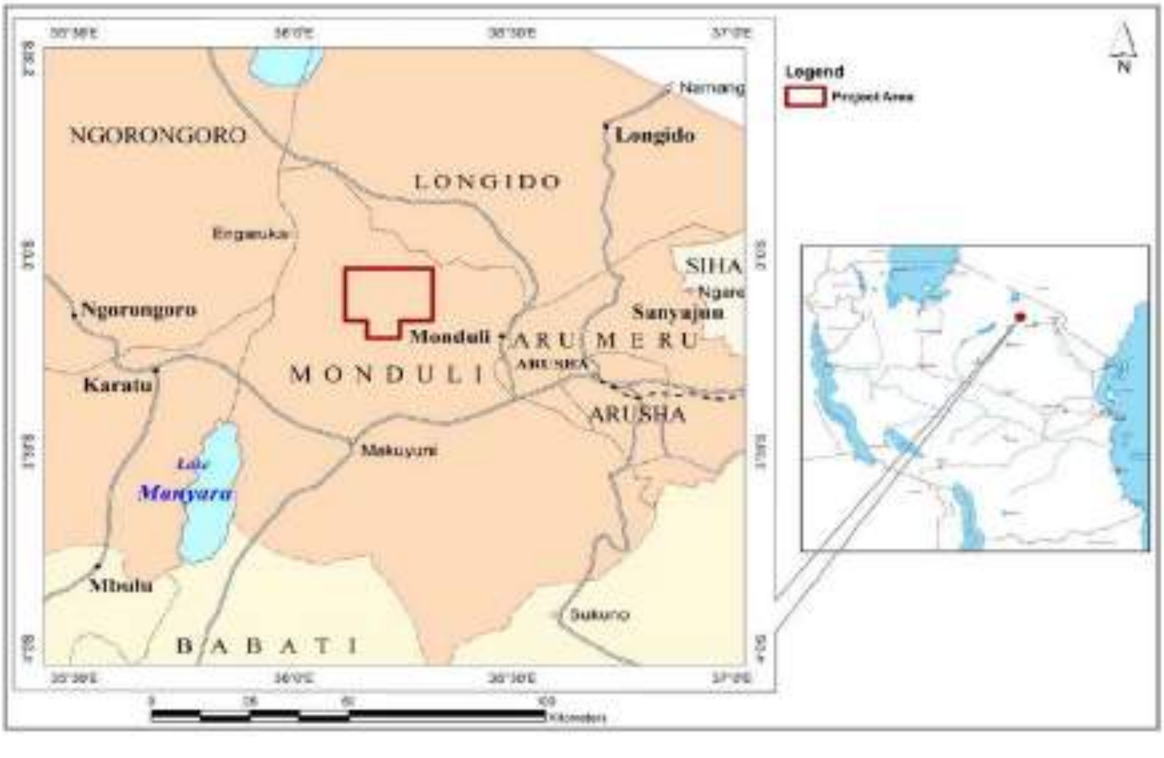
The investor may provide only transport cost during production from Engaruka village Centre to plant site, also may help on improvement of existing school, health centre and pray ground at Engaruka village Centre.

NATIONAL DEVELOPMENT CORPORATION

# “TECHNO-ECONOMIC STUDY FOR SODA ASH PROJECT AT ENGARUKA IN MONDULI DISTRICT, ARUSHA REGION, TANZANIA”

## VOLUME VII

## TRANSPORT LOGISTICS ASSESSMENT




**Prepared by:**
**Tanzania Industrial Research and Development Organization**

**May 2021**

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## EXECUTIVE SUMMARY

The National Development Corporation (NDC) plans to set up a plant for production of Soda Ash at Engaruka in Monduli District, Arusha Region. The initial production is planned to be 500,000 tons per year. Later on production will be increased to 1,000,000 tons per annum.

Brine which is abundant in Lake Engaruka basin and therefore doesn't need transport to the plant is the main raw material for production of Soda Ash and other products. Other raw materials include Coal, fuel and Carbon dioxide which would require transport from their respective sources as shown in the below table.

Table 0.1: Engaruka Soda Ash Project Cargo O – D Matrix

| **A** | **SODA ASH PRODUCTS** | | | | |
|---|---|---|---|---|---|
| | **DESCRPTION** | **ANNUAL QTY TONNES** | **TYPE OF PACKAGING** | **ORIGIN** | **FINAL DESTINATION** |
| 1. | Sodium Carbonate | 400,000 | 50 kg /1,000 kg bags. | Engaruka | Tanga / DSM for export and 4 depots for local consumption |
| 2. | Sodium Bicarbonate | 100,000 | 25/50 kg bags | Engaruka | Proposed 4 depots at Arusha, Mwanza, DSM and Dodoma |
| **B** | **RAW MATERIALS/ ENERGY** | | | | |
| 1. | Coal | 190,065 | Bulk | Kiwira/ Mbinga | Engaruka |
| 2. | Liquid Carbon Dioxide | 3,000 | Bulk | TOL DSM/Kyela | Engaruka |
| 3. | 50 kg Packing Raffia bags | 725 | Bales | DSM/ Arusha | Engaruka |
| 4. | Fuel | To be supplied by one of the oil marketing companies | | | |

Source: *Technology Assessment Study, 2020*

Economic activities of neighboring regions of Manyara, Kilimanjaro and Tanga are mostly agrarian with some industrial and mining activities. An average of 60,000 tons of cement move by rail per year from Tanga to Arusha, Moshi and other nearby areas leaving the rest to move by road.

The project site is located in a very remote area with neither road nor rail connectivity making transport logistics one of the big challenges facing the project in as far as movement of construction and raw materials as well as finished goods is concerned. Thus, transport logistics assessment has been done and indentified that for the success of the project the immediate task is to ensure that the following is undertaken:

- Construction of at least a single lane road from Engaruka Chini Village Center (ECVC) to the plant site in preparation for the construction of the plant;
- Pavement of the 95 km road from Moshi to Longido to cost about **USD 43,369,563.60**.
- Completion of pavement of the portion from Oldonyo to ECVC, part of the Mto wa Mbu to Loliondo road already in progress.
- Pavement of the 102 km road from Longido to Oldonyo to cost about **USD 48,712,584.10**.

The main objective of this study is to come up with an optimal modal mix in terms of cost effectiveness for movement of initially 500,000 tonnes of Soda Ash and 193,790 tonnes of raw materials from the plant and to the plant respectively as shown in **Table 0.1** excluding fuel that would be supplied and transported by an oil marketing company. Production is planned to increase twice and likewise the tonnage of raw materials will also double.

0.6. In the course of this study four transport modal mix options have been evaluated based on freight charges. The four options are as follows:

- From the plant to final destination all by road
- From the plant to final destination all by rail when a rail link is established
- By rail up to Arusha then by road to the plant via Makuyuni or Longido and or Monduli
- By rail to Moshi then by road to the plant via Longido (bypassing Arusha)

0.7. Analysis of the above options for the segment between the plant site and Tanga, based on the current rates obtained from Tanzania Railways Corporation and a sample of road transporters based in Arusha has revealed results provided in the below table.

**Table 0.2:** Comparison of Transport Options Freight Charges/Tonne (USD)

| ROUTE | DISTANCE (KM) | | FREIGHT CHARGES | | TOTAL CHARGES |
|---|---|---|---|---|---|
| | RAIL | ROAD | RAIL | ROAD | |
| All by road from Tanga to Engaruka via Makuyuni | - | 596 | - | 53.64 | 53.64 |
| All by rail from Tanga to Engaruka (upon completion of Arusha/Musoma Rail) | 568 | - | 34.08 | - | 34.08 |
| By rail from Tanga to Arusha then by road to Engaruka via Makuyuni | 437 | 158 | 26.22 | 14.22 | 40.44 |
| By rail from Tanga to Arusha then by road to Engaruka via Monduli | 437 | 191 | 26.22 | 17.19 | 43.41 |
| By Rail from Tanga to Moshi then by road to Engaruka via Longido | 351 | 239 | 21.06 | 21.51 | 42.57 |

Source: *CILT Analysis, 2020*

The above table clearly shows that movement of project cargo by rail from the plant to final destination is the most cost effective. The option of moving the project cargo by rail up to Arusha and then by road via Makuyuni comes second. Movement of project cargo by road from the plant to Tanga is exceedingly expensive, unless rebated rates are negotiated on the basis of return cargo for trucks delivering raw materials.

0.8. The capacity and level of service (LOS) of the existing rail and road transport infrastructure is adequate to handle the project cargo save for some constraints and deficiencies identified.

0.9. Movements of project cargo by rail either from the plant to the final destination or partially to Arusha are the two cost effective means of transport. However, while construction of the rail link to the plant is in the pipeline, in order to improve the capacity and level of service (LOS) of the existing line, on the one hand it is recommended that the following be done by TRC in anticipation of the project cargo:

- Increase of rolling stock by rehabilitating the existing 1,112 old wagons and acquiring new wagons. Under the ongoing SGR project between Dar es Salaam and Mwanza, TRC plans to buy 1,430 wagons, beefing up the total number of rolling stock to 2,586 including 44 wagons procured by the Tanzania Intermodal and Rail Development Project. Hence scarcity of wagons will be experienced if the plant starts production before the delivery of the new wagons.

- Increase of motive power availability through regular maintenance and procurement of new locomotives. TRC plans to acquire 20 new locomotives as part of the Dar es

Salaam – Mwanza SGR Project, in addition to 3 engines bought under the Tanzania Intermodal and Railway Development Project bringing the total number of main line locomotives to 74. Thus, availability of motive power will be a problem if the plant starts production before arrival of the 20 new locomotives. Another way of increasing locomotives could be by hiring from companies such as Sheltam based in South Africa.

- Modification of some stations to enable receiving of long trains.
- Reduction of block sections by reopening some stations. For example, the section between Moshi and Arusha is about 86.1 km meaning that a train has to wait at Moshi for about one and a half hours if there is another train running from Arusha to Moshi. The distance can be reduced by reopening Kikuletwa station which is 31.6 and 54.5 km from Moshi and Arusha respectively.
- On the other hand, it is recommended that the project sponsor keeps in close contact with TRC so that if possible their plans could be harmonized so as to take advantage of the benefits the two organizations are likely to gain by having a rail link between Arusha and the plant.

0.10 Participation of the private sector through outsourcing of transport logistics services would not only allow the plant to concentrate on the core business of producing soda ash but also reduce the level of investment in terms of CAPEX and OPEX to a tune of roughly **USD 16,517,200** as summarized in **Table 6.1**. In addition, outsourcing would reduce manpower involved in transport logistics and costs related thereof from 161 people to merely 28 staff as depicted in figures **6.1** and **6.2**.

0.11. For smooth movement of the project cargo during the initial period and thereafter, it is recommended that:

- An 18 km tarmac road to sustain effective movement of heavy vehicles is constructed from ECVC to the plant site because at the moment there is no road at all. This would cost about **USD 8,217,391.30**
- Upgrading to tarmac of the road from Mto wa Mbu to Loliondo be completed at least to Engaruka Junction to allow flexibility of using either Mto wa Mbu or Longido to reach the plant site. The work is in progress, therefore the cost is already provided for by the government.
- Upgrading to tarmac of 95 km road from Moshi to Longido as an alternative route in case of any emergency. The estimated cost would be **USD 43,369,563.60**.

- Construction of a railway line from Arusha to the plant site based on the American Railway Engineering and Maintenance of Way Association (AREMA) standards should be done as already planned. The “all rail” option is the most cost effective mode of transport and would make Soda Ash produced at Engaruka more competitive in both local and foreign markets. Competitors in neighboring Kenya transport Soda Ash by rail. According to the available estimates the 54 km stretch from the main line to Engaruka plant site would cost **USD 277,968,428**.

0.12 With the ongoing port modernization and expansion work, Tanga port is in a position to efficiently handle the export project cargo in the range of 350,000 tonnes per annum initially, some of which will definitely be exported to regional markets of EAC and SADC with a huge demand. Cargo destined to regional markets will mostly move by inland transport arranged by the customers themselves.

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## ABBREVIATIONS & ACRONOMY

| | | |
|---|---|---|
| 3PL | - | Third Party Logistics |
| BOO | - | Build-Own-Operate |
| BOT | - | Build-Operate-Transfer |
| b | - | Billion |
| CAPEX | - | Capital Expense / Expenditure |
| CIF | - | Cost in Freight |
| $CO_2$ | - | Carbon dioxide |
| DSM | - | Dar es Salaam |
| DWT | - | Deadweight Tonnage |
| EAC | - | East African Community |
| ECVC | - | Engaruka Chini Village Center |
| ESAP | - | Engaruka Soda Ash Project |
| ETC | - | Et cetera |
| FOB | - | Free on Board |
| FAS | - | Free Alongside Ship |
| FY | - | Financial Year |
| g | - | Grams |
| GPS | - | Global Positioning System |
| GSM | - | Global System for Mobile Communications |
| hrs | - | Hours |
| IS | - | Indian Standards |
| ISO | - | International Standards Organization |
| Kg | - | Kilogram |

| | | |
|---|---|---|
| km | - | Kilometer |
| kph | - | kilometer per hour |
| lbs | - | pounds |
| LOS | - | Level of Service |
| m | - | Meter or Million |
| MGR | - | Meter Gauge Railway |
| NRT | - | Net Registered Tonnage |
| OPEX | - | Operating Expense / Expenditure |
| O – D | - | Origin - Destination |
| PPP | - | Public Private Partnership |
| RAM | - | Rapid Appraisal Method |
| SADC | - | Southern Africa Development Community |
| SGR | - | Standard Gauge Railway |
| SPSS | - | Statistical Package for Social Sciences |
| STATA | - | Statistics and Data |
| SWOT | - | Strengths Weaknesses Opportunities and Threats |
| TANROADS | - | Tanzania National Roads Agency |
| TARURA | - | Tanzania Rural and Urban Roads Agency |
| TATOA | - | Tanzania Trucks Owners Association |
| TAZARA | - | Tanzania Zambia Railway Authority |
| TEU | - | Twenty Equivalent Unit (20’container) |
| TIRDO | - | Tanzania Industrial Research and Development Organization |
| TKM | - | Tonne Kilometer |
| TOL | - | TOL Gases Limited |

| | | |
|---|---|---|
| T | - | Tonne (s) |
| ToR | - | Terms of Reference |
| TPA | - | Tanzania Ports Authority |
| TRC | - | Tanzania Railways Corporation |
| TZS | - | Tanzania Shilling |
| Vegs | - | Vegetables |
| WH/IC | - | Warehousing and Inventory Control |

# CHAPTER ONE

# 1. INTRODUCTION

## 1.1 Authority for the Assignment

This Report is prepared pursuant to the provisions of the Contract signed between the Chartered Institute of Logistics and Transport (CILT) Tanzania and Tanzania Industrial Research Development Organization (TIRDO) for carrying out the Transport Logistics Study, as a component of the Techno-Economic Study for Establishment of Soda Ash Plant at Engaruka in Monduli District, Arusha Region.

## 1.2 Study Context, Objective, Approach and Methodology

### 1.2.1 Context

In 2007 National Development Corporation (NDC) retained the services of Rail India Transport Economic Services (RITES) to carry out a Transport Logistics Study for Lake Natron Soda Ash Project; inter alia the consultants were tasked to evaluate the following four transportation options:

- End to end by Road
- End to end by Rail
- By road from plant site to Moshi and by rail to Tanga
- By road from plant site to Arusha and by rail to Tanga

RITES also assessed the capacity of Tanga port to efficiently handle the anticipated Soda Ash traffic. At the end, it was concluded that "from a long term perspective rail transport from Lake Natron to Tanga port is the most cost effective."

While the Lake Natron project could not take off, the government of the United Republic of Tanzania as promised in its manifesto of 2015 is keen to have a similar project at Engaruka where there are huge quantities of brine with assured potential for long lasting production of Soda Ash.

NDC this time sought the services of TIRDO to commission various studies all of which are critical for the establishment of the project at Engaruka. Transport Logistics study is but one of the above as presented in 1.1 above: to evaluate similar transportation options as of Lake Natron along with Tanga Port capacity as well as warehousing possibilities if any.

### 1.2.2 Study Objectives

The main objective of this Assignment was to assess Transport Logistics requirements, as a component of the Techno-Economic Study for the establishment of an economically, environmentally and socially sound Soda Ash Plant at Engaruka including other infrastructure, bearing in mind that the main challenges to the techno economic feasibility and commercial viability of the project were:

- Social and environmental concerns
- Energy resources
- Transport infrastructure and logistics issues.

The Techno-Economic Study in total will form the bankable feasibility study for mobilization of the required resources (human, technology and capital) for the Project. The Transport Logistics Study was expected to review, analyze, assess and recommend in respect of the following:

- Recommendations made by previous studies on transport logistics in related fields
- Condition of available modes of transport to major centers and Tanga port
- Adequacy of each mode of transport and areas of up-gradation and new construction on the existing railways and roads for smooth flow of the project traffic
- An optimal cost effective modal mix (rail-rail, road-road, road-rail/rail-road)
- Suitable wagons/trucks for optimal utilization and minimization of empty movement
- Requirement of warehousing facilities, if any.

### 1.2.3 Approach and Methodology

To help understand the study process and how the findings were obtained it is of paramount importance to provide the strategic methods used in the collection and later analysis of the relevant data. Here below are the principal methodologies which were used:

(a) Desk Study – Literature Review

The Consultants conducted literature review of relevant study reports, legal, socio-economic, policy and procedural documents related to transport and logistics with particular emphasis on:

- Relevant regional economic activities of the four regions: Arusha, Kilimanjaro, Manyara and Tanga
- Inward traffic (raw materials and other supplies) and project products (outbound traffic)
- Current road/rail connectivity and transport demand
- Condition of transport infrastructure between the plant site and Tanga port
- Capacity of transport infrastructure between the plant site and Tanga port
- Level of service of transport infrastructure between the plant site and Tanga port
- TRC current and future plans
- TPA current and future plans
- TANROADS current and future plans
- TARURA current and future plans
- Road and rail transport services
- Tanga port facilities
- East African Railways Master Plan

(b) Field Research: Questionnaire Administration and Interviews

The Team designed research tools such as questionnaires and interview guides ***(See Appendix 4)*** to conduct field research surveys by way of direct interviews along with focus group discussion techniques with a cross-section of stakeholders such as: Tanzania Ports Authority, Tanzania Railways Corporation, TANROADS, TARURA and collected necessary baseline data and information relevant to the study. The designed primary data collection tools like structured and unstructured questionnaires and interviews guided the process and were used in tandem to collect necessary relevant, qualitative and quantitative primary data and information. The interview method involved one-on-one interviews with individuals or key informants selected for their positions and knowledge or diverse views. This method was used purposefully to verify and back up qualitative and quantitative information obtained from secondary data to improve the study validity and reliability.

(c) Field Visits and Observations

While secondary data from development plans of road and railway infrastructure authorities/agencies and Tanga Port etc were studied for empirical evidence, the Team made critical technical visits to transport systems in requisite regions and in similar plants like Minjingu Mine and Fertilizers Limited in Arusha Region; Kiwira Coal Mine/Kiwira-Kaburo Coal Project in Mbeya Region and Mufindi Paper Mills Ltd in Iringa Region for comparative analysis to aid in the process of making meaningful recommendations in this report.

(d) Data Analysis, Findings and Conclusions

Data processing, management and analysis entailed three activities, namely: data entry and validation, data processing and data analysis. The collected primary data from the questionnaire were keyed into a computer using STATA, Microsoft Excel and other analytical programs for further definitive analysis. Final data processing, analysis, simulations and tabulations have been done to produce the emerging outputs in terms of tables, pictures and other illustrations to help in making conclusions and recommendations in this Report.

(e) Rapid Appraisal Method (RAM)

The study took the form of rapid appraisal methods because both informants and the consultants responsibly evolved answers to key questions for adoption at every level and time. It was important to interview and consult all key stakeholders, representatives, leaders and key individuals on key issues in developing the report in order to make relevant recommendations.

## 1.3 Structure of the Report

This Report is structured in line with the Terms of Reference of the study as follows:

- **1: Introduction** presents an overview of the report as per ToR (bullet 1).
- **2: Traffic Demand Analysis** provides traffic projections in the project region and neighboring regions of Kilimanjaro, Manyara and Tanga and an assessment of the impact of the expected project cargo on the available transport capacity pursuant to ToR (bullet 2).

- **3: Rail Transport and Infrastructure Development** provides an assessment of the railway system between Arusha, Tanga and Dar es Salaam, on the one hand and suitable wagons including planned and or recommended new rail lines on the other in accordance with ToR (bullets 3 and 4).

- **4: Road Transport and Infrastructure Development** presents the condition of the existing road network in the project influence zone, road transport capacity and suitable trucks as well as planned or recommended new road alignments according to ToR (bullets 3 and 4).

- **5: Tanga Port** gives a brief account of cargo handling equipment and capacity assessment of Tanga port to handle the project cargo in pursuit of ToR (bullet 2)

- **6: Comparative Analysis** presents emerging issues and options such as cargo handling, transport operating modalities, warehousing, transport logistics management, staff transportation and observations made during the study in accordance with ToR (bullets 2 – 6).

- **7: Cost Effective Transport Modal Mix** analyses an optimal (least cost) modal mix for smooth conveyance of project cargo as per ToR (bullet 4).

- **8: Conclusions and Recommendations** add to several conclusions and recommendations made under each respective chapter.

# CHAPTER TWO

# 2. TRANSPORT DEMAND ANALYSIS

## 2.1 Economic Activities of Arusha, Kilimanjaro, Manyara and Tanga Regions

### 2.1.1 Arusha Region

Arusha Region apart from being the hub of the northern tourist circuit is predominantly agrarian. It produces: coffee, wheat, maize, paddy, millet, bananas and seed beans. Most of the cereal and pulses crops are consumed within the region but some of them like onions, tomatoes and beans are moved to markets in Dar es Salaam, Dodoma and even Tanga. A cash crop like Coffee is exported and therefore need transport to either Tanga or Dar es Salaam port. In the past Coffee used to move by rail before shifting to road following deterioration of the quality of railway transport service, particularly insufficient and late supply of wagons.

Mining of gemstones like Ruby and Sapphire done mostly by small scale miners produce small quantities while mining of Tanzanite is gaining momentum but the product is airlifted. Revamping of industrial activities in line with the national industrialization drive is going on steadily as such industrial products are expected to increase within the next five years. This will make Arusha once again a veritable industrial town. The two sectors of mining and industries contribute about 10% of the region's Gross Domestic Product (GDP) but they do not produce noticeable traffic for movement either by road or rail beyond the region. Under the Integrated Industrial Development Strategy between 2015 and 2020 a total of 387 industrial parks have been established in the region, out of which 28 are major industries and the rest are small or medium ones. This is an important factor in considering transport demand for a project like the one being studied. **Table 2.1** provides regional agricultural, mining and industrial production for the year 2019.

**Table 2.1:** Arusha Region Agricultural, Industrial and Mining Production as in 2019 (000' tonnes)

| SN | SECTOR | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | AGRICULTURAL PRODUCTS | | | | INDUSTRIAL PRODUCTION | | MINERAL RESERVES | |
| | FOOD CROP | T | CASH CROP | T | COMMODITY | T | MINERAL | T |
| 1. | Oil Seeds | 2.435 | Coffee | 99.1 | Foods | 59.2 | Soda Ash | 5,694 |
| 2. | Fruits/Vegs | 91.118 | Bananas | 58.3 | Textiles | 2.5 | | |
| 3. | Maize | 407.385 | P. Peas | 18.8 | Beverages | 53.7 | | |
| 4. | Paddy | 2.950 | Oranges | - | Wood & Paper | 3.3 | | |
| 5. | Beans | 18,783 | Mango | - | Metals | 20.8 | | |
| 6. | Wheat | 11.445 | Coconut | - | Cement/ Others | 3.1 | | |
| 7. | Sorghum | 2.950 | S/Cane | - | Rubber/Plastics | - | | |
| 8. | F/ Millet | .725 | Sisal | - | Chemicals | - | | |
| 9. | Potatoes | 5.018 | Others | - | Vegetable Oils | - | | |
| 10. | Cassava | 4.908 | | | Others | 1.5 | | |
| **TOTAL** | | **547.717** | | **176.2** | | **144.1** | | **5,694** |

Sources: *Arusha Regional Statistics Office, 2019*

It is therefore expected that there could be some traffic generated from industries to move by surface transport beyond 2020 sharing the available transport capacity with soda ash and other raw materials required by the plant.

### 2.1.2 Kilimanjaro Region

In the past Kilimanjaro and Arusha were one region and therefore the two have more less the same climatic conditions. The region is also agrarian to a big percentage with agriculture and animal husbandry contributing over 60 % of the region's Gross Domestic Product of TZS. 4,126,036 million in 2015. Agricultural and horticultural products include Coffee, Bananas, Maize, Beans, Wheat, Cotton, and Paddy, Finger Millet, Sunflower, Barley, Sisal, Onions, Groundnuts, Flowers and Vegetables. Bananas and Maize which are produced in large quantities are consumed locally. Details are provided in **Table 2.2.**

**Table 2.2:** Kilimanjaro Region Agricultural, Industrial and Mining Production as in 2018 (000' tonnes)

| SN | SECTOR | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | AGRICULTURAL PRODUCTS | | | | INDUSTRIAL PRODUCTION CAPACITY | | MINING | |
| | **FOOD CROP** | **T** | **CASH CROP** | **T** | **COMMODITY** | **T** | **MINERAL** | **T** |
| 1. | Sunflower | 6.4 | Coffee | 32.0 | Food/Beverages | 127.3 | Pozzolana | 29.1 |
| 2. | Tomatoes | 17.6 | Bananas | 391 | Textiles | 0.4 | Gypsum | 292.8 |
| 3. | Maize | 168.0 | S/Cane | 14.4 | Leather | 1.9 | Bauxite | 39.7 |
| 4. | Paddy | 17.0 | Oranges | 1.6 | Wood/ Paper | 8.6 | | |
| 5. | Beans | 28.8 | Mango | 19.0 | Ferrous Metals | 32.1 | | |
| 6. | Potatoes | 25.6 | Others | 28.0 | Cement & Others | 0.1 | | |
| 7. | Onions | 4.8 | | | | - | | |
| 8. | Others | 27.2 | | | | - | | |
| **TOTAL** | | **295.4** | | **486.0** | | **136.8** | | **361.6** |

Source :*Kilimanjaro Investment Guide May, 2018*
*CILT Analysis, 2020*

The region has abundant tourist attractions and potentials including Mt. Kilimanjaro and some national parks. Also, the manufacturing industry is growing fast and correspondingly contributing more to the regional GDP. The main industrial activities are food processing, leather and textiles, paper products, machinery and chemicals.

Minerals like Gypsum, Pozzolana, Limestone, Copper, Ceramics, Red Garnet, Bauxite Aquamarine Green and Manganese are found in the region but only a few are extracted in small quantities such as Pozzolana, Bauxite and Gypsum.

### 2.1.3 Manyara Region

Manyara Region lies south of Arusha Region with an area of 50,921 square kilometers. Livestock keeping, tourism, agriculture and mining are the main economic activities in the region. Small scale famers produce cash and food crops, namely: Beans, Pigeon Peas, Maize, Paddy, Garlic, Sunflower, Potatoes, Groundnuts, Tomatoes, Sorghum, Coffee, Finger Millet and Onions.

The industrial sector in the region is not well developed. Following the implementation of the on-going campaign under the "My Region My Industry" slogan a total of 2,400 industries have been established, most them being micro small industries (86.13%), small (12.71%) and only 1.16% representing medium or large industries.

The region is endowed with a variety of minerals, such as Tanzanite, Green Tourmaline, Moonstone, Ruby, Graphite, Red Garnet, Limestone, Rhodolite, Tsavorite, Tremolite, Anzonight, Copper, Marble, and Gold. Though mining is done by artisanal miners save for Tanzanite and graphite for export it contributes immensely to the region's GDP that amounted to TZS. 3,026,366 million in 2015. Details are provided in **Table 2.3.**

**Table 2.3**: Manyara Region Agricultural, Industrial and Mining Production as in 2018 (000' tonnes)

| **SN** | **SECTOR** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **AGRICULTURAL PRODUCTS** | | | | **INDUSTRIAL PRODUCTION CAPACITY** | | **MINING** | |
| | **FOOD CROP** | **T** | **CASH CROP** | **T** | **COMMODITY** | **T** | **MINERALS** | **T** |
| 1. | Maize/Paddy | 154.4 | Sunflower | 6.3 | Agro Based | 47.3 | Graphite | 396 |
| 2. | Sorghum /Millet | 6.7 | Tomatoes | 0.9 | Fertilizers | 3.6 | | |
| 3. | Wheat | 3.5 | Onions | 1.1 | | | | |
| 4. | Beans | 16.4 | Peas | 0.3 | | | | |
| 5. | Cassava/Potatoes | 1.3 | | | | | | |
| **TOTAL** | | **182.3** | | **8.6** | | **50.9** | | **396** |

Source: *Manyara Investment Guide May, 2018*
*CILT Analysis, 2020*

### 2.1.4 Tanga Region

Tanga region's economic activities are agriculture, livestock keeping, mining and industries including Tanga port. In the early sixties the economy of the region was robust when Tanzania was the global chief exporter of Sisal, mainly produced in Tanga by then. **Table 2.4** shows estimates of the main economic activities for 2020.

**Table 2.4**: Tanga Region Agricultural, Industrial and Mining Production projections for 2020 (000' tonnes)

| SN | SECTOR | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **AGRICULTURAL PRODUCTS** | | | | **INDUSTRIAL INSTALLED CAPACITY** | | **MINING** | |
| | **FOOD CROP** | **T** | **CASH CROP** | **T** | **COMMODITY** | **T** | **MINERAL** | **MT** |
| 1. | Maize | 186.3 | Coffee | 2.4 | Cement | 1,250.0 | Limestone | 135 |
| 2. | Paddy | 14.2 | Coconuts | 27.5 | Clinker | 1,250.0 | | |
| 3. | Beans | 30.1 | Cardamon | 1.5 | Sisal ropes | 14.3 | | |
| 4. | Potatoes | 26.4 | Sisal | 36.4 | Detergents | 25.7 | | |
| 5. | Bananas | 5.7 | Others | 152.9 | | | | |
| **TOTAL** | | **259.7** | | **220.7** | | **2,540.0** | | **135** |

Source: *Regional Office Statistics, Tanga*
*CILT Analysis, 2020*

Food crops grown in the region are Maize, Bananas, Fruits and Vegetables, Sorghum, Cassava, Rice, Beans and Potatoes. Main cash crops include Sisal, Coconuts, Cashew nuts, Cardamon, Cotton, Coffee and Tea.

Regardless that mining is undertaken by small-scale miners, quite a good number of minerals, namely: Ruby, Limestone, Garnets, Tourmaline, Kyanite, Gypsum, Feldspar, Kornerapine, Zircon, Bauxite, Amethyst and Touoise are found in Tanga region.

The region's industrial activities had deteriorated as most of public owned industries like Tanga Cement and Tanzania Fertilizer Company to mention just a few were closed between 1970s and 1990s. In the wake of privatization, some of them are already working again, for example Tanga Cement PLC that has an installed capacity to produce 1.25 million tonnes each of Clinker and Cement.

### 2.1.5 Tanga Port

Tanga port is part of Tanga Region with a current annual capacity to handle 750,000 tonnes of export and import cargo. The port is now undergoing expansion to increase the capacity to 2 million tonnes in order to cope with the envisaged upsurge of traffic including cargo emanating from both agricultural and industrial developments in the four regions, Engaruka Soda Ash plant inclusive.

## 2.2 Current Transport Demand Analysis

Assessment of the current transport demand derived from the economic activities of the four regions of Arusha, Kilimanjaro, Manyara and Tanga which form a big portion of exports as well as imports through the port of Tanga mostly to the same regions reveals as follows:

### 2.2.1 Outward Traffic (Arusha/Tanga)

As stated above all the four regions are predominantly agrarian and whatever is produced is consumed locally or within the neighboring regions, hence doesn't involve long haulage. From Table 2.1 – 2.4 it is deduced that out of the annual average exports of 118,143 tonnes through Tanga port apart from Coffee, Tea, Macadamia, Aggregates and Beans the rest of exports are from Tanga and/or Kilimanjaro estimated at 60% or 71,000 tonnes, including Sisal, Cement and Dhow exports which use road cartage. Therefore, it is safe to assert that traffic demand between Arusha and Tanga would remain around 50,000 tonnes, excluding fertilizers from Minjingu which is mostly transported by buyers themselves.

### 2.2.2 Inward Traffic (Tanga/Arusha)

Traffic demand from Tanga to Arusha is dominated by about 150,000 tonnes of cement to the three regions. The quantity could increase once TRC start full swing operations to Arusha because road transport charges are high and thus make the local product from Tanga Cement Company PLC less competitive compared to the same product from neighboring countries. It has been observed that much of the imports: petroleum products and pet coke constituting an annual average of 251,769 tonnes or about 51% of the average annual imports of 489,665 tonnes end up in Tanga, with half of the balance of about 118,950 tonnes of imports going beyond Tanga.

## 2.3 Tanzania Railways Corporation Traffic Projection and Performance

The performance of TRC hasn't been satisfactory since 2007 due to dilapidated line but with rehabilitation almost completed more cement could be loaded to Moshi and Arusha. The traffic projection and actual performance for financial years 2016/17 and 2018/19 summarized in **Table 2.5** show that while there has been expectation to move goods to Moshi, no projection has been made to load any cargo from there.

**Table 2.5:** TRC Traffic Projection and Performance 2016/17 – 2018/19

| YEAR | TYPE OF CARGO | ORIGINATING STATION | DESTINATION STATION | PROJECTION | PERFORMANCE |
|---|---|---|---|---|---|
| | | | | TONNES | TONNES |
| 2016/17 | POL (fuel) | Tanga | Central Line | 47,800 | 12,411 |
| | CEMENT Tanga Cement and others | Pongwe | Moshi and Other Central Line Stations | 34,500 | 56,617 |
| 2017/18 | POL (fuel) | Tanga | Central Line | 9,600 | 8,936 |
| | CEMENT Tanga Cement and others | Pongwe | Moshi and Other Central Line Stations | 63,000 | 77,964 |
| 2018/19 | POL (fuel) | Tanga | Central Line | 9,600 | 1,480 |
| | CEMENT Tanga Cement and others | Pongwe | Moshi and Other Central Line Stations | 63,000 | 58,888 |

Source: *TRC Planning Department,2020*

## 2.4 Project Cargo Assessment

It is planned that the plant production will initially be 500,000 tonnes of various grades of Soda Ash and later increase to 1,000,000 tonnes because raw materials of brine are readily available. The plant will be located within zero distance from the source of the primary raw material and therefore no transport will be required for brine, except for the other three inputs of Coal, fuel, Carbon dioxide and packaging materials as shown in the below table.

**Table 2.6:** Engaruka Soda Ash Project Cargo O – D Matrix

| A | **SODA ASH PRODUCTS** | | | | |
|---|---|---|---|---|---|
| | **DESCRPTION** | **ANNUAL QTY TONNES** | **TYPE OF PACKAGING** | **ORIGIN** | **FINAL DESTINATION** |
| 1. | Sodium Carbonate | 400,000 | 50 kg /1,000 kg bags. | Engaruka | Tanga , DSM for export and local consumption |
| 2. | Sodium Bicarbonate | 100,000 | 25/50 kg bags | Engaruka | Proposed depots at Arusha, Morogoro and Shinyanga |
| **B** | **RAW MATERIALS/ ENERGY** | | | | |
| 1. | Coal | 190,065 | Bulk | Kiwira/ Mbinga | Engaruka |
| 2. | Liquid Carbon Dioxide | 3,000 | Bulk | TOL DSM/Kyela | Engaruka |
| 3. | 50 kg Packing Raffia bags | 725 | Bales | DSM/ Arusha | Engaruka |
| 4. | Fuel | To be supplied by one of the oil marketing companies | | | |

Source: *Technology Assessment Study, 2020*

Note: The average weight of 72.5gms per 50kg raffia bags has been arrived at based on the standard bag measuring 710x480mm that weighs between 70-75 gm as per IS 11652 – 1986.

### 2.4.1 Soda Ash

As stated above the plant will initially produce 500,000 tonnes and then production will increase to 1,000,000 tonnes. Out of the first batch of 500,000 tonnes of Soda Ash produced, it is estimated that 30% or 150,000 tonnes will be for local consumption whilst 350,000 tonnes or 70% respectively will be for export to SADC and EAC countries as well as other foreign markets through Tanga or Dar es Salaam port.

### 2.4.2 Coal

According to the technology assessment study 190,065 tonnes of Coal would be required per annum as a source of energy going by the adopted production technology. The Team visited Kiwira – Kaburo Coal Mine Ltd and was assured that the mine produces good quality coal and of any size to suit client's requirement. Another source of coal could be Tan coal in Mbinga district. Between the two places, quality and price will be the determining factors. Regardless of wherever coal will be procured from, the cargo will have to move by road since both places have no railway connectivity, to avoid transit loses during transshipment at either Makambako or Uyole (from trucks into TAZARA wagons), Kidatu or Dar es Salaam port (from TAZARA wagons into TRC wagons) and Arusha or Moshi (from TRC wagons into trucks to Engaruka before a railway line is constructed). The trucks could be used for loading Soda Ash as return cargo and definitely at a lower rate for drop off at a transshipment point or direct delivery at final destination depending on the location.

### 2.4.3 Carbon Dioxide

The chosen technology by the Technological Assessment Team dictates that Carbon dioxide be used in the carbonization process to produce Soda Ash. The total amount of Carbon dioxide required per annum would be 3,000 tonnes. Carbon dioxide can be supplied by TOL gases Ltd from Dar es Salaam by special trucks. Alternatively, the gas can be sourced from Carbacid Investments Ltd of Nairobi. In both cases, the movement of the cargo would be by road.

### 2.4.4 Packaging Materials

For easy marketing, loading and offloading, 25/50 kg raffia bags would be mostly used. However, for big customers with offloading equipment at their sites, 1 tonne or jumbo bags could be used. For easy computation, it will be assumed that 725 tonnes of 50 kg raffia bags will be required for packing 500,000 tonnes. The number would come down in case jumbo bags are used.

### 2.4.5 Fuel

Fuel will be required for plant utilization on the one hand as well as transportation of supplies using company vehicles. For convenience and reliable supply of fuel, it is recommended that a fuel station be constructed at the project site and or nearby instead of the plant buying and transporting fuel from the source. Even with the option of outsourcing transport logistics services, the need to have fuel within reach cannot be overlooked. It is therefore further recommended that the plant contracts an oil marketing company of good repute to build, own and operate (BOO) or build, own and transfer (BOT) a petrol station within the plant.

The cost of constructing a standard petrol station of 3 tanks each with a capacity of 30,000 liters is around USD 70,000. The cost includes:

- Purchase of 3 tanks of 30,000 litres

- Two pumps for diesel and petrol with fittings
- Excavation and leveling
- Installation
- Transportation of the three tanks to site

### 2.4.6 Machinery Spares

Since it is difficult to predict machinery breakdown, a provision for spares in quantitative terms and hence transport demand for spares isn't expressed in vehicular units below.

### 2.4.7 Foodstuff for staff

The surrounding regions of Arusha, Kilimanjaro and Manyara being primarily agrarian, it is assumed that foodstuff for the workforce will be obtained locally, thus transport requirement for foodstuff is neglected in the overall transport demand analysis. Besides the costs could be borne either by the food trader or the worker who goes to buy such items from source.

## 2.5 Vehicular Units

It has been established beyond reasonable doubt that apart from the project traffic, there will be cement, some imports and fuel moving in the inward direction and some exports in the outward direction. Vehicular units of the project cargo are expressed in terms of wagons and trucks required per annum, month and eventually per day. A year and a month are taken to be 300 days and 25 days and an average payload of a wagon and a truck is counted as 40 and 30 tonnes respectively. The use of containers is considered difficult contrary to what is recommended in the RITES report because of the huge investment that would be required for the purchase of containers by the investor as shipping lines have expressed unwillingness to bring ex gratia empty containers to the plant. In case containerization would be necessary then it will be done either at the port or in an Inland Container Depot (ICD). The project cargo translated into vehicular or transportable units is as provided in **Table 2.7.**

**Table 2.7:** Project Cargo Vehicular Units

| TRAFFIC | ANNUAL TONNES | ORIGIN DESTINATION | VEHICULAR UNITS / YEAR | | VEHICULAR UNITS / MONTH | | VEHICULAR UNITS / DAY | |
|---|---|---|---|---|---|---|---|---|
| | | | **Wagons** | **Trucks** | **Wagons** | **Trucks** | **Wagons** | **Trucks** |
| **SODA ASH PRODUCTS** | | | | | | | | |
| Sodium Carbonate & Bicarbonate | 500,000 | Engaruka – Arusha, DSM Tanga, Mbeya Shinyanga, Morogoro | 12,500 | 16,667 | 1,042 | 1,389 | 42 | 56 |
| **TOTAL** | **500,000** | | **12,500** | **16,667** | **1,042** | **87** | **42** | **56** |
| **PHASE II** | **1,000,000** | | **25,000** | **33,334** | **2,084** | **174** | **84** | **112** |
| **RAW MATERIALS / ENERGY** | | | | | | | | |
| Coal | 190,065 | Kiwira – Engaruka | 4,752 | 6,336 | 396 | 528 | 16 | 21 |
| Liquid $CO_2$ | 3,000 | DSM – Engaruka | 0 | 0 | 0 | 0 | 0 | 0 |
| Packaging materials | 725 | DSM – Engaruka | 18 | 24 | 2 | 2 | 0 | 0 |
| **TOTAL** | **193,790** | | **4,770** | **6,360** | **398** | **530** | **16** | **21** |
| **PHASE II** | **387,580** | | **9,540** | **12,720** | **796** | **1,060** | **32** | **42** |

Source: *CILT Analysis, 2020*

There is a possibility of empty run if a dedicated fleet of wagons or trucks is utilized as depicted in **Table 2.7** above, that inward traffic flow of 193,790 tonnes of raw materials (3,000 tonnes of Carbon dioxide delivered by special trucks inclusive) to the plant is less than outward traffic of 500,000 tonnes of Soda Ash products.

**CHAPTER THREE**

# 3. RAIL TRANSPORT AND INFRASTRUCTURE DEVELOPMENT

## 3.1 Track Condition

The Team visited Tanga, Moshi and Arusha to view the track condition. The visit was complemented by discussions with very senior and operational staff so as to gather data before carrying out an assessment of the rail segment on which the project cargo will be moving. In order to mitigate the identified constraints, relevant recommendations have been made including areas of up gradation and new construction such as the already planned 54 km spur line to Engaruka as shown in the map below.

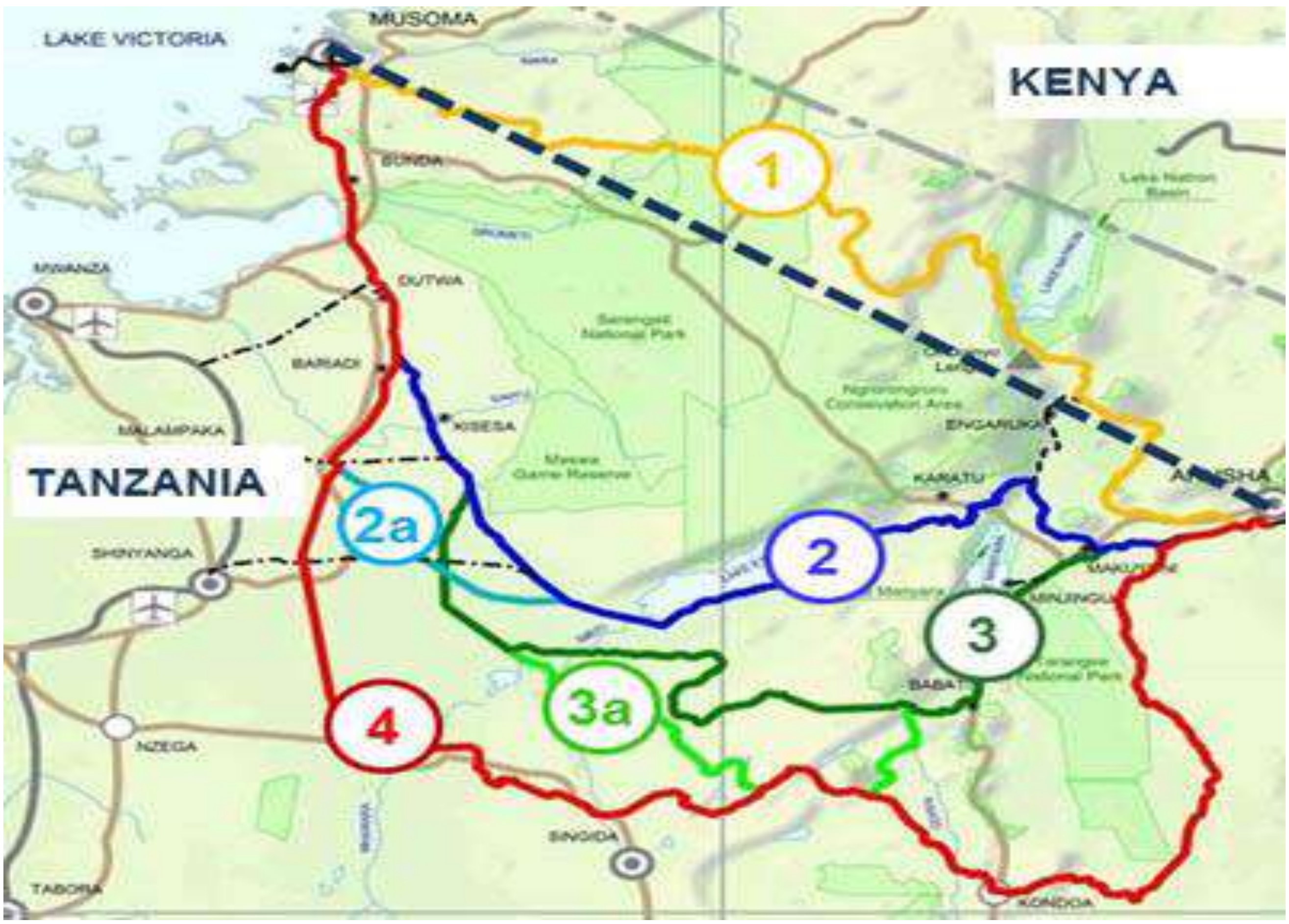



Fig 3.1: Map showing the planned spur line to Engaruka

**Source**: *Feasibility Study & Preliminary Design – Arusha to Musoma Railway (Dorsch Gruppe)*

In the course of the visit at Tanga, Arusha and Moshi the Team found out that the condition of railway infrastructure and equipment between Tanga and Arusha was as follows:

### 3.1.1 Tanga - Moshi

This stretch of 351 km, sometimes called the Usambara Railway has 3 halts and 20 stations out of which 15 are working and 5 have been closed due to decline in traffic volumes. A ruling gradient of 1 in 50 or 2% covers a distance of 3.951 km and the sectional running speed is 50 kph which had dropped to more less 20 kph after deterioration of the permanent way.

Rehabilitation work on the track was completed last year involving replacement of light 45 lbs rails with 60 lbs, rehabilitation of 12 major and 200 minor bridges as well as re-ballasting. Consequently, both passenger and goods trains are now running between Dar es Salaam, Tanga and Moshi respectively.

### 3.1.2 Moshi – Arusha

The portion stretches over a distance of precisely 86.1 km. It initially had four stations (Moshi inclusive) but two stations were since closed due to the same reason stated above, leaving the section without any intermediate station. The section has a ruling gradient of 1 in 45 over a total distance of only 0.421 km. The sectional running speed of 50 kph between Tanga and Moshi extends to Arusha.

From on ground observation, the line has been rehabilitated as shown in Fig. 3.2; 22 km stretch of the portion from Moshi towards Arusha had been completed. It was revealed that, the Tanga to Arusha line should have been fully operational by the close of the year 2019 given that the TRC Rehabilitation Project ended by that time. According to the former Minister of Works, Transport and Communication Prof. Makame Mbarawa (***24$^{th}$ July 2019***) this is expected to ***"reduce the cost of moving bulk freight by between 30% and 40%, as well as improving safety and offering faster delivery times."*** This indeed is an inducement to Engaruka Soda Ash Project.

By the time this report was being submitted, rehabilitation of the portion between Moshi and Arusha had been completed and passenger trains had started running between Dar es Salaam and Arusha.

**Fig 3.2:** Showing the rehabilitated railway line at Arusha Station

## 3.2 Wagon Requirement

Wagon requirement for the project cargo can only be obtained after determination of the wagon turnaround which includes detention time at loading and offloading stations and running time whether loaded or empty. Turnaround of wagons for the project cargo is given in **Table 3.1**

Table 3.1: Project Cargo Wagon Turnaround

| SN | DESCRIPTION | STREAM | | |
|---|---|---|---|---|
| | | **Moshi/Tanga** | **Arusha/Tanga** | **Engaruka/Tanga** |
| 1. | One Way Distance (km) | 351 | 437 | 612 |
| 2. | Average Travel Speed (km/hr) | 50 | 50 | 50 |
| 3. | Travelling Time (1/2x2) hrs | 14 | 18 | 25 |
| 4. | Loading & Offloading Time (hrs) | 8 | 8 | 8 |
| 5. | Technical Examination (hrs) | 4 | 4 | 4 |
| 6. | Power Connection (hrs) | 4 | 4 | 4 |
| 7. | Total Time (3+4+5+6) hrs | 30 | 34 | 41 |
| 8. | Turnaround Time (7/24) days | 1.25 | 1.42 | 1.71 |

Source: *CILT Analysis, 2020*

Having calculated the wagon turnaround, daily wagon requirement for the project cargo is calculated through multiplication of wagon turnaround by the transportable (vehicular) units shown in **Table 2.7.** The results thereof are entered in **Table 3.2** under the following three assumptions:

- By road to or from the plant to Moshi and then by rail to Tanga
- By road to or from the plant to Arusha and then by rail to Tanga
- By rail all along once rail connectivity is in place between the plant and Tanga that will be the same as for phase II.

Table 3.2: Daily Wagon Requirement for the Project Cargo

| SN | COMMODITY | PHASE I | | PHASE II AND ALL RAIL |
|---|---|---|---|---|
| | | Moshi | Arusha | |
| **Open Wagons** | | | | |
| 1. | Coal | 20 | 23 | 55 |
| 2. | With 5% Allowance | 21 | 24 | 57 |
| **Covered/Flat Wagons** | | | | |
| 4. | Soda Ash | 53 | 60 | 144 |
| 5. | With 5% Allowance | 56 | 63 | 151 |
| **TOTAL (2+5)** | | **77** | **87** | **208** |

Source: *CILT Analysis, 2020*

## 3.3 Adequacy Assessment

### 3.3.1 Capacity

Capacity of a rail system refers to the tonnage that could be transported while level of service (LOS) refers to operating speed and therefore transit time. As elaborated above the permanent way is passable between Tanga and Arusha as well as from Dar es Salaam to an extent of allowing movement of passenger trains and therefore the line can handle the anticipated traffic from Engaruka although the movement could have been more efficient if the main prevailing constraints are addressed as recommended herein below.

### 3.3.2 Constraints

Despite the fact that the line has been rehabilitated, control system modernized to GSM based under the Tanzania Intermodal and Railway Development Project and hopefully the signaling and telecommunications system will be improved, there are some constraints that affect the capacity of the line between Tanga and Arusha:

**(a) Shortage of Wagons**

It has been observed that the current fleet of 1,112 wagons including tank wagons shown in Table **3.3** is by far short of the demand. For the case of Soda Ash, only covered wagons which are about 500 are suitable for loading the commodity owing to its hygroscopic nature.

Table 3.3: TRC Current Rolling Stock

| SN | TYPE | LENGTH (m) | NO. | USAGE |
|---|---|---|---|---|
| 1. | CLB | 13.65 | 516 | Suitable for carrying cement, fertilizers and sundries |
| 2. | CCC | 13.95 | 193 | Suitable for rails, pipes and containers |
| 3. | HLB | 13.95 | 159 | Suitable for aggregate, sand, gravel and containers |
| 4. | PTB | 13.81 | 183 | Has capacity to carry between 35,000 – 40,000 litres |
| 5. | LSB | 15.70 | 21 | Suitable for containers, rails, equipment and pipes |
| 6. | BHB | 13.95 | 40 | Special for ballast during construction or maintenance |
| 7. | WT | 11.59 | - | Can carry between 35,000 – 40,000 litres |
| **TOTAL** | | | **1,112** | |

Source: *TRC Headquarters*

The wagon deficiency is made much worse due to poor wagon turnaround and long detention time at wagon inspection, loading and offloading points.

**(b) Low Motive Power**

Locomotive availability is much affected by frequent repairs because most of the locomotives are old enough. Another contributing factor is time wasted at crew change points. The current fleet of TRC locomotives is as provided in **Table 3.4**

Table 3.4: Existing TRC Locomotive Inventory

| CLASS | HAULING CAPACITY | NUMBER | MANUFACTURED | REMARKS |
|---|---|---|---|---|
| 90 | Up to 20 wagons | 24 | 1990 | More required |
| 89 | Up to 20 wagons | 1 | 1992/3 | More required |
| 88 U | Up to 20 wagons | 16 | Rebuilt | More required |
| 88 | Up to 20 wagons | 7 | 1972/9 | Not required |
| 73 | Up to 10 wagons | 3 | 1975 | Not required |
| 37 | Up to 2 wagons | 2 | 1980s | More required |

Source: *TRC Headquarters and Literature Review, 2020*

**(c) Side Tracks Limitations**

With exception of the main line, lengths of other side or loop lines at many stations can't accommodate or receive long trains with a composition of more than 20 wagons and over 270 m long (13.65m x 20 wagons excluding length of a locomotive) which is the most ideal number of wagons for a train hauling Soda Ash or Coal. Details of tracks length at the three major stations of Tanga, Moshi and Arusha are as shown in **Table 3.5**

Table 3.5: Tracks Length at Tanga, Moshi and Arusha Stations

| **SN** | **STATION** | **MAIN LINE (m)** | **NUMBER OF SIDE LINES AND LENGTH** | |
|---|---|---|---|---|
| | | | **NUMBER** | **LENGTH (m)** |
| 1. | Tanga | 279 | 3 | 249, 191, 99 |
| 2. | Moshi | 251 | 3 | 217, 236, 297 |
| 3. | Arusha | 325 | 3 | 413, 188, 141 |

Source: *TRC Headquarter,2020*

It can be noted from the above table that with the exception of Arusha station, main lines at the other two stations can't receive a train exceeding 280 m long, otherwise the train has to run through the station and propel to place wagons on side tracks involving shunting outside station limits that affects not only the line capacity, train operations safety but also locomotive and wagon turnaround time and utilization.

**(d) Long Block Sections**

Following paucity of traffic out of 26 stations and halts between Tanga and Arusha, 7 stations had to be closed in order to reduce labor and other operational costs. The closures led to an increase of inter sectional distance that automatically reduced sectional line capacity due to long detention of trains awaiting crossings. Inter sectional distances after the closure of the stations is as presented in **Table 3.6**

Table 3.6: TRC Station Current Status and Intersectional Distances

| SN | STATION | STATUS | LOCATION | TRACKS | DISTANCE (km) | |
|---|---|---|---|---|---|---|
| | | | | | **Old Section** | **New Section** |
| 1. | Tanga | Open | - | 4 | - | - |
| 2. | Pongwe | Open | 14.2 | 5 | 14.2 | 14.2 |
| 3. | Ngomeni | Halt | 25.1 | - | - | |
| 4. | Muheza | Open | 39.6 | 2 | 25.4 | 25.4 |
| 5. | Kihuhwi | Open | 55.3 | 2 | 15.7 | 15.7 |
| 6. | Mruazi | Halt | 65.0 | - | - | - |
| 7. | Mnyusi | Open | 69.2 | 2 | 13.9 | 13.9 |
| 8. | Korogwe | Open | 84.1 | 3 | 14.9 | 14.9 |
| 9. | Ngombezi | Halt | 92.1 | - | - | - |
| 10. | Maurui | Closed | 97.7 | 1 | 13.6 | - |
| 11. | Makuyuni | Closed | 114.1 | 2 | 16.4 | - |
| 12. | Mombo | Open | 128.0 | 3 | 13.9 | 43.9 |
| 13. | Mazinde | Closed | 141.6 | 2 | 13.6 | - |
| 14. | Mkumbara | Closed | 148.4 | 1 | 6.74 | - |
| 15. | Mkomazi | Open | 167.7 | 2 | 19.3 | 39.7 |
| 16. | Buiko | Closed | 174.3 | 2 | 6.6 | - |
| 17. | Hedaru | Open | 199.5 | 1 | 25.2 | 31.8 |
| 18. | Makanya | Open | 218.4 | 2 | 18.9 | 18.9 |
| 19. | Same | Open | 252.9 | 3 | 34.5 | 34.5 |
| 20. | Lembeni | Open | 291.3 | 1 | 38.4 | 38.4 |
| 21. | Kisangiro | Open | 311.5 | 1 | 20.2 | 20.2 |
| 22. | Kahe Jn | Open | 332.0 | 3 | 20.5 | 20.5 |
| 23. | Moshi | Open | 351.6 | 4 | 19.6 | 19.6 |
| 24. | Kikuletwa | Closed | 383.2 | 3 | 31.6 | - |
| 25. | Ussa River | Closed | 418.9 | 2 | 35.7 | - |
| 26. | Arusha | Open | 437.7 | 4 | 18.8 | 86.1 |

Source: *TRC Headquarters, 2020*

The above table illustrates that the distance between stations has increased from a minimum and maximum of 6.6 km and 38.4 km to 14.2 km and 86.1 km respectively, meaning that trains will be waiting longer before crossing each other, TRC being a single track railway.

### 3.3.3 Capacity Improvement Recommendations

**(a) Increase of Wagons**

Shortage of wagons was one of the reasons which led customers to shift from rail to road. This still persists. 44 flat wagons worth USD 2.73 million have been ordered under the Tanzania Intermodal and Railway Development Project in addition to wagons being rehabilitated. Under the current SGR project 1,430 wagons would be acquired increasing the total number of wagons to 2,586. Therefore, shortage of wagons will not be experienced if the plant starts production after the arrival of the new lot of wagons.

Even with the acquisition of new wagons and continuous refurbishment, the following additional recommended measures need to be adopted, if the availability of wagons is to be sustainable:

- Strict observation of free allowable period for loading and offloading to ensure that wagons do not over stay at loading and offloading points.
- Reduction of wagon turnaround period by avoiding unnecessary detention of trains at stations awaiting crossing or crew connection and improvement of trains' punctuality.
- Improvement of transit time through elimination of factors affecting running of trains such as locomotive and crew connection and locomotive reliability.

**(b) Increase of Locomotives**

In an effort to increase locomotive availability, 3 new Diesel Electric (DE) locomotives have been procured for USD 9.1 million under the Tanzania Intermodal and Rail Development Project. An addition of 20 locomotives is planned as part of the Dar es Salaam – Mwanza SGR project bringing the total number of locomotives to 74. Thus, the motive power position will come up with the traffic expected if only the new locomotives arrive before the plant starts production.

On top of buying more locomotives and while the existing fleet undergoes refurbishment, the following recommended steps should be taken:

- Punctual release of locomotives from locomotive sheds

- Strict observation of locomotive running maintenance schedule
- Adherence to the original equipment manufacturer (OEM) repair specifications
- Improvement of locomotive availability, utilization and reliability through proper train working plans.

**(c) Modification of Stations**

As already highlighted, side tracks at some major stations including Moshi and Tanga can't receive or accommodate long trains, thus length of such tracks have to be increased to about 330m so as to facilitate safe reception and dispatch of long trains and enhance line capacity.

**(d) Reduction of Block Sections**

Table 3.6 above shows that block section between Moshi and Arusha is over 86 km. It means that a train has to stop and wait at Moshi for about one and half hours if there is another train running between the two stations. To eradicate this bottleneck, it is recommended that some closed stations be opened for operational (crossing) purposes even if traffic levels do not justify the opening of the station. Kikuletwa is one of those stations that needs to be reopened.

## 3.4 Proposed and Planned Rail Transport Infrastructure

### 3.4.1 Arusha – Engaruka Rail Link

To benefit from the advantages of rail transport it is advisable to establish railway connectivity between Arusha and Engaruka. TRC has already planned for a link as part of the Tanga – Arusha – Musoma Railway project. According to a presentation by TRC at the 13th Joint Transport Sector Review Meeting in December 2019, ***"the Feasibility Study and Preliminary Design … has been completed. Procurement and process of engaging a Transaction Advisor … and preparation for tender documents under PPP arrangement is on ongoing and has reached negotiation stage."***

### 3.4.2 Proposed Rail Transport Infrastructure at the Plant

With the planned rail connectivity to the plant, rail transport facilities have to be provided and should therefore be taken into consideration in the course of the plant design. Additionally, the following should be considered:

**(a) Soda Ash Loading Facilities**

To facilitate loading of Soda Ash and to avoid the need to propel wagons which is unsafe for a long distance from the presumed Engaruka Station into the plant the following facilities are required:

- One locomotive running (escape) line of not less than 300m at a cost of USD 1,544,269.04
- One loading line of not less than 300m to accommodate at least 20 wagons of 13.65m long to start with. An extra line could be added to cope with additional production of Soda Ash. The cost would be in the range of USD 3,088,538.08 for the two lines.
- A loading platform measuring 150m x 20m to accommodate a minimum of 15 wagons at a cost of USD 4,350
- An in-motion weighbridge for test weighing costing about USD 213,000

**(b) Coal Offloading Facilities**

When Coal would be transported by rail, in order to eliminate the possibility of contamination of Soda Ash products by Coal, it is better to provide basically the following same facilities for offloading Coal at a different location:

- One locomotive running (escape) line of not less than 300m at a cost of USD 1,544,269.04
- One offloading line of not less than 300m to accommodate at least 20 wagons of 13.65m long each to start with. An extra line could be added to cope with additional production of Soda Ash. The cost would be in the range of USD 3,088,538.08 for the two lines.
- A simple shed measuring 30 x 35m for storage of 6-7,000 tonnes of Coal enough for at least 4 days in case of any problem and to allow offloading of at least three wagons simultaneously to avoid long detention of wagons. To construct the shed, it won’t exceed USD 2,000
- A weighbridge for test weighing costing about USD 213,000

**(c) Choice of Suitable Wagons**

Due to hygroscopic nature of Soda Ash only covered wagons will be used for loading the commodity. Flat wagons which come to either Arusha or Moshi carrying containers can also be utilized to load Soda Ash. In case for one reason or another, Coal will have to move by rail then open wagons will be used.

To avoid or minimize empty run of covered wagons which is TRC's portfolio, TRC has to canvass for more cargo to move from Tanga to Kilimanjaro, Arusha and Manyara regions, especially Cement and Limestone which is produced in abundance at Tanga and has huge demand in the three regions. It is a general practice that a customer doesn't pay for empty run of wagons. A customer only requests for a wagon for loading, whether it comes empty for loading or with cargo for offloading before loading, the same rate applies.

## CHAPTER FOUR

# 4. ROAD TRANSPORT AND INFRASTRURE DEVELOPMENT

## 4.1 Existing Regional Road network

Tanzania has a total road network of 86,472 kilometers, 12,786 kilometers are trunk roads, 21,105 kilometers are regional roads and 52,581 kilometers are district, urban and feeder roads. Out of that Arusha Region has a network of 1,441 kilometers, composed of 539 kilometers of trunk roads: 326 and 213 kilometers paved and unpaved respectively and 902 kilometers of regional roads consisting 51 paved and 851 kilometers unpaved as shown in the map below.

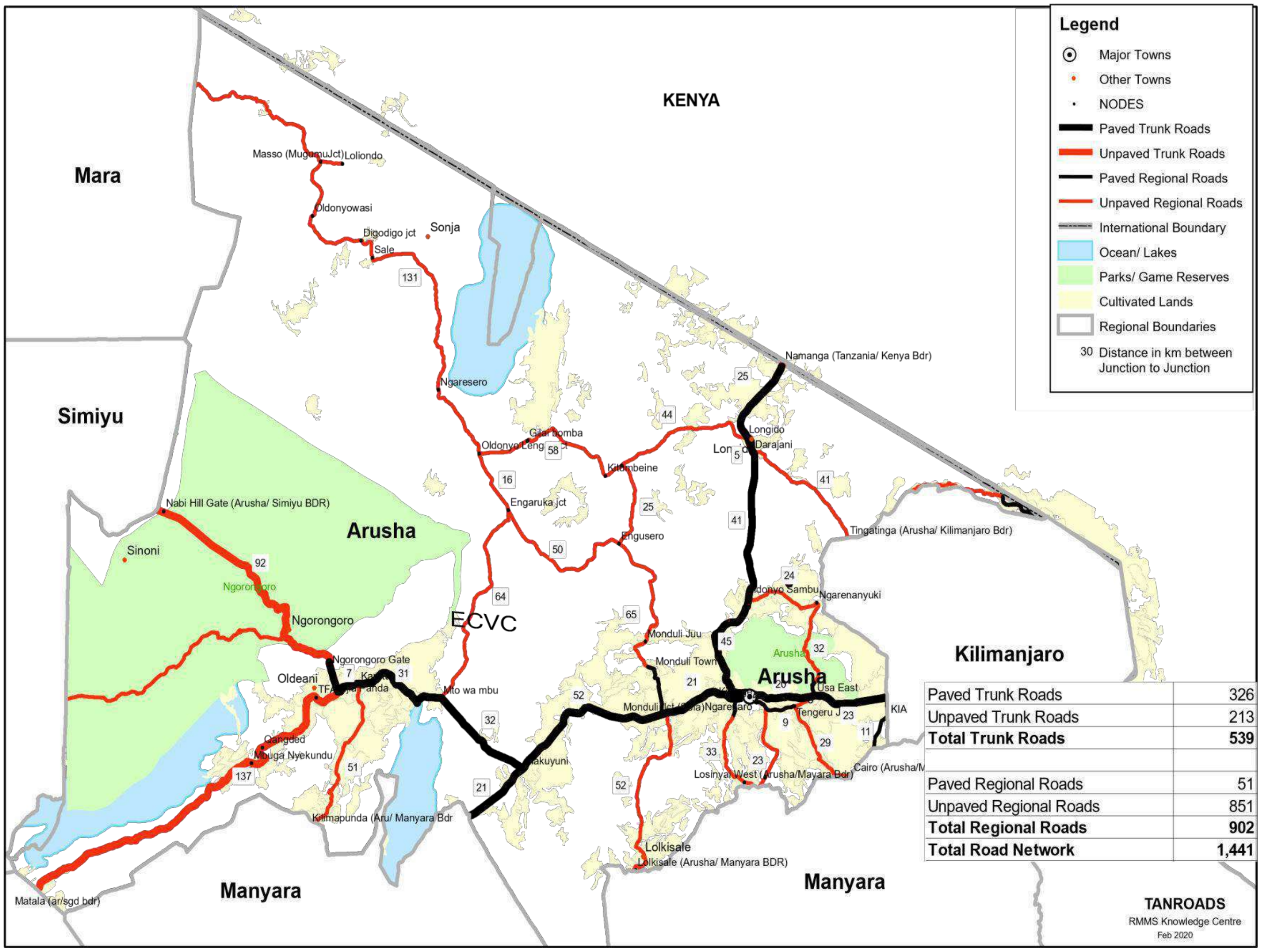



**Fig 4.1:** Arusha Region Roads Network

Source: *TANROADS, 2020*

Transportation of project cargo from Arusha or Moshi using the existing road network has four alternative routes to reach the proposed plant site, all of them having more less the same distance as detailed in **Table 4.1.**

Table 4.1: Existing Road Network between Tanga and Engaruka

| SN | STRETCH | KM | TYPE OF ROAD | ALTERNATIVE |
|---|---|---|---|---|
| 1. | Tanga – Segera | 72 | Trunk | I |
| 2. | Segera – Arusha | 366 | Trunk | |
| 3. | Arusha – Makuyuni | 77 | Trunk | |
| 4. | Makuyuni – Mto wa Mbu | 32 | Trunk | |
| 5. | Mto wa Mbu- ECVC | 31 | Being Paved | |
| 6. | ECVC – Plant Site | 18 | New Construction | |
| **ALTENATIVE I (1+2+3+4+5+6)** | | **596** | | **I** |
| 7. | Arusha – Longido | 80 | Trunk | II |
| 8. | Longido – Oldonyo | 102 | Unpaved Regional | |
| 9. | Oldonyo – Engaruka Junction | 16 | Being Paved | |
| 10. | Engaruka Junction- ECVC | 33 | Being Paved | |
| 11. | ECVC- Plant Site | 18 | Being Paved | |
| **ALTENATIVE II (1+2+7+8+9+10+11)** | | **687** | | **II** |
| 12. | Arusha- Monduli Junction | 25 | Trunk | **III** |
| 13. | Monduli Junction –Engusero Junction | 65 | Unpaved Regional | |
| 14. | Engusero Junction- Engaruka Junction | 50 | Unpaved Regional | |
| 15. | Engaruka Junction – ECVC | 33 | Being Paved | |
| 16. | ECVC- Plant Site | 18 | New Construction | |
| **ALTERNATIVE III (1+2+11+12+13+14+15)** | | **629** | | **III** |
| 16. | Tanga – Moshi | 357 | Trunk | **IV** |
| 17. | Moshi – Longido (bypass Arusha) | 95 | Gravel | |
| 18. | Longido – Oldonyo | 102 | Being Paved | |
| 19. | Oldonyo – Engaruka Junction | 16 | Being Paved | |
| 20. | Engaruka Junction- ECVC | 33 | Being Paved | |
| 21. | ECVC- Plant Site | 18 | New Construction | |
| **ALTENATIVE IV (10+11+12+13)** | | **621** | | **IV** |

Source: *CILT Analysis, 2020*

### 4.1.1 **Tanga – Arusha (438 km)**

The road is in a very good paved condition apart from some hitches on the quality in some areas. From Tanga to Segera the trunk road has a 6m wide carriage way with 1-1.5 m sealed/unsealed shoulders. Beyond Segera to Arusha the main trunk road has a carriage way of 6.0m wide with 1.0 m sealed/unsealed shoulder. An uninterrupted movement to or from Arusha could be done between 8 – 10 hours depending on the volume of other traffic/road users; the Average Traffic Density (ATD) is moderate.

### 4.1.2 **Arusha – Mto wa Mbu (109 km)**

The road is fully paved and in an excellent condition; Up to Makuyuni it is a flexible type of trunk road with a carriage way of 6.8m wide and a sealed shoulder of 1.5 m. The carriage way width narrows to 6.5 m between Makuyuni and Mto wa Mbu with no change of the shoulder. An average movement to or from Mto wa Mbu could be done between 3 and 5 hours depending on the volume of other traffic/road users. In other words, an effective and efficient transporter could make two trips per truck daily.

### 4.1.3 **Mto wa Mbu to Engaruka Village (45 km)**

The road is gravel in a sorry state but is being worked on. The following are the observations made by the Consulting Team:

- According to NDC, it is 45 km from Mto wa Mbu to Engaruka Village, hence it is 14 km from Engaruka Village to Engaruka Chini Village Centre (ECVC) which is 31 km from Mto wa Mbu.
- The process of gravelling to a first class Murram is on course from Mto wa Mbu and is expected to be completed up to Engaruka Village before June 2020. At the time of the visit 40 km were accomplished thus far
- An average movement to or from Engaruka could be done in less than 2 hours depending on the volume of other traffic/road users.
- The paving of the road has commenced with 49 km of the 103 km long stretch from Loliondo to Mto wa Mbu already done. According to TANROADS funds are available and it is expected to be fully paved to tarmac before the end of the year because the road is one of the projects mentioned in the CCM Election Manifesto 2015.
- 30 culvert set bridges all of which need revamping;

**Fig 4.2:** Showing one of the constructed bridges

- Medium size bridges need immediate reconstruction

**Fig 4.3:** Showing a medium size bridge under reconstruction

- 11 big bridges are in dire need of rehabilitation
- An uninterrupted movement to or from the project site could be done in less than half an hour as the route will be serving mostly the plant with very few other road users.

**Fig 4.4:** Showing a viaduct

- 5 special types of bridges allow water to flow over the slab. These are quite risky and not suitable for conveyance of such bulky goods. They need to be rebuilt properly ready for paving.

**Fig 4.5:** Showing a viaduct

- 12 sites without bridges. In fact, even where there were bridges some had been swept away by strong water current coming from the mountains.

**Fig 4.6:** Showing a swept away bridge

It is therefore important to rebuild the bridges ready for paving in order to sustain movement of heavy loaded trucks with their requisite carriage of 30 tonnes each time. The maintenance needs to be regular to and from Engaruka Soda Ash Plant for uninterrupted flow of traffic.

#### 4.1.4 Engaruka Chini Village Centre (ECVC) – Plant Site (18 km)

There was no road at the time of the visit. According to a Land Rover meter gauge reading the project earmarked likely site is about 18 km from Engaruka village depending on where the road would branch off from the main road to Loliondo.

The road would be under the local government and has therefore to be built by TARURA, off the Mto wa Mbu to Loliondo road within Engaruka village. According to the TARURA Representative based in Arusha the new road meets the TARURA criteria for construction of new roads namely: population/community presence, availability of social services infrastructure like schools, health centers, industries and tourism promotion incentive etc.

Based on information from the TARURA Representative in Arusha, construction of a paved road on the average costs between TZS. 900 m and 1.2 b while a first class gravel road would cost between TZS 200 m and 300 m per kilometer. Thence a tarmac road to the plant site would cost around USD 8,217,391.30.

### 4.2 Road Transport Capacity

According to Tanzania Truck Owners Association as of March 2020, there were 16,258 registered trucks with a capacity of 487,740 tonnes in the United Republic of Tanzania. Foreign trucks which come with exports from landlocked countries are also allowed to load cargo destined to their respective home countries. The list of road transporters is provided as **Appendix 5.**

### 4.3 Road Transport Constraints

The following critical constraints and challenges have to be borne in mind:

- The road expected between the project site and the trunk road from Mto wa Mbu to Loliondo will certainly need regular maintenance given the movement of heavy duty trucks loaded soda ash.
- Insufficient preparation for ensuring that roads are safe, secure and defects are attended to as and when reported in accordance to the National Road Safety Policy
- Numerous stoppages at weighbridges for test weighing causing trucks to spend more time enroute.

- Untimely spot maintenance whether on tarmac or gravel roads.

## 4.4 Trucks Requirement

### 4.4.1 Trucks Turnaround Time

Daily trucks requirement like wagons requirement for the project cargo can only be obtained after determination of trucks turnaround which includes stoppage time at loading and offloading points and traveling time whether loaded or empty. Turnaround of trucks for the project cargo is given in **Table 4.2**.

Table 4.2: Project cargo Trucks Turnaround

| SN | DESCRIPTION | STREAM | | |
|---|---|---|---|---|
| | | **Engaruka/Moshi** | **Engaruka/Arusha** | **Engaruka/Tanga** |
| 1. | Average One Way Distance (km) | 239 | 158 | 569 |
| 2. | Average Travelling Speed (kph) | 50 | 50 | 50 |
| 3. | Travelling Time (1/2x2) hrs | 10 | 7 | 12 |
| 4. | Loading / Offloading Time (hrs) | 8 | 8 | 8 |
| 5. | Minor Repairs (hrs) | 2 | 2 | 2 |
| 6. | Other Stoppages (hrs) | 1 | 1 | 1 |
| 7. | Total Time (3+4+5+6) hrs | 21 | 18 | 23 |
| 8. | Turnaround Time (7/24) days | 0.88 | 0.75 | 0.96 |

Source: *CILT Analysis, 2020*

Having calculated trucks turnaround, daily wagon requirement for the project cargo is obtained through multiplication of trucks turnaround by the transportable (vehicular) units shown in **Table 2.7**. The results thereof are entered in **Table 4.2** under the following three assumptions:

- By road to or from the plant to Moshi and then by rail To Tanga
- By road to or from the plant to Arusha and then by rail to Tanga
- By road all along from the plant to Tanga that will be the same as for phase II. The shortest distance of 569 km via Makuyuni is used.

### 4.4.2 Trucks Requirement

The number of trucks required daily is obtained through multiplication of truck turnaround by the project cargo vehicular (transportable) units shown in **Tables 4.2.** Hence, daily trucks requirement for the project cargo is as presented in **Table 4.3** below:

Table 4.3: Project Cargo Daily Trucks Requirement

| SN | PHASE | DESCRIPTION | STREAM | | |
|---|---|---|---|---|---|
| | | | **Engaruka/Moshi** | **Engaruka/Arusha** | **Engaruka/Tanga** |
| | | Vehicular Units | 56 + 21 | 56 + 21 | 56 + 21 |
| 1. | I | Basic requirement | 68 | 58 | 74 |
| 2. | | Plus 5% allowance | 71 | 61 | 78 |
| 1. | II | Basic requirement | 136 | 116 | 148 |
| 2. | | Plus 5% allowance | 142 | 122 | 156 |

Source: *CILT Analysis, 2020*

## 4.5 Choice of Suitable Trucks

The most suitable type of trucks should have been van bodies due to the hygroscopic nature of Soda Ash products. However, following the introduction of containerization, most trucking companies have resorted to buying flat bed trucks and devised a good method of securing goods using tarpaulins. The Consultants witnessed coal in bulk being loaded onto a flat bed. As a precaution, it is recommended that the raffia bags for packing Soda Ash should have a polyethylene lining.

Since coal would be carried on flat beds, the same could be used to load Soda Ash as return cargo. That being the case, it is expected that road freight rates will be comparatively low making the product a bit cheaper to buyers.

## CHAPTER FIVE

# 5. TANGA PORT

## 5.1 Current Port Capacity (Throughput)

Tanga is the first port established in Tanzania during colonial time. Currently it is the second largest Port after Dar es Salaam, located 352 km from Dar es Salaam northwards. Due to proximity of Tanga port to the project area, other things being equal 350,000 tonnes of Soda Ash for export and some imports of mainly machinery spares would be expected to pass through the port annually. It is therefore important to assess its capacity in terms of handling equipment, draught and stockpile.

The current handling capacity of the port with the existing cargo handling equipment is about 750,000 tonnes including over 65,000 tonnes of containerized cargo. The port works 24/7.

## 5.2 Existing Facilities

The port has both rail and road connectivity. It is a lighterage (lightering) port whereby offloading and loading of ships is in stream by use of barges or lighters. On the quayside, there are 2 berths with a minimum and maximum draught of 2.5 and 4.5 during low and high tide respectively and 12 stream berths at outer anchorage with draught between 5 and 12.5m.

For handling of dhows and schooners, there is a dedicated dhow wharf. There are sheds with storage capacity of over 120,000$m^2$ which with the increase of containerization could be demolished to expand the existing container yard of 13,000 $m^2$ capable of accommodating 500 twenty equivalent units (TEUs).

A bulk buoy facility for oils serves the lighterage quays by a connected submarine pipe as most of the fuel for consumption in the four regions of Tanga, Kilimanjaro, Arusha, Manyara and even the lake zone pass through the port of Tanga.

The existing shore handling and marine equipment include the following (numbers in brackets may be changing frequently due to additions or breakdowns):

- Labor boat (1)
- Tugs (3)
- Pilot boat (1)
- Bagging machine (1)

- Barges (5)
- Mooring boat (1)
- Rail/Road weighbridge (1)
- Mobile cranes (2)
- Portal cranes (6)
- Forklifts (10)
- Tractors (5)
- Trailers (18)
- Bale clamps (4)
- Hopper and grabs
- Front loader (1)
- Reach stackers (2)

**Fig 5.1:**Showing existing cargo handling equipment at Tanga Port

## 5.3 Tanga Port Recent Traffic Performance

For the past two financial years Tanga port has been handling a mean average of 52,745 tonnes per month, which is below its current average monthly capacity of 62,500 tonnes as depicted in **Table 5.1.**

Table 5.1: Cargo Handled by Tanga Port During FY 2018/19 and 2019/20

| SN | EXPORTS | | | | IMPORTS | | | |
|---|---|---|---|---|---|---|---|---|
| | COMMODITY | | TONNES | | COMMODITY | | TONNES | |
| | | | 2018/19 | 2019/20 | | | 2018/19 | 2019/20 |
| 1. | Ore | Iron | 0 | 0 | Motor | Vehicles | 0 | 0 |
| | | Gold | 0 | 0 | | Tractors | 0 | 0 |
| 2. | Pulses | Beans | 0 | 0 | Machinery | Industrial | 0 | 0 |
| | | Peas | 756 | 540 | | Agricultural | 0 | 0 |
| 3. | Coffee | | 3,204 | 2,772 | Pet Coke | | 147,024 | 82,066 |
| 4. | Tea | | 0 | 1,332 | Petroleum | | 268,816 | 234,722 |
| 5. | Gypsum | | 0 | 0 | LPG | | 33,958 | 14,265 |
| 6. | Limestone | | 0 | 0 | Containers | | 0 | 0 |
| 7. | Aggregates | | 4,862 | 0 | Machinery Spares | | 1,076 | 1,296 |
| 8. | Sisal & Ropes | | 25,668 | 20,457 | Chemicals | | 38,308 | 51,228 |
| 9. | Cement &Clinker | | 2,870 | 0 | Dhow imports | | 4,588 | 12,634 |
| 10. | Containers | | 0 | 0 | Liquid Paraffin | | 0 | 828 |
| 11. | Timber | | 29,366 | 13,968 | Essential oils | | 1,752 | 0 |
| 12. | Macadamia | | 7,635 | 6,770 | HO4 | | 3,908 | 0 |
| 13. | Cosmetics | | 0 | 0 | General Cargo | | 45,602 | 37,700 |
| 14. | Dhow Exports | | 35,716 | 58,837 | | | | |
| 15. | General Cargo | | 12,867 | 8,666 | | | | |
| **TOTAL** | | | **122,944** | **113,342** | | | **545,032** | **434,739** |
| **2018/19 ANNUAL TOTAL (122,944 + 545,032)** | | | | | | | **667,976** | |
| **2019/20 ANNUAL TOTAL (113,342 + 434,739) UP TO MAY 2020** | | | | | | | **548,081** | |

Source: *TPA, 2020*

## 5.4 Port Capacity Assessment

### 5.4.1 Cargo Handling Capacity

As indicated in section 2 above, traffic levels are not expected to raise up abruptly though the nation is undertaking various initiatives in agriculture, industry and mining sectors. According to the Marketing Study, it is estimated that out of the initial 500,000 tonnes of Soda Ash produced annually, about 150,000 tonnes would be consumed locally, leaving 350,000 tonnes for export, some of which will definitely be exported through Dar es

Salaam due to other considerations like less ocean freight rate or will be delivered by road especially to regional markets of SADC and EAC whose demand is estimated to be in the range of 489,472 tonnes and 24,090 tonnes annually respectively. Even if it is assumed that all Soda Ash exports would pass through Tanga port, it would mean an addition of less than 30,000 tonnes per month. About 700 tonnes and 40,825 tonnes of exports and imports are expected to be generated as result of the estimated annual economic growth rate of between 5% and 7% of agricultural, industrial and mining activities in the four regions.

### 5.4.2 Ship Handling capacity

Pursuant to the Indian Standard that deals with loading on waterfront structures covering vertical live loads, horizontal forces due to berthing, bollard pulls, wave forces, currents and winds (IS:4651-Part III- 1974), with a draught of 12 m to be achieved after the modernization project, a ship of 60,000 dwt which is big enough can berth at Tanga port. Standard dimensions of vessels relative to draught according to IS: 4651-Part III (1974) is as provided in **Table 5.2**

Table 5.2: Standard Dimensions of Vessels According to IS: 4651-Part III (1974)

| SN | DRAUGHT (M) | DEAD WEIGHT (T) | BEAM (M) | LENGTH (M) |
|---|---|---|---|---|
| 1. | 7.9 | 10,000 | 18.5 | 140.0 |
| 2. | 9.0 | 15,000 | 20.7 | 163.0 |
| 3. | 9.7 | 20,000 | 22.8 | 180.0 |
| 4. | 10.3 | 25,000 | 24.7 | 194.0 |
| 5. | 10.7 | 30,000 | 26.5 | 205.0 |
| 6. | 11.1 | 40,000 | 29.7 | 223.0 |
| 7. | 11.8 | 50,000 | 32.5 | 235.0 |
| 8. | 12.0 | 60,000 | 35.0 | 245.0 |

Source: *IS: 4651-Part III (1974)*

### 5.4.3 Storage Capacity

Assessment of the capacity of the port to store the project cargo in particular soda Ash is based on the following generally acceptable criteria for a port like Tanga:

- Vessels arrival interval
- 1.5 times the maximum vessel size in terms of dead weight and net registered tonnage
- One tenth of the cargo in question

Assuming that export of all Soda Ash will be through Tanga port during the two phases, and the size of vessels calling at the port, its storage requirements is assessed according to last norm (one tenth of the cargo in question) and tabled below.

Table 5.3: Export Soda Ash Storage Requirement at Tanga Port

| A | ASSUMPTIONS | | |
|---|---|---|---|
| | **ITEM** | **PHASE 1 EXPORT** | **PHASE II EXPORT** |
| 1. | Annual export volume (tonnes) | 350,000 | 700,000 |
| 2. | Average ship size (DWT) – tonnes | 20,000 | 30,000 |
| 3. | Average ship size (NRT) – tonnes | 11,800 | 16,800 |
| 4. | Total annual ship calls (1/3) | 30 | 42 |
| 5. | Planned annual working days | 355 | 355 |
| 6. | Daily operations hours | 24 | 24 |
| 7. | Annual operations hours (5x6) | 8,520 | 8,520 |
| 8. | Vessel arrival interval in hrs (7/4) | 284 | 203 |
| 9. | Vessel arrival interval in days (8/24) | 12 | 8 |
| **B** | **STORAGE CAPACITY REQUIREMENT** | | |
| Based on one tenth of the export volume (1/10) tonnes | | 35,000 | 70,000 |

Source: *CILT Analysis, 2020*

The above table shows clearly that storage capacity of 35,000 tonnes calculated on the basis of one tenth of the export volume conservatively estimated at 350,000 tonnes per year or roughly 30,000 tonnes monthly is enough to accommodate 30,000 tonnes of Soda Ash exported by the plant per month.

### 5.4.4 Prevailing Constraints

As of now efficiency of port operations and attractiveness of the port face a few constraints that are worth mentioning.

**(a) Draught Limitation**

Due to draught limitation only small ships call at Tanga port and after loading goods have to be transshipped onto big vessels at Mombasa or elsewhere, thus ocean freight for cargo loaded at Tanga is usually higher compared to other ports including Dar es Salaam.

**(b) Pilotage Restriction**

Owing to the narrowness of the entrance channel, for safety reasons pilotage of vessels is restricted to daytime only which affects berthing of vessels as well as dwell time of vessels in the port.

### 5.4.5 Port Expansion

The port is now undergoing expansion to increase the capacity to 2 million tonnes in order to cope with the envisaged upsurge of traffic including cargo emanating from both agricultural industrial developments in the four regions including Engaruka Soda Ash plant.

The two phase port modernization project includes construction of two berths of over 446 m long and dredging to deepen the entrance channel and draught to over 12 m to enable ships come alongside the quay instead of ships anchoring 1.7 km in the outer anchorage which is expensive to the port and eventually to the final customer.

The modernization project includes acquisition of more cargo handling equipment, rehabilitation of sheds and tracks within the port.

## CHAPTER SIX

# 6. COMPARATIVE ANALYSIS

## 6.1 Transport Logistics Management and Operations Options

Various bottlenecks and deficiencies that are likely to affect the smooth flow of cargo from Engaruka have been identified. It is therefore imperative to discuss the resultant issues and options available for the viability and sustainability of the proposed plant.

According to Porter's five forces analysis a high degree of dependency on existing distribution channels is one of the factors that increase customers' bargaining power and affects profitability. There are two options to operate or manage transport logistics function in a plant or industry; in-house or outsourcing. Each option has its advantages and disadvantages.

### 6.1.1 In-house Transport Logistics Services

This refers to a situation whereby transport logistics management and all operations are done by the plant.

**(a) Disadvantages of In-house Transport Logistics Services**

Apart from distracting the plant from the core business of producing Soda Ash, it requires an extra investment in trucks or even wagons. For a fleet of 156 trucks required (as per **Table 4.3**) for the proposed plant an investment of USD 7,800,000 at an average of USD 50,000 per truck, let alone recurring maintenance and running expenses including fuel and spares that is in the range of USD 7,742,200. Furthermore, provision of USD 975,000 annually for depreciation, deprives the plant the opportunity to reinvest that money for production of other products or increase the level of production. Estimates of major costs involved are as summarized in **Table 6.1.**

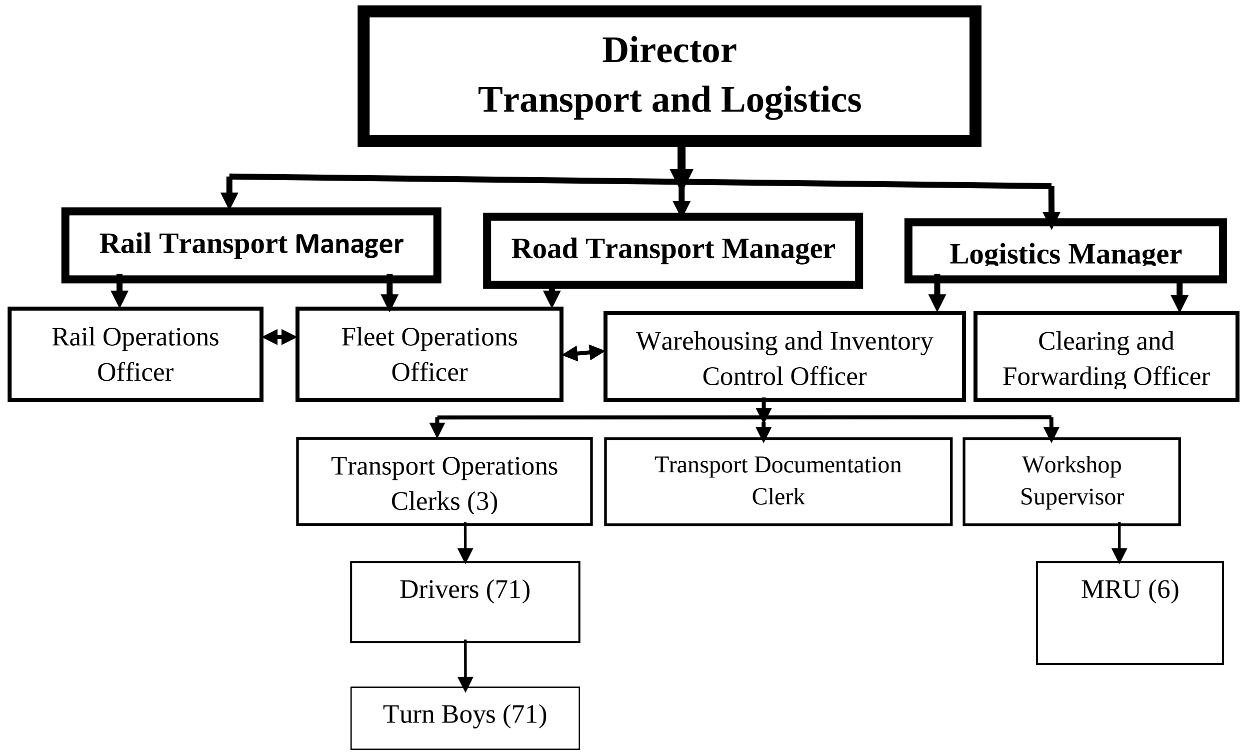
Table 6.1: CAPEX and OPEX of In-house Transport Logistics Services (USD)

| SN | EXPENSE | EXPENSE DETAILS | AMOUNT USD |
|---|---|---|---|
| **A.** | **CAPEX** | | |
| 1. | Purchasing | 156 trucks for both phases as shown in Table 4.3 @ 50,000 | 7,800,000 |
| 2. | Depreciation | Computed by straight line (salvage value 0 and life span 8 yrs | 975,000 |
| **SUB TOTAL CAPEX** | | | **8,775,000** |
| **B.** | **OPEX** | | |
| 1. | Insurance | 750 per vehicle based on value | 117,000 |
| 2. | Permits | LATRA levies 100 per vehicle | 15,600 |
| 3. | Fuel | 300 days x 600km/8ltrs/km x156 trucks x 1/ltr | 3,510,000 |
| 4. | Tyres | 20 tyres /truck x 156 trucks x 220/tyre x 2times/ year | 1,372,800 |
| 5. | Maintenance | Servicing of trucks including oil estimated | 1,485,400 |
| 6. | Repairs | Spares for repairs not covered by insurance estimated | 867,000 |
| 7. | Salaries | For drivers only excluding administrative staff @ 200 | 374,400 |
| **SUB TOTAL OPEX** | | | **7,742,200** |
| **GRAND TOTAL** | | | **16,517,200** |

Source: *CILT Analysis*, *2020*

In terms of labor cost, a fully fledged department must be established to manage the function instead of a unit with skeleton staff. Organograms for in-house and outsourced transport logistics department and unit are provided below as **Fig. 6.1** and **Fig. 6.2** respectively for comparison purposes.

**Fig 6.1:**Showing an organizational structure of in-House transport logistics directorate

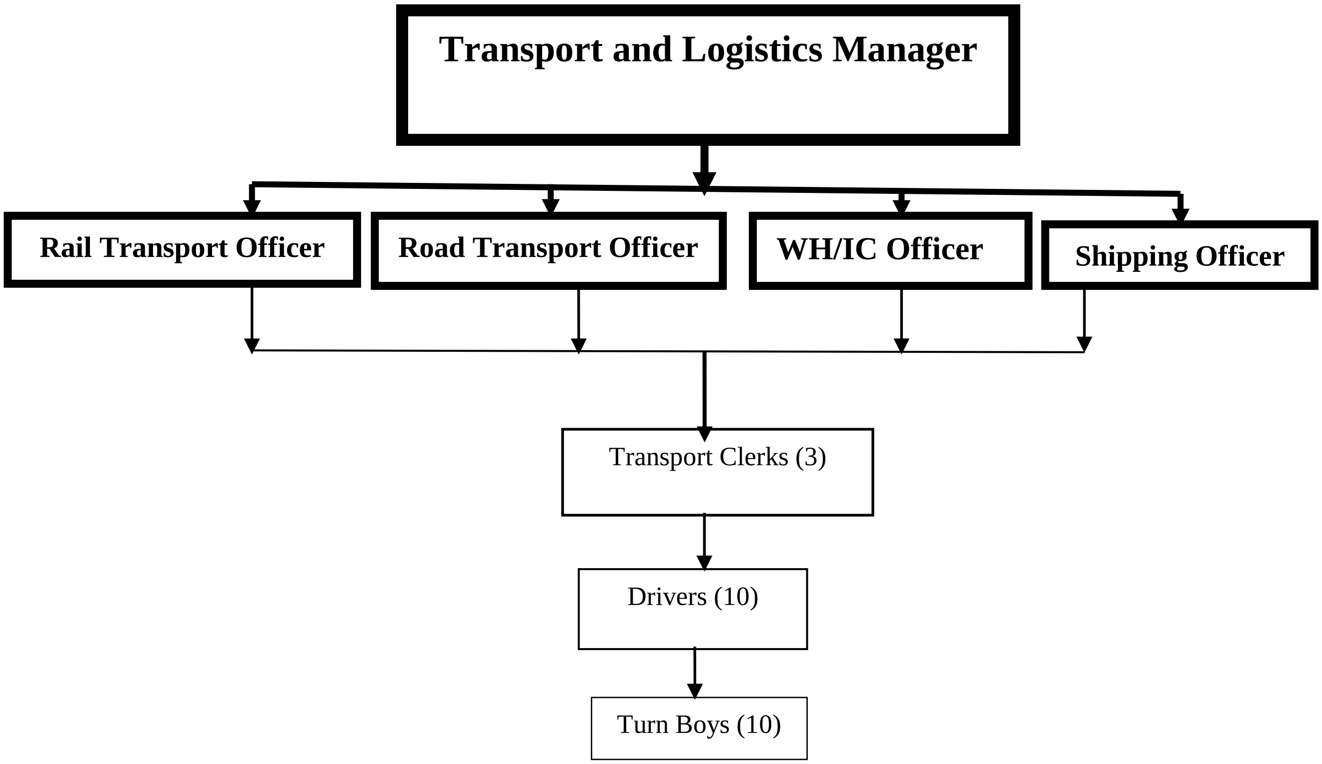



**NOTES:**

(I) The number of drivers and turn boys is as calculated and presented in **Table 4.3** for the Engaruka/Moshi option

(II) MRU stands for maintenance and repair unit. The number of mechanics is obtained through a formula whereby MRU factors are multiplied by the number of vehicles, taking into account the base vehicle class, usually a passenger vehicle and then divided by MRU mechanic to vehicle ratio. Simply, the number of mechanics is obtained based on specialization, namely: mechanical, electrical, fitter and turner, and engine, then supervisor and assistant responsible for spares.

**Fig 6.2:** Showing an organizational Structure of a transport Logistics Department




(b) Advantages of In-house Transport Logistics Services

The only advantage of the proposed plant owning and managing its transport logistics services is flexibility and the use of transport equipment to advertise products.

## 6.2 Transport Logistics Arrangement Responsibility

Whoever makes arrangements for transport in most contracts is held responsible in case anything to the contrary happens including short or late delivery of goods. It is for that reason that it is proposed that the responsibility of making arrangements for transport of Soda Ash products be left to customers themselves as is the case of Minjingu Phosphates and Fertilizers Ltd.

## 6.3 Transport Modal Mix

Generally, railways offer cheap rates, especially for longer distances and move big quantities as compared to road transport unless there is no rail connectivity as is the case of the proposed plant at Engaruka. Nevertheless, the option of moving project cargo by rail is taken into consideration as already there are plans to build a spur line to Engaruka as part of the Tanga-Arusha- Musoma project. Therefore, there are four options to move project cargo as follows:

- All by road
- All by rail only when rail connectivity is established between Arusha and Engaruka
- By rail to Moshi and then by road to Engaruka
- By rail to Arusha and then by road to Engaruka

### 6.3.1 All by Road

The current road freight rates are in the range of USD 0.09 per tonne per kilometer which is over 65% above the rail freight rate of USD 0.06 and 0.05 per tonne per kilometer from Arusha to Tanga and Dar es Salaam respectively. It is crystal clear that the all road option is the most expensive, thus a modal mix could bridge the gap in the interim.

The condition of the existing road network between Tanga and Mto wa Mbu (Alternative I) is excellent as discussed in the foregoing section. Alternatives II and III though comparatively shorter, some sections are yet to be upgraded.

Other issues with road transport is road degradation due to daily use of such a big number of vehicles and environmental concerns in that about 27 (800/30) trucks would be passing the area at different times as compared to a single train hauling the same quantity of 800 tonnes of project cargo bearing in mind that the proposed plant is within the game reserve.

At present movement of Coal and carbon Dioxide has to be by road from source to destination because of the following reasons:

- There is no rail connectivity between both Kiwira and Tan coal with the nearest railway system which is TAZARA. Even if there was rail connectivity, TAZARA Cape gauge (1,067 mm) is different from TRC MGR though transshipment can be done at two points: Kidatu in Morogoro and Dar es Salaam port assuming that there will be a rail link to the factory already. To avoid wastage during transshipment from one wagon to another, it would be necessary to invest in wagons which are compatible with the two systems to enable swapping of wagon bodies.
- Another alternative is to use ISO open top containers for easy loading and swapping.
- Carbon dioxide is moved by special trucks therefore it will continue like that until arrangements are made between TRC and TOL Gases Ltd to load gas by wagons.

### 6.3.2 All by Rail

Once rail connectivity is established between the proposed plant and Arusha, this option will be feasible.

Based on the current TRC freight rates, it will be much cheaper to move both products and inputs by rail, bearing in mind that with railways the further the distance the cheaper the rate. Currently it costs 132 Tanzania Shillings per tonne per kilometer between Arusha and Tanga as compared to 115 Tanzania Shillings per tonne per kilometer between Arusha and Dar es Salaam. Extrapolation of the same rates would mean that the cost per tonne per kilometer between the plant and Tanga and the plant to Dar es Salaam would be 169 Tanzania Shillings and 148 Tanzania Shillings respectively.

### 6.3.3 By Road and Rail

This option implies that the project cargo will be moved to Engaruka from Moshi or Arusha and vice versa by road and then by rail to and from Tanga. Between the two transshipment points of Moshi and Arusha six alternative routes exist as shown in **Table 6.2**

Table 6.2: Alternative Road Routes between Moshi, Arusha and Engaruka

| SN | ALTERNATIVE | STRETCH | KM | ROAD TYPE |
|---|---|---|---|---|
| 1. | I: Arusha – Engaruka Via Longido | Arusha – Longido | 90 | Trunk |
| | | Longido – Oldonyo | 102 | Gravel |
| | | Oldonyo – Engaruka Junction | 16 | Being Paved |
| | | Engaruka Junction- ECVC | 33 | Being Paved |
| | | ECVC- Plant Site | 18 | New Road |
| **TOTAL DISTANCE ALTENATIVE I** | | | **259** | |
| 2. | II: Arusha – Engaruka Via Makuyuni | Arusha - Makuyuni | 77 | Trunk |
| | | Makuyuni – Mto wa Mbu | 32 | Trunk |
| | | Mto wa Mbu – ECVC | 31 | Being Paved |
| | | Engaruka Junction – Plant Site | 18 | New Road |
| **TOTAL DISTANCE ALTENATIVE II** | | | **158** | |
| 3. | III: Moshi – Engaruka Via Longido | Moshi – Longido | 95 | Gravel |
| | | Longido – Oldonyo | 102 | Gravel |
| | | Oldonyo – Engaruka Junction | 16 | Being Paved |
| | | Engaruka Junction- ECVC | 33 | Being Paved |
| | | ECVC- Plant Site | 18 | New Road |
| **TOTAL DISTANCE ALTENATIVE III** | | | **264** | |
| 4. | IV: Moshi – Engaruka Via Makuyuni | Moshi – Arusha | 81 | Trunk |
| | | Arusha - Makuyuni | 77 | Trunk |
| | | Makuyuni – Mto wa Mbu | 32 | Trunk |
| | | Mto wa Mbu – ECVC | 31 | Being Paved |
| | | ECVC – Plant Site | 18 | New Road |
| **TOTAL DISTANCE ALTENATIVE IV** | | | **239** | |
| 5. | V: Moshi – Arusha - Engaruka via Longido | Moshi – Arusha | 81 | Trunk |
| | | Arusha - Longido | 90 | Gravel |
| | | Longido – Oldonyo | 102 | Gravel |
| | | Oldonyo – Engaruka Junction | 16 | Being Paved |
| | | Engaruka Junction- ECVC | 33 | Being Paved |
| | | ECVC- Plant Site | 18 | New Road |
| **TOTAL DISTANCE ALTERNATIVE V** | | | **340** | |
| **6.** | VI: Arusha- Engaruka via | Arusha – Monduli Junction | 25 | Paved |
| | | Monduli Junstion– Engusero | 65 | Gravel |

| | | | | |
|---|---|---|---|---|
| | Monduli | Engusero – Engaruka Junction | 50 | Gravel |
| | | Engaruka Junction- ECVC | 33 | Being Paved |
| | | ECVC – Project Site | 18 | New Road |
| **TOTAL DISTANCE ALTENATIVE VI** | | | **191** | |

Source: *CILT Analysis, 2020*

From the above table, it is deduced that based on distance by road the short, shorter and shortest routes (with respective distances in brackets) are:

- Arusha/ Engaruka Plant via Makuyuni (158)
- Arusha/ Engaruka Plant via Monduli (191)
- Moshi/ Arusha/Engaruka Plant via Makuyuni (239)

Further analysis is done to determine the most cost effective route between Arusha/ Engaruka via Makuyuni or Monduli and Moshi Engaruka via Longido from Tanga and results are entered in **Table 6.3**

Table 6.3: Comparison of Freight Charges (per tonne in USD)

| **ROUTE** | **DISTANCE (km)** | | **FREIGHT CHARGES** | | **TOTAL CHARGES** |
|---|---|---|---|---|---|
| | **RAIL** | **ROAD** | **RAIL** | **ROAD** | |
| Tanga/Arusha/ Engaruka via Makuyuni | 437 | 158 | 26.22 | 14.22 | 40.44 |
| Tanga/Arusha/ Engaruka via Monduli | 437 | 191 | 26.22 | 17.19 | 43.41 |
| Tanga/Moshi/ Engaruka via Longido | 351 | 239 | 21.06 | 21.51 | 42.57 |

Source: *CILT Analysis, 2020*

The above analysis divulges that the most competitive rail road route between Tanga and Engaruka is via Makuyuni through Arusha, followed by Tanga/Arusha/ Engaruka via Monduli and last is Tanga/Moshi/Engaruka via Longido (bypassing Arusha).

## 6.4 Warehousing

In most cases warehousing facilities enroute are necessitated by either lack of coordination or mismatch of vehicular units between two modes of transport where more than one mode of transport is involved. Other determining factors of warehouse requirement at transshipment points are capacity of handling equipment and goods handling method as discussed in the following section.

Going by the above assertion, warehouses will not be required if the project cargo will be moved by either rail or road from origin to destination.

All-rail option can only happen after rail connectivity has been established between Arusha and Engaruka, presumably under the Tanga-Arusha-Musoma Railway Project. The all-road option is not attractive due to high transport cost. Cost benefit analysis reveals that the one-time cost of building a warehouse for transshipment at Moshi or Arusha is by far less than the transport cost of moving the project cargo by road from Tanga to Engaruka in a year as shown in **Table 6.4.**

Table 6.4: Cost comparison between warehousing and road transport (USD)

| SN | COMMODITY | ANNUAL TONNAGE | FREIGHT CHARGES | | DIFFERENCE |
|---|---|---|---|---|---|
| | | | ALL ROAD | ROAD/RAIL | |
| 1. | Soda Ash | 500,000 | 25,965,000.00 | 20,728,333.40 | 5,236,666.60 |
| 2. | Raffia Bags | 725 | 37,649.25 | 30,056.08 | 7,593.17 |

Source: *CILT Analysis, 2020*

The above table shows that if need be it is better to construct a warehouse at Moshi or Arusha as compared to moving cargo by road throughout. It should be noted that TRC has a warehouse at Moshi and Arusha. The issue of storage at Tanga port has already been discussed in section 5 (Tanga port).

## 6.5 Project Cargo Handling

Handling arrangement is a matter that requires attention in the entire logistics chain of project cargo movement especially when two modes of transport will be used. In the case of rail transport, handling is done at only two points; at the plant and at the port in the case of export. The port is responsible for handling cargo once in its premises. For cargo meant for domestic consumption once handling is completed at the plant the rest remains the customer's responsibility. The following equipment are recommended for cargo handling at the plant but their respective numbers will depend on capacity of each equipment and plant design:

- Conveyors (for coal and soda ash)
- Bagging machines (for soda ash)
- Truck loader

In case of road rail modal mix, goods will have to be transshipped at Moshi or Arusha. Thus, there is need to install cargo handling equipment as recommended below:

- Wagon loaders
- Pay loaders

- Reclaim hoppers (for coal handling only)

### 6.6 Use of Dar es Salaam Port

The possibility of some export project cargo going through the port of Dar es Salaam can't be ignored because some customers may prefer Dar es Salaam to Tanga for some reasons.

### 6.7 Use of Third Party Logistics (3PL) Service Providers

In the preceding sections, the option of using in-house or outsourcing transport logistics has been evaluated, bearing in mind that total logistics services include transportation, clearing and forwarding, warehouse management, rate negotiation, carrier selection, cargo consolidation, and inventory management. The benefits expected to be derived from outsourcing include focus on core business and cost reduction. However, outsourcing is associated with lack of innovation once contracts are signed leading to diminished value addition and operational stagnation.

### 6.8 Lessons from Similar Organization Visited

The following are findings from places visited which the current project can learn from and benefit in terms of cost reduction:

#### 6.8.1 Lessons from Minjingu Mine and Fertilizers Limited

- The Minjingu factory is located just 200 meters away from the phosphate raw materials mine such that the cost of transportation of the raw materials to the factory for processing is minimal. The same could be for Engaruka unless there are some inhibiting factors.

- The Minjingu factory buildings were purposefully designed to accommodate production as well as storage of products. The dimensions of the set-up being 100m x 45m x 20m high. This is an adequate volumetric space in terms of conventional standards. Having such a building will eliminate the need of constructing a separate warehouse. This is quite instructive for Engaruka Soda Ash Project.

- The issue of Minjingu looking anxiously towards the construction of a rail spur proposed in the initial TRC feasibility study in order to drastically reduce transport cost is an idea Engaruka Soda Ash Project should emulate.

- The factory operates 10 depots located in various parts of the country with the biggest at Arusha to serve areas around and exports to Kenya and Uganda. Products are delivered to these depots which in turn supply various customers whose duty is then to transport the products to places for resale or final consumption. For Engaruka this should provide a lucid lesson for not only distribution but taking on board the need to move its products nearer to the consumers, especially those factories that use soda ash products in various parts of Tanzania.

- Minjingu has also encouraged its consumers to procure and transport their products either straight from the factory or from the 10 depots operated in various parts of the country and beyond especially in Kenya. Engaruka Project could emulate such practice to significantly reduce transportation and warehousing costs.

### 6.8.2 Mufindi Paper Mills Ltd

- The factory has been developed in an area where the critical raw materials are at call purposefully i.e. the wooden logs (obtained from the surrounding forest) are systematically crushed to provide the critical raw material for the manufacture of their product (paper);
- Having a goods shed for receiving and storing the needed soda ash as a necessary material for paper production;
- Establishing a plant for power generation needed in the process of production of the final products instead of solely relying on TANESCO;
- Construction of a siding to bring in the needed raw materials as well as take out the products using rail at site;
- The factory buildings were deliberately designed to accommodate the production processes as well as storage of products with all necessary infrastructures to load and offload products whether using road or rail transportation. Having such a building eliminates the idea of constructing a separate building for warehousing and internal movement of raw materials as well as finished products;
- The presence of a rail system near the factory, save for shortfalls like inappropriate pricing and or failure to honor scheduled times obviously has significantly reduced transport costs in the transport logistics supply chain for Mufindi Paper. This is also further supplemented by customers coming with their trucks to load the products at the factory;
- The company has also acquired a fleet of vehicles to supplement external transporters many of which are awaiting increased production to move products to various parts of the country given that the factory intends to become the largest such type in East and Central Africa in the near future.

### 6.8.3 Kiwira Coal Mine / Kiwira- Kaburo Coal Project

- Coal was initially mined underground and transported using spiral shafts. The mine now operates an open pit at Kaburo from where the coal is then moved to Kiwira about 30 km by road. There is also a short-cut which would shorten the distance to 7 km, but is in disuse due to a broken bridge. Once the bridge is repaired it should provide a better alternative. This is instructive for Engaruka with respect to the location of the plant and the distance involved in the movement of raw materials.

- Customers either come to procure and load their cargo using their own transport or where orders are received from prominent clients like Cement factories or textile Mills in Tanga, Arusha and Dar es Salaam respectively, the orders are processes and then customers are notified to arrange for transportation. This could a lesson for Engaruka.

- The packaging and or form of carriage vary from customer to customer depending on the means of carriage. This could also prove instructive for Engaruka with respect to the issue of warehousing structure, packaging and loading facility at the plant as well as leaving the cost of transportation to customers.

- Besides the conveyer belt, the mine originally had internal light rail trolleys to move coal from the warehouse to the point of loading. This is a useful option for quick movement of products from a warehouse to a loading bay especially when the electronically operated conveyer is out of use. Engaruka could consider this as an important input in internal movement of the product from the warehouse to the loading bay.

- While Kiwira operates no depots like Minjingu or Mufindi Paper, the management proposes to make such an arrangement in some near future once it procures its own trucks to move the product nearer to the point of need or point of exportation. This is an aspect that could be considered critical for the case of Engaruka soda ash project given the prospective customers.

- The Mine had extensive building infrastructures including a warehouse for coal measuring 15 m wide, 30 m long and 10 m high enough to accommodate between 2,000 and 3,000 tons of coal with an electric conveyor belt to the loading bay where the processed coal is delivered to the customer.

## *6.9* Staff Transport

Transportation of staff is another issue that must be analyzed so as to adopt the best option. Basically there are the following four alternatives:

- Provision of staff accommodation within the plant neighbor hood
- To buy buses for picking workers at specified points
- To pay transport allowance and let every worker arrange for his/her own transport
- To outsource staff transport on the company's account

Analysis of each of the above alternatives reveals as follows:

- Provision of staff houses is expensive in terms of initial investment and subsequent maintenance costs, although the investment could be left to private property developers.
- Purchase of buses is equally costly and involves additional workers such as drivers and maintenance staff.
- Payment of transport allowance increases the wage bill as it becomes part of salary and it is paid even if a worker is on leave, sick or under suspension
- Outsourcing is the best option in that the contractor is responsible for everything from buying, operating and maintaining the buses.

## 6.10 Conclusions

Based on the above comparative analysis and lessons learnt from the three establishments it is concluded that:

- Before a rail link is established between Arusha and Engaruka the only option will be to move project cargo to and from Tanga to Moshi/ Arusha by rail and then by road to Engaruka
- Movement of project cargo by rail from origin to destination is the most cost efficient and optimal logistical option
- It is cheaper to build a warehouse at Arusha or Moshi compared to road haulage of project cargo from origin to destination
- The shortest route to Engaruka Plant by road is from Arusha via Makuyuni (158).
- It is more economical to outsource transport services than maintaining an in-house transport department.
- Lessons from the three establishments of Minjingu, Mufindi and Kiwira are very instructive in terms of minimizing transport logistics costs, while ensuring services

are taken nearer to the consumers who are the key stakeholders in the business transaction of Soda Ash, for assured sustainable posterity of Engaruka project.

# CHAPTER SEVEN

## 7. COST EFFECTIVE MODAL MIX

### 7.1 Cost Allocation

Evaluation of an optimal cost effective modal mix has been done taking into account constraints and deficiencies without due consideration of costs of infrastructure upgrading or construction of new railway lines and roads because such costs are borne by the government, executive agencies and organizations like TANROADS, TARURA, TRC and TPA. It would be misleading to consider them because an investor doesn't shoulder such costs under normal circumstances. Thus the analysis is narrowed down to costs directly or indirectly related to the movement of project cargo; finished product and raw materials (Coal, Carbon dioxide and packaging materials).

On one hand, it is assumed and expected that customers will be arranging for transport and paying freight for their cargo (Soda Ash) especially for local consumption, while on the other it is recognized that the plant will be paying freight charges up to the port for Soda Ash purchased under FOB or FAS for export.

As aforesaid some cost might have already been incurred and some will be met as project implementation progresses. It is a prelude to identify parties responsible for construction and rehabilitation of transport infrastructure for the smooth flow of project cargo and apportioning costs as follows:

Tanzania Ports Authority

- Storage sheds in ports
- Cargo handling equipment
- Rehabilitation of railway system at Tanga port

Tanzania Railways Corporation

- Construction of a rail link between Arusha and Engaruka
- Extension of loop line at Moshi and Arusha stations
- Acquisition of more wagons and locomotives
- Cargo handling equipment at Moshi and/or Arusha

TARURA/TANROADS

- Pavement of Mto wa Mbu to Engaruka road
- Construction of the new road from ECVC to the plant site
- Pavement of the road from Moshi to Longido and beyond
- Pavement of all other roads which could be used in case of emergency

Engaruka Soda Ash plant

- Cargo handling equipment at the plant
- Storage facilities at the plant
- Cargo handling equipment at Moshi and/or Arusha (if not provided by TRC)

Apart from being responsible for costs in respect of the above facilities and equipment, the plant has a legal obligation of paying freight charges for raw materials and Soda Ash bought under FOB and FAS that become the basis of determining the optimal modal mix in terms of cost efficiency. Thus in the assessment of the least cost modal mix, only freight charges will be the major determining factor because the other two costs remain the same regardless of the transport mode used.

## 7.2 Transport Route Options

As already discussed in previous sections, there are four options of transporting project cargo. The options are:

- 1 (a); By rail from Tanga to Moshi and then by road to Engaruka via Arusha subject to pavement of the Mto wa Mbu to Loliondo road and construction of the new road to the plant
- 1(b): By rail from Tanga to Moshi and then by road to Engaruka via Longido (bypassing Arusha) provided that the road between Moshi and Longido is paved and the new road to the plant is constructed
- 1I: By rail from Tanga to Moshi/Arusha and then by road to Engaruka via Monduli
- 2 (a): By road to Engaruka via Arusha (as in 1 (a))

- 2 (b): By road to Engaruka via Longido (bypassing Arusha)
- 3: By rail to Arusha and then by road to Engaruka
- 4: By rail from Tanga to Engaruka. This can only happen after a rail link has been established between the plant and Arusha

## 7.3 Freight Charges per Ton

Since the plant will squarely be responsible for the movement of project cargo both inputs and finished goods purchased under FOB and FAS, freight charges determines the cost effectiveness of a route. In the interim, before construction of a railway line to the plant which might take time and needs a lot of investment (according to EAC Railway Enhancement Project Study, 500 km of the Arusha – Musoma railway was estimated to cost USD 1,419,000,000 in 2016). There will be three modal mix alternative routes as explained in Section 6. Freight charges for the various routes are as tabled below:

Table 7.1: Transport Modal Mix Routes Freight Charges (per tonne in USD)

| ROUTE | DISTANCE | | FREIGHT CHARGES | | TOTAL CHARGES |
|---|---|---|---|---|---|
| | RAIL | ROAD | RAIL | ROAD | |
| Tanga/Engaruka via Makuyuni | 437 | 158 | 26.22 | 14.22 | 40.44 |
| Tanga/Engaruka via Monduli | 437 | 191 | 26.22 | 17.19 | 43.41 |
| Tanga/Moshi/ Engaruka via Longido | 351 | 239 | 21.06 | 21.51 | 42.57 |

Source: *CILT Analysis, 2020*

## 7.4 Optimal Modal Mix

From an analysis in the preceding sections, the best option is to move project cargo to and from the plant by rail. The option is only feasible and possible after the plant is linked by rail to Arusha. Before that materializes the alternative route that attracts the lowest freight charges as shown in **Table 7.1** is by rail to Arusha and then by road via Makuyuni to Engaruka. The next best option is movement of project cargo by rail from/to Moshi and then by road via Longido and the last transport modal mix is by rail to and from Arusha and then by road via Monduli to Engaruka as summarized in **Table 7.2**

Table 7.2:Transport Modal Mix Routes Ranking by Freight Charges Per Tonne (USD)

| **RANK** | **ROUTE** | **DISTANCE** | | **FREIGHT CHARGES** | | **TOTAL CHARGES** |
|---|---|---|---|---|---|---|
| | | **RAIL** | **ROAD** | **RAIL** | **ROAD** | |
| 1 | Tanga/Arusha/ Engaruka via Makuyuni | 437 | 158 | 26.22 | 14.22 | 40.44 |
| 2 | Tanga/Moshi/Engaruka via Longido | 351 | 239 | 21.06 | 21.51 | 42.57 |
| 3 | Tanga/Arusha/Engaruka via Monduli | 437 | 191 | 26.22 | 17.19 | 43.41 |

Source: *CILT Analysis, 2020*

A direct road to Engaruka from Arusha without necessarily going through Longido should be even much shorter though the consultants didn't use topo sheets. However, that would need fresh survey prior to construction as opposed to the existing road via Longido that only requires upgrading to tarmac.

## CHAPTER EIGHT

# 8. CONCLUSIONS AND RECOMMENDATIONS

In view of the issues and findings as given in the preceding sections, the following constitute conclusions and recommendations.

## 8.1 Conclusions

### 8.1.1 Export Transport Logistics

There is a probability of using Dar es Salaam port for export due to some more favorable conditions available at Dar es Salaam such as availability of numerous ICDs for stuffing cargo into containers and less ocean freight should the plant start operations before dredging at Tanga port is completed and lighterage operations ceased.

### 8.1.2 National Distribution of Project Products

With the construction of Tanga-Musoma Railway nearing negotiation level, there is evidence that this could be a viable option for distribution of the project products by rail. Note the quote: ***"the Feasibility Study and Preliminary Design … has been completed. Procurement and process of engaging a Transaction Advisor … and preparation for tender documents under PPP arrangement is ongoing and has reached negotiation stage."*** Status by September 2019. Nevertheless, it suffices to conclude that in the interim, the internal distribution shall majorly be by use of roads and rail from Arusha. Based on information from the market study, a total of 154 industrial settings that use Soda Ash are variously distributed in 13 regions of the country, necessitating the establishment of depots for easy distribution.

### 8.1.3 Transport Modal Mix

If the project will start production before the rail link between Arusha and Engaruka is in place, the use of both road and rail transport will be the only transport modal mix from Engaruka to the ports of exportation and consumption.

### 8.1.4 Private Sector Participation

Involvement of the private sector in the provision of transport logistics services can't be avoided. It is one way of sharing risk, minimizing investment in non-core activities and reducing operating costs.

### 8.1.5 Use of Information Communication Technology

Even if transport logistics services would be outsourced, the plant will remain with its role of monitoring movement of cargo in order to ensure customer satisfaction and proper planning of production processes in the case of raw materials.

## 8.2 Recommendations

### 8.2.1 Export Transport Logistics

Taking into account that a customer would pay less by rail to move a ton of Soda Ash to Dar es Salaam as compared to Tanga when rail connectivity is fully established between the plant and Arusha, it is recommended that the option of using Dar es Salaam port be considered primal for cost competitiveness.

### 8.2.2 National Distribution of Project Products

To effectively serve Soda Ash users (current and potential) located in different regions it is recommended that four hubs/depots be established along transport corridors as follows:

- Arusha depot to cater for 20 users in Arusha, Kilimanjaro, Manyara, Singida.
- Dar es Salaam depot to cater for 120 users in Dar es Salaam, Zanzibar, Coast, Morogoro, Lindi and Mtwara.
- Mwanza depot to cater for 10 users in Geita, Shinyanga, Simiyu, Tabora, Kagera, Kigoma, Mara and Mwanza.
- Dodoma depot to cater for 4 users in Iringa, Dodoma, Rukwa, Mbeya, Njombe, Ruvuma, Katavi and Songwe.

Further it is recommended that distribution be done only at the four “hubs” so as to allow the plant concentrate with production and other strategic matters. The hubs could be in the form of a commission agent, authorized distributor or whole seller. Transport cost to each respective hub could be embedded in the selling price.

Considering the sensitive use of Soda Ash like water treatment (25% of the total consumers) it is discreet to ensure reliable and uninterrupted supply of Soda Ash. Hence, it is recommended that the plant maintains a small fleet of 10 vehicles to deliver goods at short notice notwithstanding the costs of having the trucks.

It is important to emphasize that the establishment of selling centres away from the factory will act as a catalyst for setting up small and medium size industries that use Soda Ash close to the centres, thereby creating employment to more people.

### 8.2.3 Transport Modal Mix

The use of rail transport being cheap as it is and with its connectivity to regional markets will make Soda Ash produced at Engaruka more competitive in terms of price. In the meantime, emphasis should be towards pavement of the Mto wa Mbu to Engaruka and the new road to the plant site. It is therefore highly recommended that the project sponsor begins as soon as possible to beseech the government to speed up the process leading to the construction and completion of Arusha – Musoma Railway with a spur to Engaruka.

### 8.2.4 Private Sector Participation

With regard to the involvement of the private sector in the project, it is recommended as follows:

- Transport logistics services for project cargo be outsourced
- Staff transportation should be outsourced or arrangements be made to have public passenger transport operating between the plant and Engaruka village. The Land Transport Regulatory Authority (LATRA) or the Monduli District Council could be requested to institute the arrangement.
- Private railway operators under the open access regime could be invited to bring in their own rolling stock and locomotives for movement of the project cargo. An annual traffic volume of over 1.5 million tons is attractive enough for any serious investor to consider investing in both rolling stock and motive power once a railway line is constructed to link the plant with Arusha.

### 8.2.5 Use of Information Communication Technology

To ensure that transport logistics are managed efficiently and on real time, it is recommended that ICT in the form of a GPS based Transport Management Information system (TMIS) be established and used for tracking movement of wagons and trucks as well as analysis of transport logistics services routinely.

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**APPENDICES**

## Appendix 1: Project Cargo O-D Matrix

| A | SODA ASH PRODUCTS | | | | |
|---|---|---|---|---|---|
| | **DESCRPTION** | **ANNUAL QTY TONNES** | **TYPE OF PACKAGING** | **ORIGIN** | **FINAL DESTINATION** |
| 1. | Sodium Carbonate | 400,000 | 50 kg /1,000 kg bags. | Engaruka | Tanga , DSM for export and local consumption |
| 2. | Sodium Bicarbonate | 100,000 | 25/50 kg bags | Engaruka | Proposed depots at Arusha, Morogoro and Shinyanga |
| **B** | **RAW MATERIALS/ ENERGY** | | | | |
| 1. | Coal | 300,000 | Bulk | Kiwira/ Mbinga | Engaruka |
| 2. | Liquid Carbon Dioxide | 1,300 | Bulk | TOL DSM/Kyela | Engaruka |
| 3. | 50 kg Packing Raffia bags | 725 | Bales | DSM/ Arusha | Engaruka |
| 4. | Fuel | To be supplied by one of the oil marketing companies | | | |

Source: *TIRDO*

**Appendix 2: List of Persons Met and Interviewed**

| SN | DATE OF VISIT | NAME OF INTERVIEWEE | JOB TITLE | CONTACT | ORGANIZATION |
|---|---|---|---|---|---|
| 1. | 22/1/2020 | Mr. Mziray | District Administrative Secretary | +255717561575<br>+255689625368 | Monduli District |
| 2. | 22/1/2020 | Mr. Felix Mpwage | The Executive Secretary | +255755409402<br>+255652268182 | Monduli District |
| 3. | 22/1/2020 | Mr. Ipyana Mwambete | Works Manager | +255784395861 | Minjingu Mine & Fertilizers Ltd |
| 4. | 22/1/2020 | Mzee Laizer | Driver / Guide | +255759453208 | Engaruka Centre |
| 5. | 22/1/2020 | Mr. Willy Martin | Guide | +255762705461 | Engaruka Village |
| 6. | 23/1/2020 | Eng. Edward A. Amboko | Regional Coordinator | +255753588828<br>+255713587617 | TARURA |
| 7. | 23/1/2020 | Eng Fadhili | Engineer | +255764355388 | TARURA |
| 8. | 23/1/2020 | Eng. John D.E Kalupale | Regional Engineer | +255754295337 | TARURA |
| 9. | 23/1/2020 | Mr. Seth Ringia | Engineer | +255755305487 | TANROADS |
| 10. | 23/1/2020 | Mr. Fita Marmo | Transporter | +255753303044 | Arusha |
| 11. | 23/1/2020 | Mr. Harjit Singh Grewal | Director | +255754287201<br>+255754287700 | Simba Trucking Limited |
| 12. | 23/1/2020 | Mr. Ramadhan Gumbo | District Traffic .Manager | +25576567037<br>+255717569478 | TRC Tanga |
| 13. | 24/1/2020 | Mr. Ajuaye Kheri Msese | Port Manager | +255756212618<br>+255692114498 | TPA Tanga |
| 14. | 24/1/2020 | Mr. Kasango | Port Supervisor | +255782499881<br>+255713499881 | TPA Tanga |
| 15. | 24/1/2020 | Mr. I*vo Tukker* | Consultant | +31614103838<br>+31102865940 | Maritime Transport Business Solutions |
| 16. | 24/1/2020 | Mr. Rodrigo Muricy | Senior Port Planner | +441344567300 | NIRAS |
| 17. | 24/1/2020 | Wijnand Harmans | Port Consultant | +31647999595 | ANOVA |
| 18. | 24/1/2020 | Robert Schot | Port Consultant | +316200196295 | ANOVA |
| 19. | 23/2/2020 | Eng. Goima | TRC – CME | +255786293466 | TRC |
| 20. | 11/3/2020 | Eng. Gregory J Chogo | Factory Manager | +255755683118<br>+25578368118 | Mufindi Paper Mill |
| 21. | 12/3/2020 | Eng. Peter Maha | Project Coordinator | +255712507217 | Kiwila Coal Mine |
| 22. | 12/3/2020 | Samuel A. Kibalanga | Ag. General Manager | +255763414263 | Kiwila Coal Mine |
| 25. | 19/3/2020 | Mr. Athman Ali | Business Development Manager | | TRC |
| 26. | 20/3/2020 | Eng. Daudi Mlwale | Director, Sales and Business Development | +255685750218 | TOL Gases Limited |
| 27. | 20/3/2020 | Mr. Kassim Vikwato | Marketing | +255785280265 | TOL Gases Limited |

| | | | | | |
|---|---|---|---|---|---|
| | | | Officer | +25571921585 | |

Source: *CILT,* *2020*

**Appendix 3: Generic Questionnaire for Transport Logistics Study**

**1. General Physical/ Demographic Information on the Project:**

1.1 Name of Interviewee/ Title (optional) ……………………………………… ……………………………………………………….

1.2 Organization …………………………………… ………………………………………………..

1.3 Location: Project Site (1) Arusha (2) TIRDO(3) OTHER (4) Please specify …………………………………………….

1.4 Nature of facility: Road (1) Rail (2) Warehouse/ Storage (3) Other (4) Please specify ………………………..

1.5 General Comments observed: ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… ……………………………………………………………………………………………… …………………………

**2. Infrastructural Provisions and Facilities:**

2.1 Roads: Tarmac (1) 1st Class Murram (2) Murram (3) Earthen

2.2 Status: Bad (4) Fair (3) Good (2) Very Good (1)

2.3 Bridges: Bad (4) Fair (3) Good (2) Very Good (1)

2.4 Lay Bays: yes (1) No (2)

2.5 Trucks: T. Number ………………. Specify Tonnage and No. …………………………………………………………………

2.6 General Comments on the ideal and existing Road transport

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2.7 General Comments on the idea and existing Rail transport
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2.8 General Comments on the idea and existing Warehousing/ storage
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**Management/ Resource Issues:**

2.9 Overall resource eextraction eexpected: Annually (1) ……………… tons Monthly (2) ……………… tons

2.10 Products: Soda Ash ………… Edible Salt ………………… other Bicarbonates …………………….. ,………………………….., …………………, ………………………………….., ………………………………….., …………………………. ………………………………… Add others ………………………………………………………………………………………………….

2.11 Cargo Loads daily Qty: Fuel ……….. Processed Resource ………………. Other (Please specify) ………………

2.12 ESIA Issues to be addressed: ………….………………………………, ……………………………, ……………….……., ……………………………………, ………………………………….., ……………………………………

2.13 General Comments/ Calculations on resource quantities in relation to transport and logistics handling:
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2.14 Vehicle maintenance provisions: …………………………………………………………………………………………………
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2.15 Loading and Offloading provisions: …………………………………………………………………………………………………
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2.16 Others (specify) …………………………………………………………………………………………………
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**Other Specific Issues:**

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**Critical Views of Stakeholders:**

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**Government: Central /Regional/ District:**

***Regional/Central:***

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***General population:***

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**Any other information:**

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3. **Recommendations:**

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***Consultant …………………………………………***
***Date……………………………………………..***
***Interview/ Questionnaire number ……………., …………………….., …. /2019***

## Appendix 4: List of Registered Road Transporters in Tanzania

| SN | COMPANY NAME | CONTACT | TELEPHONE | LOCATION |
|---|---|---|---|---|
| 1 | SUPERSTAR FORWARDERS | S.A.SEIF | +255784785747 | DSM |
| 2 | TRANSCARGO LTD | ALKARIM DAWOOD | +255754786222 | DSM |
| 3 | ASAS TRANSPORTERS CO.LTD | NAIF ASAS | +255784767124 | DSM |
| 4 | FAMARI INVESTMENT | ABDALAH ABRI | +255784910091 | DSM |
| 5 | Z.H.POPPE TRANSPORT | Z.H.POPPE | +255784220303 | DSM |
| 6 | NAS NASHAULIERS | ALLY SAID | +255774325552 | DSM |
| *7* | EDHA AWADH CO.LTD | EAWADH | +255754203636 | DSM |
| 8 | KANJI LALJI LTD | AMYN LALJI | +255754780144 | DSM |
| 9 | GOLDEN FLEET | MOHAMMED ASIF | +255752786901 | DSM |
| 10 | GOLDEN COACH | MOHAMMED ASIF | +255752786901 | DSM |
| 11 | SENGEREMA MOTORS | AMRAN MOHD | +255784232933 | DSM |
| 12 | RUVU TRANSPORT | SEIFII | +255784203640 | DSM |
| 13 | S.S.B TRANSPORT | OMAR BKHRESSA | +255784234520 | DSM |
| 14 | OILCOM | ISLAM | +255754783881 | DSM |
| 15 | AL HUSHOOM | NAUSHAD | +255713300272 | DSM |
| 16 | SAFARI CARGO | ABDALAH MALIK | +255754781255 | DSM |
| 18 | PRIME FUELS LTD | HADYA BASALIVANG | +255784691111 | DSM |
| 19 | MAJENGO TRANSPORT | MZEE MAJENGO | +255713222709 | DSM |
| 20 | ZAM ZAM ROAD HAULAGE | HASNAIN | +255655606177 | DSM |
| 21 | MERZARIO LTD | ANDREA | +255754788206 | DSM |
| 22 | FLYING CARGO LTD | PARBAT | +255754232328 | ARUSHA |
| 23 | TRANSISCO COMPANY | PARBAT | +255754232328 | ARUSHA |
| 24 | MANYARA COMPANY | PARBAT | +255754232328 | ARUSHA |
| 25 | VIGU TRADING CO.LTD | VIRAN MKOMBA | +255754604130 | DSM |
| 26 | BARWAAQO | HASSAN | +255784269209 | DSM |
| 27 | HERSI WARSAME | HERSI WARSAME | +255754278108 | DSM |
| 28 | SWIFTMOTORS | MR.DEWJI | +255752786901 | DSM |
| 29 | DALBIT PETROLEUM | ESTHER NGERO | +255782083711 | DSM |
| 30 | ALISTAR LOGISTICS | ALISTAIR JAMES | +255784643228 | DSM |
| 31 | LAKE OIL LTD | ALLY AWADH | +255784680000 | DSM |
| 32 | LIBERTY TRANSCARGO | KARIM KHALFAN | +255754277255 | DSM |
| 33 | NILEPERCH FISHERIES | SABU VAROOR | +255784500326 | DSM |
| 34 | LASAR LOGISTICS LIMITED | ABSHIR GURE | +255754988833 | DSM |
| 35 | CRYSTAL LOGISTICS | LEONARD SHARMA | +255753474644 | DSM |
| 36 | MOUNT MERU GROUP | ATUL | +255715777555 | ARUSHA |
| 37 | AWALE 2007 CO.LTD | AWALE SHIRWA | +255754366328 | DSM |
| 38 | EDNA BONIFACE | EDNA BONIFACE | +255713520577 | DSM |
| 39 | JOHN KIVARIA MBAGA | JOHN KIVARIA | +255713520577 | DSM |
| 40 | TANGANYIKA UNIVERSAL ltd | MOHAN | +255782455660 | ARUSHA |
| 41 | CHUNDAWADRA | RAJESH RAJA | +255754650110 | ARUSHA |
| 42 | NANAK HAULIERS LTD | BALRAJ MATHARU | +255767999200 | MOSHI |

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| 43 | JOEL TRADERS LTD | E.MRECHA | +255754494788 | DSM |
| 44 | KORU FREIGHT LTD | ASSENGA | +255777326617 | DSM |
| 45 | PANONE &COMPANY LTD | NGILOI | +255712087010 | DSM |
| 46 | A.M MBARAK | MBARAK AMER | +255784205205 | DSM |
| 47 | WORLD OIL LTD | GERVAS BIDYANGUZE | +255754274617 | DSM |
| 48 | TRUCKLINE LTD | AJAY/VICKY | +255784666099 | ARUSHA |
| 49 | EFFICIENT FREIGHTERS | SIRIL MAKOY | +255754692712 | DSM |
| 50 | USANGU LOGISTICS | SAAD IBRAHIM | +255774778899 | DSM |
| 51 | ERMOIL CO.LTD | J.MASHELE | +255754318621 | DSM |
| 52 | AFRITOKI LTD | HUMAID BADAR SEIF | +255784300800 | DSM |
| 53 | SOUD INDUSTRIES LTD | SAID SOUD | +255754336615 | DSM |
| 54 | CAMEL OIL TRANSPORT | ABDALLAH NAHDI | +255784783880 | DSM |
| 55 | MICHAEL S.KIMARO | MICHAEL S.KIMARO | +255754271782 | ARUSHA |
| 56 | RUBY ROADWAYS LTS | AVINASH PATEL | +255784225395 | DSM |
| 57 | GBP TANZANIA LTD | BADEL SEIF | +25575750750 | DSM |
| 58 | MOHMOOD TRANSPORT | MOHMOOD MOHM | +255754560017 | DSM |
| 59 | JAMEN TRUCK CO.LTD | JULIUS MENDA | +255754292702 | ARUSHA |
| 60 | AVCO INVESTMENT LTD | KAKE DHARIWAL | +255754370740 | ARUSHA |
| 61 | DHANDO ROAD HAULAGE | KARIM DHARSI | +255784420786 | DSM |
| 62 | SIMBA LOGISTICS | MOHAMED DEWJI | +255774620521 | DSM |
| 63 | MATANDA INVESTMENT LTD | NIKSON G TERRY | +255754671232 | DSM |
| 64 | EDBRO TRANSPORT | EDBRO TRANS | +255784220303 | DSM |
| 65 | S.B.MERALI | SHAFIK B MERALI | +255754501786 | DSM |
| 66 | SULEIMAN NKYA | SULEIMAN.A.NKYA | +255784510877 | ARUSHA |
| 67 | CONSOLIDATED TRANSPORT | KARIM LADHA | +255784780261 | DSM |
| 68 | FAKHRIS HIGHWAY CARRIERS | FAKHRIS | +255754277452 | DSM |
| 69 | OMAR AWADH TRANSPORT | OMAR AWADH | +255713605530 | DSM |
| 70 | BRIGHTSUN LOGISTICS | SANDESH AGGRAWAL | +255754555888 | ARUSHA |
| 71 | AMRI SULEIMAN YASIN | AMRI SULEIMAN YASIN | +255763444449 | DSM |
| 72 | MWANAMBOKA TRANSPORT | SALUM SAAD ALLY | +255784780880 | DSM |
| 73 | MAIMUNA HAJI MAHMOUD | MAIMUNA HAJI MAHM | +255717909777 | DSM |
| 74 | KASHILAGATEMBE TRANS | RAMADHAN MANSOUR | +255718606628 | DSM |
| 75 | ANA ANTHONY MROSSO | ANA ANTHONY MROSO | +255713520577 | MOSHI |
| 76 | DCW LTD | AHMED K.KHAKI | +255783224717 | DSM |
| 77 | HEAVEN LOGISTICS T LTD | MGENDELA GAMA | +255718000006 | DSM |
| 78 | TWIGA TANZANIA LTD | NELSON EBONG | +2552861054 | DSM |
| 79 | RONETRADE TECH SERVICES | RICHARD NKANDA | +255754279143 | DSM |
| 80 | KHALI INTERTRADE LTD | LILOKA A.LILOKA | +255754283155 | DSM |
| 81 | ROBERTO BIAGIO TRANS | ROBERTO BIAGIO | +255763777222 | DSM |
| 82 | LILOKA A.LILOKA | LILOKA A.LILOKA | +255655700275 | DSM |
| 83 | ABDULREHMAN NOOR | ABDULREHMAN | +255754443888 | DSM |
| 84 | AYOUB TRANSPORT | AYOUB A.OMARY | +255767548281 | DSM |
| 85 | HUSSEIN FARAH OMAR | HUSSEIN F.OMAR | +255754822958 | DSM |

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|---|---|---|---|---|
| 86 | BUSINESS TRUST TANZANIA | EMMANUEL KAZIMOTO | +255787999971 | DSM |
| 87 | ISAACK RICHARD MGAYA | ISAACK RICHARD | +255752222244 | DSM |
| 88 | FARID SEIF ALLY | FARID S.ALLY | +255713332153 | DSM |
| 89 | HAFEZ HAMED ALLY | HAFEZ H.HAMED | +255712334433 | DSM |
| 90 | AMOUR HAMDAN HAMAD | AMOUR H.HAMDAN | +255788000171 | DSM |
| 91 | ABDULBASIT HAMDAN | ABDULBASIT | +255713297488 | DSM |
| 92 | MAHSEN Y.SAID | MAHSEN.Y.SAID | +255773283644 | DSM |
| 93 | NGONGONGO ZA KIMONILE | ELEUTHRUS KOMBA | +255754784618 | DSM |
| 94 | BHANJI LOGISTICS LTD | NIZAR BHANJI | +255754332409 | DODOMA |
| 95 | MO-PEARLS LOGISTICS LTD | HAMDY M AL HADJI | +255783323131 | DSM |
| 96 | MECKSON WILSON FUWANJA | MECKSON FUWANJA | +255787257560 | DSM |
| 97 | BENNY STEVEN MWINUKA | BENNY S.MWINUKA | +255715747633 | DSM |
| 98 | KUNDAN ENTERPRISES | GUROIAL REHAL | +255754309526 | MOSHI |
| 99 | M.A.SAID &COMPANY LIMITED | SWALEH MOHAMED | +255784366210 | TANGA |
| 100 | OMARI IBRAHIM ZUBERI | OMARI I.ZUBERI | +255713720833 | TANGA |
| 101 | R.N.MOHAMED.CO.LTD | R.N.MOHAMED | +255716000010 | TANGA |
| 102 | ZZZ COMPANY LIMITED | ZILLY I MKUMBWA | +255755004202 | DSM |
| 103 | NELLY INVESTMENT CO LTD | ALEEM KANJI | +255755004202 | DSM |
| 104 | FARAJ MBARAK SALMIN | FARAJ MBARAK | +255754283337 | DSM |
| 105 | G&S TRANSPORT LTD | MOHAMED AHMED | +255754617158 | DSM |
| 106 | MOHAMED SALEH NAHDI & CO | MOHAMED S. NAHDI | +255774282810 | DSM |
| 107 | AHAMEDI IBRAHIM | AHMED ABDALLAH | +255713210712 | DSM |
| 108 | NYOTA VENTURE COMPANY | MADUKA PATRIK | +255787038027 | DMS |
| 109 | JUVENILE MUSHI | JUVENILE MUSHI | +255754835960 | DSM |
| 110 | ELIDADI FLIKLEY MACHA | ELIDADI MACHA | +255754294870 | DSM |
| 111 | M. SAID TRANSPORTER CO. | MOHAMED SAID | +255652426666 | DSM |
| 112 | ECS LOGISTICS LIMITED | ECS LOGISTICS | +255714057477 | DSM |
| 113 | EGID EDIMUND MTIKILE | EGID MTIKILE | +255754260790 | DSM |
| 114 | HAMPSHIRE HATHAWAY LTD | HAMPSHIRE | +255774200005 | DSM |
| 115 | BOISA INVESTMENT LTD | BOI IDDI SAID | +255713229688 | DSM |
| 116 | ACER PETROLEUM(T)LTD | ACER PETROLEUM | +255715505094 | DSM |
| 117 | IYETU TRANSPORTERS | MUNIR | +255754364498 | MBEYA |
| 118 | MUFINDI WOODPOLES PLANT | MALEK KADERBAKSH | +255767886666 | IRINGA |
| 119 | Y.S.K LTD | NAJIB Y SAID | +255774404071 | DSM |
| 120 | YASLAM SALEM AWADH | YASLAM SALEM | +255773598888 | DSM |
| 121 | DELINA GENERAL LTD | DAVIS E MOSHA | +255774542222 | DSM |
| 122 | OMAR ENTERPRISES LTD | OMAR | +255713771168 | DSM |
| 123 | WAYAN TRANSPORT | HASSAN AHMED | +255779445566 | DSM |
| 124 | HAMALATUL INVESTMENT | ABDI S ABDI | +255713122623 | DSM |
| 125 | EMARALD HAULAGES LTD | YASIN ALI | +255717678257 | DSM |
| 126 | FARAJ SAID MOHAMMED | MR.FARAJI SAID | +255756066624 | DSM |
| 127 | PROTRANS LTD | AKBER KERMAL | +255784786930 | DSM |
| 128 | EMMANUEL MBAGO | EMMANUEL B.MBAGO | +255784765899 | DSM |

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|---|---|---|---|---|
| 129 | WILLIAM CHANZENZE | WILLIAM J.CHANZENZE | +255788000002 | DSM |
| 130 | AZAN MILL LTD | GRYSON MINJA | +255754286856 | DSM |
| 131 | MOWARA LIMITED | ALI FAWAZ | +255784324872 | DSM |
| 132 | TALHA GROUP | ZAINUL N DOSSA | +255713123002 | DSM |
| 133 | ABUSHIRI TRANSPORTER | ABUSHIRI M.ALLY | +255754381291 | DSM |
| 134 | MAPELELE TRANSPORT LTD | DAVID NYEMBELE | +255715336764 | DSM |
| 135 | MPANGO 2005 (T)LTD | FELIX MODESTER | +255754930956 | DSM |
| 136 | TACAS LTD | ANSELM SABI | +255754313265 | DSM |
| 137 | MULTIMODAL TRANSPORT | SYED NAZRE ABBAS | +255653888088 | DSM |
| 138 | GNM AND COMPANY LIMITED | GOLDEN N MCHOI | +255754978844 | DSM |
| 139 | DIN MOHAMMED DIN | DIN MOH.DIN | +255773828284 | DSM |
| 140 | JAMAL SALEH ZAHRAN | JAMAL SALEH ZAHRAN | +255767381515 | DSM |
| 141 | TRANSFUEL LOGISTICS LTD | NAIF J ABRI | +255774011011 | DSM |
| 142 | ZEFARELIS FUGAMBI MTANGA | ZEFARELIS F.MTANGA | +255754655832 | DSM |
| 143 | KHALID MAREE AWADH | KHALID AWADH | +255773279044 | DSM |
| 144 | MOHAMMED ABDULLAH | MOHAMMED OSMAN | +255713332225 | DSM |
| 145 | EUROMAX LTD | PETER KINABO | +255713463643 | DSM |
| 146 | FARAJ HAMIS WAPANDE | FARAJ WAPANDE | +255715280644 | DSM |
| 147 | HASSAN ISSA | HASSAN ISSA | +255713332225 | DSM |
| 148 | SAFAYA TRANSPORT | SAFAYA TRANSPORT | +255754773545 | MOSHI |
| 149 | IYETU TRANSPORTERS | DAVID YOSIAH | +255754322828 | DSM |
| 150 | BRAVO LOGISTICS | ANGELINA | +255784478255 | DSM |
| 151 | CONTINENTAL CARGO | AHMED DAKIK | +255754344444 | ARUSHA |
| 152 | NETHA TRADING CO.LTD | THADEUS A.MINJA | +255784904190 | DSM |
| 153 | SIMERITA TRANS LTD | GODWIN PAUL | +255787104810 | DSM |
| 154 | MAISAM MOHAMMED FAZAL | MAISAM M.FAZAL | +255713666607 | DSM |
| 155 | CHAUSIKU HARUNA JUMA | GABRIEL EZEKIEL | +255712700720 | DSM |
| 156 | CHAULA TANZANIA LIMITED | HAMIS JAFU | +255655687017 | DSM |
| 157 | EYAN FREDY GODFREY | EYAN FREDY GODFREY | +255786911901 | DSM |
| 158 | AHAM INVESTMENT CO.LTD | AMER AHMED | +255754399838 | SHINYANGA |
| 159 | THORNSWIFT INV.L.T.D | HASSAN NAQVI | +255786786132 | DSM |
| 160 | MR.BENNY MWITA SAMMOH | MR.BENNY MWITA | +255784239188 | DSM |
| 161 | DEO I ASSENGA CO LTD | DEO I ASSENGA | +255713223051 | DSM |
| 162 | KLEB COMPANY LTD | SALMIN KLEB | +255773307778 | DSM |
| 163 | AFROIL INVESTMENT LTD | SALMIN KLEB | +255773307778 | DSM |
| 164 | CHARAN SINGH&SONS LTD | CHARAN SINGH | +255754382027 | ARUSHA |
| 165 | HAMIDU OMARI SAKENA | HAMIDU | +255717393718 | DSM |
| 166 | COSMAS NDELLE SHUNGU | COSMASS NDELLE | +255655966342 | DSM |
| 167 | HUSSEIN RAMADHAN ISAYA | HUSSEIN RAMADHAN | +255715463505 | DSM |
| 168 | NASSOR KHALFAN MOHAMED | NASSOR KHALFAN | +255713117031 | DSM |
| 169 | SULEIMAN NASSOR SEIF | SULEIMAN SEIF NASSOR | +255714444591 | DSM |
| 170 | SAID ASHUR SALIM | SAID ASHUR SALIM | +255714444591 | DSM |
| 171 | KENAMU INVESTMENTS | JAMES KABELINDE | +255754763607 | DSM |

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|---|---|---|---|---|
| 172 | N.H.S NASHER | N.H.S NASHER | +255713404045 | DSM |
| 173 | ABDALLAH NASSOR | ABDALLAH NASSOR | | DSM |
| 174 | GIJOMA INVESTMENT CO.LTD | GIBRON J MAWALA | +255755008422 | DSM |
| 175 | E.A WAREHOUSING(T)LTD | EDHA A NAHDI | +255774345678 | DSM |
| 176 | AKAI COMPANY LIMITED | KHADIJA HUSSEIN | +255754480905 | SINGIDA |
| 177 | MUSLIM MAJID SEIF | MUSLIM MAJID SEIF | +255773282800 | DSM |
| 178 | WARE INTERNATIONAL | WATSON KIHAKA | +255714666615 | DSM |
| 179 | SALUM MAJID SEIF | SALUM MAJID | +255713261427 | DSM |
| 180 | MAJID SEIF MUSLIM | MAJID SEIF | +255753261427 | MANYONI |
| 181 | ROAD FORCE LIMITED | RAJESH SHIVJIRA | +255784461304 | DSM |
| 182 | MARIO MAHENGE | CHUKI SHABA | +255784622019 | DSM |
| 183 | LIIBAN TRANSPORT | ABDIKANI | +255714444591 | DSM |
| 184 | CELIUS FRANCIS MPASHA | CELIUS F. MPASHA | +255784223496 | DSM |
| 185 | JAMBO FREIGHT LTD | JOE MARTIN MZUANDA | +255754800400 | DSM |
| 186 | KIDIKU CO.LTD | RESPICIOUS FAUSTINE | +255782498849 | DSM |
| 187 | OMOS ENTERPRISES | OSMAN GAO | +255754270749 | DSM |
| 189 | MOHAMED BIN KLEB | MOHAMED ALLY | +255777444777 | DSM |
| 190 | HAMIDU HEMEDI MVUNGI | HAMIDU HEMEDI | +255784327848 | DSM |
| 191 | MOHAMED ALLY BANI | MOHAMED ALLY BANI | +255784229522 | DSM |
| 192 | HAMID ABEID SALUM | HAMID ABEID SALUM | +255784770045 | DSM |
| 193 | COLLIN FRANK MOSHY | COLLIN FRANK MOSHY | +255785927000 | DSM |
| 194 | MANENOYUSUFU NGAHARA | MANENO YUSUF | +255713467577 | DSM |
| 195 | ALLELIO ANANDUMI REMEN | ALLELIO ANANDUMI | +255754319766 | DSM |
| 196 | VSR CO.LTD | VENANCE MSAKY | +255754308234 | DSM |
| 197 | F.N.TRANSPORT LTD | FARZANA NAIJI | +255655290388 | DSM |
| 198 | ISLAM SALEH NAHDI LTD | TALAL ISLAM | +255774100100 | DSM |
| 199 | MBARAK MAREI MBARAK | MBARAK MAREI | +255714666766 | DSM |
| 200 | SAMSON E. MVUNGI | SAMSON E MVUNGI | +255754266729 | DSM |
| 201 | TANZANIA HAULAGE1980 | MR.ANWAR | | DSM |
| 202 | MAJARIBU TRADING CO.LTD | MAJARIBU | +255715622019 | DSM |
| 203 | TAYATE TRANSPORT CO.LTD | TASIA MMARI | +255754382502 | DSM |
| 204 | SEIF ALLY MBARAK | SEIF ALLY MBARAK | +255713301310 | DSM |
| 205 | MOHAMED SEIF ALLY | MOHAMED SEIF ALLY | +255713301310 | DSM |
| 206 | AMANI CARGO LIMITED | MUNAWER MOHAMED | +255754376660 | DSM |
| 207 | HEZRON S KYANDO | HEZRON KYANDO | +2552851542 | DSM |
| 208 | INNOCENT IZACK MSEMO | INNOCENT I. MSEMO | +255713304223 | MOSHI |
| 209 | MATARAZI INVESTMENT | ADAM MATARAZI | +255755556555 | DSM |
| 210 | B52 INVESTMENT LTD | ROSEMENA GASPER | +255719605390 | DSM |
| 211 | ANNA DONASIAN MKUSU | ANNA D. MKUSU | +255784355340 | DSM |
| 212 | MIEMBE SABA OIL COMPANY | ONESMO | +255784583363 | DSM |
| 213 | LEONS JOHN KIMARO | LEONS JOHN KIMARO | +255715286202 | MOSHI |
| 214 | HENDRY KAROLI MROSO | HENDRY MROSO | +255754286202 | MOSHI |
| 215 | DIANA ROSE SPARE PARTS | RAYMOND KIMARO | +255784794700 | DSM |

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|---|---|---|---|---|
| 216 | SUNVIC EXPRESS | AMERJIT DHILON | +255787993030 | ARUSHA |
| 217 | BHIKHA AND SONS LTD | KEVAL BHIKHA | +255784777490 | DSM |
| 218 | IMARA EXPRESS LTD | IMRAN MOHAMMED | +255655300001 | DSM |
| 219 | UKOD CO.LTD | JAMA IBRAHIM | +255766798260 | DSM |
| 220 | LUCIA ABDULLE OMAR | LUCIA A OMAR | +255754383464 | DSM |
| 221 | TRUCK PARTS LTD | ABBAS ALLY | +255715001134 | DSM |
| 222 | NICOLAS ALOYCE NGAGA | NICOLAS ALOYCE | +255715283874 | DSM |
| 223 | PREMIUM (T) LTD | MARIAM SALIM | +255713652342 | DSM |
| 224 | HEELAM CROSS BOARDER | ABDULATIF NASHER | +255272544760 | DSM |
| 225 | MAMBA AUTO SPARES CO.LTD | ALBERT GODFREY | +255754274808 | DSM |
| 226 | MALG INTERNATIONAL | MALG | +255719635483 | DSM |
| 227 | KAJA SPARES AGENTS | KAJA | +255713948594 | DSM |
| 228 | KRB FREIGHT CO.LTD | KRB | +255786262218 | DSM |
| 229 | OCEANLINK SHIPPING LTD | OCEANLINK | +255713108203 | DSM |
| 230 | LELA HAMAD AZIZ | AZIZ HAMAD | +255658382736 | MOSHI |
| 231 | ABDUL KHALFAN MOHAMED | ABDUL KHALFAN MOH | +255714057744 | DSM |
| 232 | JO&BRO COMPANY LTD | ROSEMENA GASPER | +255719605390 | DSM |
| 233 | LIFE TIME TRANSPORT | CHUKI SHABA | +255715622019 | DSM |
| 234 | MUSSO TRANSPRT COMPANY | MUSSO TRANSPORTER | +255784622019 | DSM |
| 235 | 50,50 TRANSPORT CO.LTD | SUNGURA OMARY | +255715733334 | DSM |
| 236 | NDUMI TRANSPORT | CHUKI SHABAN | +255222181477 | DSM |
| 237 | HASSAN BAKARI NYUNGURE | HASSAN BAKARI | +255713443880 | DSM |
| 238 | AL-DAMASY TRUCKS CO | ALLY DAMASY KIBUGA | +255754282367 | DSM |
| 239 | RUVUVU CARGO CARRIERS | ABDALLAH SAIF | +255713334888 | DSM |
| 240 | SAI BABA TRUCKS LIMITED | SATISH G. LAXMAN | +255754555700 | DSM |
| 241 | ROYAL AMANYA BARAKA | ALEX MTUNGI | +255777964200 | DSM |
| 242 | M.A.ISMAN LTD | M.A.ISMAN | +255754275144 | DSM |
| 243 | SAFE TRANSIT | SAFE TRANSIT | +255787864255 | DSM |
| 244 | KILIMANJARO TRUCK CO. LTD | GILIAD | +255784607231 | DSM |
| 245 | SADAI TRANSPORT (T) | GILIAD MIHAMBO | +255784607231 | DSM |
| 246 | KHELA INVESTMENT | ELIAS ZAKAYO | +255754368849 | DSM |
| 247 | GABI AMULIKE MWANUNU | GADI MWANUNU | +255757746087 | DSM |
| 248 | VGK COMPANY LIMITED | VALENCE V.MSACKY | +255715262040 | DSM |
| 249 | WAZO ROAD HAULAGE LTD | VALENCE V.MSACKY | +255754710069 | DSM |
| 250 | MWAHABI INVESTMENT LTD | HABIB MFURU | +255719427720 | DSM |
| 251 | AMANI LOGISTICS LIMITED | AHMED M BAAMER | +255773274444 | DSM |
| 252 | SAFEWAY TRANSPORT LTD | AKIL M KANJI | +255773323300 | DSM |
| 253 | HASNAIN KHAMIS DAMJI | HASNAIN KHAMIS | +255764333789 | DSM |
| 254 | DAVID N MUSHI | DAVID MUSHI | +255754692122 | DSM |
| 255 | SAMSON CHRISTOPHER | SAMSON MAGUGE | +255784601154 | DSM |
| 256 | GABRIEL MATHIAS MAIKO | GABRIEL MATHIAS | +255713260015 | DSM |
| 257 | EASTERN UNION (T) LTD | FRANK | +255754306887 | DSM |
| 258 | BHANJI TRANSPORT LTD | IGBAL BHANJI | +255754332408 | DSM |

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|---|---|---|---|---|
| 259 | PERBLOGISTICS LIMITED | PAULBEDA | +255784445200 | DSM |
| 260 | TRANSPORT MASTER LTD | MICHAEL C.ROUSSOS | +255754279220 | DSM |
| 261 | TRANSAFRICA LOGISTICS LTD | SAVIO FERNANDES | +255754352222 | DSM |
| 262 | EBLINA LTD | EBLINA | +255755448244 | DSM |
| 263 | ISMAIL HYDAR OMARY | ISAMAIL H OMARY | +255712674222 | DSM |
| 264 | CHARLES BENEDICT TEMBA | C.B TEMBA | +255762143300 | DSM |
| 265 | SOUD NASSOR ABDU | SOUD NASSOR | +255715189118 | DSM |
| 266 | KANANI TRANSPORTSERVICES | HANIF KANANI | +255754289902 | DSM |
| 267 | MURO INV.CO.LTD | MANSOUR | +255716841210 | DSM |
| 268 | NICOLAS A MAKULE | NICOLAS A MAKULE | +255754280257 | DSM |
| 269 | ISRAEL AARON | ISRAEL AARON | +255784353652 | DSM |
| 270 | EZEKIEL GABRIEL MASSAWE | EZEKIEL G MASAWE | +255754274642 | DSM |
| 271 | ABDILLAH OMARY MNTAMBO | ABDILLAH MNTAMBO | +255754274642 | ARUSHA |
| 272 | SALIM A.SAMEJA | SALIM A.SAMEJA | +255715451022 | DSM |
| 273 | MAWENZI FREIGHT SERVICES | ANTHONY COLMAN | +255713297542 | DSM |
| 274 | D&M SYSTEMS LTD | BETSON D KIWANGA | +255783113099 | DSM |
| 275 | ATTIYE MBARAK MOHAMMED | ATTIYE MBARAK | +255773753395 | DSM |
| 276 | SAID ABDALLAH BAKHAMIS | SAID ABDALLAH | +255713330011 | DSM |
| 277 | GOLIS INVESTMENT LTD | MOHAMED | +255713504335 | DSM |
| 278 | DOHA TRANSPORT CO.LTD | SAID HAMED | +255784299770 | DSM |
| 279 | MSOZA TRANSPORT CO LTD | SAID MSOZA | +255784299770 | DSM |
| 280 | HIGHWAY EXPRESS (T)LTD | HIGHWAY EXPRESS | Nil | DSM |
| 281 | AQUARIUS EXPRESS LTD | AQUARIUS | Nil | DSM |
| 282 | W.S.INVESTMENT LIMITED | WERASIMBOS.LEMA | +255762685099 | MOSHI |
| 283 | RAVIRAM HAULAGE LTD | IRENE T MAKOY | +255754692712 | DSM |
| 284 | GLENRICH TRANSPORTATION | NOORESH VELLANI | +255717578097 | DSM |
| 285 | NYATI TRANSPORT | ANWAR MOHAMED | +255713230088 | DSM |
| 286 | HUSSEIN A.KANGESA | HUSSEIN A.KANGESA | +255713486767 | DSM |
| 287 | ABDALLAH THABIT HUWEL | ABDALLAH THABIT | +255774747474 | DSM |
| 288 | WAY PLUS CO.LTD | JACKLINE KWEKA | +255715479751 | DSM |
| 289 | HAMIS OMAR KASWIZA | HAMIS O.KASWIZA | +255754883638 | DSM |
| 290 | ABDUL HAMID SAMEJA | ABDUL H.SAMEJA | +255715308118 | DSM |
| 291 | AIBO LOGISTICS | BONNEY G.MAJILA | +255717615535 | DSM |
| 292 | AMIRI MUSA ABDALLAH | AMIRI ABDALLAH | +255754851280 | DSM |
| 293 | PETER BENARD URASA | PETER URASSA | +255659855133 | DSM |
| 294 | FLEET LOGISTICS T LTD | ISSA AHMED | +255687371653 | DSM |
| 295 | EUGEN ELIAS MARIWA | EUGEN ELIAS | +255754695758 | DSM |
| 296 | NICOLAUS ATHANAS SWAI | NICOLAUS ATHANAS | +255784667165 | DSM |
| 297 | SIMBA STANLEY MCHAKI | STANLEY MCHAKI | +255754479513 | DSM |
| 298 | KISHEN ENTERPRISES LTD | KISHEN ENTER.LTD | +255715236666 | DSM |
| 299 | AT&T TRANSPORT COMPANY | ABDUL LATIF J MOHD | +255787313603 | DSM |
| 300 | WASINI SHOPPING CENTRE | OMARI ALI OMARI | +255768242846 | DSM |
| 301 | LIBERTY EXPRESS T LTD | SULEMAN | | DSM |

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|---|---|---|---|---|
| 302 | INNOVATION AGENCIES LTD | STEPHERY RWEIKIZA | +255713263776 | DSM |
| 303 | NAM TRANSPORTERS | NSAJIGWA MWAIPAJA | +255754465835 | DSM |
| 304 | SOUTHERN LOGISTICS LTD | ABDULAWAHAB | +255763999444 | MAFINGA |
| 305 | MAJALIWA HITRA TENGERASI | MAJALIWA | +255784622019 | DSM |
| 306 | SHADIAH INVESTMENT CO | SHADIAH | Nil | DSM |
| 307 | ELPID LEANDRY BILAURI | CHUKI SHABA | +255784622019 | DSM |
| 308 | ALI JUMA RAMADHANI | ATHUMAN RAMADHAN | +255784622019 | DSM |
| 309 | SAID A.MSEKWA | SAID A.MSEKWA | +25522181477 | DSM |
| 310 | RAMADA TRANSPORT LTD | RAMADA | +255713117031 | DSM |
| 311 | TAYEA SALMEN SULAIMAN | TAYEA SALMEN | +255713117031 | DSM |
| 312 | BAAKAR TRANSPORT | BAAKAR | Nil | DSM |
| 313 | INARA INVESTMENT (T)LTD | KABOTA EMMANUEL | +255782946666 | DSM |
| 314 | HALUWENGE TRANSPORT LTD | HALUWENGE | +255767536158 | DSM |
| 315 | GLOBAL –RIC LIMITED | GLOBAL –RIC LTD | +255688725966 | DSM |
| 316 | SAMWEL CHRISTOPTHER | SAMWEL CHRISTOPHER | +255755780285 | DSM |
| 317 | NICODEMUS EMILIAN MROSO | NICODEMUS MROSSO | +255713520577 | DSM |
| 318 | BURTON JAPHET LUNYUNGU | BURTON JAPHET | +255755033990 | IRINGA |
| 319 | MAKUNGU JOHN MADUKA | MAKUNGUJOHN | +255752621195 | DSM |
| 320 | SELEMANI PREYGOD MSHANA | SELEMANI MSHANA | +255762599599 | DSM |
| 321 | WILLIAM PALLANGYO | WILLAM ELIAKIRA | +255655498846 | DSM |
| 322 | BLUE FALCON TRANSPORT | SAID ZAHOR | +255773369515 | DSM |
| 323 | DODOMA TRAN.AGENCY LTD | S.S.MAND | +255784301444 | ARUSHA |
| 324 | SALMA SALUM ABDALLAH | SALMA S.ABDALLAH | +255752727272 | DSM |
| 325 | RAJABU HASSAN LANGUKA | RAJAB HASSAN | +255754276875 | DSM |
| 326 | RAY TRANSPORT | RAJABU HASSAN | +255787596895 | DSM |
| 327 | ACORN LOGISTICS LTD | ANWAR AHMED | +255787338844 | DSM |
| 328 | GILBERT NAHOMU KILEWO | GILBERT KILEWO | +255754471762 | DSM |
| 329 | THOMAS NDONDE AGENCY | ROJE THOMAS | +255787542202 | DSM |
| 330 | EAST AFRICAN FOSSILS LTD | BENARD | +255764960326 | DSM |
| 331 | KIMANJI INVESTMENT CO.LTD | KIMANJI | +255754626970 | DSM |
| 332 | SUPERMAN TRANSPORT LTD | SALIM | +255719635483 | DSM |
| 333 | FADHILI KUZWA MACHIBYA | FADHILI KUZWA | +255755780285 | DSM |
| 334 | JAMAL TRANSPORT CO.LTD | JAMAL | +255755780285 | DSM |
| 335 | VACHA ENTERPRISES LTD | ABUBAKARY ISMAIL | +255754839458 | DSM |
| 336 | PROSPER JOSEPH MSELE | PROSPER JOSEPH | +255655917176 | DSM |
| 337 | VICENT GEORGE MINJA | VICENT MINJA | +255754764063 | DSM |
| 338 | TERRY BORN INVESTMENT CO. | TERRY BORN | +25522181477 | DSM |
| 339 | ABDULKARIM H.KIYOGOMO | ABDUL KARIM | +255784585443 | DSM |
| 340 | CALVIN ITAEL MAIMU | CALVIN MAIMU | +255718300000 | DODOMA |
| 341 | BEYTULLAH SHAHADULLAH | SHAHDULLAH RAHIM | +255716719165 | DSM |
| 342 | TANZANIA STEEL PIPES LTD | DAVIS B CHONJO | +255784987630 | DSM |
| 343 | F.A.A.INDUSTRIES CO.LTD | FARID A AHMED | +25577900001 | KIBAHA |
| 344 | MANSOOR INDUSTRIES LTD | AL KARIM HIRANI | +255784601155 | MWANZA |

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|---|---|---|---|---|
| 345 | BUDGET MOVERS CO.LTD | JONAS NYAGAWA | +255756709111 | DSM |
| 346 | KISMA TRANSPORT CO.LTD | ALI AHMED | +255715454699 | DSM |
| 347 | MUSSE TRADING & TRANS | ABDI | +255784433284 | DSM |
| 348 | ANOLD BENJAMEN LEMA | ANOLD B LEMA | +255714833575 | DSM |
| 349 | EUROPE TRANSPORT LTD | ALLY ADAN | +255762202037 | DSM |
| 350 | ISMAIL ABDILLAHI HASHI | ISMAIL HASHI | +255718056519 | DSM |
| 351 | KASUKU TRANSIT & G SUPPLY | ZARIBU | +255754800549 | DSM |
| 352 | HEZRON MWASOMOLA | HEZRON | +255762492905 | DSM |
| 353 | KAPESA MBERESERO | JERRY | +255764960326 | DSM |
| 354 | M.MACHA & V.KIMARIO CO | SHALA | +255715413244 | DSM |
| 355 | GODFROID KAMUZINZI | GODFROID KAMUZINZI | +255719493829 | DSM |
| 356 | ISSAH MAHAMUD HASSAN | ISAAH MAHAMUD | +255655780285 | DSM |
| 357 | PATRICK MBERESERO | PATRICK BENEDICT | +255715536158 | DSM |
| 358 | KAKALY ELIAS NG’AMILO | KAKALY ELIAS | +255655447111 | DSM |
| 359 | OMEGA SAFARI LIMITED | SALMA A MUSOKE | +255754323224 | DSM |
| 360 | HEKIMA ENTERPRISES CO. LTD | HEKIMA | +255754363032 | DSM |
| 361 | SHABANI MFINANGA | SHABANI S.MFINANGA | +255754278383 | DSM |
| 362 | HASSAN YUFUF ISMAIL | HASSAN ISMAIL | +255713117031 | DSM |
| 363 | SAHAN CO LTD | HUSSEIN ADAM | +255784389655 | DSM |
| 364 | ELIFURAHA RICHARD MSUYA | ELIFURAHA RICHARD | +255713520577 | DSM |
| 365 | ADBULLAHI HASSAN WADERE | ABDULLAHI HASSAN | +255788117031 | DSM |
| 366 | IBRAHIM S.MSHANA | IBRAHIM MSHANA | +255714608360 | DSM |
| 367 | DICKSON FARES URASSA | DICKSON FARES | +255753467889 | HIMO |
| 368 | ALLY ABEID SALUM | ALLY ABEID SALUM | +255756235925 | SHINYANGA |
| 369 | SALEH AFIF YAHYA | SALEH AFIF YAHYA | +255752557558 | DSM |
| 370 | WEMA MSUYA | WEMA MSUYA | +255714057744 | DSM |
| 371 | MOHAMED ABDI NOOR | MOHAMED ABDI | +255753984853 | DSM |
| 372 | NASSOR BISHER BINZOU | MOHAMMED NASSOR | +255713117031 | DSM |
| 373 | MAK HOLDINGS CO LTD | ESTHER M MAKYAO | +255754884577 | DSM |
| 374 | CANADIAN TRADING CO.LTD | M.FARAH | +255756552255 | DSM |
| 375 | HASSAN BAKARI MSANGA | HASSAN BAKARI | +255754693141 | DSM |
| 376 | MUNIR NAHID ABDALLAH | MUNIR NAHID | +255754484886 | DSM |
| 377 | AREF ABDALLAH BAKHAMIS | AREF BAKHAMIS | +255713330011 | DSM |
| 378 | CATHERINE RICHARD SWAI | CATHERINE SWAI | +255655562055 | MOSHI |
| 379 | HUSSEIN KINDUU IDI | HUSSEIN KINDUU | +255715288516 | DSM |
| 380 | WAKATI TRANSPORT CO.LTD | GERALD P.SAWANYA | +255754292839 | DSM |
| 381 | EDITH TRANSPORT SERVICE | EDITH TRANSPORT | +255754203067 | DSM |
| 382 | CHARLES SYDNEY MAWALA | CHARLES SYDNEY | +255756621148 | DSM |
| 383 | ABDI K.ABTIDON | ABDI K.ABTIDON | +255715310740 | DSM |
| 384 | ISAAC & SONS HAULAGE LTD | JOEL N | +255754765276 | DSM |
| 385 | KINOLE LOGISTICS (T) LTD | JUMA KASSIM | +255784601856 | DSM |
| 386 | HADIJA ALLY ATHUMAN | HADIJA ALLY | +255715622019 | DSM |
| 387 | PHILBERT G.MKOLWE | PHILBERT G. MKOLWE | +255754484501 | DSM |

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|---|---|---|---|---|
| 388 | KENETH KAINI KYANDO | KENET KYANDO | +255754278065 | DSM |
| 389 | MOHAMMED HAMUD SALUM | MOHAMED H. SALUM | +255788866666 | DSM |
| 390 | MUSTAQIM TRANSPORT LTD | ALLY SAID | +255754283409 | DSM |
| 391 | AHMED HASSAN GULLEID | AHMED HASSAN | +255752575604 | DSM |
| 392 | MENARD NAIMAN NJAU | MENARD NAIMAN | +255715236666 | MOSHI |
| 393 | NICOLAUS STEPHEN LAUWO | NICOLAUS STEPHEN | +255715236666 | MOSHI |
| 394 | MASHA ALLAH TRANSPORT | ABDUL AZIZ | +255755222444 | DSM |
| 395 | TAHBIT HILAL MOHAMED | THABIT HILAL | +255715500500 | DSM |
| 396 | HAFEEZ KHALID HILAL | HAFEEZ HILAL | +255715000003 | DSM |
| 397 | C.B COMPANY LTD | CYPRIAN TWELE | +255754516700 | DSM |
| 398 | ABASI SADIKI KAZAURA | ABASI SADIKI | +255715622019 | DSM |
| 399 | ATHUMANI RAMADHANI JUMA | ATHUMANI R. JUMA | +255769602918 | DSM |
| 400 | FM ABRI LTD | ABDALLAH ABRI | +255784910091 | DSM |
| 401 | A.A.TRANS LTD | AKBER B VERSI | +255754007786 | DSM |
| 402 | FIFA &FLOW TRO CO.LTD | FRANK | +255755001561 | DSM |
| 403 | GLORIA TRANSPORT CO.LTD | GLORIA MECK | +255755847786 | DSM |
| 404 | HAVENLIGHT SAMSON NKYA | SAMSON NKYA | +255712554676 | DSM |
| 405 | SALUM SAID MATUMLA | SALUM SAID | +255712126644 | DSM |
| 406 | MASUD SEIF MAJID | MASUD SEIF | +255715504700 | DSM |
| 407 | GREENLAND TRANSPORT LTD | SAID AL JUMHI | +255658959513 | DSM |
| 408 | CIPEX COMPANY LIMITED | CUTHBERT MBOWE | +255754304160 | DSM |
| 409 | SENT LOGISTICS | NASSOR ACHARTY | +255713333770 | DSM |
| 410 | BOCCO GENERAL TRADING | EMIL ROGATE | +255773233929 | DSM |
| 411 | MOHAMMED HUSSSEIN | MOHAMMED AHMED | +255754975466 | DSM |
| 412 | KAH LOGISTICS COMPANY | HAMID ISMAIL | +255713605655 | DSM |
| 413 | NANAI GROUP OF COMPANIES | ALI KHATIB ALI | +255774445844 | DSM |
| 414 | ABDI HASSAN AHMED | ABDI HASSAN | +255754861693 | DSM |
| 415 | HEMED SEIF HAMDUHN | HEMED SEIF HAMDUHN | +255717557162 | DSM |
| 416 | YASSA GENERAL SUPPLIES | YASSA GEN.SUPP | +255768439933 | DSM |
| 417 | SALUM SAID MALIK | SALUM SAID MALIK | +255754655832 | DSM |
| 418 | HAELI TRANSPORTER | HAELI | +255767295367 | DSM |
| 419 | SILENT ROAD HAULAGE | SILENT ROAD | +255717007609 | DSM |
| 420 | JAMAL HAULIERS LIMITED | JAMAL | +255784960306 | DSM |
| 421 | VICTOR DAIMON MSALILWA | VICTOR DAIMON | +255719635483 | IRINGA |
| 422 | YUBA INVESTMENT LIMITED | YUBA | +255719635483 | DSM |
| 423 | BANADIR TRANSPORT CO.LTD | LIBAN | +255653627884 | DSM |
| 424 | KHERI DAUDI KIDINILO | KHERI DAUDI | +255764960326 | DSM |
| 425 | MOHAMMED JAMA YUSUF | MOHAMMED JAMA | +255756398111 | DSM |
| 426 | KISHEGENA TRANSPORT CO | KISHEGENA | +255778501700 | DSM |
| 427 | ABDULKARIM HUSSEIN MSIME | ABDULKARIM | +255754437775 | DSM |
| 428 | TANZANIA CUTTLERIES LTD | HASSAN AL BHAI | +255754451697 | DSM |
| 429 | H.H.A TRANSPORT LTD | HASSAN | +255754688449 | DSM |
| 430 | ELISANTO MONGI | ELISANTO | +255715442312 | DSM |

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|---|---|---|---|---|
| 431 | TENTH MARUHE/TRANSPORT | JAMES | +255757744728 | DSM |
| 432 | MOHAMED JAALAN ISMAIL | MOHAMED | +255754300762 | DSM |
| 433 | TARGERT LOGISTICS | LUCAS | +255719635483 | DSM |
| 434 | LENGUME INVESTMENT LTD | ELIAS LEKESON | +255787384914 | DSM |
| 435 | MASKI &SONS CONSTRUCTION | KENY KIMARO | +255715821807 | DSM |
| 436 | NASSOR SAID NASSOR | NASSOR SAID NASSOR | | DSM |
| 437 | USAFIRISHAJI TRADERS | USAFIRISHAJI | +255754655832 | DSM |
| 438 | SILVERSTONE CORPORATION | O .AWADH | +255717450150 | DSM |
| 439 | RODRICK JOHN ARON | RODRICK JOHN | +255754655832 | IRINGA |
| 440 | ELLY MGENI YUSCALI | ELY MGENI | +255754655832 | KIBAHA |
| 441 | UWEI INTERNATIONAL LTD | TONY HOY | +255763888999 | DSM |
| 442 | YAKUB MOHAMED FAZAL | YAKUB MOHAMED | +255754300354 | MWANZA |
| 443 | A.K TRANSPORT CO.LTD | MBARAK AMER | +255784205205 | DSM |
| 444 | OCEAN CLEARING | SAAD IBRAHIM | +255782999333 | DSM |
| 445 | MPS LTD | SAAD IBRAHIM | +255782999333 | DSM |
| 446 | ELLY IDDI MASASI | ELLY IDDI MASASI | +255784769448 | IRINGA |
| 447 | RICHARD ATHANAS LYAMUYA | RICHARD ATHANAS | +255755163131 | MOSHI |
| 448 | BULUSH TRANSPORTER | ABDALLAH AHMED | +255755301144 | DSM |
| 449 | FARAH MOHAMED GULLED | FARAH M.GULLED | +255754099019 | DSM |
| 450 | JAZZY LOGISTICS CO.LTD | JULIUS LUCAS | +255715228855 | DSM |
| 451 | AFRAS TRANSPORT CO.LTD | WEMA MSUYA | +255714057744 | DSM |
| 452 | PANGANI LOGISTICS LIMITED | FRANK ELIAS | +255715203630 | TANGA |
| 453 | COSMASS PIUS KAMALA | COSMAS PIUS | +255769255376 | DSM |
| 454 | SHUNGURI INVESTMENT | YASINI | +255754692991 | DSM |
| 455 | NDIKUMANA GABRIEL | NDIKUMANA GABRIEL | +255718117031 | DSM |
| 456 | OLYMPIC OIL LIMITED | KHALID S.KARWANI | +255784280999 | DSM |
| 457 | M.A.CARGO TRUCKERS CO.LTD | ARIF | +255713323030 | MOROGORO |
| 458 | EASYTRANS TANZANIA LTD | AZIM AMARSHI | +255769773232 | DSM |
| 459 | TSN LOGISTICS LTD | AHMED M | +255655786222 | DSM |
| 460 | FRANCO LOGISTICS (T)LTD | FRANK AUGUSTINE | +255715445776 | DSM |
| 461 | ELIREEMA MAMUYA | ELIREEMA MAMUYA | +255713512077 | MOSHI |
| 462 | PROSPER SHIRIMA | PROSPER SHIRIMA | | MOSHI |
| 463 | B.WORLD INVESTMENT 2003 | KUMUNI SILAYO | +255769237389 | DSM |
| 464 | JUMA SAMKA SANGA | JUMA SAMKA | +255754650435 | MAFINGA |
| 465 | ALLY ISMAIL MUNISI | ALLY ISMAIL | +255787089226 | DSM |
| 466 | JOHO YAKOBO NG’WANGEZE | JOHO YAKOBO | +255754287054 | TANGA |
| 467 | CHESCO FRANCE NG’UMBI | CHESCO FRANCE | +255787650381 | MAFINNGA |
| 468 | SEIF BADRU MOHAMED | SEIF BADRU | +255712557162 | TANGA |
| 469 | MANSOOR SEIF BADRU | MANSOOR SEIF | +255712557162 | TANGA |
| 470 | Y.P.ROAD HAULAGE LTD | LALIT ISANABAR | +255786274000 | DSM |
| 471 | NAM ENTERPRISES LTD | NAMNYAKI | +255713634130 | DSM |
| 472 | VICTORIA MOULDERS LTD | JIGNESH PATEL | +255784450350 | MWANZA |
| 473 | SIMERA TRANSPORT LIMITED | RAHIM | +255774770677 | DSM |

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|---|---|---|---|---|
| 474 | MTAMBO TRUCKS | MOHAMED MTAMBO | +255765251504 | DSM |
| 475 | MKATANGA LTD | SHIMA DANFORD | +255779443366 | DSM |
| 476 | IBRAHIM NASSOR SULEIMAN | IBRAHIM SULEIMAN | +255765653977 | DSM |
| 477 | VONNESLY TRADING CO.LTD | OBEID MASAWE | +255759738251 | ARUSHA |
| 478 | KISARIA INVESTMENT CO.LTD | KOMUNI SILAYO | +255769237389 | MOSHI |
| 479 | J.R.TRADERS LIMITED | JULIUS MLAY | +255755396999 | MOSHI |
| 480 | HAPPINESS ENTERPRISES | PETER M.SHIRIMA | +255754363099 | DSM |
| 481 | HAPPYLINE ELIEZER MACHA | HAPPYLINE MACHA | | DSM |
| 482 | OMARY JUMA MSUYA | OMARY JUMA | +255718138094 | MOSHI |
| 483 | MAXI JAMES MOSHI | MAXI JAMES | +255754262148 | MOSHI |
| 484 | SHABANI ALLY SHABANI | SHABANI ALLY | | DSM |
| 485 | M&F TRANSPORT | LUCAS | | DSM |
| 486 | FARID HASSAN KILUWA | FARID HASSAN | | DSM |
| 487 | YAATE INV COMPANY LTD | LUCAS | | DSM |
| 488 | KILIFUEL INVESTMENT LTD | FARAJI SAID | +255754304074 | DSM |
| 489 | AMINICO INTERNATIONAL | HASSAN J KYARUZI | +255713224442 | DSM |
| 490 | MAKINI INTERTRADE LIMITED | WILLIAM SHAYO | +255755376197 | DSM |
| 491 | KHAMIS NASOOR MBAROK | KHAMIS MBAROK | +255784284979 | DSM |
| 492 | MACHAME BUSINESS T LTD | MACMILLA ELINGAYA | +255754851539 | DSM |
| 493 | BAHAMA TRANS | BASLEY | +255784276543 | DSM |
| 494 | ABG AFRICANLINK TRADERS | BATULI NASSOR | +255784297934 | DSM |
| 495 | J M HAULIERS (T)LIMITED | J M HAULIERS | +255715622019 | DSM |
| 496 | MATHIAS MASHINAGU NZUGU | MATHIAS NZUGU | +255784622019 | DSM |
| 497 | FAISAL GENERAL TRADING CO | FAISAL | +255754270931 | DSM |
| 498 | ALLMAGAN TRANSPORT LTD | FARMAN ABDI DAHIR | +255713706688 | DSM |
| 499 | UNIFREIGHT (T)LTD | A.MOHAMMED | +255784336611 | DSM |
| 500 | STEPHEN FREDRICK MKOMBO | STEPHEN FREDRICK | +255713358950 | DSM |
| 501 | MGK MINING SERVICES LTD | GEMA KISAKA | +255755383072 | DSM |
| 502 | KVD GENERALSUPPLIES LTD | STANLEY MBUYA | +255718350019 | DSM |
| 503 | SMART TRANSPORT (T)LTD | SULEMAN | +255784446677 | DSM |
| 504 | UNDERLINE COMPANY LTD | MOHID SALEH | +255786900699 | MWANZA |
| 505 | CHIYANGA ENTERPRISES | CHIYANGA | +255754368152 | DSM |
| 506 | GTS LOGISTICS LTD | SHARMAPAL | +255784600222 | DSM |
| 507 | AHMED ABDALLAH SAID | AHMED ABADALLAH | +255715282850 | DSM |
| 508 | ALLY NASSOR RASHID | ALLY NASSOR | +255754861693 | SHINYANGA |
| 509 | JOPEPRI ENTERPRISES | JOHN MWABE | +255767942422 | MOSHI |
| 510 | TIMOTH T.NKWERA | TIMOTH NKWERA | +255768909890 | DSM |
| 511 | MWENGE TRANSPORT | MWENGE | +255714838686 | DSM |
| 512 | BELAKA INT. TRANSPORT LTD | LUCAS | +255719635483 | DSM |
| 513 | DOUBLE M TRANS LOGISTICS | EVARIST | +255719111012 | MBEYA |
| 514 | PICK TRADING LTD | SHILESH BAROT | +255655868093 | DSM |
| 515 | AHMED OMARY KABURU | AHMED OMARY | +255788117031 | DSM |
| 516 | HALGAN INTERNATIONAL LTD | HALGAN | +255656550829 | DSM |

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|---|---|---|---|---|
| 517 | ABUBAKARI TRANSPORT | A.A KHONDO | +255713596102 | DSM |
| 518 | OASCO TRUCKING CO.LIMITED | OASCO | +255659560888 | KONGWA |
| 519 | GULAM TAJ MOHAMMED | GULAM TAJ | +255756993944 | DSM |
| 520 | IYANA ENTERPRISES | BETTY MACHANGO | +255754282554 | DSM |
| 521 | HASSEKI INVESTMENT | JOHARI KICHWABUTA | +255713299592 | DSM |
| 522 | OBERT WATSON KYAND | OBERT WATSON | +255715622019 | TUKUYU |
| 523 | YASINI NDIMUABO MUSSA | YASINI NDIMUABO | +255715622019 | TABORA |
| 524 | DELL TRAILER MANUFACTURE | MERAMAN | +255756958256 | ARUSHA |
| 525 | MBULU TRADING CO.LTD | ABDALLAH | +255714838687 | ARUSHA |
| 526 | R.M AND L.M CO.LIMITED | LUCAS JOSEPH MALEO | +255652685216 | DSM |
| 527 | NASSER SAID SAIF | NASSER SAID SAIF | +255777060916 | DSM |
| 528 | SAMEER KARIM THAWER | SAMEER K. THAWER | +255712557162 | DODOMA |
| 529 | PWANI HAULIERS LIMITED | MAHESH PATEL | +255784287832 | DSM |
| 530 | MOHAMED ABDULWAHAAB | MOHAMED ABDUL | +255719605390 | DSM |
| 531 | AHMED SALEH NAGI | AHMED SALEH | +255714057744 | DSM |
| 532 | AIFOLA PRIME TRADERS LTD | HIMID MGOYI | +255716452045 | DSM |
| 533 | NASAM PETROLEUM CO.LTD | H.MNINDA | +255716386545 | KIOMBOI |
| 534 | LIBERATUS SILVESTER TEMU | LIBERATUS | +255715236666 | SANYA JUU |
| 535 | NSEMBOTRANSPORTATION | NSEMBO | +255715236666 | DSM |
| 536 | MALI-KV-TRANSPORT | MALI | +255715236666 | DSM |
| 537 | SAMWEL SAID TWEVE | SAMWEL SAID | +255719757475 | MBEYA |
| 538 | ABDULGHANI JAMA NOOR | ABDULGHANI | +255714556689 | DSM |
| 539 | SABASTIAN MSOLA | SABASTIAN ABDALLAH | +255719635483 | KONGWA |
| 540 | AHMED HOSHI GEDI | AHMED HOSHI | +255767532201 | BABATI |
| 541 | MORNING CARGO FREIGHT | FRANCIS SINDIYO | +255784270307 | ARUSHA |
| 542 | 3P LTD | AUDREY HOSEYA | +255754396770 | DSM |
| 543 | FAUZ SELEMAN SAID | FAUZ SELEMAN | +255715280304 | DSM |
| 544 | AHMED MERALI BASHIR | AHMED MERALI | +255754751053 | DSM |
| 545 | ISAACK LESION MOLLEL | ISAACK LESION | +255756400004 | DSM |
| 546 | ISMAIL MOHAMED ISMAIL | ISMAIL MOHAMED | +255767600822 | MBARALI |
| 547 | ATHUMANI MAKUNJA | ATHUMANI MGANGA | +255714977441 | MOROGORO |
| 548 | S.A.SAID&CO LTD | ABDALLAH SEIF | +255767379993 | DSM |
| 549 | PAZI HAMISI MWINYIMKUU | PAZI HAMISI | +255713775600 | DSM |
| 550 | FRANK PETER LYIMO | FRANK PETER | +255754236666 | MOSHI |
| 551 | STANLAUS KAGANDE | STANLAUS RWEIKIZA | +255712450101 | KARAGWE |
| 552 | BENNO DAMIAN URASSA | BENNO DAMIAN | +255769500823 | SHINYANGA |
| 553 | GENES LEAONARD MASSAWE | GENES LEONARD | +255718335290 | MOSHI |
| 554 | KULIAPA FWALO | KULIAPA CHOTIPANGO | +255788777778 | DODOMA |
| 555 | RATCO LIMITED | MOHAMMED SALIM | +255784200422 | TANGA |
| 556 | MICHAEL JOSEPH MASSAWE | MICHAEL JOSEPH | +255719605390 | ARUSHA |
| 557 | ABSHIR AHMED YUSUPH | ABSHIR AHMED | +255719635483 | DSM |
| 558 | NJAKE ENTERPRISES LIMITED | NJAKE | +255719635483 | MOSHI |
| 559 | ALEISO EZEKIEL MREMA | ALEISO EZEKIEL | +255719635483 | DSM |

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|---|---|---|---|---|
| 560 | HAFUN TRANS AGENCY LTD | HAFUNTRANS | +255719635483 | DSM |
| 561 | VICHIKE MAKOKO MAHUNA | VICHIKE MAKOKO | +255716307055 | DSM |
| 562 | GEMOIL (T)LTD | GILBERT MRMA | +255755464636 | DSM |
| 563 | STAR INVESTMENT LTD | PAUL NAMIROPO | +255779535353 | DSM |
| 564 | UNIVERSAL G&G CO.LTD | GILBERT MREMA | +255755464636 | DSM |
| 565 | NAPAKU LIMITED | DEO ERNEST | +255757273492 | ARUSHA |
| 566 | FILMASH TANZANIA CO.LTD | FILMASH | +255713658376 | DSM |
| 567 | ULOGA (T)LTD | ULOGA | +255713658376 | MOSHI |
| 568 | HUSSEIN SWALEHE MJILI | HUSSEIN SWALEHE | +255754313054 | SINGIDA |
| 569 | SAID HAMAD MOHAMMED | SAID HAMAD | +255714200007 | TANGA |
| 570 | ABDALLAH ISLAM ELFAN | ABDALLAH ISLAM | +255712110533 | DSM |
| 571 | SALMEEN TRANSPORT LTD | SALEH SALMEEN | +255713286444 | DSM |
| 572 | SIGINON TANZANIA LIMITED | JOSHUA KULEI | +255684711884 | DSM |
| 573 | THEMI JULIUS SIZIA | BAZIGU JOSEPH | +255715282458 | DSM |
| 574 | GAAS COMPANY LTD | GAAS | +255767117031 | DSM |
| 575 | THARMA FREIGHT CO.LTD | NICODEMUS MZURI | +255753278869 | DSM |
| 576 | ABDALLAH MOHAMED | ABDALLAH NASSOR | +255715454532 | DSM |
| 577 | R.HASSAN TRANSPORT LTD | ABDINUR ALI | +255754502420 | DSM |
| 578 | TANZANIA STONE QUARRIES | I DINANI | +255774789123 | DSM |
| 579 | TASTY CHOICE LIMITED | JOHN MWEDAD | +255754809766 | DSM |
| 580 | ABED MAHMOOD MUHAMED | ABED MAHMOOD | +255715236666 | DSM |
| 581 | ALNOUR AHMED | ALNOUR AHMED | +255754270151 | DSM |
| 582 | INNOCENT MBERESERO | INNOCENT BENEDICT | +255719635485 | MOSHI |
| 583 | DAUDI ALLY MSUYA | DAUDI ALLY | +255715536158 | DSM |
| 584 | PROMATEX EST LTD | JULIUS MWAMBA | +255716980012 | DSM |
| 585 | M.M STEEL MILLS LTD | SABASH PATEL | +255754325068 | DSM |
| 586 | SUPERNOVA TRANSPORT LTD | SUPERNOVA | +255712228522 | DSM |
| 587 | SSSU INVESTMENT CO LTD | SALUM IDI | +255756335533 | DSM |
| 589 | TANPERCH TANZANIA LTD | SAID | +255784148134 | MWANZA |
| 590 | KE GAS LTD | SALIM | +255713334698 | DSM |
| 591 | JAMES WILFRED URIO | JAMES WILFRED | +255754461449 | DSM |
| 592 | LAKE TRANS LTD | ALLY AWADH | +255784680000 | DSM |
| 593 | BRIDGEWAYS LOGISTICS | IBRAHIM MWABILI | +255754226227 | DSM |
| 594 | M.H NASSOR CO.LIMITED | MOHAMED HUSSEIN | +255715491111 | DSM |
| 595 | MBAROUK KHAMIS | MBAROUK KHAMIS | +255653080203 | TANGA |
| 596 | ROME0 LUCAS TARIMO | ROMEO LUCAS | +255754693843 | MOSHI |
| 597 | KIDOSHI RAJAB KINANJA | KIDOSHI RAJABU | +255714057744 | MOSHI |
| 598 | ROBERT ALPHONCE MLAY | ROBERT ALPHONCE | +255754383561 | ROMBO |
| 599 | CREN TRANSPORT AGENT LTD | ALLY MOHAMED | +255754890744 | DSM |
| 600 | ALLIED TRANSPORT AGENT | MOHAMED | +255787222254 | DSM |
| 601 | MNYENGE LIMITED | KUNAMBI | +255786656934 | DSM |
| 602 | AULA INVESTMENT CO.LTD | AULA | +255767374142 | SANYAJUU |
| 603 | SHAMSA NASSOR HALFAN | SAHMSA NASSOR | +255655453300 | SHINYANGA |

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|---|---|---|---|---|
| 604 | FADYA ALLY HAMISI | FADYA ALLY | +255655453300 | MBEYA |
| 605 | STELLA WILLIAM KAMETA | STELLA WILLIAM | +255713838686 | MBEYA |
| 606 | JAMAL SALUM ABOOD | JAMAL SALUM | +255717087812 | DSM |
| 607 | LAKE CORRIDOR PETROLEUM | LAKE CORRIDOR | +255654789809 | DSM |
| 608 | ABDULRAHMAN KHATIB | ABDURAHMAN | +255784779077 | DSM |
| 609 | YUSUF ISMAIL HURE | YUSUF ISMAIL | +255764601797 | ARUSHA |
| 610 | KISMART WILFRED KIMAMBO | KISMART | +255716547354 | MPWAPWA |
| 611 | CHARLES AMBOKILE FUNGO | CHARLES AMBOKILE | +255754274094 | DSM |
| 612 | AZIZA NASSOR AL HINAI | AZIZA NASSOR | +255715369647 | DSM |
| 613 | MAJID HUSSEIN KICHWABOTA | MAJID HUSSEIN | +255713425251 | BUKOBA |
| 614 | MEM LOGISTICS (T)LIMITED | EMANUEL | +255713646292 | DSM |
| 615 | NY GROUP TANZANIA LIMITED | ZAINAB OMAR | +255716681065 | DSM |
| 616 | ELIEZA E NITANGA | ELIEZA EDWARD | +255754482487 | DSM |
| 617 | ALLEN WILBARD KASSA | ALLEN WILBARD | +255715380543 | DSM |
| 618 | BAUNEK BABIEL MUSHI | BAUNEK BABIEL | +255773380543 | DSM |
| 619 | ABDULMALIK ABDALLAH | ABDULMALIK ABDALLAH | +255755312265 | DSM |
| 620 | RENDS TRANSPORT LIMITED | RENDS | +255788117031 | DSM |
| 621 | ASHA ABDULKADIR YUSUF | ASHA A. YUSUF | +255788117031 | DSM |
| 622 | AZIMIO PATRICK MAGEHEMA | AZIMIO PATRICK | +255718587041 | DSM |
| 623 | PAOFA TRADING ENTERPRISES | PATRICK O FANUEL | +255717672733 | DSM |
| 624 | MADALE TRUCKING CO.LTD | MASHAKA JONAS | +255754819356 | DSM |
| 625 | CHAAWEST SERVICES CENTER | JAMAS | +255784288899 | DSM |
| 626 | JOSEPH THOMAS KLERRUU | JOSEPH THOMAS | +255754302069 | DSM |
| 627 | GEORGE MBERESERO | GEORGE BENEDICT | +255719635483 | MWANGA |
| 628 | NTIRABAMPA OSCAR NGARA | NTIRABAMPA OSCAR | +255719355483 | DSM |
| 629 | YUSUF HAMED RASHID | YUSUF HAMED | +255714057744 | DSM |
| 630 | SAID ISMAIL WARSAMA | SAID ISMAIL | +255784230940 | ARUSHA |
| 631 | TAK BIIL INVESTMENTS LTD | TAK BIIL | +255788563383 | DSM |
| 632 | LRM INVESTMENT CO LTD | DAVIS SYLVESTER | +255754266620 | DSM |
| 633 | ABUBAKAR SUED KAGASHEKI | ABUBAKARSUED | +255788563383 | DSM |
| 634 | KHAMIS SOUD ABOUSHIR | KHAMIS SOUD | +255715622019 | DSM |
| 635 | AHMED MOHAMED SHAYO | AHMED MOHAMED | +255655309338 | CHALINZE |
| 636 | ZAINAB ABTWALIB SHAYO | ZAINAB ABTWALIB | +255655309338 | CHALINZE |
| 637 | LUSHOTO TANKERS SERVICES | MOHAMED MANSUR | +255784443195 | DSM |
| 638 | HASSAN MAHMUD ZIAD | HASSAN MAHMUD | +255754469951 | DSM |
| 639 | LOGI TRANS LTD | LOGITRANS | +255752332668 | DSM |
| 640 | BORIN INVESTMENT LIMITED | BORIN INVESTMENT | +255715391279 | DSM |
| 641 | PAOLO MWANGAMBO | PAOLO SINDIKA | +255713269829 | DSM |
| 642 | MAX TRANSPORT LTD | MAX TRANSPORT | +255655780285 | DSM |
| 643 | METAL PRODUCTS | SRIDHAR PEDDI | +255785230111 | DSM |
| 644 | GAZA TRANSPORT CO.LTD | GAZA TRANSPORT | +255754543299 | MBEYA |
| 645 | ZEIN ENTERPRISES CO.LTD | AHMED HASHIM | +255754744333 | DSM |
| 646 | JOSEPH JOHN SHIRIMA | JOSEPH JOHN | +255754841930 | MOSHI |

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|---|---|---|---|---|
| 647 | PIRTHIPAL SINGH SANGHERA | PIRTHIPAL SINGH | +255754621050 | DSM |
| 648 | ELINEEMA KESSEN MARO | ELINEEMA KESSEN | +255754268387 | ARUSHA |
| 649 | YAHAYA MASHAKA | YAHAYA MOHAMED | +255715236666 | DSM |
| 650 | HATIBU ALI MBERESERO | HATIBU ALI | +255715236666 | MOSHI |
| 651 | BRAVE ENGINEERING &CONST | PROSPER NGUMA | +255754317300 | DSM |
| 652 | BETRICE MWAKAMISA | THOMAS ESILI | +255754566507 | MBEYA |
| 653 | GABRIEL EZEKIEL MASSAWE | GABRIEL EZEKIEL | +255755808522 | DSM |
| 654 | MEMADENT TRADERS | ANATHOL JOSEPH | +255754350677 | DSM |
| 655 | ATHANAS P TARIMO | ATHANAS P TARIMO | +255767973743 | DSM |
| 656 | KYEJU TRANSPORTATION LTD | IDDI S KYEJU | +255767584686 | DSM |
| 657 | SIMBA MTOTO TRANSPORT | ALI ABDI AWADH | +255754307875 | TANGA |
| 658 | ZAKARIA LANGOI PALANGYO | ZAKARIA LANGOI | +255789187547 | ARUSHA |
| 659 | AFRICAN CANIVAL GROUPLTD | INNOCENT SHIRIMA | +255785607232 | DSM |
| 660 | GOJOPA COMPANY LTD | HENRY PASAPE | +255713849070 | DSM |
| 661 | ZAINABU MURTAZA VIRSAM | ZAINABU MURTAZA | +255715763000 | BUKOBA |
| 662 | WIMROD INVESTMENT LTD | WILLIAM MRIMI | +255713470777 | DSM |
| 663 | ADVOCATE LEONARD NYOMBI | LEONARD NYOMBI | +255715236666 | DSM |
| 664 | AMI&VAI INVESTMENT LTD | REHEMA H CHEGEKA | +255754775495 | DSM |
| 665 | HANS LOGISTICS LTD | TONY HON | +255715198198 | DSM |
| 666 | FRANK OBEID MUSHI | FRANK OBEID MUSHI | +255766111888 | DSM |
| 667 | FREDRICK ADAM NYALUKE | FREDRICK ADAM | +255712009009 | DSM |
| 668 | KITENDAGURO TRADING LTD | ROBERT | +255769430001 | DSM |
| 669 | FIRST TRUCK CO LIMITED | FIRST TRUCK | +255713567898 | DSM |
| 670 | BEPAL LOGISTICS LTD | PAUL EMMANUEL | +255718203733 | DSM |
| 671 | TRANSOCEANIC PROJECTS | ARVAL HEADRICK | +255713077777 | DSM |
| 672 | FRANK MUSHI | FRANK MUSHI | +255719635483 | DSM |
| 673 | MAZANGARA TRADERS &CO | ALLY ATHUMAN | +255713234656 | DSM |
| 674 | JUEDA INVESTMENT CO LTD | LUKIO | +255754278176 | DSM |
| 675 | ROYAL PAINTS CENTRE LTD | KIKOISE SAITOTI | +255655367833 | DSM |
| 676 | MASTER ONE LTD | MBARAK | +255713210930 | DSM |
| 677 | ARISTIDES M KENIZIO | ARISTIDES KENIZIO | +255785515560 | DSM |
| 678 | FAZAL DAD LIMITED | SAJAD GULLAM | +255754333124 | DSM |
| 679 | RAFIKI AUTO SPARES LTD | EDWARD MASHANA | +255715808588 | DSM |
| 680 | SUPER SONIC SAFARI LIMITED | SHAZIR | +255717420150 | DSM |
| 681 | SOCIETY OF PRECIOUS BLOOD | THOMAS WAMBURA | +255756774977 | DSM |
| 682 | MOHAMED ABOKOR ABDI | MOHAMED ABOKOR | +255754228567 | DSM |
| 683 | HORSEED TRANSPORT | HORSEED | +255788117031 | DSM |
| 684 | VICENT JOSEPH NYERERE | VICENT JOSEPH | +255655231918 | MUSOMA |
| 685 | BATK LOGISTICS COMPANY | L.KIMARO | +255786271823 | DSM |
| 686 | WESTERN HAULIERS | LUCAS | +255785602319 | DSM |
| 687 | MOHAMED HASSAN YARE | MOHAMED HASSAN | +255785703023 | DSM |
| 688 | FETI YOHANIS SANGA | FETI YOHANIS | +255785888869 | IRINGA |
| 689 | ABDULRAHMAN HAJI | ABDURAHMAN | +255754300354 | MOSHI |

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|---|---|---|---|---|
| 690 | KENICE & TRANSPORT | EUSTACE JOHN MASAKI | +255784855300 | DSM |
| 691 | JUMA WAZIRI SANGALI | JUMA WAZIRI | +255715386334 | DSM |
| 692 | KURSK FREIGHT LTD | DENIS S MTUI | +255652252222 | DSM |
| 693 | TRIPLE A HAULEIERS LTD | HUSSEIN JETHA | +255782102958 | DSM |
| 694 | Y.N.INVESTMENT | IDDI YASIN NYAGAWA | +255713154735 | DSM |
| 695 | SHAIMAK COMPANY LTD | ISSA MOHAMED | +255717540004 | DSM |
| 696 | ALEXANDERA BOHAY | ALEXANDERA | +25525038921 | DSM |
| 697 | KAKA INVESTMENT CO LTD | MAJALIWA | +255655307013 | DSM |
| 698 | RAPHAEL LOGISTICS (T) LTD | RAPHAEL | +255715206036 | DSM |
| 699 | ALLY SABRY EL HAJ | ALLY SABRY | +255655000355 | DSM |
| 700 | SHIRAZ KHUDABAKSH SALIM | SHIRAZ | +255764602239 | DSM |
| 701 | LUC NYANDWI | LUC NYANDWI | +255788117031 | DSM |
| 702 | HAMIS SAID KANGAULAYA | HAMIS SAID | +255655480330 | DSM |
| 703 | MILLIAN ZEPHANIA MMARI | MILLIAN ZEPHANIA | +255719635483 | DSM |
| 704 | SIKI GENERAL SUPPLIES | LUCAS | +255719635483 | DSM |
| 705 | TADEY ANSELIMU MARIKI | TADEY ANSELIMU | +255713324227 | MOSHI |
| 706 | BUNDALA S BUNDALA | ERIC SEMIT | +255715822674 | DSM |
| 707 | BALLY NATTY BALLY | BALLY NATTY | +255715448867 | DSM |
| 708 | JDL LOGISTICS CO LTD | LUCAS | +255719635483 | DSM |
| 709 | SAIF HAMDOON AMOUR | SAIF HAMDOON | +255655312917 | KARAGWE |
| 710 | BENNO MOSES MAGAHO | BENNO M. MAGAHO | +255754378066 | DSM |
| 711 | MANSUR JUMA MSUYA | MANSUR JUMA | +255719635483 | DSM |
| 712 | USAGARA SERVICE STATION | KARUME AMIR | +255784333125 | MWANZA |
| 713 | SANTANA CARGO | SHWABUA MUSHI | +255754467646 | ARUSHA |
| 714 | ARUSHA FRIEGHT TRANSPORT | AUGUSTINE SAKWERA | +255754333338 | DSM |
| 715 | ANNA JOSEPH NERI | ANNA J NERI | +255776158926 | DSM |
| 716 | MUNAWER M RASHID | MUNAWER RASHID | +255754376660 | DSM |
| 717 | NJM LOGISTICS (T)LIMITED | N J MEENA | +255713402111 | DSM |
| 718 | NASAI TRANSPORT | CALVIN MAIMU | +255756300000 | DSM |
| 719 | RASCO MOTORS (T)LIMITED | AHMED SAID ABDALLAH | +255784764014 | DSM |
| 720 | OSMAN HUSSEIN ISMAIL | OSMAN HUSSEIN | +255713117031 | ARUSHA |
| 721 | FRANK BENN MWANUKE | FRANK BENN | +255713117031 | IRINGA |
| 722 | SALEH ASHUR KHAMIS | SALEH ASHUR | +255718621010 | DSM |
| 723 | SHABIR AHMED ABDALLAH | SHABIR AHMED | +255713666360 | DSM |
| 724 | MANGARE TRANSPORTERS | L MANGARE | +255715290864 | DSM |
| 725 | MOHAMED AL-BEITY | MOHAMED ABUBAKAR | +255715387060 | DSM |
| 726 | BARNABAS SHIRIMA | BARNABAS CLEMENCE | +255716201620 | ARUSHA |
| 727 | FREIGHTWORX LIMITED | SHAIB NGOTA | +255784602364 | MWANZA |
| 728 | NUHU RAJABU MIRARO | NUHU RAJAB | +255754564232 | ARUSHA |
| 729 | CHARLES GODSON SHOO | CHARLES GODSON | +255784896494 | DSM |
| 730 | HARRISSON WINGIA MSEKE | HARRISSON WINGIA | +255754541554 | DSM |
| 731 | MODERN ROAD HAULAGE | ROSEMENA GASPER | +255719605390 | DSM |
| 732 | CHRIS FRANK MAGERELI | CHRIS FRANK | +255655170177 | DSM |

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|---|---|---|---|---|
| 733 | ANWAR ALLY SAAD | ANWAR ALLY | +255713311333 | DSM |
| 734 | GERVAS SEIF MLELWA | GERVAS SEIF | +255754965677 | DSM |
| 735 | MATESO GROUP CO.LTD | MATESO GROUP | +255715282458 | DSM |
| 736 | BUKENE TRANSPORTERS LTD | SUHAIL M ALI | +255788514466 | DSM |
| 737 | ANKETH INVESTMENTS LTD | MIKIDAD JAPHARI | +255755783379 | KIBAHA |
| 738 | LUHOTA INVESTMENT LTD | MICHAEL NG'AMILO | +255715390813 | DSM |
| 739 | MS JOACHIM ALOYCE MYELLA | JOACHIM ALOYCE | +255784506109 | MBEYA |
| 740 | MZAKIRU BIGIRWA | MZAKIRU ABBAKARY | +255714681615 | DSM |
| 741 | SURENDER BUDH S COMPANY | SURINDER SINGH | +255716524622 | DSM |
| 742 | IBRAHIM RUDIAEL MMARI | IBRAHIM RUDIAEL | +255784380543 | DSM |
| 743 | ZASH SERVICES LTD | HASNAIN H DEWJI | +25571297000 | DSM |
| 744 | MICHAEL SEMVUA | MICHAEL MELCHIORY | +255713452634 | DSM |
| 745 | LUBUBU CO.LTD | NGHUMBU KIJA OKU | +255655580285 | DSM |
| 746 | BLB5 COMPANY LIMITED | BULEK B LYOCHI | +255754580285 | DSM |
| 747 | ALTAF DIAMOND REMTULLA | REMTULAH | +255719259252 | DSM |
| 748 | PANISH INVESTMENT LIMITED | ABBAS MZIRAY | +255784469933 | DSM |
| 749 | OMAR RAMADHAN MWINJAKA | OMAR RAMADHAN | +255767900570 | DSM |
| 750 | DERICK GLOBAL TRADING | DERICK | +255715435487 | DSM |
| 751 | FLEET EXPRESS LTD | YUSUF ESSAJI | +255786608746 | DSM |
| 752 | SAJJD MOHAMED VIRANI | SAJJD MOHAMED | +255789902737 | DSM |
| 753 | KHADIJA ISMAIL HUSSEIN | KHADIJA I. HUSSEIN | +255754480905 | SINGIDA |
| 754 | SALIM SAID MOHAMED LTD | SAID SALIM MOHAMED | +255774450050 | TANGA |
| 755 | MATESO MWANDULAMI | MATESO ANTHONY | +255715282458 | DSM |
| 756 | VIRGIL AKWILINI SWAI | VIRGIL AKWILINI SWAI | +255716226240 | DSM |
| 757 | V&H.INVESTMENT LTD | HARISH P CHAWDA | +255715397937 | DSM |
| 758 | GODLOVE LEVI MGENI | GODLOVE LEVI | +255719605390 | DSM |
| 759 | CARGOSTARS LTD | DIONIZ MALINZI | +255713417734 | DSM |
| 760 | NASSOR RASHID AHMED | LIEMBA | +255719000004 | TANGA |
| 761 | GATEWAY LOGISTICS | GODWIN | +255712300000 | DSM |
| 762 | ABOU SEIF /ASA ENTERPRISES | ABOU ALLY SEIF | +255719605390 | DSM |
| 763 | MAURICE MWENDABAI | MAURICE MOOKA | +255777964200 | DSM |
| 764 | NIKODEM RUBEN MALYA | NIKODEM R. MALYA | +255655989964 | DSM |
| 765 | AGGARWAL ROAD HAULAGE | AGGARWAL | +255767321030 | ARUSHA |
| 766 | IKAANAMI WILDADI KIONDO | IKAANAMI WILDADI | +255767157744 | DSM |
| 767 | SALEHE YAHYA MOHAMED | SALEHE YAHYA | +255715131388 | DSM |
| 768 | VRAJLALS AGENCIES LTD | MITUL | +255784274999 | DSM |
| 769 | HAAMILU TRANSPORT LTD | MOHAMED | +255653662733 | DSM |
| 770 | TANUK MINING SERVICES LTD | NISHAZ HUSSEIN | +255784777200 | DSM |
| 771 | YUSUF ATHUMANI ALLY | YUSUFU ATHUMAN | +255655558698 | DSM |
| 772 | JANAT HUSSEIN MSUYA | JANAT HUSSEIN | +255653130103 | DSM |
| 773 | SALEKO TRADER LIMITED | BRIDGET | | DSM |
| 774 | ALOO SALIM ABDALLAH | ALOO SALIM | +255754315741 | DSM |
| 775 | OMARY ABDALLAH IDHA LTD | OMARY ABDALLAH | +255717700000 | DSM |

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|---|---|---|---|---|
| 776 | KHANAN KHAN LODHI | KHANAN KHAN LDOHI | +255715622019 | DSM |
| 777 | ENOCK MELKIZEDECK | ENOCK MELKIZEDECK | +255717101020 | DSM |
| 778 | RELIANCE CARGOTRANSPORT | EVARIST MWANGA | +255788413311 | DSM |
| 779 | JONAS CHITOFU MLIPU | JONAS CHITOFU | +255754636007 | DODOMA |
| 780 | ABDALLAH HASSAN | ABDALLAH SULEIMAN | +255769005700 | DSM |
| 781 | ABDULAZIZ YESLAM KULAIB | ABDULAZIZ YESLAM | +255713327755 | DSM |
| 782 | BARAK ATHUMAN MOSSES | BARAK ATHUMAN | +255713523131 | DSM |
| 783 | HASAT TRADING COMPANY | HASAT TRADING | +255767265565 | DSM |
| 784 | HORIZON LOGISTICS CO.LTD | HORIZON LOGISTICS | | DSM |
| 785 | ASSENGA ALEX LUCAS | ASSENGA ALEX | +255715399805 | DSM |
| 786 | REMIGIUS PATRICK PAULO | REMIGIUS PATRICK | +255754220995 | DSM |
| 787 | SALIM SAID SALIM | SALIM SAID SALIM | +255767223984 | TANGA |
| 788 | SEMU MBAZI MJEMA | SEMU MBAZI MJEMA | +255754299854 | DSM |
| 789 | KIOMBOI HOLDING LIMITED | FRANKJYUNGE | +255715432595 | DSM |
| 790 | FURAHISHA FRANCIS MSIGWA | FURAHISHA FRANCIS | +255755454912 | MAFINGA |
| 791 | MOTISUN LOGISTIC SERVICES | ALY DEWJI | +255682896344 | DSM |
| 792 | EPIMARCK LIGALAMA | EPIMARCK RAPHAEL | +255688332587 | DSM |
| 793 | MAN AND ELI LOGISTICS | ELIAH B FUNGO | +255713786797 | DSM |
| 794 | AHMED KASSIM RAJAB | AHMED KASSIM | +255784448819 | DSM |
| 795 | MSELEI TRANSPORT TOURS | RESPIKIUS FAUSTIN | +255715282458 | MOSHI |
| 796 | BROADWAYSBUSINESS | SHAKANYI RUGATIRI | +255714029520 | DSM |
| 797 | TITO GENERAL STORES LTD | TITO WILLBARD | +255754382448 | DSM |
| 798 | RAHIM HUSSEIN ANAND | RAHIM HUSSEIN | +255718786124 | DSM |
| 799 | JOEFF GROUP (T)LTD | JOSEPH EDWARD | +255653264023 | DSM |
| 800 | JAWADU ATHUMANI TABU | JAWADU ATHUMANI | +255713223244 | DSM |
| 801 | ADINA TRADING COMPANY | AMINA IDDI DARABU | +255773363644 | DSM |
| 802 | AGH TRANSPORTATION LTD | AGH TRANSPORTAION | +255717678257 | DSM |
| 803 | AMANI SAFARI ADVENTURES | CHARLES MROSSO | +255789650524 | DSM |
| 804 | SOLTAN (TZ)GROUP LIMITED | MEHDI SOLTAN | +255788488270 | DSM |
| 805 | ATHUMANI NYAKI HOZA | ATHUMANI NYAKI | +255719210286 | DSM |
| 806 | R.J.MOTICHAND TRANS | KAMAL MOTICHAND | +255659807050 | DSM |
| 807 | TRANSCARE LOGISTICS LTD | SALMEEN KLEB | +255773307778 | DSM |
| 808 | PETROZANIA LIMITED | PETROZANIA | +255719605390 | DSM |
| 809 | JOSEPHAT TWAHA JOHN | JOSEPHAT T.JOHN | +255766696132 | DSM |
| 810 | DARFFOR ENTERPRISES | ARVIND K SUJEER | +255779138442 | DSM |
| 811 | MUSSA SHABAN MOHAMED | MUSSA SHABAN | | URAMBO |
| 812 | SAAB TRANS CO.LTD | ALTAF BORA | +255686986786 | DSM |
| 813 | ABDALLAH SAID SELEMAN | ABDALLAH SAID | | KIGOMA |
| 814 | RASHID HIRJI BUSHIR | RASHID HIRJI BUSHIRI | +255786526681 | KAHAMA |
| 815 | ISACK ZAKARIA MOLEL | ISACK ZAKARIA | +255785663322 | DSM |
| 816 | MWINYIJUMA HAMIS NG’AJAH | MWINYIJUMA HAMIS | +255656040322 | DSM |
| 817 | EUGENE SAMWEL LYANZILE | EUGENE SAMWEL | +255654749633 | DSM |
| 818 | VOLCAN LOGISTICS | FERNANDO OLIVEIRA | +255755400673 | DSM |

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| 819 | HEMED ALI CHUMBUWENI | HEMEDI ALI | +255653332217 | DSM |
| 820 | STATE OIL TANZANIA LTD | SINDA ESSYA SIMBU | +255767401789 | DSM |
| 821 | HASSAN JOHO EDWARD | HASSAN JOHO | +255655890500 | DSM |
| 822 | KATANGA HAULIERS LTD | KATANGA | +255783292652 | DSM |
| 823 | PATHTRAACERS LOGISTICS | AGREY MEENA | +255762998873 | DSM |
| 824 | MUSTAPHA MOHAMED | MUSTAPHA AHMAD | +255652389655 | DSM |
| 825 | RAJABU JUMA SHEMWARIKO | RAJABU JUMA | +255714057744 | DSM |
| 826 | NKIRA INVESTMENTS LTD | GEOFREY NGATARA | +255754275042 | DSM |
| 827 | K.N.SOLANKI TRANSPORT LTD | KEVAL N.SOLANKI | +255713335121 | DSM |
| 828 | KELVEN RONALD PANIS | KELVEN RONALD | +255719605360 | DSM |
| 829 | SUNSHINE TRANSPORTATION | ANTHONY MAGNUS | +255715241800 | DSM |
| 830 | ALLY MUSA SWEYA | ALLY MUSA | +255754765761 | SONGEA |
| 831 | WAPAKAYA INVESTMENT LTD | ROZIMINA TESHA | +255754564232 | DODOMA |
| 832 | NAGIB YESLEM SAID | NAGIM YESLEM | +255774404071 | DSM |
| 833 | FESTUS KIVUTHA MUTHIANI | FESTUS K.MUTHIANI | +255718914790 | DSM |
| 834 | ET&TS INVESTMENT LTD | PRAYGOD TOWO | +255754299108 | DSM |
| 835 | VIRGIN MARY LOGISTICS | FRANCIS MSUNGU | +255767330399 | DSM |
| 836 | MILLAMA ORGANIC TRADING | FRIDA D RUGEMALIRA | +255754477958 | DSM |
| 837 | NUR HASSAN TRANSPORT LTD | ABDIRASHID | +255714785789 | DSM |
| 838 | ZABRON ANANIDZE SIKILO | ZABRON N.SIKILO | +255754566507 | NJOMBE |
| 839 | VGM INVESTMENT CO.LTD | MR.MECKY | +255755094233 | DSM |
| 840 | BANSALTRANSPORT | RAVINDER SINGH | +255784511302 | ARUSHA |
| 841 | MEST INVESTMENT CO.LTD | MR.S.PAUL | +255713246667 | DSM |
| 842 | WATSON GERVAS KANG’ONYA | WATSON GERVAS | +255713585950 | DSM |
| 843 | NETHERLANDS TT & D LTD | WILLAM MOLLEL | +255784754818 | DSM |
| 844 | AL AMER HOLDINGS (T)LTD | MBARAK | +255784222750 | DSM |
| 845 | JOMBA AUTO TRANSPORT | JOMBA AUTO | +255789789789 | DSM |
| 846 | KAY JUNIOR CO.LTD | KAY | +255765611593 | DSM |
| 847 | MATHAYO &SON TRANSPORT | JASPER M KAWEZU | +255754293055 | DSM |
| 848 | COLTAJI INVESTMENT LTD | CLEMENT L TIMOTHY | +255655375955 | DSM |
| 849 | GG&CC TRANSPORTATION | DORA MWENDA | +255754269161 | DSM |
| 850 | DANVIC PETROLEUM (T) LTD | VICTOR NDONDE | +255786191434 | DSM |
| 851 | MZAKING INTE.TRANSPORT | MR.LEONARD | +255777800900 | DSM |
| 852 | KALIS LOGOSTICS | KALIS | +255754243331 | DSM |
| 853 | HAMBLASH INVESTMENT LTD | HAMBLASH | +255687371653 | DSM |
| 854 | DIAMOND MOTORS LIMITED | MR.RUPIN J RAJANI | +255754778899 | DSM |
| 855 | WAGAD TRANSPORT CO.LTD | YASIN ABUBAKAR | +255754282596 | DSM |
| 856 | SAID MUSSA ZUBEIR | SAID MUSSA | +255658432985 | DSM |
| 857 | AYUB JILAONEKA MGIMBA | AYUB JILAONEKA | +255713265533 | DSM |
| 858 | MWARI TRANSPORT LTD | C.BOEHL | +255688222444 | DSM |
| 859 | LUSAJO ADAM MWAIJULU | LUSAJO ADAM | +255754759275 | DSM |
| 860 | LISHA INVESTMENT | LISWA SHABAN MABULA | +255784389798 | NZEGA |
| 861 | ABDU JUMAAN SALIM | ABDU JUMAAN | +255713234571 | DSM |

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|---|---|---|---|---|
| 862 | MAKANDO CYBRA TRANS LTD | MAKANDO CYBRA | +255783281557 | DSM |
| 863 | TALEH & INVESTMENT | MOHAMED SAID FARAH | +255785486240 | DSM |
| 864 | PETER MATEI LASHAYO | PETER.M.LASHAYO | +255754562353 | DSM |
| 865 | J.KANALI TRANSPORT LTD | JULIUS THOMAS | +255719518931 | DSM |
| 866 | A.S. AL-JABRY INVESTMENT | ABDALLAH AL JABRY | +255754315741 | DSM |
| 867 | SUNGURWA TRADERS CO.LTD | RAMADHAN A.MSENGI | +255767413069 | DSM |
| 868 | B.V.K OVERLAND CARRIER | BONIFACE VITUS | +255754229808 | DSM |
| 869 | SMARTFLEX CO.LTD | GEORGR CHIMALILO | +255774677777 | DSM |
| 870 | EFFECTIVE TRANSPORTERS | ISABELA ASENGA | +255754654702 | DSM |
| 871 | MSEROE ENTERPRISES | ROBERT NICHOLAUS | +255713404231 | DSM |
| 872 | BARKE OMARY KARAMM | BARKE OMARY | +255714410441 | DSM |
| 873 | ORWAY TRANSPORT LTD | ONEST BALTAZAR | +255754390605 | DSM |
| 874 | FM CARGO LIMITED | MAGNUS MAPINDULI | +255713846276 | DSM |
| 875 | G.S.HOLDING (T)LTD | GADIEL AYO | +255754281561 | DSM |
| 876 | TON EDWARD NYAGE | TON EDWARD | +255717999866 | DSM |
| 877 | PATRICK MAKANDO | PATRICK MAKANDO | +255783281557 | DSM |
| 878 | BADEL SALEH ABRI | BADEL SALEH | +255755881888 | DSM |
| 879 | UNIVERSAL RENTALS LTD | MOHINDERJIT OBHAN | +255777100025 | DSM |
| 880 | ASHIF. FATEHALI LADHANI | ASHIF F. LADHANI | +255784781508 | DSM |
| 881 | EVARISTE HOGA | EVARISTE HOGA | +255755276460 | DSM |
| 882 | BERNAD JACOB FRIMUS | LIBERAT NSANYIMANA | +255716459495 | DSM |
| 883 | HUMPHUREY JOHN MROSSO | HUMPHUREY J. MROSSO | +255657998396 | DSM |
| 884 | ABBAS MURTAZA DINANI | ABBAS M. DINANI | +255758488488 | DSM |
| 885 | NOUFAL MOHAMMED | AUTOFREIGHT LTD | +255779361111 | DSM |
| 886 | AIMABLE NGABONZIZA | AIMABLE NGABONZIZA | +255759489254 | DSM |
| 887 | SALUM CONTINENTAL CO | SEIF NASSOR ALI | +255714709293 | DSM |
| 888 | DEO ARAKAZA KETE | DEO ARAKAZA KETE | +255753579257 | DSM |
| 889 | FAST TRANSPORT COMPANY | MANAGING DIRECTOR | +255767940468 | DSM |
| 890 | KIKONGO TRANSPORT LTD | KIKONGO TRANSPORT LTD | +255719830358 | DSM |
| 891 | ZAWADI AGENCY LIMITED | ZAWADI AGENCY LIMITED | +25574584323 | DSM |
| 892 | BETI ZEFANIA MACHANGE | BETI ZEFANIA MACHANGE | +255714810290 | DSM |
| 893 | AMOS NYAUMBA | AMOS ASHERY NYAUMBA | +255715502258 | DSM |
| 894 | HASHIM MUSSA MWASHA | HASHIM MUSSA MWASHA | +255754447874 | DSM |
| 895 | FEISAL HEMED | FEISAL HEMED SAID | +255712400007 | DSM |
| 896 | RAHIM IBRAHIM KANGILE | RAHIM IBRAHIM KANGILE | +255715545582 | DSM |
| 897 | KASSIM N.KHAMIS | KASSIM NASSOR KHAMIS | +255713470803 | DSM |
| 898 | MARC NIBASUMBA | MARC NIBASUMBA | +255758423900 | DSM |
| 899 | A GURE TRANSPORT LIMITED | AGURE | +255717678257 | DSM |
| 900 | JAMA MOHAMED ALLY | RJ LUI CO LTD | | DSM |
| 901 | SANDRA | SANDRA S. MAJALIWA | +255754201129 | DSM |
| 902 | WAZIRI HASSAN & SONS | ALLY ABDALLAH | +255688011041 | DSM |
| 903 | WALIOBA MWAMLIMA | WARIOBA V. MWAMLIMA | +255754596521 | DSM |
| 904 | BADBOY MZ INVESTMENT | JORDAN CELESTINO | +255772088088 | DSM |

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|---|---|---|---|---|
| 905 | PIDDA SUPPLIES | PIDDA SUPPLIES | +255754262099 | DSM |
| 906 | MAGRETH HILLMAR MPILI | MAGRETH HILLMA MPILI | +255754520119 | DSM |
| 907 | MARCEL GABRIEL TARIMO | MARCEL GABRIEL TARIMO | +255754286202 | DSM |
| 908 | LEONS HENDRY KIMARIO | LEONS HENDRY KIMARIO | +255754286202 | DSM |
| 909 | ABDULATIF | ATN PETROLEUM CO.LTD | +255787313603 | DSM |
| 910 | MOHAMED SINANI &SONS LTD | FARID | +255714777010 | DSM |
| 911 | RAYMOND SHIFOYA MUSHI | RAYMOND S. MUSHI | +25575598171 | DSM |
| 912 | GOSA COMPANY LIMITED | GOSA COMPANY LIMITED | +255715567025 | DSM |
| 913 | ORIO GUEST HOUSE | ALPHONCE K. ORIO | +255784435287 | DSM |
| 914 | SABUNI AMIRI SABUNI | SABUNI AMIRI SABUNI | +255719210286 | DSM |
| 915 | MASAMA TRUCK | NICHOLAUS A.MAKULE | +255754280257 | DSM |
| 916 | ABUBAKAR ISMAIL CHUWA | ABUBAKAR CHUWA | +255767942422 | DSM |
| 917 | KISEM INVESTMENT CO.LTD | KISEM | +255715569025 | DSM |
| 918 | MELOD TRANS LIMITED | DONISIA J. MASSAWE | +255715706173 | DSM |
| 919 | PATRA JANGHAN GULLAM | PATRA JANGHAM GULLAM | +255762190991 | DSM |
| 920 | ASAM LOGISTIC COMPANY | AYUBU KASSIMU | +255784817562 | DSM |
| 921 | WILFRED JOHN MDASSA | WILFRED JOHN MDASSA | +255713413700 | DSM |
| 922 | RANDHIR SINGA TEJA | RANDHIR SINGA TEJA | +255784468746 | DSM |
| 923 | JUBILEE WORLDWIDE | SAM A. MAINGI | +255716664985 | DSM |
| 924 | UKOD LOGISTIC CO.LTD | AHMED H. ABDULLAH | +255767694919 | DSM |
| 925 | FRANK JAM LOGIS.CO LTD | JAMES JOHN MINJA | +255754857060 | DSM |
| 926 | DAHIM COMPANY LIMITED | DAMIAN BUPAMBA | +255656620077 | DSM |
| 927 | TRANSMAMS (T) LTD | GOD LISTEN MMARI | +255659762462 | DSM |
| 928 | LFK SERVICE STATION | LEONARD | +255754564778 | DSM |
| 929 | YAATE INVESTMENT CO.LTD | SAID ADAM | +255767600000 | DSM |
| 930 | NEPO & BROTHER TRANS | NEPO | +255778039454 | DSM |
| 931 | MSOUTH CO,LIMITED | MSOUTH | +255655502200 | DSM |
| 932 | S.TRANSPORT | S.TRANSPORT | +255658558055 | DSM |
| 933 | LUSEKELO MWANDENGA | LUSEKELO S.MWANDENGA | +255754655832 | DSM |
| 934 | STACO CHEM LTD | STACO MOTORS LTD | +255652126212 | MOROGORO |
| 935 | SHELARA LOGISTIC.CO.LTD | KHALID M. AHMED | +255784302091 | DSM |
| 936 | COSMOS HAULAGE CO.LTD | MZUZURI | +255655804257 | DSM |
| 937 | KORNET COMPANY LIMITED | ERIC S.BEN | +255783590491 | DSM |
| 938 | PETRO LOGISTIC LIMITED | MZUZURI | +255786707060 | DSM |
| 939 | SUPER CARRIS CO.LTD | MOHAMED ADAN ABDI | +255755940521 | DSM |
| 940 | ISMAIL.B.SALAH | ISMAIL BEDEL SALAH | +255783571455 | DSM |
| 941 | LIEMBA MADENI MOHAMED | NASSOR RSHID AHMED | +255784540640 | DSM |
| 942 | GILIAD SHIJA MIHAMBO | GILIAD SHIJA MIHAMBO | +255655607231 | DSM |
| 943 | MDOPE TRANSPORT CO. | JULIUS F MDOPE | +255754872890 | DSM |
| 944 | SHAMSHUDIN ABDULLAH | HIDDIG TRANSPORT | +255764853374 | DSM |
| 945 | EASE LIMITED | ERIC GENDARME | +255736618074 | DSM |
| 946 | SAMEER RIDHWAN AHMED | SAMEER R. AHMED | +255754566507 | DSM |
| 947 | RAMADHAN BARUANI | RAMADHAN M. BARUANI | +255787408427 | DSM |

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|---|---|---|---|---|
| 948 | BROADGAS PETROLEUM LTD | SAID M MSWAKI | +255685404002 | DSM |
| 949 | JUSTIN SPARES INVESTMENT | JUSTIN | +255784467299 | DSM |
| 950 | ABDI JAMAL ISMAIL | ABDI JAMAL ISMAIL | +255756548814 | DSM |
| 951 | RAINER TRADERS & FOODS | RAINER | +255756900200 | DSM |
| 952 | MOHAMED S. GURNAH | MOHAMED S. GURNAH | +255688877077 | DSM |
| 953 | KAHAMA OIL MILLS LTD | MHOJA NKWABI | +255754780777 | KAHAMA |
| 954 | DENDAR INVESTMENT LTD | ISLAM AGIL ISLAM | +255766120324 | DSM |
| 955 | DAR ES SAALAM ICD LTD | PATRIZIA PONTI | +255756272386 | DSM |
| 956 | LULUTONG TRANSPORT LTD | CHEN WUPING | +255767686162 | DSM |
| 957 | ELATH TRANSPORT CO.LTD | JUMA KAMBI | +255717466457 | DSM |
| 958 | WIBONELA COMPANY LTD | NASSIBU H. WIBONELA | +255756782265 | DSM |
| 959 | SHIRE PETROLEUM(T) LIMITED | ALWI SHARIF | +255687636878 | DSM |
| 960 | AQUARIUS ROADWAYS (T) LTD | RAHIM S. JETHA | +255754455225 | DSM |
| 961 | RAINER TRADERS & FOODS | RAINER LUKARAH | +255756900200 | SUMBAWANGA |
| 962 | ABDI JAMAL ISMAIL | ABDI JAMAL ISMAIL | +255756548814 | MANYONI |
| 963 | JUSTINSPAREPARTS INV | EMMANUEL A. SIRIKWA | +255784467299 | DSM |
| 964 | BROADGAS PETROLEUM LTD | SAID M. MSWAKI | +255685404062 | DSM |
| 965 | RAMADHANI BARUANI | RAMADHANI | +255787408427 | DSM |
| 966 | A.P.O COMPANY LTD | SHEIKH OMAR | +255713206092 | DSM |
| 967 | TANZANIA CHINA INT | HAPPY | +255763330000 | DSM |
| 968 | PROFFESSIONAL FORWARDER | SEIF YUSUF MSHANA | +255713244784 | DSM |
| 969 | SARMA LOGISTICS(T) LTD | AUGUSTINE | +255714661166 | DSM |
| 970 | SALIM MAJID SAID | SALIM MAJID SAID | +255719409677 | MOROGORO |
| 971 | ASSIF.A. HASSAM | ASSIF.A.HASSAM | +255754693291 | SUMBAWANGA |
| 972 | KHALIFA ABDULAZIZ | KHALIFA A. KHALIFA | +255687191999 | SONGEA |
| 973 | VOYAGE ONE LIMITED | RAJU POOSPATI | +255688938963 | DSM |
| 974 | DAR ES SAALAM CORRIDOR | SAADA SHAABAN | +255658539890 | DSM |
| 975 | ELIZABETH STEVEN | MARY LUCAS PETER | +255754823677 | DSM |
| 976 | DSM CORRIDOR SHIPS | SAADA SHAABAN | +255754318798 | DSM |
| 977 | HENRY WILLIAM MGALAMA | MC& MH ENTERPRISES | +255754566507 | DSM |
| 978 | INTERLINK LOGISTICS LTD | MAGRETH .F. TESHA | +255763890020 | DSM |
| 979 | MALHAM LOGISTICS CO. LTD | OBAS MATOLA NDELWA | +255715008923 | DSM |
| 980 | APEX ENGINERING CO.LTD | RICHARD MUSHI | +255753329583 | DSM |
| 981 | MAHUSIANO ENTER PRISES | SALONI MBILINYI | +255762610620 | DSM |
| 982 | KUNG FU (T) LTD | KUNGFU (T) | +255715871657 | DSM |
| 983 | WRIGHT LOGISSTICS LTD | WRIGHT LOGISSTICS | +255652999088 | DSM |
| 984 | OILLINK (T) LTD | AREF A. BAKHAMIS | +255713330011 | DSM |
| 985 | TULO INVESTMENTS | HAMISI MATIKA | +255784283839 | DSM |
| 986 | SAKAHA COMPANY LIMITED | HAMISI MWIZA | +255713993050 | DSM |
| 987 | EFFCO SOLUTION (T) LTD | GEORGE MSENDA | +255684462495 | DSM |
| 988 | RAMIA HUD TAGALILE | RAMIA | +255688644886 | DSM |
| 989 | HOSEA IRUNGU KAKWAYA | HOSEA IRUNGU KAKWAYA | +255784705050 | DSM |
| 991 | LILOLI TRANSPORT SERVICS | ELIKIRA.S. MASSAWE | +255767448894 | DSM |

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|---|---|---|---|---|
| 992 | NAFANA TRANSPORT | MOHAMED IQBAL SINGH | +255713490573 | DSM |
| 994 | BACKTOWN TRANSPORT LTD | RIADHA HUSSEIN | +255784271341 | DSM |
| 995 | GOLDEN LOGISTICS LTD | MAGDALENA MLENGEYA | +255767422359 | DSM |
| 996 | MOUNT MERU MILLERS | ARVIND MITTAL | +255715400440 | DSM |
| 998 | SUNAFAZU TRANSPORT LTD | ABDILLAH H. ALLY | +255754605959 | DSM |
| 1000 | PRIME CARGO CONNECTION | LAXFORD M. KAJENA | +255755807077 | DSM |
| 1002 | MOHAMED MOHAMED | MOHAMED S. MOHAMED | +255754563798 | DSM |
| 1004 | LIBERTY EXPRESS (T) LTD | SUHAN PRADHAN | +255754307489 | DSM |
| 1005 | IBRAHIM MOHAMED | IBRAHIM | +255784524107 | DSM |
| 1007 | FLORAH SALUM | FRORAH T | +255715857401 | DSM |
| 1009 | AHMED | AHMED FREIGHT LTD | +255756235925 | DSM |
| 1011 | DELUXE LOGISTICS (T) LTD | MOHINDERJIT S. OBHAN | +255777100025 | DSM |
| 1014 | ABDALLAH | ABDALLAH ISLAM ELFAN | +255712110533 | DSM |
| 1016 | CHOLO IRISH CO LTD | ATHANAS RANGE | +255712042520 | DSM |
| 1018 | OCEAN CLEARING | SAAD ABDALAH | +255787819081 | DSM |
| 1020 | HILDA TRANSPORTATION | HILDA ISACK MAKUNDI | +255652291180 | DSM |
| 1022 | KUGIS | SURINDER SINGH MAIR | +255754545555 | DSM |
| 1024 | TRANSHIGHWAY TRUCKING | ALNOOR BHANJI | +255754230568 | DSM |
| 1025 | MAKUMIRA FILLING STATION | CHARLES MAKOI | +255754278206 | DSM |
| 1026 | SAM CARGO INVI LTD | SAM CARGO | +255713244946 | DSM |
| 1027 | ISUMBA TRANS LIMITED | ISUMBAD | | DSM |
| 1029 | ODILON BUBERWA | ODILON O. BUBERWA | +255713465836 | DSM |
| 1031 | NEW SEVERIN STORES CO LTD | SEVERIN | +255784339829 | DSM |
| 1032 | MUSTAQEEM A DOSSA | MUSTAQEEM A DOSSA | +255787892994 | DSM |
| 1033 | PAGU LOGISTICS CO LTD | PAGU LOGISTICS CO LTD | +255787399480 | DSM |
| 1034 | SAID HAIDAR SHAABAN | SAID HAIDAR SHAABAN | +255713673624 | DSM |
| 1035 | FELISTA GENGELE SHILA | FELISTA GENGELE SHILA | +255754363031 | MOROGORO |
| 1038 | TKT COMPANY LIMITED | TWALIB KHALID | +255754783444 | MOROGORO |
| 1040 | VRAJLAS(AGENCIES) LIMITED | DIVYESK V. KARIA | +255784274777 | MWANZA |
| 1041 | OMAR ABDALLAH IDHA | OMAR ABDALLAH IDHA | +255713333666 | MOROGORO |
| 1042 | ALNOOR LOGISTICS (T) LTD | ALNOOR | +255755312265 | DSM |
| 1045 | MOHAMED JUMBE MOHAMED | MBEGU J. MOHAMED | +255715711188 | DSM |
| 1047 | YEMBELA GROUP CO.LTD | MIRIAM M YEMBELA | +255767920766 | DSM |
| 1048 | PRINCE AMMI ARRA | PRISCUS JOHN | +255786022008 | DSM |
| 1050 | SINGASIPA TRANSPORT LTD | KENNEDY ADOLE | +255754203490 | DSM |
| 1051 | KAPRICON LINE & CO | KAPESA B. MBERESERO | +255754565467 | MOSHI |
| 1053 | BURETA ENTERPRISES LTD | LUCAS BURETA | +255754323000 | ARUSHA |
| 1055 | RAHIM HUSSEIN ANAND | RAHIM H. ANAND | +255718786124 | DSM |
| 1057 | JAWADU ATHUMANI ATABU | JAWADU A.I ATABU | +255713223244 | DSM |
| 1058 | ADINA TRADING COMPANY | ADINA | +255754363232 | DSM |

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|---|---|---|---|---|
| 1059 | AGH TRANSPORTATION LTD | AGH TRANSPORTATION | +255717678257 | DSM |
| 1060 | AMANI SAFARI ADVENTURES | CHARLES MROSSO | +255789650524 | ARUSHA |
| 1061 | SOLTANT(TZ)GROUP LIMITED | MEHDI SOLTAN | +255788488270 | DSM |
| 1062 | MSELEI TRANS AND TOURS | SAID S ,MFINANGA | +255767982955 | MOSHI |
| 1063 | ISMAIL ADEN RAGE | RAGE | +255784261761 | TABORA |
| 1064 | GG& CC TRANSPORTATION | DORA MWENDA | +255713505404 | DSM |
| 1065 | COLJATI INVESTMENT | COLJATI INVESTMENT | +255655375955 | DSM |
| 1066 | MATHAYO &SON TRANSPORT | JASPER M. KIWELU | +255754293055 | ARUSHA |
| 1067 | DANVIC PETROLEUM (T) LTD | VICTOR NDONDE | +255786191434 | DSM |
| 1068 | STANLEY NYAKUNGA | STANLEY A. NYAKUNGA | +255715583999 | DSM |
| 1069 | ABSON COMPANY LTD | ABASI ISSA IDDI | +255715308782 | DSM |
| 1070 | ASB TRANSPORT LIMITED | FAHAD FAWAZ | +255784388288 | DSM |
| 1071 | FLEET EXPRESS LTD | YUSUF ESSAJI | +255786608746 | DSM |
| 1072 | KUYELLA ENTERPRISES LTD | FELICIAN E. KUYELLA | +255754099279 | DSM |
| 1073 | ANJELA ZAKAYO NNKO | ANJELA ZAKAYO NNKO | +255754814989 | DSM |
| 1074 | VIRGIN MARY LOGISTICS | FRANCIS MSANGU | +255767330399 | DSM |
| 1075 | ET & TS INVESTMENT LTD | PRAY GOD TOWO | +255754299108 | DSM |
| 1076 | FESTUS K. MUTHIANI | FESTUS K. MUTHIANI | +255718914790 | DSM |
| 1077 | NURHASSAN TRANSPORT LTD | ABDIRASHID YUSUF NUR | +255714785789 | DSM |
| 1078 | MILLAMA ORGANIC TRADING | BUBERWA ODILION JOHN | +255713465836 | DSM |
| 1079 | ZABRON ANANIDZE SIKILO | HENRY W. MGALAMA | +255754566507 | NJOMBE |
| 1080 | VGM INVESTMENT CO. LTD | MR. MECKY | +255755094233 | DSM |
| 1081 | BANSAL TRANSPORT LTD | BALVINDER BANSAL | +255784511302 | ARUSHA |
| 1082 | KWANZA HOLDINGS LIMITED | JULIUS JOSEPH MOSI | +255754570526 | DSM |
| 1083 | NAN AFRICA(2001)TANZANIA | ZOO NASSOR BONZOO | +255714515555 | DSM |
| 1084 | HUMPHUREY JOHN MROSSO | HUMPHUREY J. MROSSO | +255657998396 | DSM |
| 1085 | EVARISTE HOGA | EVARISTE HOGA | +255755276460 | DSM |
| 1086 | ASHIF FATEHALI LADHANI | SHANIF F LADHNI | +255784781508 | DSM |
| 1087 | MARC NIBASUMBA | MARC NIBASUMBA | +255758423900 | DSM |
| 1088 | KASSIM NASSOR KHAMIS | KASSIM NASSOR KHAMIS | +255713470803 | UNGUJA |
| 1089 | ABUBAKARY ISMAIL CHUWA | ABUBAKARY I. CHUWA | +255767942422 | DSM |
| 1090 | ACER PETROLEUM(T)LTD | ACER PETROLEUM | +255715505094 | DSM |

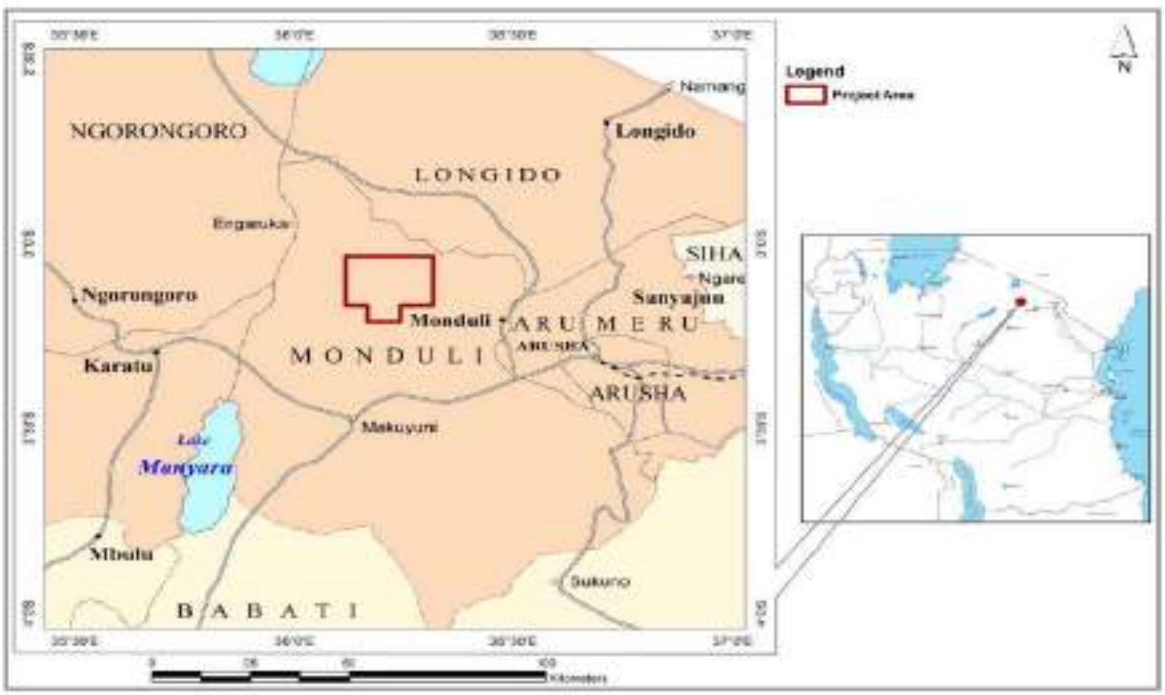
Source: *TATOA, 2020*

NATIONAL DEVELOPMENT CORPORATION

# TECHNO-ECONOMIC STUDY FOR SODA ASH PROJECT AT ENGARUKA IN MONDULI DISTRICT, ARUSHA REGION, TANZANIA

## VOLUME IX

## PROJECT APPRAISAL




**Prepared By**
**Tanzania Industrial Research and Development Organization**

**May 2021**

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| BCR | Benefits/Cost ratio |
| BE | Break Even analysis |
| CB | Cost Benefit |
| CEO | Chief Executive Officer |
| CSR | Corporate Social Responsibility |
| DFIs | Development Finance Institutions |
| EIRR | Economic Internal Rate of Return |
| ENPV | Economic Net Present Values |
| EPV | Economic Present Value |
| EPZA | Export Processing Zones Authority |
| ESAP | Engaruka Soda Ash Project |
| ESIA | Environment and Social Impact Assessment |
| GDP | Gross Domestic Product |
| GOT | Government of Tanzania |
| HH | Household |
| HR | Human Resource |
| ICT | Information and Communications Technology |
| IFC | International Finance Corporation |
| IRR | Internal Rate of Return |
| JVA | Joint-Venture Agreement |
| MD | Managing Director |
| NDC | The National Development Corporation |
| NHIF | National Health Insurance |
| NPV | Net Present Value |
| NSSF | National Social Security Fund |
| NTA | National Technical Awards |
| OHS | Occupational health and safety |
| PB | Payback Period |
| PR | Public Relations |
| ROE | Return on Equity |
| SAP | Soda Ash Plant |
| SDL | Service Delivery Levy |
| SI | Strategic Investor |
| SLAs | service level agreements |
| SPV | Special Purpose Vehicle |
| SSA | subscription and shareholders agreement |
| TANESCO | Tanzania Electric Supply Company Limited |
| TIB | Tanzania Investment Bank |
| TIC | Tanzania Investment Centre |
| TIRDO | Tanzania Industrial Research and Development Organization |
| TOR | Terms of Reference |
| TZS | Tanzanian Shilling |
| URT | United Republic of Tanzania |
| USD | United States Dollars |
| VET | Vocation Education Training |
| WAY | Weighted Average Yield |
| WCF | Workers Compensation Fund |

# EXECUTIVE SUMMARY

The main objective of the appraisal component of the study is to assess the overall financial and economic viability of the Engaruka Soda Ash Project (ESAP). The component has therefore addressed the aspects of human resources requirements and costs; projected project revenues and costs; financial appraisal in terms of profitability, internal rate of return (IRR), net present value (NPV) and payback; project financing; economic analysis; and risks & mitigation measures.

## Human Resources Requirements and Costs

This section of the report has analysed and proposed the relevant business functions and organisational structure, manning levels, skills requirements, and HR cost estimates. Best practices require three different levels of functions for delivering business results - high-level demarcation of functional roles in the business. These are the Plan and Govern Level; Produce and Deliver Level and Service and Support Level. Proposed organization structure consists of 5 departments: Production and Technical Services; Sales, Marketing and Logistics; Resource Supply, Monitoring & Evaluation; Health, Safety and Environment; and, Corporate Services. It is therefore a lean and efficient structure. A total of 223 staff will gradually be employed by ESAP.

## Ownership, Financing and Financial Viability

ESAP is a mega project that will require a total US$ 367.1 million to operationalize, *over and above the strategic value of the brine resources*. It is proposed to be a joint venture involving the Government of Tanzania (GoT) and a Strategic Investor (SI) owning the project in a **49:51** ratio. The two should jointly set up a **Special Purpose Vehicle (SPV),** a company that will run the business operations and as such it will be easier to attract project financing. The GoT contribution to the project will be in the form of the huge and strategic soda ash deposits, land and other natural resources surrounding the project area. It is also in terms of the various preparations to get the project reads for swift implementation. The SI investment will be in the form of equity investment to facilitate the acquisition of relevant project equipment and infrastructures as well as arrangement of debt financing to ensure that ESAP takes off in 2025. A debt to equity ratio of **67:33** to fund the project is recommended.

The project will be financially viable and bankable**.** Its financial viability metrics for duration of about 25 years are as follows:

a. ESAP Net Present Value (NPV) will be **US$ 335.1 million**.
b. ESAP Internal Rate of Return (IRR) is **19.7%.**
c. ESAP Payback Period is **5** years.

**Economic analysis**

The economic analysis has dwelt on Value added generated; Foreign exchange effect; Employment creation; Balance of payment; Social opportunity costs; Externalities; Cost Benefit analysis and Ratios. The findings have established that the project has substantial socio-economic benefits including employment generation, contribution to value added, generation of foreign exchange and other community level impacts including improvement in social services. Though there are as well, social opportunity costs and externalities associated with the project, but the benefits outweigh costs.

The cost-Benefit analysis has revealed that this project is economically viable. At a discounting rate of 10%, the project generates the ENPV of US$ 1,763 million. At a *social-discounting* rate of 5%, the ENPV is even higher at US$ 3,226 million. In addition, the Benefit-Cost Ratios are high (greater than 1), ranging from 3.8 to 4.9 when the discounting rate is varied from 10% to 5%. This is a clear indication that the project benefits outweigh costs. On the other hand, the Economic Rate of Return (ERR) is 0.6%, which is lower than the discount rate, but this was expected since this analysis involves social aspects with limited returns as compared with commercial ones.

Without the Project scenario attempts to analyse the situation when the project is not implemented. Based on a set of assumptions, ENPV generated range from US$ 48.0 million to US$ 91.8 million when the discounting rate is varied from 10% to 5%. This is substantially low return when compared with the '*with the project"* scenario with an ENPV ranging between US$ 1,763 million and US$ 3,226 million with the same discounting rates. The Benefit-Cost Ratios are however positive, ranging from 4.2% to 6.8%. The ERR is smaller than 1 (0.4%) which indicates very limited growth in economic benefits in the absence of ESAP. The Comparison of two cases (*With the Project* and *Without the Project*) tells that by having the project, the community and country as a whole will benefit more than if the project is not implemented.

**Risk analysis**

On the average, ESAP is assessed as a moderately risky intervention and the risks that are envisaged can be readily managed. A list of the major, most critical risks is detailed in the report along with appropriate mitigation measures.

**Conclusion and Recommendation**

The project is both financial and economically viable and is recommended for implementation.

# CHAPTER ONE

# 1 INTRODUCTION

## 1.1 Background

The National Development Corporation (NDC) was established as a statutory body by an Act of Parliament in 1962 and it is wholly owned by the Government of the United Republic of Tanzania. NDC has responsibility for promoting economic development in Tanzania in partnership with the private sector. Currently, NDC is in the process of establishing a soda ash plant at Engaruka in Monduli District, Arusha Region. It thus commissioned the Tanzania Industrial Research and Development Organisation (TIRDO) to undertake the techno-economic study of the project.

Tanzania is endowed with huge deposits of soda ash at Engaruka Basin in the northern part of Tanzania about 190 km North-West of Arusha town. The basin is located about 58 km Southeast of Lake Natron in the East Africa Rift Valley System. It is a very flat area extending for about 18 km in a North-South and 13 km in an East-West direction. It is an internally drained basin, which is fed by water from streams, rivers and ion-rich underground springs flowing from the surrounding volcanic cones and up thrown blocks.

NDC has conducted a drilling exploration and preliminary brine simulation at the Engaruka Basin. Based on the size of the basin and the thickness of the aquifer, it is estimated that there is a total of 3,813,320,000 $m^3$ of brine in the basin. This brine is being replenished at a rate of 513,334,000 $m^3$ /year. Pursuant to the outcome of the above studies, the Government of United Republic of Tanzania (URT) has entrusted NDC to fast track utilization of this resource for creation of formidable base for the development of chemical industry in the country. In the light of the foregoing, NDC has conceived a grand project, which will involve setting up of extraction of soda ash plant at Engaruka and construction of associated infrastructure for the project.

## 1.2 The Objective and Scope of the Appraisal Component

The objective of the appraisal component of the techno-economic study of the project was to assess its financial and economic viability. The component has addressed the following aspects:

a. Human resources requirements and costs.
b. Projected project revenues and costs
c. Financial appraisal in terms of profitability, internal rate of return (IRR), net present value (NPV) and payback.
d. Project financing.
e. Economic analysis.
f. Major risks & mitigation measures.

## 1.3 Study Methodology

The approach to this study component was highly participatory and consultative where the client and other key stakeholders were involved in all the steps. Mixed methods - involving both qualitative and quantitative data were employed to inform the findings. The following specific methodological steps were followed in the course of implementing the study:

**Step1*: Kick-off meeting with the Client and preparation of the inception report***

The assignment started with a meeting with the client to deliberate further on the technical aspects of the study with a view of underpinning the objectives of the study, the proposed methodology and the expected outputs.

Specifically, the initial kick-off meeting sought to make the consultants familiar with the assignment and levelling the expectations between the two parties. Initial consultation enabled the consultants and the client to create a shared understanding on how the assignment would best be conducted, how the clients and other implementing partners would be involved and agreed on the assignment timeline and methodology.

**Step *2: Preparation of detailed inception report***

After agreement was reached on common issues, a detailed inception report was prepared in which the roadmap of the study was clearly defined. The inception report was shared with the client for comments before the assignment started.

**Step *3: Fieldwork and consultative process***

The fieldwork and consultations involved the following:

a) **Fieldwork in Engaruka**, which included physical familiarization with the project site and its surrounding communities. It also included interviews with the leadership and people of the villages and ward in which the project is located. Furthermore, interviews/consultations were held with the Arusha Regional Secretariat, Arusha Municipality and Monduli District Council officials.

b) **Interviews in Dar es Salaam were conducted with key informants.** The consulted Institutions included TIC, NDC and TIB on the best way the project could be financed.

**Step *4: Mobilizing and review of inputs from other teams***

Thereafter, the team embarked on intensive review of inputs from the other teams. The aim of the review was to get in-depth understanding of the project and provide input data for appraising the component.

**Step 5:** ***Preparation of an Interim Report***

Based on the information collected, the interim report was prepared and shared with the client. Among other things, the interim report presented initial findings, progress made, challenges observed during the first phase of project implementation and the way forward towards the finalisation of the report. The report was presented to a joint session of NDC and TIRDO held at Morogoro. Pertinent comments were addressed as necessary.

***Step 6: Preparation of the Draft Report***

The draft report was prepared following receipt of pertinent inputs from the other teams. The report was presented to another joint session of NDC and TIRDO held at Morogoro. The report was also presented to a joint NDC, MoF and TIRDO meeting held in Dar es Salaam.

***Step 7: Preparation and Submission of the Final Report***

This Final Report has addressed all the pertinent comments received from the various forums and stakeholders.

## CHAPTER TWO

## 2 HUMAN RESOURCES REQUREMENTS AND COSTS

The overriding vision is to have the envisaged the Engaruka Soda Ash Project (ESAP) well-structured and competently managed and run for the benefit of the country. This, among other things, needs an efficient organisational structure and essential human resources. Informed by the other components of this ESAP techno-economic study, stakeholder consultations, best practice and logical analysis, this section of the report has analysed and proposed the relevant business functions, organisational structure, manning levels, skills requirements, and HR cost estimates.

### 2.1 Business Functions and Organisational Structure

The main core and support functions (organisational structure) that will effectively ensure ESAP's delivery and performance to the satisfaction of shareholders are detailed hereinafter. These are expected to facilitate the putting of the right person, in the right job, at the right place and right time. For it is said: *"PEOPLE, not cash, buildings, or equipment, have become the critical differentiators of a business enterprise. PEOPLE are the profit lever, the source of sustainable competitive advantage…"*

#### 2.1.1 Key Levels of Business Functions

Best practices require three different levels of functions for delivering business results.

**(A): The Plan and Govern Level**

This level entails the Board and Senior Management members with the role to assess and interpret needs and opportunities outside the organization, to establish direction, to influence and align others towards a common aim. They formulate and communicate visions and strategies to deliver desired business results. They also focus on managing improvement (innovation and adapting to changes) and oversee enterprise wide performance. They energize the organization by providing leadership through communicating plans and results.

**(B): The Produce and Deliver Level**

The core business of ESAP lies here. This level executes strategy by implementing all set strategies to deliver business results. It is the level that produces the core products and services, manages the delivery of such products and services to customers, monitors and evaluates performance in the market place, audits all business areas and mitigate risks, carries out research, develops new products and services as the market may demand subject to alignment to business strategy.

**(C): The Service and Support Level**

This is where broad business support activities sit. It includes all activities that support the core business to deliver its targets such as managing human resources to ensure high level of productivity, managing all operational and administrative activities including legal and ICT to ensure the business is run at optimal operational cost, managing the procurement function to ensure the required supplies/services are made available on time and at cost-effective, managing financial and physical resources of the business by enforcing cost control policies and reporting on financial performance, management of treasury and liquidity of the company, and managing internal and external communication as well as stakeholders' engagement.

### 2.1.2 Strategic Outsourcing

ESAP will and should leverage strategic outsourcing where it makes sound business sense. It is always not possible for an organization to hire all the requisite skills. Most progressive organizations outsource services after undertaking "*make or buy*" analysis of each service that needs to be provided. Outsourcing of non-core services will provide management with more time to focus on core business activities. This will also reduce the overall headcount and create a lean and professional-oriented organization.

Thus, subject to further review by ESAP management, the following services are proposed to be outsourced or contracted out:

- (i) Catering services
- (ii) Housing services
- (iii) Health care services
- (iv) Security services
- (v) General cleaning services and gardening
- (vi) Debt collection
- (vii) Garbage collection and disposal services
- (viii) Some specialized maintenance and services (e.g. ICT and electronic maintenance services)

Furthermore, it is proposed that ESAP develops clear outsourcing policy, procedures and tools including service level agreements (SLAs) in order to ensure that outsourcing does not lead to undue costs and poor performance.

### 2.1.3 Proposed Organisation Structure of ESAP

As discussed later in the report, NDC will seek a competent private investor to run ESAP as a joint venture. Both will establish and own ESAP as Special Purpose Vehicle (SPV) with its own legal face. The board of the SPV will include members from the Government and the private investors. It is recommended that the Government appoint the chairperson of the board.

Further, the SPV will have to have a befitting organisational structure based on the conceptualisation and recommendations given in this subsection.

An *organizational structure* is a diagrammatic presentation of how the organization has been designed to function. It is a crucial management device that facilitates the specification and grouping of functions and activities as well as definition of key mechanisms for activity supervision and coordination in order to attain the objectives and vision of the organisation.

An organisational structure indicates how individuals and groups in an organization are arranged with respect to the positions they hold; relative authority they possess, and functions they perform in the organization; what each organizational unit performs and the main jobs within it; and, how the different units relate to each other in performing their functions. It also contains a structure of the key policy making organs – the Board.

An effective structure is that which is aligned to the vision and strategies of the organization. It is also that which promotes institutional sustainability by promoting a lean structure that delivers the core mandates of the institution.

The following ***guiding principles*** were used to guide the development of the proposed organisational structure, i.e., the structure has to:

a. Support implementation of the Government's industrialization drive in the mining sector.
b. Facilitate efficient and effective running of ESAP's operations.
c. Consider and accommodate other aspects internal or external that might have a considerable influence on the organizational goals and objectives.
d. Ensure a decentralized institution with fewer managers.
e. Ensure lean staffing of corporate support functions.
f. Promote responsiveness and accountability for results.
g. Ensure fewer boundaries between different vertical ranks.

The proposed organizational structure of the SPV (ESAP) is shown in **Figure 2.1**. It should be noted that the Internal Audit office will be answerable to the Board of Directors but will be report to the CEO for administrative issues. It is also strongly recommended that the Deputy General Manager be appointed by the Government.

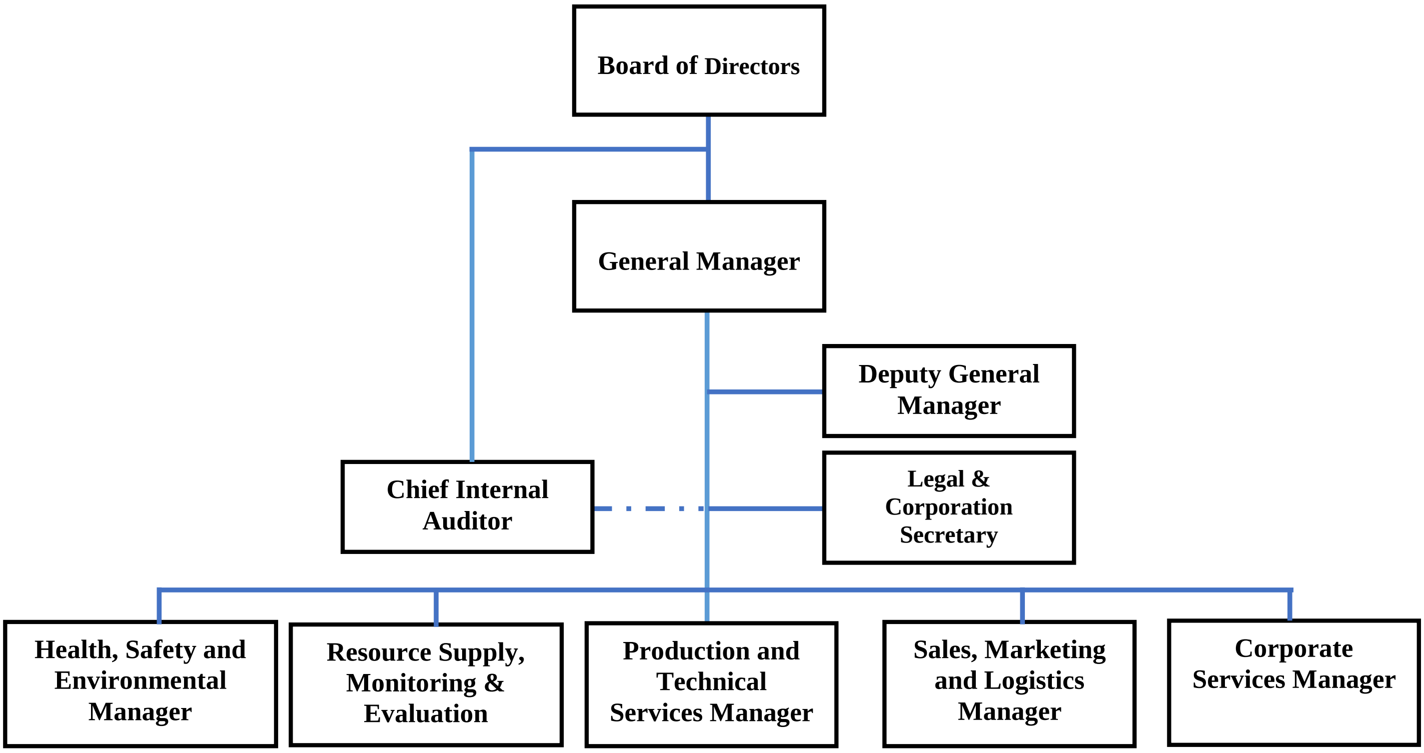

Figure 2-1: Organization structure of the SPV (ESAP)

It also proposed that the Board of Directors will have two Sub-Committees as shown in **Table 2.1**. The composition and mandates of the Board and Sub-Committees as likewise shown in the table.

**Table 2-1: Proposed Board and Committee Compositions and Mandates**

| Board/Committee | Composition | Mandates |
|---|---|---|
| Board | • Chairperson – appointed by the Government. Must have expertise and experience in large commercial production and marketing roles in the minerals sector<br>• Four other members – two appointed by the Government and two by the private sector partners:<br>o 1 expert in marketing especially international marketing<br>o 1 expert in finance and administration<br>o 1 expert in geology | • Overall management of ESAP<br>• Ensuring shareholders' and national interests are maximised<br>• Management of ESAP in line with best global management practices.<br>• Ensuring of compliance to all regulatory practices<br>• Promote sound environment management in ESAP's operations |

| Board/Committee | Composition | Mandates |
|---|---|---|
| | o 1 expert in chemical processing engineering | |
| Board Technical Committee | • Chairperson – Board member with expertise in chemical processing engineering<br>• Board member with expertise in geology<br>• Director of Production and Technical Services<br>• Director of Sales, Marketing and Logistics<br>• Legal and Corporations Secretary | • This committee shall be responsible for all technical issues covering the core business of ESAP. These include:<br>o Exploration<br>o Pumping the resource<br>o Production<br>o Quality assurance<br>o Technical services<br>o Research and development<br>o Marketing and logistics |
| Audit, Finance and Administration Committee | • Chairperson – Board member with expertise in finance and administration<br>• Board member with expertise in marketing and international marketing<br>• Director of Sales, Marketing and Logistics<br>• Director of Corporate Services<br>• Director of Production and Technical Services<br>• Chief Internal Auditor<br>• Legal and Corporations Secretary | • Review and provide guidance to the full Board about:<br>o ESAP's Budgets and its implementation<br>o Policies or recommendations having potential financial implications<br>o Financial strategies for major projects<br>o Working capital and cash flow management<br>o Other transactions or financial issues that management desires to have reviewed by the Finance Committee<br>• Develops and reviews and advises the Board on the ESAP's assets-liabilities and risk management issues<br>• Evaluate internal controls to ensure that accounting systems provide adequate, timely, and accurate information, protection against loss through negligence, dishonesty or otherwise.<br>• Develops efficient and effective internal auditing systems.<br>• Studies, reports on cases of loss or attempt to occasion loss due to misuse of resources, misappropriations or fraud and advises the Board accordingly<br>• Ascertains compliance to applicable laws and regulations; internal policies and procedures; plans, budgets and financial regulations.<br>• Ensures compliance to Accounting, Auditing and other applicable standards and guidelines set by professional bodies.<br>• Review and advises the Board on all human resource management and administration matters.<br>• Reviews annual financial statements before their submission to external auditors and advises the Board accordingly |

## 2.2 Units and Positions

The various units/sections, positions and manning levels required of the proposed organisational structure in Figure 2.1 are analysed in this Section.

***It should be noted that for the junior professional, technical and administrative positions, the indicated years of experience are the recommended ones for effective performance. However, it is proposed that at the stage of recruitment, ESAP should consider inexperienced staff (e.g., fresh from universities) to be trained by the company itself. This will widen the options for getting good people and contribute the capacity development needs of the country.***

### 2.2.1 Units and Positions at the Plan and Govern Level

#### *2.2.1.1 Managing Director's Office*

The Managing Director (MD) is the CEO. He/she has overall responsibility for managing ESAP successfully according to the expectations of shareholders. **Table 2.2** shows the proposed staffing of the MD's office. An Office Management Assistant is proposed and will be responsible for coordinating the activities of the MD's office by providing administrative support to the MD and members of the Senior Management Team.

**Table 2-2: Proposed Manning Level of the MD's Office**

| Position | Head Count | Qualifications | Experience Years |
|---|---|---|---|
| General Manager | 1 | Master's degree in Business Administration & Bachelors in Chemical/Processing Engineering | 10 |
| Office Management Assistant | 1 | Bachelor's degree in secretarial services | 5 |
| MD's Driver | 1 | | |
| **Total Head Count** | **3** | | |

#### *2.2.1.2 Internal Audit Unit*

The Unit is responsible for all internal audit functions. It will have a dotted reporting line to the MD and solid reporting line to the Board's committee responsible for finance and audit. The recommended manning level is given in **Table 2.3**.

**Table 2-3: Proposed Manning Level of the Internal Audit Unit**

| Position | Head Count | Qualifications | Experience Years |
|---|---|---|---|
| Chief Internal Auditor | 1 | Master degree in Accounting. CPA, Registered Auditor | 5 |
| Internal Auditor | 1 | Bachelor degree in Accounting | 3 |
| **Total Head Count** | **2** | | |

#### 2.2.1.3 Legal Services Unit

The Legal & Corporation Services Unit will have the principal role of providing legal and corporate services. It will also support the Board with secretarial services. The functions of the Unit will include Litigation Management, Contract Management, Board of Directors Coordination and Support, Provision of General Legal Support, Risk Management & Compliance. The recommended manning level is given in **Table 2.4**.

**Table 2-4: Proposed Manning Level of the Legal Services Unit**

| Position | Head Count | Qualifications | Experience Years |
|---|---|---|---|
| Legal & Corporation Secretary | 1 | Masters in Law | 5 |
| **Total Head Count** | **1** | | |

### 2.2.2 Units and Positions at the Produce and Deliver Level

#### 2.2.2.1 Production and Technical Services

The Production and Technical Services area will consist of 3 major departments: (1) Resources Supply, Monitoring and Evaluation; (2) Production, (3) Health, Safety and Environment. The recommended manning level is given in **Table 2.5** & **Table 2.6.**

**Table 2-5: Proposed Managerial and Administrative Staff of the Production and Technical Services Area**

| Position | Head Count | Qualifications | Experience Years |
|---|---|---|---|
| Production Manager | 1 | Bachelor degree in Process/Chemical Engineering | 5 |
| | | | |
| Resource Supply, Monitoring and Evaluation Manager | 1 | Bachelor degree in Mining Engineering | 5 |
| | | | |
| Health, Safety and Environment Manager | 1 | Bachelor Degree in Environment Engineering | 5 |
| | | | |
| **Total Head Count** | **3** | | |

**Table 2-6: Proposed Technical Staff of the Production and Technical Services Area**

| **S/N** | **Type** | **Engineers** | **Technicians** | **Artisans** | **Total** | **Qualification*** |
|---|---|---|---|---|---|---|
| | Operation | | | | | Chemical and Process Engineering professionals, except where stated. Engineers with Bachelor degree; Technicians with NTA level 6; Artisans with VET Certificate II or III |
| 1 | Brine Water Receiving Tanks | | | 3 | 3 | |

| S/N | Type | Engineers | Technicians | Artisans | Total | Qualification* |
|---|---|---|---|---|---|---|
| 2 | Filtration Unit | | 3 | | 3 | |
| 3 | Carbonation Unit | 3 | 3 | 6 | 12 | |
| 4 | Crystal Washing Unit | | 3 | 6 | 9 | |
| 5 | Drying Unit | | 3 | 6 | 9 | |
| 6 | Calcination Unit | 2 | 3 | 6 | 11 | |
| 7 | Packaging Unit | | 3 | 12 | 15 | |
| 8 | Boiler House | | 3 | 6 | 9 | Including Mechanical & Electrical Engineering professionals |
| 9 | Power Plant | 2 | 6 | 9 | 17 | |
| 10 | Desulphurization Unit | 1 | 2 | 3 | 6 | |
| 11 | Standby Generator | | | 3 | 3 | |
| 12 | Ponds & Pumping | 2 | 3 | 6 | 11 | Mining Engineering professionals |
| 13 | CO2 Storage & Supply Unit | 1 | 3 | 6 | 10 | |
| 14 | Coal Storage & Preparation Unit | | 3 | 6 | 9 | |
| 15 | Diesel Storage Unit | | | 3 | 3 | |
| 16 | Fresh Water Treatment Unit | | 3 | 6 | 9 | |
| 17 | General Maintenance | 1 | 3 | 9 | 13 | Mechanical & Electrical Engineering professionals |
| 18 | Infrastructure Maintenance | 1 | 2 | 8 | 11 | Infrastructure Engineering professional |
| 19 | Quality Control | 1 | 6 | | 7 | Including Chemistry professionals. |
| 20 | Control Room | 2 | 6 | | 8 | IT professionals |
| 21 | Hydrogeology | 1 | 2 | | 3 | |
| 22 | Geology | 2 | | | | |
| 23 | Health, Safety and Environmental Management | 2 | 1 | | | |
| | Total | 21 | 61 | 104 | 183 | |

*NB: Chemical and Process Engineering professionals, except where stated. Engineers with Bachelor degree; Technicians with NTA level 6; Artisans with VET Certificate II or III. Experience requirements: engineers, 4 years; Technicians, 3 years; and Artisans, 3 years.

#### 2.2.2.2 Marketing, Sales and Logistics Area

The Marketing, Sales & Logistics functions will handle marketing, selling, logistics and transport and procurement operations. The recommended manning level is given in **Table 2.7.**

**Table 2-7: Proposed Managerial and Administrative Staff of the Marketing, Sales & Logistics Area**

| Position | Head Count | Qualifications | Experience Years |
|---|---|---|---|
| Sales, Marketing and Logistics Manager | 1 | Bachelor in Commerce/Business Administration (Marketing option) | 5 |

| Position | Head Count | Qualifications | Experience Years |
|---|---|---|---|
| Sales Officers | 4 | Diploma in marketing and sales | 3 |
| Promotion and Advertising Officers | 1 | Diploma in marketing and sales | 3 |
| Logistics Officers | 3 | Bachelor in Procurement and Warehousing | 3 |
| | **8** | | |

### 2.2.3 Units and Positions at The Service and Support Level

#### 2.2.3.1 Corporate Services

The Corporate Services function will handle four major activities (1) Finance and Accounting; (2) Human Resources Management; (3) Procurement and Stores; (4) Administrative Services. The recommended manning levels are given in **Table 2.8.**

**Table 2-8: Proposed Manning Level of the Department of Corporate Services**

| Position | Head Count | Qualifications | Experience Years |
|---|---|---|---|
| Manager, Corporate Services | 1 | Master in Finance/Accounting, CPA, Authorized Accountant | 8 |
| ***Finance Section*** | | | |
| Finance Supervisor | 1 | Bachelor in Accounting | 3 |
| Accountants | 2 | Diploma in Accounting | 3 |
| ***Human Resources Management Section*** | | | |
| HRM supervisor | 1 | Bachelor's Degree in Human Resources or related field | 3 |
| HR officers | 1 | Bachelor's Degree in Human Resources Management | 3 |
| ***Procurement and Stores Section*** | | | |
| Procurement Management Supervisor | 1 | Master and Bachelor Degrees in Procurement and Supplies. Certified Procurement Professionals by Government | 3 |
| Procurement and Supplies Officers | 1 | Bachelor Degrees in Procurement and Supplies Management | 3 |
| ***Administration Services Section*** | | | |
| Administration services supervisor | 1 | Bachelor's Degree in Public Administration or related fields | 3 |
| Estates management supervision | 1 | Bachelor's Degree in Estates Management or related fields | 3 |
| Drivers | 5 | Completion of Elementary school (Standard VII) and Valid driver's license class "B", "C", "D", and "E" | 6 |
| ICT System Administrators | 2 | Bachelor's Degree in Computer Science or related fields | 3 |
| **Total Head Count** | **17** | | |

### 2.3 Skills Training Requirements

Based on the vision and mission of proposed ESAP, the organization will need to work with well-educated, experienced, innovative, dynamic and resourceful people who are prepared to go an extra mile to achieve set targets. Considering the technological and risk level of envisaged production plant, **Table 2.10** presents the main skills training requirements.

**Table 2-9: Skills Development Training Requirements**

| S/N | Type of Training | Target Group |
|---|---|---|
| 1 | Occupational health and safety | All employees |
| 2 | Financial management | Management Team |
| 3 | Maintenance (planning & cost) | Production and technical services staff |
| 4 | Security (plant & individual) | All employees |
| 5 | Compliance policies | Management and all professional staff |
| 6 | Environmental protection and awareness | All employees |
| 7 | Quality management | Management and all professional staff |
| 9 | Leadership development (Qualities, Responsibilities, Team building, Communication, etc. | Management and all professional staff |
| 10 | Code of Business Conduct (ethics and culture) | All employees |
| 11 | Leadership in Plant Operations (lean manufacturing, performance measures, etc.) | Management and all professional staff |
| 12 | Computer literacy | All employees |
| 13 | World class logistics management and marketing | All marketing and logistics staff |
| 14 | Selling and marketing to local, regional and international markets | Marketing staff, Management Team |
| 15 | Effective management of logistics in the context of Tanzania | Logistics staff, Management Team |

## 2.4 HR Requirements and Costs Estimates

Number of directly required staff and the annual remuneration estimates for core ESAP operations is as indicated in **Table 2.11**. These are estimated at the level of full operations. In setting the proposed monthly salaries, several *guiding principles* were considered:

1. The salaries should not be significantly smaller than the average salaries paid by organizations/companies in the same or comparable industries – otherwise it would be quite difficult to attract competent people.

2. Within ESAP, compensation levels should be a fair and equitable- reflecting the relative weights of the various positions.

3. ESAP remuneration should not entirely come from salaries. Other sources of remuneration would be designed and operationalized including performance-based incentives and benefits. Given the location of ESAP – the benefits for employees will include housing, security, health services, access to education and sports facilities, etc.

**Table 2-10: Staffing and Estimated Remuneration Costs (TZS)**

| Cadre | Quantity | Monthly Salary (per head) | Gross Monthly Salary | Annual Salary |
|---|---|---|---|---|
| General Manager | 1 | 6,500,000 | 6,500,000 | 78,000,000 |
| Deputy Manager | 1 | 5,000,000 | 5,000,000 | 60,000,000 |
| Managers | 7 | 3,500,000 | 24,500,000 | 294,000,000 |
| Officers/ Professionals | 39 | 2,000,000 | 78,000,000 | 936,000,000 |
| Technicians/Assistant Officers | 63 | 1,500,000 | 94,500,000 | 1,134,000,000 |
| Artisans | 104 | 800,000 | 83,200,000 | 998,400,000 |
| Secretaries | 1 | 500,000 | 500,000 | 6,000,000 |
| Office Attendants | 1 | 300,000 | 300,000 | 3,600,000 |
| Drivers | 6 | 500,000 | 3,000,000 | 36,000,000 |
| **Total Staffing** | **223** | | | |
| **Total Annual Staffing Costs (Gross)** | | | | 3,546,000,000 |
| | | | | |
| **NSSF-10% of gross** | | | | 354,600,000 |
| **WCF -1% of gross** | | | | 35,460,000 |
| **SDL-4% of gross** | | | | 141,840,000 |
| **NHIF-3% of gross** | | | | 106,380,000 |
| **Grand Total** | | | | **4,184.280,000** |

# CHAPTER THREE

# 3 FINANCIAL ANALYSIS

## 3.1 Financial Analysis

This Chapter presents and analyses the projected performance of the proposed Engaruka Soda Ash Project (ESAP). It has analysed the project's financial viability using several methods, i.e., Net Present Value (NPV); Internal Rate of Return (IRR) and Payback Period (PB).

## 3.2 Discount Rate

ESAP's projected cash flows were discounted by using 10% as an appropriate discount factor, which includes an assumed risk premium of 3%. The project is a new venture, which is being proposed to be established with Government initiatives. Its risk profile is therefore significant given the fact that there is no similar project/business whose expected return could be used in estimating the discount factor for ESAP.

## 3.3 Financial Analysis Assumptions

The following assumptions have been considered in the ESAP financial analysis:

1) The project period is 25 years as per best practices and will be from 2025 to 2049;
2) ESAP production and cash inflows will start in 2025;
3) ESAP financing will be by equity and debt in the 33:67 ratio;
4) The borrowing rate is 4% for international finance;
5) Project financiers will be the Government of Tanzania; strategic investors and International Development Finance Institutions (DFIs) in the ratio as defined above;
6) Fully capacity utilisation of the plant will be reached I 2028;
7) ESAP total Capital Expenditure (CAPEX) will amount to US$ 366.1 million which will be capitalised and amortised for the period of 25 years;
8) Sales are projected to grow by 1% year to year, in general;
9) Sales for 2025 (year 1) based on 70% of the full capacity rising to 85% in 2027 and then remaining relatively stable thereafter.
10) Water costs to increase by 1% per year.
11) The value of consumables for motor vehicles estimated at 0.5% of revenue;
12) Stationery costs is estimated at TZS 20,000,000/= per year and will grow by 4% annually;
13) Professional services is estimated at TZS 500,000,000/= per year and will grow by 4% annually;
14) Training budget is estimated at 1% of staff costs per year;
15) Marketing costs is estimated at 0.05% of sales per year;
16) Insurance costs estimated at 0.5% of the first investment cost (excluding pre-operating investments);

17) Motor vehicles amortised for 10 years;
18) Office equipment amortised for 5 years;
19) Management fee is estimated at 0.2% of sales
20) Royalty of 4% of total sales values will be paid annually during the projection period;
21) ESAP will have 182 employees from operationalisation in 2025, raising to 223 in 2027.

### 3.4 Project Investment Plan

ESAP is a mega project that will require a total US$ **367.1 million** to operationalize, *over and above the strategic value of the brine resources.* The operationalization investment entails the pre-operating investments, purchase of equipment, development of the infrastructure, construction of buildings, acquisition of the motor vehicles, etc. (See **Table 3-1**).

**Table 3-1: Capital Expenditure in USD**

| ***ITEMS (In US$)*** | **Total** | **Equity** | **Loan** |
|---|---|---|---|
| **A. FIXED INVESTMENTS** | | | |
| 1.Land | 19,895,555 | 19,895,555 | 0 |
| 2.Plant Site | 7,846,048 | 7,846,048 | 0 |
| 3.Town Investment | 4,368,634 | 4,368,634 | 0 |
| 4.Exploration | 348,007 | 348,007 | 0 |
| 5.Water Supply | 1,845,935 | 1,845,935 | 0 |
| 6.Motor Vehicles and roads | 700,000 | 700,000 | 0 |
| 7.Office Equipment | 114,565 | 114,565 | 0 |
| 8.Plant and brine pumping equipment | 307,251,909 | 61,450,382 | 245,801,527 |
| **Total Fixed Investments** | **342,370,653** | **96,569,126** | **245,801,527** |
| **B. PRE-OPERATING INVESTMENT** | | | |
| 1.Establishment of status of soda ash/brine contents in sediments at Engaruka basin | 4,638 | 4,638 | 0 |
| 2.Executing exploratory drilling to establish the status of soda ash. Brine in sediments at Engaruka Basin | 63,547 | 63,547 | 0 |
| 3.Undertaking simulation of brine evaporation for soda ash project at Engaruka | 19,761 | 19,761 | 0 |
| 4.Drilling of two water boreholes at Engaruka | 24,255 | 24,255 | 0 |
| 5.Detailed Drilling of boreholes at Engaruka | 240,249 | 240,249 | 0 |
| 6.Techno-Economic Study for Engaruka Soda Ash Project | 737,021 | 737,021 | 0 |
| 7.Estimated Compensation for PAP | 7,234,043 | 7,234,043 | 0 |
| **Total Pre-Operating Investment (POI)** | **8,323,514** | **8,323,514** | **0** |
| **C. TOTAL INVESTMENTS** | 350,694,167 | 104,892,640 | 245,801,527 |
| **D. WORKING CAPITAL** | | | |
| WORKING CAPITAL REQUIRED | 16,355,946 | 16,355,946 | 0 |
| **TOTAL PROJECT COST** | **367,050,113** | **121,248,586** | **245,801,527** |
| **EQUITY SHARE (%)** | | 33 | 67 |

A detailed discussion of the financing of ESAP is given in Chapter 4 of this Volume. However, briefly, ESAP is proposed to be a joint venture involving the Government of Tanzania (GoT) and a Strategic Investor (SI) owning the project in a 49:51 ratio. The GoT contribution to the project will be in the form of the huge and strategic soda ash deposits, land and other natural resources surrounding the project area. It is also in terms of the various preparations to get the project reads for swift implementation. The SI investment will be in the form of equity investment to facilitate the acquisition of relevant project equipment and infrastructures as well as arrangement of debt financing to ensure that ESAP takes off in 2023. The proposed financing will be in 33:67 ratio, being equity and debt financing respectively. The SI will be solely responsible for all issues related to the debt financing given that the Government (country) will have already contributed enormously in term of the '*sustainable'* brine resources estimated, presently, at 3,813,320,000 m3 and is being replenished at an annual rate of 513,334,000m3. Its annual safe yield is estimated at 102,666,800m3. The SI is expected to arrange a ten-year loan of US$ 245.8 million. The investor is also going to meet all other costs amounting to US$ 76.9 million. This amount excludes the land and pre-operating investments which will be the responsibility of the Government.

### 3.5 Projected Profit and Loss

Projected Profit and Loss Statements are shown in ***Appendix 1.*** ESAP is estimated to make profit from its first year of operation. The profit before tax is estimated at **US$ 42.8 million** in 2025 and rising to **US$ 110.5 million** in 2049.

### *3.6* Projected Cash Flow Statements

***Appendix 2*** shows the projected cash flows of the project. They indicate that the project will meet all its financial obligations.

### 3.7 Projected Balance Sheets

Detailed Balance Sheets Projections are shown in ***Appendix3***. The balance sheets depict a healthy financial position with the total assets growing consistently from **US$ 367.1 million**. at the end 2025 to **US$ 2.41 billion** in 2049.

### 3.8 Key Performance Metrics

ESAP estimated cash flows were obtained from the projected Income Statements and were discounted by 10%, being the required return for the project. The analysis provided the following results:

d. ESAP Net Present Value (NPV) will be **US$ 335.1 million**.
e. ESAP Internal Rate of Return (IRR) is **19.7%.**
f. ESAP Payback Period is **5** years.

# CHAPTER FOUR

# 4 PROJECT FINANCING

This Chapter recommends a financing approach for the Engaruka Soda Ash Project (ESAP). The process of reaching the recommendation benefited enormously from consultations with NDC, TIC and TIB as well as review of pertinent literature.

## 4.1 The General Financing Approach

It is advantageous for ESAP to adopt a ***project financing*** approach. This best conceives ESAP as a distinct entity (a SPV) with the Government and other equity holders in the project. Other key direct stakeholders will be (private) equity partners and financiers. In this set-up, ESAP will be expected to repay all its financing obligations exclusively out of its own cash flow and subject to its own assets. The approach will enhance effectiveness of resources allocation, economies of scale and risk management.

The government and the private investor(s) will enter into a joint-venture agreement (JVA) that ideally should stipulate their mutual expectations. Furthermore, the shareholders and the SPV will enter into a subscription and shareholders agreement (SSA).

As an SPV, ESAP will have its own legal face with incorporation being in line with applicable laws of the land. As such, it will be able to access appropriate tax concessions, subsidies, and rebates in line with its strategic national profile.

To facilitate ESAP's swift take-off, the other partners of the project should be carefully chosen. The preferred investor should have a firm position on the international market place and thus able to organise sizable win-win business off-take agreements. This is hugely important since ESAP is expected to entail a substantial amount of capital investment, making having an initial foot in the door of the international market for its products quite important.

The investor must therefore be sought through open international competitive tendering process. Prospective bidders should be pre-qualified in order to exclude firms which do not possess the necessary capability to develop the project. The NDC should restrict the tender to the pre-qualified firms. These must have the necessary resources, competence and positions on the international soda ash market. The foreign firms will be encouraged to team up with local firms as well.

The pre-qualified firms will be invited to submit proposals for partnering with the NDC in the joint development of the project. It will then negotiate with the selected partners to sort out any crucial issues before contracting.

## 4.2 Financing Specifics

NDC will enter into joint ownership with the appropriate investor. In line with the mining law, 16% of ESAP's ownership shall be sovereign equity to account for the special opportunity to engage in the sector. The amendments to the mining law in 2017 came into effect in July in terms of the Written Laws (Miscellaneous Amendments) Act, 2017 and changed the shareholding structure requirements. "*It is now mandatory for all Mining Licensees or Special Mining Licence holders to give the Government at least a 16 per cent free carried interest in the capital of their companies. The Government is also entitled to acquire (in total) up to 50 per cent of the shares in a mining company, proportional with the quantified value of tax expenditures incurred by the Government in favour of the mining company*."

When the total Government share (including NDC's) reflects minority shareholding, the management of the project via the SPV will largely be the responsibility of the private investor. This has the advantage of limiting government administrative involvement in the project's operations and thus facilitate a more business responsive environment and performance. As such, it is important to ensure that the private investor is really a very strong one and must meet defined criteria including being a major global market dominant player able to guarantee off-take business from the outset.

**In line with the foregoing, it is important to underscore that total Government share ownership should ideally be 49%**. ***The Government is providing the 'sustainable" valuable mineral resource, land, pre-operational investments (Table 3.1) and substantive goodwill into the project. As such, the Government should simply enlist a competent private investor (s) who will appreciate and accept this fact.***

Given the huge investment requirements, in addition to equity contribution by the SI, there will be need to borrow. As the options for significant in-country borrowing of sizable investments are rather severely limited, borrowing from external sources is the most likely option. It is proposed that ***the right foreign joint venture partner should also bare fully the responsibility for any borrowing*** and must therefore be able to engage with strong, reputable investment banks from outside the country for debt financing of the project.

The consultations on the best equity: Loan-gearing ratio have suggested that *as ESAP is envisaged to be a moderate risk project, it can be relatively highly geared to ratios of 60 - 70 % debt.* It is moderate risk because of the abundance of the resource and enabling country infrastructure and legal framework. There is also high local and export demand for soda ash and related products.

The Public Corporations Act, among other things, defines the expected roles of NDC in the joint venture. Established in 1962, NDC, a holding corporation under the Public Corporation Act of 1969, *"has a crucial mandate as a development and promotion institution to stimulate industrialization in partnership with private sector."* This requires ESAP to be run in a manner consistent with the aspirations of the Act, closely safeguarding national interests through strategic engagements, monitoring and hand-off oversight. For this role, NDC - even though will be a minority equity owner - should charge a negotiable management fee as a proportion of sales.

### 4.3 Operationalization of the proposed PPP financing approach

In general, "project finance" is the approach proposed for ESAP since the debt and equity used to finance the project are to be paid back from the cash flows generated by the project with the project's assets, rights, and interests held as secondary collateral. This therefore requires establishing ESAP as an SPV with a separate legal framework in line with the PPP policies and law.

The SPV must have clear rights to occupy land as well as the rights to the mineral resource. Thus, the land and resources must be evaluated through a process that is acceptable to both sides of the ownership. NDC/Government will own the land and the resource. The residents will be compensated for their land by the government and therefore will no longer claim ownership.

To facilitate attraction of the right investor and hence financier, it is proposed that NDC applies for incentives on behalf of the investor as per the TIC Act and then ensure they are approved by MoF and gazetted. Although, it is quite possible for the investor to apply for special incentives over and above the formal ones, the attraction, choice and selection of the right investors *must not be too grounded on a promise of too many incentives*, which ultimately demean the value of the strong business case that the project possesses.

The TIC grants Certificates of Incentives under authority conferred upon it by Part III, Section 17 (1-8) of Tanzania Investment Act, 1997. [http://www.tic.go.tz/selectedIncentives]. Holders of certificate of incentives are entitled to various investment incentives as stipulated in the Investment Act, 1997. NDC will have a role to facilitate the investor to access the incentives available via the TIC and EPZA within respective legal frameworks. In order to enjoy the rights and protection under the TIC, a foreign investor must have a Certificate of Incentive issued for a duration of three years and renewable for another term of two years. Prior to the application of this Certificate of Incentive, an investment wholly owned by a foreigner must have an investment capital of not less than Tanzanian shillings equivalent to United States Dollars Five Hundred Thousand (USD 500,000) and if locally owned, the minimum investment capital is not less than Tanzanian shillings equivalent to United States Dollars Three Hundred Thousand (USD 300,000). These amounts are deployed over a period of three to five years. The Tanzania Investment Centre (TIC) offers a package of investment benefits and incentives to both domestic and foreign investors.

Enterprises engaging or intending to engage in Mining and Petroleum Sectors shall follow the approval process contained in their respective laws (Mining Act 2010 & Petroleum Act 2015). However, the Centre upon request shall assist all investors to obtain permits and authorization required by other laws to set up and operate investment in Tanzania.

- Strategic investment project criteria:
    - Investment above US500 million
    - Must create about 1,500 jobs
    - Cover geographically disadvantaged area – economically
    - Transfer technology

ESAP must apply for the status as strategic investment status and can ask to have special incentives (to provide soft landing). It can apply for additional incentives above the normal e.g. tax and non-tax. **The additional incentive must be reflected in the business plan like construction of last mile connectivity infrastructure.** According to TIC, incentives are provided on demand by investors – not automatic and they available only to projects registered at TIC. They differ for citizen and non-citizens (51% ownership is the cut off criteria and a function on the level of investment).

It is also important to note that according to TIC, there is a new law for investments likely to be approved soon and may likely have significant changes to the incentives and mechanism to ensure their enforcement.

### 4.4 Summary: Financing/Ownership Structure Framework

The overriding vision is to have the envisaged the Engaruka Soda Ash Project (ESAP) well owned and competently managed and run for the benefit of the country.

ESAP's ownership structure is determined by several factors/considerations. First, the Natural Wealth and Resources (Permanent Sovereignty) Act of 2017 requires the country to have an "equitable stake" in projects related to mineral resources exploitation. Second, the *Miscellaneous Amendments Act (2017)* amended the *Mining Act* for the Government to have a minimum sixteen per cent non-dilutable free carried interest in any mining company operating under a mining licence or a special mining licence and increase this interest to an extent equivalent to the total tax expenditure incurred by the Government in favour of the mining company **(up to a maximum of fifty per cent).**

Thirdly, the Government through NDC and other efforts have already invested significantly during the pre-operation phase for the project. Fourth, for projects like these with remarkably high economic multiplier impacts, government involvement is strategically useful and important. ESAP is recognised by the Government (registered by TIC) as an anchor project, thus one has immense potential to drive socio-economic development of a large area. The project is envisaged to have immense potential economic benefits for the local communities and the nation at large.

Fifth, given the current financing environment, ESAP's substantial levels of investment can only be realistically financed with the involvement of strong foreign investors, assuming the right mix of equity and debt can be met.

Sixth, the nature of the global market for soda ash has tall barriers to entry as it is dominated by a few gigantic companies. Thus, strategically, inviting a foreign investor as partner with a significance foot on the international market will readily enable ESAP to have a quick start and have competitive access to the international markets, considering that 86% of its products will be exported.

Considering the foregoing factors, **100% private ownership and 100% public** ownership are not the right financing/ownership models. *The most realistic model is joint Government and Private Ownership. Thus, the Government of Tanzania – represented by the National Development Cooperation (NDC) and a competent private sector, should jointly own ESAP. The two should jointly set up a* ***Special Purpose Vehicle (SPV),*** *a company that will run the business operations and as such will be it easier to attract project financing. By a competent private sector investor, it is meant among other things ability to attract both equity and loan capital and having a strong market share of the international market. The majority shareholding should be of the private owner considering the need for a flexibility and agility in operational decisions.*

**As already argued, the total Government share ownership should ideally be 49%**. ***The Government is providing the valuable mineral resource, land, pre-operational investments and substantive goodwill into the project. The private investor (s) should provide equity and be responsible for debt financing for return of ownership of 51%. As such, the Government should simply enlist a competent private investor (s) who will appreciate and accept this fact.***

## CHAPTER FIVE

## 5 ECONOMIC ANALYSIS

Economic analysis assesses projects from the view of society as a whole (the national economy). It assesses **overall impact of a project on the welfare of all the citizens of the country concerned**. The purpose of project economic analysis is to assess whether a project is economically viable for the country. Economic analysis in this chapter entails the following aspects:

- Value added generated
- Foreign exchange effect
- Employment creation
- Balance of payment
- Social opportunity costs
- Externalities
- Linkages (Forward and backward)
- Cost Benefit analysis and Ratios.

### 5.1 Value added generated

Gross value added (reported as GDP) is the broadest measure of economic activity included in this analysis. The sum of gross value added across all industries is equivalent to a country's GDP. In this study, value added of ESAP is considered as **the wealth created by employee's efforts and comprises salaries and wages, fringe benefits, interest, dividend, tax, depreciation** and **net profit** retained. In other words, value added may also be considered as the increase in market value resulting from an extraction of soda ash its natural reserve excluding the cost of goods and services purchased from outside. Analysis indicates that from direct contribution of ESAP to GDP increased from US$ 77.7 million in 2025 (equivalent to 0.11% of GDP) to US$ 169.0 million (equivalent to 0.11%) of GDP in 2049 (**Table 5.1**).

**Table 5-1: ESAP direct contribution to GDP (US$ Millions)**

| Item | 2025 | 2028 | 2030 | 2035 | 2038 | 2040 | 2045 | 2049 |
|---|---|---|---|---|---|---|---|---|
| Payroll costs | 0.70 | 0.70 | 0.76 | 0.92 | 1.04 | 1.12 | 1.37 | 1.60 |
| Payment to capital (Profit) | 42.84 | 75.16 | 79.79 | 93.97 | 98.49 | 100.63 | 105.85 | 110.45 |
| Corporate Tax | 18.36 | 32.21 | 34.19 | 40.27 | 42.21 | 43.13 | 45.36 | 47.34 |
| Interests | 9.8 | 7.9 | 6.9 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Dividends | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Depreciation | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 |
| Royalty payments | 4.3 | 6.2 | 6.4 | 6.7 | 6.9 | 7.0 | 7.4 | 7.7 |
| Others | 0.38 | 0.50 | 0.51 | 0.53 | 0.54 | 0.55 | 0.57 | 0.59 |
| ***Total estimated Direct Value Added (Millions of US)*** | ***77.7*** | ***124.0*** | ***129.8*** | ***145.7*** | ***150.5*** | ***153.8*** | ***161.8*** | ***169.0*** |
| | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Estimated Tanzania GDP (Millions of USD) | 72,626.31 | 79,360.73 | 84,193.80 | 97,603.69 | 106,654.19 | 113,149.43 | 131,171.20 | 147,634.34 |
| ***% contribution of ESAP to GDP*** | ***0.11*** | ***0.16*** | ***0.15*** | ***0.15*** | ***0.14*** | ***0.14*** | ***0.12*** | ***0.11*** |

With regard to indirect and induced effects, several studies have established the value-added multipliers in mining projects to range between 2.7 to 2.8. However, in our case, we tend to be more conservative assuming a multitier of 2.2, being 1.8 and 0.4 for indirect and induced scenarios, respectively.

Based on this assumption, the indirect value-added effect of ESAP is estimated at US$ 139.9 million while the induced effect is US$ 31.1 million in 2025. With these estimates, the total value added (direct, indirect and induced) for the first year (2025) is **US$ 248.8 million** which is equivalent to 0.34% of the country's GDP (Based on the latest GDP figures of 2019).

**Table 5-2: ESAP Total contribution to GDP (US$ million)**

| | 2025 | 2028 | 2030 | 2035 | 2038 | 2040 | 2045 | 2049 |
|---|---|---|---|---|---|---|---|---|
| Direct | 77.7 | 124.0 | 129.8 | 145.7 | 150.5 | 153.8 | 161.8 | 169.0 |
| Indirect effect | 139.9 | 223.2 | 233.6 | 262.2 | 270.8 | 276.8 | 291.3 | 304.1 |
| Induced Effect | 31.1 | 49.6 | 51.9 | 58.3 | 60.2 | 61.5 | 64.7 | 67.6 |
| **Total Effect** | **248.8** | **396.7** | **415.4** | **466.1** | **481.5** | **492.0** | **517.9** | **540.7** |

With time, when the project is starting to pay back, the total Value-Added impact and respective contribution to GDP are projected to increase as depicted in **Figure 5.1**. The total value-added increases from US$ 248.8 million in 2025 to US$ 540.7 million in 2049 while the contribution to GDP increases from 0.34% to 0.37% over the same period.

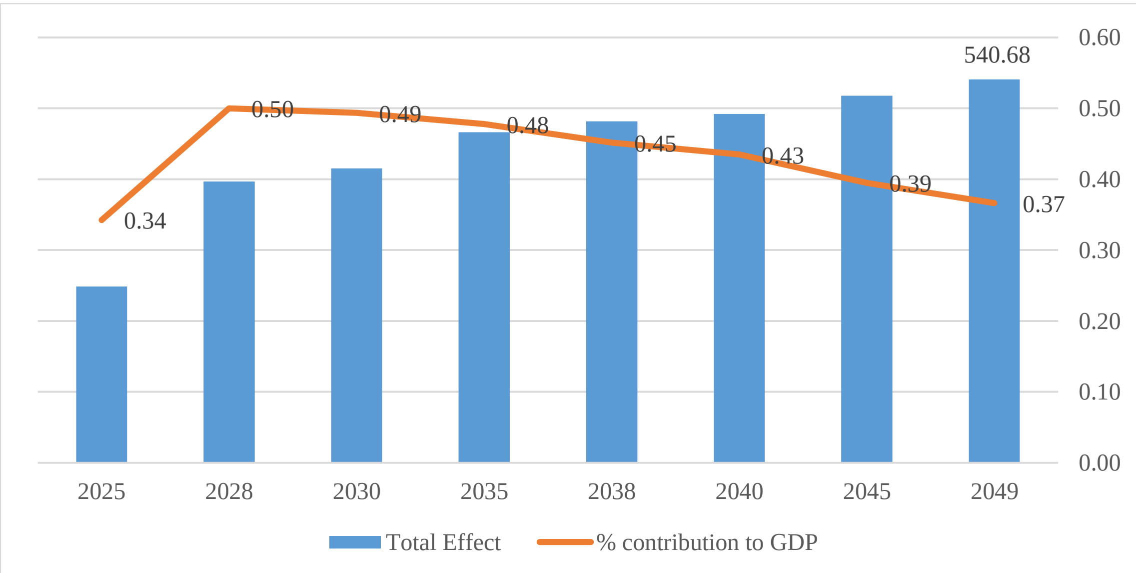


Figure 5-1: Total Value-Added Effects and contribution to GDP (Millions of US$, unless otherwise defined)

### 5.2 Foreign exchange and Balance of Payments effects

The ESAP project is expected to have significant effect to the foreign exchange and Balance of payments in general. According to the marketing study, data from various sources indicated that annual importation of soda ash varied from around 15,000 tons to 50,000 tons. These costs the country in terms of foreign exchange loss of between US$ 5.25 million and US$ 17.5 million annually at an average price of US$ 350 per ton. In addition, the market study estimates that the average annual exports value of soda ash resulting from the ESAP is around US$ 120 million. The total exchange generated and saved as a result of the project will therefore be to the tune of above US$ 120 million annually. This will have positive impact in the balance of payments in terms of improving the trade balance, accumulation of foreign reserves and enhanced stability of Tanzanian shilling against other international currencies.

### 5.3 Employment creation

The project is expected to generate a total of 223 direct employments when operating at full capacity. The total net labour income expected is amounting to US$ 0.6 million annually.

**Table 5-3: Direct ESAP employment effect (US $ million)**

| | |
|---|---:|
| Number of employees | 223 |
| Total wage Bill | 0.7 |
| Assume 85% take home | 0.6 |
| Total annual labour income | 0.6 |

Employment multiplier is estimated at 6 for indirect impact and 4 for induced impact based on similar studies.[1] This means that for every one direct job at ESAP, there are additional 6 paid employees and 4 self-employed individuals supported in the broader economy. In this case, the indirect employment effect of the ESAP is 1,338 jobs and induced effect is 892 jobs. This gives a total employment effect (direct, indirect and induced) of 2,453 jobs.

As for the labour income multipliers, the direct and indirect impacts of mining projects range from 1.2 to 5.7, as reported in a 2009 study of several South American copper and gold mines by the World Bank and International Finance Corporation[2]. Borrowing from Ghana experiences, this study assumes the indirect labour income effect of 3.0 and induced labour income multiplier of 0.5. Since the direct labour income is estimated at US$ 0.6 million, this implies that the indirect labour income is US$ 1.8 million and induced labour income is US$

[1] See “EY (2013). African Barrick Gold’s total economic and tax contributions in Tanzania, 2012” for such studies

[2] "Large Mines and Local Communities: Forging Partnerships, Building Sustainability." World Bank and International Finance Corporation (IFC). 2002. See p.6. Note that the multipliers stated in this report have also been cited in the ICMM’s “Mining Partnerships for Development”; see p.8.

0.03 million. The total employment income effect is therefore US$ 2.4 million for the first years (2025).

**Table 5-4: Summary of Total Employment Effect (in US$ unless otherwise stated)**

| | |
|---|---|
| Direct employment (No. of jobs) | 223 |
| Indirect employment (No. of jobs) | 1,338 |
| Induced employment (No. of jobs) | 892 |
| **Total employment effect** (No. of jobs) | **2,453** |
| | |
| Direct employment income | 0.6 |
| Indirect employment income | 1.8 |
| Induced employment income | 0.03 |
| **Total employment income effect** | **2.4** |

After years of project operation, the projected income effects are expected to increase further, following the expansion in capacity utilization and other factors. The projected estimates indicate that that the total employment income effects will increase from US$ 2.4 million in 2025 to US$ 5.5 million in 2049 (**Figure 5.2**).

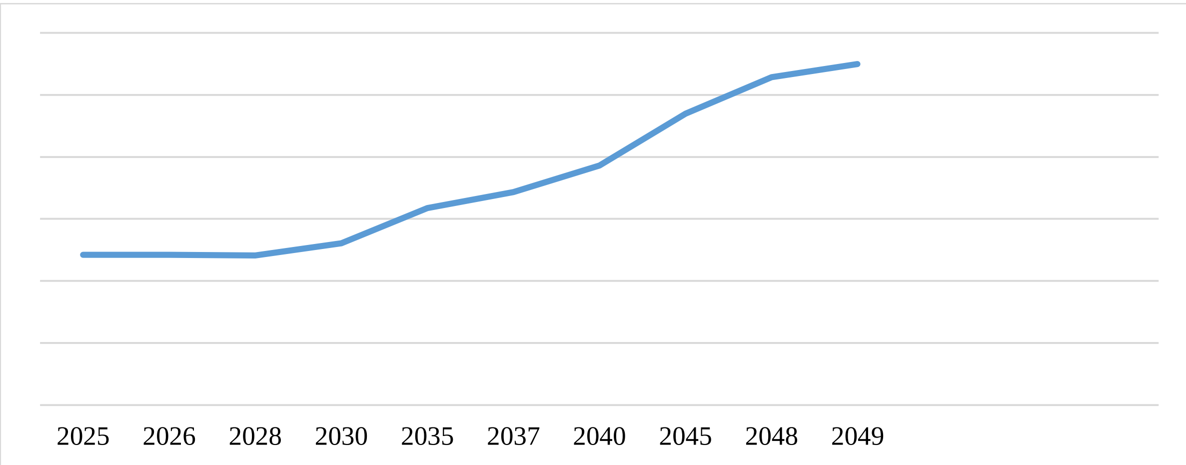


Figure 5-2: Projected total income employment impacts (Millions of US$)

## 5.4 Social opportunity costs.

### 5.4.1 Pastoralism and Agriculture

The concept of social opportunity cost of factor of inputs is derived from the recognition that, when resources are used for one project, other opportunities to use these resources are sacrificed. The social prices typically differ from market prices. During consultations with stakeholders at of the project, it was noted that for the case of ESAP, the opportunity costs is largely observed on the aspect of land which is largely used for livestock keeping and cultivation (particularly of maize). Based on information collected through desk review and consultation with stakeholders including communities around the project area in Engaruka, the annual estimated opportunity cost of land is US$ 1,902,855.65 (**Table 5.5**). This is what the communities around the project area feel that they will lose as a result of their land being used for the project instead of livestock keeping and maize cultivation.

**Table 5-5: Estimated opportunity cost of Land (TZS and US$)**

| **Livestock Keeping** | **TZS unless stated otherwise** | **US$** |
|---|---|---|
| Land size (hectares) | 24,000 | |
| Total number of livestock | 89,857 | |
| Annual livestock earning per HH | 2,380,000 | 1,034.78 |
| Number of HHs in the area | 2,180 | |
| % of HH owning livestock (60%) | 1,308 | |
| Total annual livestock revenue | 3,113,040,000 | 1,353,495.65 |
| Annual Variable costs | 933,912,000 | 406,048.70 |
| Net annual livestock revenue | 2,179,128,000 | 947,446.96 |
| *Opportunity cost of livestock keeping* | *2,179,128,000* | 947,446.96 |
| | | |
| **Maize Production** | | |
| Number of HHs | 2,180 | |
| % of HH growing maize (80%) | 1,744 | |
| Average farm size (ha) | 2 | |
| Yield (Tons/ha) | 1.8 | |
| Annual Income | 3,139,200,000 | 1,364,869.57 |
| Annual Variable costs (30% of total cost) | 941760000 | 409,460.87 |
| Net maize production income | 2,197,440,000 | 955,408.70 |
| *Opportunity cost of maize production* | *2,197,440,000* | 955,408.70 |
| | | |
| **Total Annual Opportunity cost of Land** | **4,376,568,000** | **1,902,855.65** |

The estimated total social opportunity cost for the land is increasing over years as presented in Figure 5.3 from US$ 1.9 million in 2025 to US$ 4.9 million in 2049.

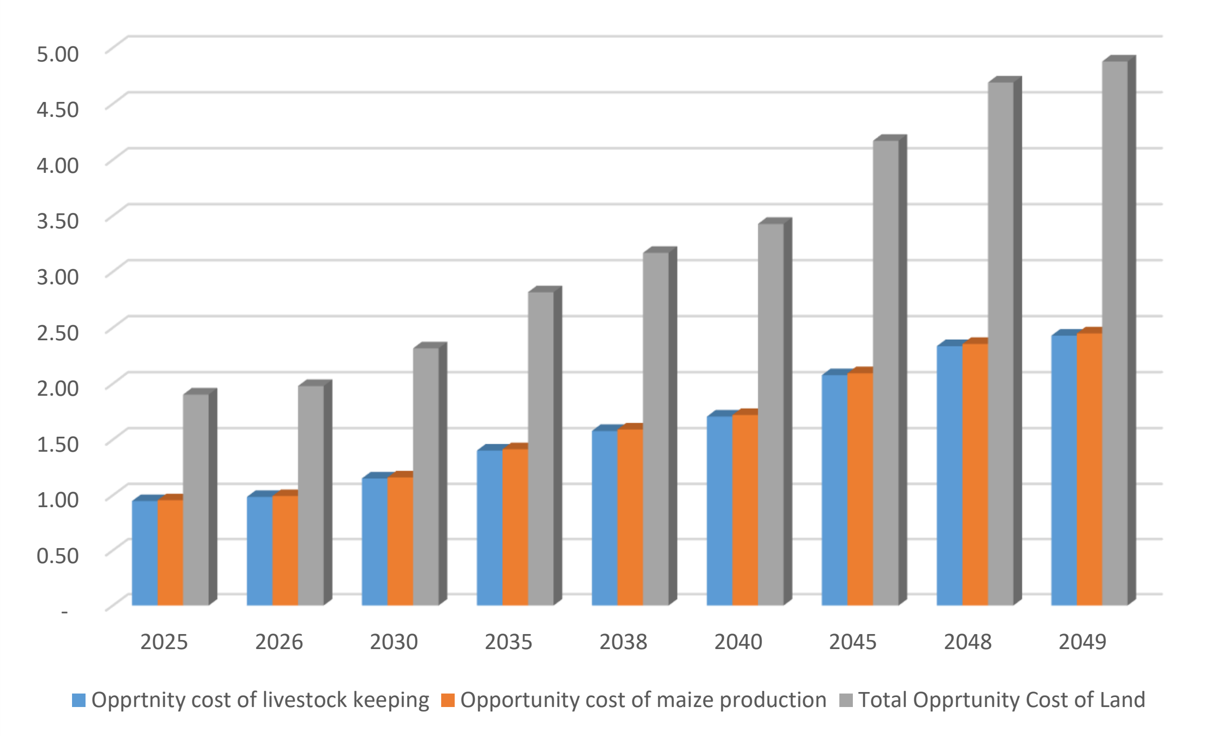

Figure 5-3: Projected Social Opportunity Cost of Land (Millions of US$)

### 5.4.2 Tourism

Tourism is one of the upcoming economic activities in Engaruka and surrounding villages where the Soda ash extraction and processing plant is proposed to be constructed. The area is a transit/corridor and/or dispersal area for many types of wild animals to several national parks. Furthermore, the area hosts Game Controlled Area (GCA) as well as Mto wa Mbu, Burko and Ngorongoro hunting blocks. The trunk road transverse Engaruka to Northern part of Tanzania notably Lake Natron where lesser Flamingo are found there in abundant, Ngorongoro Game Reserve make Engaruka as a stopover point. Also, Engaruka is famous for having ruins of the ancient people. Many Archaeologists and Historians come to Engaruka for tourism and for archaeological and/or paleontological studies. It is within these few tourist and archaeological features make Engaruka unique area in Monduli district. Residents of Engaruka particularly women of Maasai origin sell ornaments, beads and other attractive materials to the tourists passing through or coming for wildlife hunting. The proposed ESAP in the area will increase income of the community residents in the area through causal employment, skilled labour employment and business, which will be stimulated by the establishment of the factory. Interviews with Local Government Leaders[3] revealed that the project would have no impact on tourism sector. In fact, it is perceived that the project may likely complement the tourism activities in the area.

[3] Engaruka Ward Executive Officer (WEO)

### 5.5 Externalities

Many projects, although they produce outputs that are transacted through markets, generate externalities that affect the society but are not internalized—that is, not reflected in market prices of their outputs and inputs. The negative externalities as established by ESIA study is TZS 640,500,000/= which is equivalent to US$ 278,478.3 using the exchange rate of TZS 2,300/- per US$. The economic analysis has assumed the spreading of costs of externalities as follows: 50% of the total externality costs will be incurred during the first 8 years of the implementation of the project; 30% during the second 8 years; and 20% during the final years.

### 5.6 Other community level impacts of the projects

During interviews with key stakeholders, stakeholders were optimistic that the project would have enormous benefits to the local communities. The cited ones included improved transport services between Engaruka and Mto wa Mbu, availability of water and health services, expansion of business services in the township and additional income earning from casual labouring particularly during the construction phase. This section attempts to quantify the mentioned potential benefits at community level.

#### 5.6.1 Improved Transport services

The best way to estimate benefits from the improved transport services is through time saving (hours) saved which can be put in alternative economic activity. However, due to limited information we opted to use the possible impact this may have on households' income. Several studies indicate that the average household income in Engaruka is around TZS 40,000/= per month (TZS 480,000 per year)[4] . If we assume that the improved transport cots has an income effect of 5% to the household level, and given the fact that the number of households in Engaruka Ward is 3,071, then the increase in income due to improvement in transport services is TZS 73,704,000 or US$ 32,045 annually (for the first years of operation).

#### 5.6.2 Business Expansion

The business is expected to expand in Engaruka Township due to increased population, increased spending from project workers and other factors. Assuming the business impact of the project is 10% of the households' income, and then the total additional in income will be TZS 147,408,000 or US$ 64,090.4 per year.

[4] 1) USAID (2010), Village Reports for Engaruka, Migombani, Naitolia, and Selela in Monduli District. The Whole Village Report. University of Minnesota; 2) Kadigi, et. Al (2012), A comparative study of Costs and Benefits of Soda Ash Mining and Promotion of Ecotourism and Sustainable use of natural resources in lake Natron Basin, Tanzania

### 5.6.3 Increased Income from casual labouring

In this aspect, communities were assumed to benefit from gross income of casual labouring during the construction phase, which is expected to take 2 years. It is further assumed that the number of casual labours will be 8 times that of permanent employees-which means 2,000 workers since the projected number of permanent employees is 250. Assuming the two years has 730 days but the casual labourers will effectively work for only 80% of these days, then the total working days is 584. For all 2,000 casual labourers, the total person-days will therefore be 1,168,000. Experience shows that the daily pay for casual labourers in formal projects like this is about TZS 10,000/=. Hence, the estimated incomes for 2 years for all 2,000 casual labourers is TZS 11,680,000,000/= or TZS 5,840,000,000 per year. Under the Business As Usual Scenario (BAU) where the normal casual labour are paid US$ 1 per day (or TZS 2,300), the income earned would be only 2,686,400,000/= (US$ 1,168,000) for 2 construction years or TZS 1,343,200,000/- (US$ 584,000) per year.

### 5.6.4 Easy accessibility of water and health services

Community expects that water and health services will be readily available due to the establishment the project. In this case, costs of these services will go down through time saving to access the same and reduction in price to increased supply of the services.

According to TDHMS 2015-16, the average household expenditure foe health services is TZS 62,484/= per annum in Arusha Region. If we assume this is the same situation in Engaruka ward, the total health expenditure in the ward with 3,071 households is TZS 193,006,208/=. Assuming that the health expenditure will decline by 3% annually due to the project, then the annual decline in household expenditure (for all 3,071 households) will be TZS 5,756,650.92 equivalent to US$ 2,502.9.

As for water services, EWURA affordability Study done in 2019[5] estimates that the overall water affordability ratio is 6.9% of the total household income. Babati, which has more or less similar features with Monduli, had the affordability ratio of 6.4%. Assuming this is the case for Engaruka, this means a single household spends TZS 30,720/= out of its annual income of TZS 480,000/= for water services. For all 3,071 households, annul income spent on water services is TZS 94,341,120/=. If we assume a 5% reduction in water expenditure as a result of the project, the total saving in water services is TZS 4,717,056 or US$ 2,050.9 per year.

## 5.7 Cost Benefit analysis and Ratios

### 5.7.1 With Projects

The Cost-Benefit analysis has revealed that this project is economically viable. The project generates positive Economic Net Present Values (ENPV) for different scenarios of discounting factors indicating that it efficiently viable to undertake the project. At a discounting rate of

[5] Affordability Study of EWURA's regulated services. August, 2019

10%, the project generates the ENPV of US$ 1,763 million. At a *social-discounting* rate of 5%, the ENPV is even higher at US$ 3,226 million.

In addition, the Benefit-Cost Ratios are high (greater than 1), ranging from 3.8 to 4.9 when the discounting rate is varied from 10% to 5%. This is a clear indication that the project benefits outweigh costs. On the other hand, the Economic Rate of Return (ERR) is 0.6% which is lower than the discount rate but this was expected since this analysis involves social aspects with limited returns as compared with commercial ones. The key findings of cost-benefit analysis and ratios are summarized in **Table 5-7.**

**Table 5-6: Cost-Benefit analysis and Ratios (with the Project)**

| Economic Indicator | Value |
|---|---|
| ENPV @10% | 1,763 |
| ENPV @7% | 2,502 |
| ENPV@ 5% | 3,226 |
| | |
| EIRR | 0.6 |
| | |
| EPV of Benefits @ 10% | 2,397 |
| EPV of Cost @ 10% | 634 |
| Benefits/Cost ratio | 3.8 |
| | |
| EPV of benefits @ 7% | 3,241 |
| EPV of costs @ 7% | 739 |
| Benefit cost Ratio | 4.4 |
| | |
| EPV of benefits @ 5% | 4,062 |
| EPV of costs @ 5% | 836 |
| Benefit cost Ratio | 4.9 |

**Note:** Shadow price standard conversion factor (SCF) which convert financial prices to economic prices was assumed to be 0.9

### 5.7.2 Without Project

Without Project analysis attempts to assess the Cost-Benefit Analysis in the absence of the Project. The analysis is based on the following assumptions:

1) Without the project, the community would not be able to make such a big investment compared to the project. It is therefore assumed that the level of investment which community could make over time either with similar or different project is only 5% of the investment in the *with the project* scenario.
2) The opportunity cost is zero in the absence of the project
3) In the absence of the project, the externality costs are assumed to be only 1% of the *"with project"* scenario
4) Financial charges in the *without the project* scenario of the project is zero
5) Income from sales and other revenues from the *without the project* scenario is zero
6) Increased value added is only 5% of the *with the project* scenario
7) Employment effect is only 15% of the *with the project* value

8) Improvement in transport services is 95% of the *with the project* scenario
9) Improvement in businesses is 90% of the *with the project* scenario
10) Casual laborers are paid US$ 1 per day (or TZS 2,300) as opposed to TZS 10,000 per day in *with project* scenario
11) Improvement in health services is 97% of the *with the project* scenario
12) Improvement in water services is only 95% of the *with the project* scenario
13) There is no impact on the tourism sector hence no difference between *"without project*" and "*with project*" scenarios in this case.

Based on the assumptions, the findings indicate that the ENPV generated range from US$ 48.0 million to US$ 91.8 million when the discounting rate is varied from 10% to 5%. This is substantially low return when compared with the '*with the project"* scenario with an ENPV ranging between US$ 1,763 million and US$ 3,226 million with the same discounting rates. The Benefit-Cost Ratios are however positive, ranging from 4.2% to 6.8%. The ERR is smaller than 1 (0.4%) which indicates very limited growth in economic benefits in the absence of ESAP.

The Comparison of two cases (*With the Project* and *Without the Project*) tells that by having the project, the community and country as a whole will benefit more than, if the project is not implemented.

**Table 5-7: Cost-Benefit analysis and Ratios (without the Project)**

| **Economic Indicator** | **Value** |
|---|---:|
| ENPV @10% | 48.0 |
| ENPV @7% | 70.1 |
| ENPV@ 5% | 91.8 |
| EIRR | 0.4 |
| EPV of Benefits @ 10% | 63.0 |
| EPV of Cost @10% | 15.0 |
| Benefits/Cost ratio | 4.2 |
| EPV of benefits @7% | 85.6 |
| EPV of costs @ 7% | 15.4 |
| Benefit cost Ratio | 5.5 |
| EPV of benefits @ 5% | 107.5 |
| EPV of costs @ 5% | 15.7 |
| Benefit cost Ratio | 6.8 |

**Note:** Shadow price standard conversion factor (SCF) which converts financial prices to economic prices was assumed to be 0.9

# CHAPTER SIX

## 6 RISK ANALYSIS

Risk is conceived as an uncertainty that may affect effective implementation and success of the ESAP. It may affect the project both negatively or positively and is characterized by its probability of occurrence and its uncertain impact on the ESAP. On the average, ESAP is assessed as a moderately risky intervention and the risks that are envisaged can be readily managed. **Table 6.1 summarizes the envisaged major operational risks to ESAP and suggested mitigation measures for pursuit by ESAP owners, management and staff.** The environmental and social risks are detailed in the ESIA report and therefore not repeated here in detail. ESAP management is expected to regularly undertake detailed assessment of the risks involved and develop and implement more specific mitigation measures. The management will also develop and implement a comprehensive risk management strategy.

**Table 6-1. Assessment of the Major ESAP Business Risks**

| No | Risks | Elaboration | Probability of Occurrence | Proposed Major Mitigation Strategies |
|---|---|---|---|---|
| 1 | Market Risks | • High international market barriers by the few dominant global companies | H | • Seek collaboration with a joint venture partner with strong position on the international markets |
| | | • High competition since soda ash is a widely traded product | H | • Engage with JV partners in countries with favourable trade terms with Tanzania.<br>• Work to get soda ash included in bilateral trade agenda of major trade partners.<br>• Promote and exploit fully the potential for local market consumption.<br>• Develop regularly updated strategies for achieving economies of scale, competitive cost structure and responsive product diversity.<br>• Develop effective capacity to commercialize new value-added products. |
| | | • Thin EAC soda ash market and threat of large-scale imports of soda ash and related products from low-cost producers. | H | • Collaborate with the Government to protectively boost local manufacturing for products which utilize soda as feedstock and attract foreign direct investment in such products. |
| 2 | Transportation and logistics risks | • Existing transportation and logistics may substantially affect the prices and delivery to the clients. In mind, it is the significant use of road transport and the bad condition of the Mto wa Mbu – Engaruka road | M | • There are Government efforts to rehabilitate and improve the Arusha – Tanga railway as well as upgrade to tarmac level the Mto wa Mbu – Engaruka road. |
| 3 | Utility risks | • The project's vicinity does not have potentially very reliable water sources | M | • The techno-economic assessment has included a comprehensive assessment of access to utilities and it is expected that the recommendations will be adequate to mitigate these risks. |
| | | • Unreliable power supply and high energy cost. One of the leading concerns of the manufacturing industry is the power supply. Indeed, during the past ten years the supply of electricity has been unpredictable. Frequent | M | • ESAP will work with TANESCO and MIT to continually address the specific challenges of the project regarding access to reliable power.<br>• The Government is expanding the electricity generation capacity including the construction of the Nyerere |

| No | Risks | Elaboration | Probability of Occurrence | Proposed Major Mitigation Strategies |
|---|---|---|---|---|
| | | power rationing, interruptions and low voltages. Furthermore, electricity tariffs are uncompetitive. | | Hydropower Plant which is expected to enable lower, competitive electricity tariffs. |
| 4 | Financial risks | • Unattractive capital structure and debt coverage | M | • The recommendations of this report regarding capital structure and debt coverage are designed to be attractive to both the Government (NDC), potential investors and financiers. |
| | | • High cost of working capital. Manufacturers consider the access costs to working capital to be too high in Tanzania, ranging between 16 to 25 per cent for commercial banks. The absence of strong development banks or other financial institutions that could provide long-term development credits at lower interest rates is related limitation. | M | • Involve JV partners with strong connections to international financing institutions that can offer adorable terms. |
| | | • Foreign currency related risks | L | • The bulk of ESAP debt is expected to be foreign exchange denominated. |
| 5 | Technology risks | • Technology access can be a source of considerable uncertainty given that the plant will be procured on a turn-key basis<br>• Unreliable access to good soda ash production relevant skills owing to lack of formal training institutions offering specialized courses in the line of business. | M | • Effort will be required to partner with a foreign investor who has ready access to technologies otherwise the cost of technical assistance can be prohibitive.<br>• Ensure strong warranties and insurances are used.<br>• The turnkey contract must have adequate protections (liquidated damages, performance bonds, retention monies, capex reserve, etc).<br>• Develop and implement effective plant maintenance systems to reduce chances of costly breakdowns.<br>• ESAP will regularly train its staff in identified skills. The crucial areas for training have been proposed in this report. |
| 6 | Regulatory/ Political risks | • Mining policies and rules on development, exploration and processing may pose challenges in production and marketing of soda ash for consumption both locally and in international markets.<br>• Taxes, regulations, governmental policies, trade agreements (bilateral, regional, and global) or their | M | • The government is highly committed to implementing the recent blueprint on regulatory reforms as much as possible.<br>• TIC protects investors in Tanzania. Once firmed up, investments are protected against nationalization, expropriation and adverse government actions. |

| No | Risks | Elaboration | Probability of Occurrence | Proposed Major Mitigation Strategies |
|---|---|---|---|---|
| | | interpretations to products related to mining, soda ash, or industries that use soda ash may affect the estimated market for soda ash project | | • The financing strategy for ESAP entails a significant component of debt being raised by international development finance institutions with capacity to manage political risks. |
| 7 | Environmental Risks | • Pollution during construction | L | • During the construction phase the pollution impacts will be of temporary nature. The construction contractors will be required to have mitigation measures as outlined in the ESAP Environmental Management Plan to address air pollution, gaseous emissions, dust pollution, noise pollution, solid waste, etc. |
| | | • Pollution during the operational phase | L | • During the operational phase the pollution impacts will be of temporary nature. ESAP management is expected to regularly develop and implement mitigation measures as outlined in the ESAP Environmental Management Plan to address pollution related to liquid effluents, solid waste, noise, etc. |
| | | • Occupational health and safety risks | L | • ESAP is planned and expected to be operated according to established world-class safety practices and occupational health and safety OHS strategies and measures on implemented in line with national and international laws. |
| | | • Force majeure | L | • ESAP will at all times have in place appropriate insurance schemes (including fire insurance) |
| 8 | Resource risks | • Future uncertainties in the supply of quality and sufficient soda | L | • Engaruka Basin is expected to have economically, sufficient quality soda ash given its location in geographical, tectonic and geological environment.<br>• This TIRDO study has shown the available resource to be huge and able to enable production for quite a long time. The quantity of the resource is 3,813,320,000 $m^3$ and is being replenished at an annual rate of 513,334,000$m^{3.}$ Its annual safe yield is estimated at 102,666,800$m^3$. |

# CHAPTER SEVEN

# 7 CONCLUSIONS AND RECOMMENDATIONS

## 7.1 Conclusions

**ESAP is a mega project that will require a total US$ 367.1 million to operationalize, *over and above the strategic value of the brine resources*.** It is proposed to be a joint venture involving the Government of Tanzania (GoT) and a Strategic Investor (SI) owning the project in a 49:51 ratio. The GoT contribution to the project will be in the form of the huge and strategic soda ash deposits, land and other natural resources surrounding the project area. It is also in terms of the various preparations to get the project reads for swift implementation. The SI investment will be in the form of equity investment to facilitate the acquisition of relevant project equipment and infrastructures as well as arrangement of debt financing to ensure that ESAP takes off in 2023. A debt to equity ratio of 67:33 to fund the project is recommended.

**The project will be financially viable and bankable.** Its financial viability metrics for duration of about 25 years are as follows:

a. ESAP Net Present Value (NPV) will be **US$ 335.1 million** (assuming a 10% discount rate).
b. ESAP Internal Rate of Return (IRR) is **19.7%.**
c. ESAP Payback Period is **5** years.

**ESAP is economically viable.** It has substantial both direct and indirect positive benefits. Some of its positive economic benefits are in terms of value-added generation; foreign exchange and balance of payments; employment creation; backward and forward linages; and government taxes and levies. The project generates positive Economic Net Present Values (ENPV) for different scenarios of discounting factors indicating that it efficiently viable to undertake the project. At a discounting rate of 10%, the project generates the ENPV of US$ 1,763 million. At a *social-discounting* rate of 5%, the ENPV is even higher at US$ 3,226 million. In addition, the Benefit-Cost Ratios are high (greater than 1), ranging from 3.8 to 4.9 when the discounting rate is varied from 10% to 5%. This is a clear indication that the project benefits outweigh costs. On the other hand, the Economic Rate of Return (ERR) is 0.6% which is lower than the discount rate but this was expected since this analysis involves social aspects with limited returns as compared with commercial ones.

## *7.2 Recommendations*

The project is recommended for implementation. To ensure successful implementation:

1) The specific recommendations outlined in this Volume will require careful attention.
2) The Government will need to carefully choose a suitable joint-venture partner. The preferred investor should have a firm position on the international market place and thus able to organize sizable win-win business off-take agreements. The partner must also have connections and reputations to attract debt financing from attractive financiers.

## REFERENCES

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# APPENDICES

## *Appendix 1: Project Profit and Loss Statements (US$)*

| PROJECTED SALES | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Local Market | 22,366,308 | 27,159,088 | 31,951,868 | 32,271,387 | 32,594,101 | 32,920,042 | 33,249,242 | 33,581,734 | 33,917,552 | 34,256,727 | 34,599,295 |
| Exports | 85,800,715 | 104,186,583 | 122,572,450 | 123,798,175 | 125,036,156 | 126,286,518 | 127,549,383 | 128,824,877 | 130,113,126 | 131,414,257 | 132,728,399 |
| **A. TOTAL SALES** | 108,167,023 | 131,345,670 | 154,524,318 | 156,069,561 | 157,630,257 | 159,206,559 | 160,798,625 | 162,406,611 | 164,030,677 | 165,670,984 | 167,327,694 |
| **B. DIRECT OPERATING COST** | | | | | | | | | | | |
| 1. Harvested Soda Ash (Processing of Soda Ash) | 8,118,611 | 9,858,313 | 11,598,015 | 11,605,995 | 11,614,055 | 11,622,196 | 11,630,418 | 11,638,722 | 11,647,109 | 11,655,580 | 11,664,136 |
| 2. Utilities | 349,244 | 349,244 | 424,082 | 498,920 | 503,909 | 508,948 | 514,038 | 519,178 | 524,370 | 529,614 | 534,910 |
| 3. Consumables - GAC and lubricants | 68,436 | 68,436 | 83,101 | 97,766 | 98,744 | 99,731 | 100,728 | 101,736 | 102,753 | 103,781 | 104,818 |
| 4. Consumables-Vehicles &cranes, etc | 540,835 | 540,835 | 656,728 | 772,622 | 780,348 | 788,151 | 796,033 | 803,993 | 812,033 | 820,153 | 828,355 |
| 5. Packaging | 1,193,747 | 1,193,747 | 1,352,913 | 1,591,662 | 1,607,579 | 1,623,654 | 1,639,891 | 1,656,290 | 1,672,853 | 1,689,581 | 1,706,477 |
| 6. Staff Costs | 704,245 | 704,245 | 673,821 | 700,774 | 728,805 | 757,957 | 788,275 | 819,806 | 852,599 | 886,703 | 922,171 |
| **Total Direct Operating Costs** | 10,975,117 | 12,714,819 | 14,788,660 | 15,267,739 | 15,333,439 | 15,400,638 | 15,469,383 | 15,539,725 | 15,611,717 | 15,685,412 | 15,760,867 |
| **C. GROSS PROFIT** | 97,191,906 | 118,630,851 | 139,735,658 | 140,801,822 | 142,296,817 | 143,805,921 | 145,329,242 | 146,866,886 | 148,418,961 | 149,985,572 | 151,566,827 |
| **D. INDIRECT OPERATING COSTS** | | | | | | | | | | | |
| 7. Administration Overheads (non-staff) | 20,921,224 | 20,980,641 | 20,995,273 | 19,865,248 | 18,687,635 | 17,460,506 | 16,181,856 | 14,849,600 | 13,461,570 | 12,015,510 | 10,509,073 |
| 8. City service levies | 32,450 | 39,404 | 46,357 | 46,821 | 47,289 | 47,762 | 48,240 | 48,722 | 49,209 | 49,701 | 50,198 |
| 9. CSR | 10,817 | 13,135 | 15,452 | 15,607 | 15,763 | 15,921 | 16,080 | 16,241 | 16,403 | 16,567 | 16,733 |
| 10. NDC Management fee | 216,334 | 262,691 | 309,049 | 312,139 | 315,261 | 318,413 | 321,597 | 324,813 | 328,061 | 331,342 | 334,655 |
| 11. Annual mining fees | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 |
| 12. Contigency (10%) | 3,228,094 | 3,446,983 | 3,675,089 | 3,569,019 | 3,458,344 | 3,342,876 | 3,222,419 | 3,096,771 | 2,965,718 | 2,829,043 | 2,686,516 |
| Total Ind. Op. Costs bef Dep'n & POI | 24,533,919 | 24,867,854 | 25,166,221 | 23,933,835 | 22,649,292 | 21,310,478 | 19,915,192 | 18,461,147 | 16,945,962 | 15,367,163 | 13,722,175 |
| 9. Depreciation | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 |
| 10. POI Amortization | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 |
| **E. TOTAL INDIRECT OPER'G COSTS** | 26,165,190 | 26,499,124 | 26,797,491 | 25,565,105 | 24,280,562 | 22,941,748 | 21,546,462 | 20,092,417 | 18,577,233 | 16,998,434 | 15,353,445 |

| PROJECTED SALES | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **F. OPERATING PROFIT** | 71,026,716 | 92,131,727 | 112,938,167 | 115,236,717 | 118,016,255 | 120,864,173 | 123,782,780 | 126,774,469 | 129,841,728 | 132,987,139 | 136,213,382 |
| G. INTEREST (4%) | 9,832,061 | 9,832,061 | 8,848,855 | 7,865,649 | 7,865,649 | 6,882,443 | 5,899,237 | 4,916,031 | 3,932,824 | 2,949,618 | 1,966,412 |
| H. PROFIT BEFORE TAX | 61,194,655 | 82,299,666 | 104,089,312 | 107,371,069 | 110,150,606 | 113,981,731 | 117,883,543 | 121,858,438 | 125,908,904 | 130,037,520 | 134,246,969 |
| I. TAX (30%) | 18,358,397 | 24,689,900 | 31,226,794 | 32,211,321 | 33,045,182 | 34,194,519 | 35,365,063 | 36,557,532 | 37,772,671 | 39,011,256 | 40,274,091 |
| **K. PROFIT** | **42,836,259** | **57,609,766** | **72,862,518** | **75,159,748** | **77,105,424** | **79,787,211** | **82,518,480** | **85,300,907** | **88,136,233** | **91,026,264** | **93,972,879** |

# Appendix 1: Project Profit and Loss Statements (US$) Cont'd

| PROJECTED SALES | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Local Market | 34,945,287 | 35,294,740 | 35,647,688 | 36,004,165 | 36,364,206 | 36,727,848 | 37,095,127 | 37,466,078 | 37,840,739 | 38,219,146 | 38,601,338 | 38,987,351 | 39,377,225 | 39,770,997 |
| Exports | 134,055,683 | 135,396,240 | 136,750,203 | 138,117,705 | 139,498,882 | 140,893,871 | 142,302,809 | 143,725,837 | 145,163,096 | 146,614,727 | 148,080,874 | 149,561,683 | 151,057,299 | 152,567,872 |
| **A. TOTAL SALES** | 169,000,971 | 170,690,981 | 172,397,890 | 174,121,869 | 175,863,088 | 177,621,719 | 179,397,936 | 181,191,915 | 183,003,835 | 184,833,873 | 186,682,212 | 188,549,034 | 190,434,524 | 192,338,869 |
| **B. DIRECT OPERATING COST** | | | | | | | | | | | | | | |
| 1. Harvested Soda Ash (Processing of Soda Ash) | 11,672,777 | 11,681,505 | 11,690,320 | 11,699,223 | 11,708,216 | 11,717,298 | 11,726,471 | 11,735,735 | 11,745,093 | 11,754,544 | 11,764,089 | 11,773,730 | 11,783,467 | 11,793,302 |
| 2. Utilities | 540,259 | 545,661 | 551,118 | 556,629 | 562,196 | 567,817 | 573,496 | 579,231 | 977,145 | 977,439 | 977,735 | 978,034 | 978,336 | 978,641 |
| 3. Consumables - GAC and lubricants | 105,867 | 106,925 | 107,994 | 109,074 | 110,165 | 111,267 | 112,379 | 113,503 | 114,638 | 115,785 | 116,943 | 118,112 | 119,293 | 120,486 |
| 4. Consumables-Vehicles &cranes, etc | 836,638 | 845,005 | 853,455 | 861,989 | 870,609 | 879,315 | 888,109 | 896,990 | 905,960 | 915,019 | 924,169 | 933,411 | 942,745 | 952,173 |
| 5. Packaging | 1,723,542 | 1,740,777 | 1,758,185 | 1,775,767 | 1,793,525 | 1,811,460 | 1,829,574 | 1,847,870 | 1,866,349 | 1,885,012 | 1,903,862 | 1,922,901 | 1,942,130 | 1,961,551 |
| 6. Staff Costs | 959,058 | 997,420 | 1,037,317 | 1,078,809 | 1,121,962 | 1,166,840 | 1,213,514 | 1,262,054 | 1,312,537 | 1,365,038 | 1,419,640 | 1,476,425 | 1,535,482 | 1,596,901 |
| **Total Direct Operating Costs** | 15,838,141 | 15,917,294 | 15,998,389 | 16,081,493 | 16,166,672 | 16,253,997 | 16,343,543 | 16,435,384 | 16,921,721 | 17,012,837 | 17,106,438 | 17,202,613 | 17,301,454 | 17,403,055 |
| **C. GROSS PROFIT** | 153,162,830 | 154,773,687 | 156,399,501 | 158,040,377 | 159,696,416 | 161,367,721 | 163,054,393 | 164,756,532 | 166,082,113 | 167,821,036 | 169,575,774 | 171,346,421 | 173,133,070 | 174,935,815 |
| **D. INDIRECT OPERATING COSTS** | | | | | | | | | | | | | | |
| 7. Administration Overheads (non-staff) | 10,602,440 | 10,696,957 | 10,792,644 | 10,889,521 | 10,987,609 | 11,086,931 | 11,187,508 | 11,289,365 | 11,392,524 | 11,497,010 | 11,602,848 | 11,710,063 | 11,818,684 | 11,928,735 |
| 8. City service levies | 50,700 | 51,207 | 51,719 | 52,237 | 52,759 | 53,287 | 53,819 | 54,358 | 54,901 | 55,450 | 56,005 | 56,565 | 57,130 | 57,702 |
| 9. CSR | 16,900 | 17,069 | 17,240 | 17,412 | 17,586 | 17,762 | 17,940 | 18,119 | 18,300 | 18,483 | 18,668 | 18,855 | 19,043 | 19,234 |
| 10. NDC Management fee | 338,002 | 341,382 | 344,796 | 348,244 | 351,726 | 355,243 | 358,796 | 362,384 | 366,008 | 369,668 | 373,364 | 377,098 | 380,869 | 384,678 |
| 11. Annual mining fees | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 | 125,000 |

| PROJECTED SALES | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12. Contigency (10%) | 2,704,161 | 2,722,119 | 2,740,399 | 2,759,009 | 2,777,960 | 2,797,259 | 2,816,918 | 2,876,159 | 2,896,012 | 2,916,250 | 2,936,886 | 2,957,930 | 2,979,395 | 3,001,293 |
| Total Ind. Op. Costs bef Dep'n & POI | 13,837,203 | 13,953,735 | 14,071,798 | 14,191,423 | 14,312,640 | 14,435,482 | 14,559,982 | 14,725,384 | 14,852,745 | 14,981,861 | 15,112,771 | 15,245,511 | 15,380,121 | 15,516,642 |
| 9. Depreciation | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 | 1,298,330 |
| 10. POI Amortization | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 | 332,941 |
| **E. TOTAL INDIRECT OPER'G COSTS** | 15,468,474 | 15,585,005 | 15,703,068 | 15,822,693 | 15,943,910 | 16,066,753 | 16,191,252 | 16,356,655 | 16,484,015 | 16,613,132 | 16,744,041 | 16,876,781 | 17,011,391 | 17,147,912 |
| **F. OPERATING PROFIT** | 137,694,356 | 139,188,682 | 140,696,433 | 142,217,684 | 143,752,506 | 145,300,969 | 146,863,141 | 148,399,877 | 149,598,098 | 151,207,905 | 152,831,733 | 154,469,639 | 156,121,679 | 157,787,903 |
| G. INTEREST (4%) | | | | | | | | | | | | | | |
| H. PROFIT BEFORE TAX | 137,694,356 | 139,188,682 | 140,696,433 | 142,217,684 | 143,752,506 | 145,300,969 | 146,863,141 | 148,399,877 | 149,598,098 | 151,207,905 | 152,831,733 | 154,469,639 | 156,121,679 | 157,787,903 |
| I. TAX (30%) | 41,308,307 | 41,756,605 | 42,208,930 | 42,665,305 | 43,125,752 | 43,590,291 | 44,058,942 | 44,519,963 | 44,879,429 | 45,362,371 | 45,849,520 | 46,340,892 | 46,836,504 | 47,336,371 |
| **K. PROFIT** | **96,386,049** | **97,432,077** | **98,487,503** | **99,552,379** | **100,626,754** | **101,710,678** | **102,804,199** | **103,879,914** | **104,718,669** | **105,845,533** | **106,982,213** | **108,128,748** | **109,285,175** | **110,451,532** |

## *Appendix 2: Project Cash Flow (US$)*

| ITEMS (In US$) | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A. Cash In-Flow** | | | | | | | | | | | | |
| 1. Cash Sales | | 108,167,023 | 131,345,670 | 154,524,318 | 156,069,561 | 157,630,257 | 159,206,559 | 160,798,625 | 162,406,611 | 164,030,677 | 165,670,984 | 167,327,694 |
| 2. Equity | 121,248,586 | | | | | | | | | | | |
| 3. Fixed Investment Loan | 245,801,527 | | | | | | | | | | | |
| 4. Beginning Cash Balance | 0 | 16,355,946 | 60,823,475 | 95,484,359 | 145,397,995 | 197,608,860 | 251,765,402 | 308,603,731 | 368,173,329 | 430,525,353 | 495,712,703 | 563,790,085 |
| **Total Cash-In Flow** | **367,050,113** | **124,522,969** | **192,169,145** | **250,008,677** | **301,467,556** | **355,239,117** | **410,971,961** | **469,402,356** | **530,579,940** | **594,556,031** | **661,383,688** | **731,117,779** |
| **B. Cash Out-Flow** | | | | | | | | | | | | |
| 1. Total Investment | 350,694,167 | | | | | | | | | | | |
| 2. Direct Operating Costs | | 10,975,117 | 12,714,819 | 14,788,660 | 15,267,739 | 15,333,439 | 15,400,638 | 15,469,383 | 15,539,725 | 15,611,717 | 15,685,412 | 15,760,867 |
| 3. Total Ind. Ope Costs bef. Dep'n & POI | | 24,533,919 | 24,867,854 | 25,166,221 | 23,933,835 | 22,649,292 | 21,310,478 | 19,915,192 | 18,461,147 | 16,945,962 | 15,367,163 | 13,722,175 |
| 4. Interest (4%) | | 9,832,061 | 9,832,061 | 8,848,855 | 7,865,649 | 7,865,649 | 6,882,443 | 5,899,237 | 4,916,031 | 3,932,824 | 2,949,618 | 1,966,412 |
| 5. Tax (30%) | | 18,358,397 | 24,689,900 | 31,226,794 | 32,211,321 | 33,045,182 | 34,194,519 | 35,365,063 | 36,557,532 | 37,772,671 | 39,011,256 | 40,274,091 |
| **Total Cash Out-Flow** | **350,694,167** | **63,699,494** | **72,104,634** | **80,030,530** | **79,278,543** | **78,893,562** | **77,788,078** | **76,648,875** | **75,474,434** | **74,263,174** | **73,013,450** | **71,723,545** |
| **C. Net Cash** | 16,355,946 | 60,823,475 | 120,064,511 | 169,978,147 | 222,189,013 | 276,345,555 | 333,183,884 | 392,753,482 | 455,105,506 | 520,292,856 | 588,370,238 | 659,394,234 |
| **D. Loan Payments** | | | | | | | | | | | | |
| 1. Principal for Fixed Inv. Loan | 245,801,527 | 0 | 24,580,153 | 24,580,153 | 24,580,153 | 24,580,153 | 24,580,153 | 24,580,153 | 24,580,153 | 24,580,153 | 24,580,153 | 24,580,153 |
| 2. Principal for Working Cap. Loan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Loan Payments** | **0** | **0** | **24,580,153** | **24,580,153** | **24,580,153** | **24,580,153** | **24,580,153** | **24,580,153** | **24,580,153** | **24,580,153** | **24,580,153** | **24,580,153** |
| **E. Ending Cash Balance** | **16,355,946** | **60,823,475** | **95,484,359** | **145,397,995** | **197,608,860** | **251,765,402** | **308,603,731** | **368,173,329** | **430,525,353** | **495,712,703** | **563,790,085** | **634,814,081** |

## *Appendix 2: Project Cash Flow (US$) Cont'd*

| ITEMS (In US$) | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 | 2042 | 2043 | 2044 | 2045 | 2046 | 2047 | 2048 | 2049 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A. Cash In-Flow** | | | | | | | | | | | | | | |
| 1. Cash Sales | 169,000,971 | 170,690,981 | 172,397,890 | 174,121,869 | 175,863,088 | 177,621,719 | 179,397,936 | 181,191,915 | 183,003,835 | 184,833,873 | 186,682,212 | 188,549,034 | 190,434,524 | 192,338,869 |
| 2. Equity | | | | | | | | | | | | | | |
| 3. Fixed Investment Loan | | | | | | | | | | | | | | |
| 4. Beginning Cash Balance | 634,814,081 | 732,831,401 | 831,894,749 | 932,013,522 | 1,033,197,171 | 1,135,455,196 | 1,238,797,144 | 1,343,232,613 | 1,448,743,798 | 1,555,093,736 | 1,662,570,540 | 1,771,184,023 | 1,880,944,041 | 1,991,860,487 |
| **Total Cash-In Flow** | **803,815,052** | **903,522,382** | **1,004,292,639** | **1,106,135,392** | **1,209,060,259** | **1,313,076,914** | **1,418,195,080** | **1,524,424,529** | **1,631,747,632** | **1,739,927,609** | **1,849,252,752** | **1,959,733,057** | **2,071,378,565** | **2,184,199,356** |
| **B. Cash Out-Flow** | | | | | | | | | | | | | | |
| 1. Total Investment | | | | | | | | | | | | | | |
| 2. Direct Operating Costs | 15,838,141 | 15,917,294 | 15,998,389 | 16,081,493 | 16,166,672 | 16,253,997 | 16,343,543 | 16,435,384 | 16,921,721 | 17,012,837 | 17,106,438 | 17,202,613 | 17,301,454 | 17,403,055 |
| 3. Total Ind. Ope Costs bef. Dep'n & POI | 13,837,203 | 13,953,735 | 14,071,798 | 14,191,423 | 14,312,640 | 14,435,482 | 14,559,982 | 14,725,384 | 14,852,745 | 14,981,861 | 15,112,771 | 15,245,511 | 15,380,121 | 15,516,642 |
| 4. Interest (4%) | 0 | 0 | 0 | 0 | | | | | | | | | | |
| 5. Tax (30%) | 41,308,307 | 41,756,605 | 42,208,930 | 42,665,305 | 43,125,752 | 43,590,291 | 44,058,942 | 44,519,963 | 44,879,429 | 45,362,371 | 45,849,520 | 46,340,892 | 46,836,504 | 47,336,371 |
| **Total Cash Out-Flow** | **70,983,651** | **71,627,633** | **72,279,117** | **72,938,220** | **73,605,064** | **74,279,770** | **74,962,467** | **75,680,731** | **76,653,896** | **77,357,069** | **78,068,728** | **78,789,016** | **79,518,079** | **80,256,067** |
| **C. Net Cash** | 732,831,401 | 831,894,749 | 932,013,522 | 1,033,197,171 | 1,135,455,196 | 1,238,797,144 | 1,343,232,613 | 1,448,743,798 | 1,555,093,736 | 1,662,570,540 | 1,771,184,023 | 1,880,944,041 | 1,991,860,487 | 2,103,943,289 |
| **D. Loan Payments** | | | | | | | | | | | | | | |
| 1. Principal for Fixed Inv. Loan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2. Principal for Working Cap. Loan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Loan Payments** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **E. Ending Cash Balance** | **732,831,401** | **831,894,749** | **932,013,522** | **1,033,197,171** | **1,135,455,196** | **1,238,797,144** | **1,343,232,613** | **1,448,743,798** | **1,555,093,736** | **1,662,570,540** | **1,771,184,023** | **1,880,944,041** | **1,991,860,487** | **2,103,943,289** |

## *Appendix 3: Projected Balance Sheets (US$)*

| **ITEMS (In US$)** | **2,024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** | **2032** | **2033** | **2034** | **2035** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I. ASSETS | | | | | | | | | | | | |
| **1.1. CURRENT ASSETS** | | | | | | | | | | | | |
| Total Current Assets | 16,355,946 | 60,823,475 | 95,484,359 | 145,397,995 | 197,608,860 | 251,765,402 | 308,603,731 | 368,173,329 | 430,525,353 | 495,712,703 | 563,790,085 | 634,814,081 |
| **1.2. FIXED ASSETS** | | | | | | | | | | | | |
| Total Fixed Assets | 342,370,653 | | | | | | | | | | | |
| Accumulated Depreciacion | | 1,298,330 | 2,596,660 | 3,894,989 | 5,193,319 | 6,491,649 | 7,789,979 | 9,088,308 | 10,386,638 | 11,684,968 | 12,983,298 | 14,281,627 |
| Book Value of Fixed Assets | 342,370,653 | 341,072,323 | 339,773,993 | 338,475,664 | 337,177,334 | 335,879,004 | 334,580,674 | 333,282,345 | 331,984,015 | 330,685,685 | 329,387,355 | 328,089,026 |
| POI | 8,323,514 | | | | | | | | | | | |
| Accumulated POI | 0 | 332,941 | 665,881 | 998,822 | 1,331,762 | 1,664,703 | 1,997,643 | 2,330,584 | 2,663,524 | 2,996,465 | 3,329,406 | 3,662,346 |
| Book Value of POI | 8,323,514 | 7,990,573 | 7,657,633 | 7,324,692 | 6,991,752 | 6,658,811 | 6,325,871 | 5,992,930 | 5,659,990 | 5,327,049 | 4,994,108 | 4,661,168 |
| **TOTAL ASSETS** | **367,050,113** | **409,886,372** | **442,915,985** | **491,198,351** | **541,777,946** | **594,303,217** | **649,510,276** | **707,448,604** | **768,169,358** | **831,725,438** | **898,171,549** | **967,564,275** |
| **2. LIABILITIES & EQUITY** | | | | | | | | | | | | |
| Total Current Liabilities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2.2. LONG TERM LIABILITIES** | | | | | | | | | | | | |
| 1. Fixed Investment Loan | 245,801,527 | 245,801,527 | 221,221,374 | 196,641,222 | 172,061,069 | 147,480,916 | 122,900,764 | 98,320,611 | 73,740,458 | 49,160,305 | 24,580,153 | 0 |
| **Total Long Term Liabilities** | 245,801,527 | 245,801,527 | 221,221,374 | 196,641,222 | 172,061,069 | 147,480,916 | 122,900,764 | 98,320,611 | 73,740,458 | 49,160,305 | 24,580,153 | 0 |
| **3. EQUITY** | | | | | | | | | | | | |
| 1. Equity | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 |
| 2. Profit of Previous Period | | | 42,836,259 | 100,446,025 | 173,308,543 | 248,468,291 | 325,573,715 | 405,360,927 | 487,879,407 | 573,180,314 | 661,316,546 | 752,342,810 |
| 3. Current Profit | | 42,836,259 | 57,609,766 | 72,862,518 | 75,159,748 | 77,105,424 | 79,787,211 | 82,518,480 | 85,300,907 | 88,136,233 | 91,026,264 | 93,972,879 |
| **Total Equity** | 121,248,586 | 164,084,845 | 221,694,611 | 294,557,129 | 369,716,877 | 446,822,301 | 526,609,513 | 609,127,993 | 694,428,900 | 782,565,132 | 873,591,396 | 967,564,275 |
| **TOTAL LIABILITIES AND EQUITY** | **367,050,113** | **409,886,372** | **442,915,985** | **491,198,351** | **541,777,946** | **594,303,217** | **649,510,276** | **707,448,604** | **768,169,358** | **831,725,438** | **898,171,549** | **967,564,275** |

## *Appendix 3: Projected Balance Sheets (US$) Cont'd*

| **ITEMS (In US$)** | **2036** | **2037** | **2038** | **2039** | **2040** | **2041** | **2042** | **2043** | **2044** | **2045** | **2046** | **2047** | **2048** | **2049** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I. ASSETS | | | | | | | | | | | | | | |
| **1.1. CURRENT ASSETS** | | | | | | | | | | | | | | |
| Total Current Assets | 732,831,401 | 831,894,749 | 932,013,522 | 1,033,197,171 | 1,135,455,196 | 1,238,797,144 | 1,343,232,613 | 1,448,743,798 | 1,555,093,736 | 1,662,570,540 | 1,771,184,023 | 1,880,944,041 | 1,991,860,487 | 2,103,943,289 |
| **1.2. FIXED ASSETS** | | | | | | | | | | | | | | |
| Total Fixed Assets | | | | | | | | | | | | | | |
| Accumulated Depreciacion | 15,579,957 | 16,878,287 | 18,176,617 | 19,474,946 | 20,773,276 | 22,071,606 | 23,369,936 | 24,668,265 | 25,966,595 | 27,264,925 | 28,563,255 | 29,861,584 | 31,159,914 | 32,458,244 |
| Book Value of Fixed Assets | 326,790,696 | 325,492,366 | 324,194,036 | 322,895,707 | 321,597,377 | 320,299,047 | 319,000,717 | 317,702,388 | 316,404,058 | 315,105,728 | 313,807,398 | 312,509,069 | 311,210,739 | 309,912,409 |
| POI | | | | | | | | | | | | | | |
| Accumulated POI | 3,995,287 | 4,328,227 | 4,661,168 | 4,994,108 | 5,327,049 | 5,659,990 | 5,992,930 | 6,325,871 | 6,658,811 | 6,991,752 | 7,324,692 | 7,657,633 | 7,990,573 | 8,323,514 |
| Book Value of POI | 4,328,227 | 3,995,287 | 3,662,346 | 3,329,406 | 2,996,465 | 2,663,524 | 2,330,584 | 1,997,643 | 1,664,703 | 1,331,762 | 998,822 | 665,881 | 332,941 | 0 |
| **TOTAL ASSETS** | **1,063,950,324** | **1,161,382,402** | **1,259,869,905** | **1,359,422,284** | **1,460,049,037** | **1,561,759,716** | **1,664,563,914** | **1,768,443,828** | **1,873,162,497** | **1,979,008,030** | **2,085,990,243** | **2,194,118,991** | **2,303,404,166** | **2,413,855,698** |
| **2. LIABILITIES & EQUITY** | | | | | | | | | | | | | | |
| Total Current Liabilities | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2.2. LONG TERM LIABILITIES** | | | | | | | | | | | | | | |
| 1. Fixed Investment Loan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Long Term Liabilities** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **3. EQUITY** | | | | | | | | | | | | | | |
| 1. Equity | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 | 121,248,586 |
| 2. Profit of Previous Period | 846,315,689 | 942,701,738 | 1,040,133,816 | 1,138,621,319 | 1,238,173,698 | 1,338,800,451 | 1,440,511,130 | 1,543,315,328 | 1,647,195,243 | 1,751,913,911 | 1,857,759,444 | 1,964,741,657 | 2,072,870,405 | 2,182,155,580 |
| 3. Current Profit | 96,386,049 | 97,432,077 | 98,487,503 | 99,552,379 | 100,626,754 | 101,710,678 | 102,804,199 | 103,879,914 | 104,718,669 | 105,845,533 | 106,982,213 | 108,128,748 | 109,285,175 | 110,451,532 |
| **Total Equity** | 1,063,950,324 | 1,161,382,402 | 1,259,869,905 | 1,359,422,284 | 1,460,049,037 | 1,561,759,716 | 1,664,563,914 | 1,768,443,828 | 1,873,162,497 | 1,979,008,030 | 2,085,990,243 | 2,194,118,991 | 2,303,404,166 | 2,413,855,698 |
| **TOTAL LIABILITIES AND EQUITY** | **1,063,950,324** | **1,161,382,402** | **1,259,869,905** | **1,359,422,284** | **1,460,049,037** | **1,561,759,716** | **1,664,563,914** | **1,768,443,828** | **1,873,162,497** | **1,979,008,030** | **2,085,990,243** | **2,194,118,991** | **2,303,404,166** | **2,413,855,698** |

(17)

GN. No. 349

THE UNITED REPUBLIC OF TANZANIA

# ENVIRONMENTAL IMPACT ASSESSMENT

# Certificate

***[Section 92(1) of the Environmental Management Act No. 20 of 2004]***

**Application Reference No.10901**

**Registration No. EC/EIA/2021/0533**

**This is to Certify that**

*M/S.* ....NATIONAL DEVELOPMENT CORPORATION (NDC)........................

*of*.........P. O. BOX 2669, DAR ES SALAAM..........................................

*has this day been granted an Environmental Impact Assessment Certificate for the proposed project/Activity titled*..ESTABLISHMENT OF SODA ASH PROJECT..........................

*to be implemented/carried out at* ENGARUKA CHINI, MBAASHI, IRERENDENI AND IDONYONAADO VILLAGES, ENGARUKA BASIN IN MONDULI DISTRICT, ARUSHA REGION

*This certificate shall remain in force during the whole lifecycle of this specific project unless henceforth revoked or suspended.*

*General conditions and terms attached to this certificate are set out herein behind and specific conditions are annexed.*

Dated this........24...................day of ..........06..................2021

..........................................

**Selemani Saidi Jafo (MP)**

Minister of State, Vice President's Office - Union and Environment

**CONDITIONS OF CERTIFICATE**

1. This Certificate is valid during the whole lifecycle of this specific project unless henceforth revoked or suspended.
2. The Minister shall be notified of any transfer/variation/surrender of this certificate.
3. Observe all relevant national policies and legislation that guide this specific project throughout its life cycle.
4. Ensure safe disposal of all types of wastes (solid or liquid) in specified sites.
5. Ensure environmental sustainability by avoiding any form of pollution by using most viable management techniques.
6. Adhere to the Environmental Management Plan (EMP) and Monitoring plan (MP) and constantly improve and update them by taking into account any new development.
7. Constantly liaise with relevent authorities and consult stakeholders including local communities in case of any new development or changes as regards to implementation of your project plan activities.
8. Adhere to all proposed mitigation measures as specified in the Environmental Management Plan contained in the Environmental Impact Statement.
9. Abide to all national social and environmental safeguard policies and standards and strive to maintain and constantly improve standards.
10. Prepare an Emergency and Contingency plan and put in place risk and safety measures.
11. Conduct periodic Environmental Audits and facilitate monitoring by relevant authorities.
12. Design and implement an internal Environmental and Safety Policy and Awareness Programme.
13. Prepare Annual Environmental Reports and any other reports requested by competent authorities and the Government.
14. Obtain all other relevant permits.

**The above conditions shall be read together with the specific conditions spelt out in the Annex attached to this Certificate**

**NATIONAL ENVIRONMENT MANAGEMENT COUNCIL (NEMC)**

***BARAZA LA TAIFA LA HIFADHI NA USIMAMIZI WA MAZINGIRA***

Tel: No. Dir.: +255 22 277 4852
Tel: +255 22 277 4889
Mobile: +255 713 608930
Fax: +255 22 277 4901
E-mail: nemc@nemctan.org

Regent Estate Plot 29/30
P.O. Box 63154,
DAR ES SALAAM,
TANZANIA

# *Delivery Note*

**M/S. NATIONAL DEVELOPMENT CORPORATION (NDC), P.O. Box 2669, DAR ES SALAAM,** hereby confirm that, for the purpose of "Section 92 (1) of the Environmental Management Act No. 20 of 2004," I have read and understood to the best of my knowledge the conditions of the EIA Certificate **NO. 10901/EC/EIA/2021/0533 of 24TH JUNE, 2021** issued regarding the implementation of the proposed project/activity titled: **ESTABLISHMENT OF SODA ASH PROJECT.** In view of the above, I agree to adhere to the stipulated **"CONDITIONS OF CERTIFICATE"** and **"SPECIFIC TERMS"** annexed herein.

Dated this 05TH day of JULY 2021

DR. YOHANA MTONI

Name Signature

NATIONAL DEVELOPMENT CORPORATION
P.O. Box 2669
DAR ES SALAAM

Proponent's Official Seal

Title/Position: ACTING DIRECTOR, HEAVY INDUSTRIES

Issued by:
LILIAN LUKAMBUZI

Name Signature Official Seal

**For: Director General NEMC**

THE UNITED REPUBLIC OF TANZANIA

ENVIRONMENTAL IMPACT ASSESSMENT

# Certificate

*[Section 92(1) of the Environmental Management Act No. 20 of 2004]*

**Application Reference No.10901**

**Registration No. EC/EIA/2021/0533**

**This is to Certify that**

*M/S.* NATIONAL DEVELOPMENT CORPORATION (NDC)

*of* P. O. BOX 2669, DAR ES SALAAM

*has this day been granted an Environmental Impact Assessment Certificate for the proposed project/Activity titled* ESTABLISHMENT OF SODA ASH PROJECT

*to be implemented/carried out at* ENGARUKA CHINI, MBAASHI, IRERENDENI AND IDONYONAADO VILLAGES, ENGARUKA BASIN IN MONDULI DISTRICT, ARUSHA REGION

*This certificate shall remain in force during the whole lifecycle of this specific project unless henceforth revoked or suspended.*

*General conditions and terms attached to this certificate are set out herein behind and specific conditions are annexed.*

Dated this 24 day of 06 2021

**Selemani Saidi Jafo (MP)**

Minister of State, Vice President's Office - Union and Environment

## CONDITIONS OF CERTIFICATE

1. This Certificate is valid during the whole lifecycle of this specific project unless henceforth revoked or suspended.
2. The Minister shall be notified of any transfer/variation/surrender of this certificate.
3. Observe all relevant national policies and legislation that guide this specific project throughout its life cycle.
4. Ensure safe disposal of all types of wastes (solid or liquid) in specified sites.
5. Ensure environmental sustainability by avoiding any form of pollution by using most viable management techniques.
6. Adhere to the Environmental Management Plan (EMP) and Monitoring plan (MP) and constantly improve and update them by taking into account any new development.
7. Constantly liaise with relevant authorities and consult stakeholders including local communities in case of any new development or changes as regards to implementation of your project plan activities.
8. Adhere to all proposed mitigation measures as specified in the Environmental Management Plan contained in the Environmental Impact Statement.
9. Abide to all national social and environmental safeguard policies and standards and strive to maintain and constantly improve standards.
10. Prepare an Emergency and Contingency plan and put in place risk and safety measures.
11. Conduct periodic Environmental Audits and facilitate monitoring by relevant authorities.
12. Design and implement an internal Environmental and Safety Policy and Awareness Programme.
13. Prepare Annual Environmental Reports and any other reports requested by competent authorities and the Government.
14. Obtain all other relevant permits.

**The above conditions shall be read together with the specific conditions spelt out in the Annex attached to this Certificate**

**SPECIFIC CONDITIONS TO NATIONAL DEVELOPMENT CORPORATION (NDC) FOR THE PROPOSED ESTABLISHMENT OF SODA ASH PROJECT AT ENGARUKA BASIN, MONDULI DISTRICT IN ARUSHA REGION**

**A. ENVIRONMENTAL MANAGEMENT PLAN IMPLEMENTATION**

1. Ensure that, the mitigation measures are implemented accordingly as stated in the Environmental Management Plan (EMP);
2. Ensure that, all nearby water sources (surface including Lake Engaruka and underground) are protected from pollution in all phases of the project;
3. Ensure that a proper environmental management organization pertinent with the type of project, at both project and site level is developed and made operational to guide the implementation of the Environmental Management and Monitoring Plans for the project;
4. The Soda Ash Project should have Health, Safety and Environmental department with a qualified environmental expert to guide implementation of the Environmental Management and Monitoring Plans;
5. Wildlife expertise should be onsite (hired) during project implementation so as to implement the requirements of the Wildlife Act, 2009;
6. District game officer, TANAPA, TAWA and any other relevant authority should be consulted during project implementation,
7. Maintain, liaison with the key regulatory institutions and sectors in the course of implementation and operation of the project and prompt reporting of incidents as per law;
8. Ensure that solid and liquid wastes are properly managed in course of the project operation;
9. Ensure that hazardous wastes, such as oil contaminated wastes, empty chemical containers, healthcare wastes are managed properly and handled by the certified dealer from relevant authority;
10. Ensure that establishment of proper monitoring schedules for noise level, soil, water and air quality are made as indicated in the Environmental Monitoring Plan;
11. Ensure low carbon development e.g. adopting rain water harvesting practices and use of solar panel as alternative source of energy,
12. Ensure that the Government through its Mandated Institutions gets access to monitoring data, monitoring network facilities and are facilitated to verify any monitoring information;
13. **Ensure that, one copy of the EIA report is submitted to Resident Mine Office-Arusha, Ministry of Livestock and Fisheries Development, TAWA and TAWIRI and District Environmental Management Officer in Monduli District Council so as to facilitate the EMP implementation and follow-up.**

**B. SAFETY MATTERS**

14. Ensure that, Health and Safety Management Plan is approved by relevant authorities and made readily available for inspection. Among other things, a record of baseline health status for each employee should be kept and regular occupational medical check-up made against that; should also observe the requirements of the Occupational Health and Safety Act, 2003;
15. Ensure that, proper and approved Personal Protective Equipment (PPE) are provided to workers and are used as required by relevant policies, regulations and guidelines;

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NATIONAL DEVELOPMENT CORPORATION
P.O. Box 2669 05/07/2021
DAR ES SALAAM

16. Ensure that safety precautions are in place and fire fighting facilities/equipments are also in place and an Emergency Preparedness and Response Plan is prepared, implemented and updated annually;
17. Ensure that safe buffer zone is established and observed;

## C. DESIGN OF THE CRITICAL FACILITIES TO COMPLY WITH BOTH NATIONAL AND INTERNATIONAL STANDARDS

18. Processing Plant, Effluent Treatment Plant (ETP), brine storage/holding ponds and brine extraction wells should be properly designed based on site specialist studies conducted on hydrology, hydrogeology, geotechnical survey and geochemical characterization of the project area to avoid environmental pollution;
19. The design of the project (Soda Ash Project) should consider the existence of wildlife and animals migratory corridors within the proposed project area;
20. All facilities whose design is by law subject to approval by a regulatory authority should be approved by such authority and the approved designs submitted to the Council for records and future reference.
21. Any changes or improvement in the design of the project and other critical components, made at any project stage, including abandonment, should be done in consultation with the Council and, after approval by respective authorities;
22. Ensure that proper design of storm water management system is in place and should be separated from waste water emanating from project operations.

## D. CORPORATE SOCIAL RESPONSIBILITY

23. All commitments aiming at demonstrating the Company's observance of the Corporate Social Responsibility (CSR) principles should for key items be in form of Memorandum of Understanding (MoU) with relevant communities and all MoUs should be witnessed by relevant Local Government Authorities (LGAs);
24. Ensure that communities around the project area and general public are aware of the dangers they can be exposed to by the project activities; in its regard, a communication and awareness raising strategy to the local community and the general public should be put in place and implemented throughout the lifetime of the project;
25. Monitoring of the environmental quality should be extended to the nearby community areas and the project buffer zone, focusing on water quality, air quality and soil quality; monitoring results should among others, be periodically communicated to the Project Affected Persons (PAPs).

## E. OTHER LEGAL REQUIREMENTS

26. Land acquisition exercise including valuation and compensation for people and institutes whose their properties will be affected should be done fairly and promptly in consultation with Monduli District Council before project implementation;
27. The multiple land use plan (model) of the area should be reviewed before project implementation in consultation with Monduli District Council and TAWA;

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NATIONAL DEVELOPMENT CORPORATION
P. O. Box 2669
DAR ES SALAAM

28. There Government Notice (GN) for Game Controlled Area (GCA). this GN should be revoked (de-Gazette) to ensure that the land use of the proposed project is compatible with the intended development;
29. Ensure to pay relevant legal fees/subscriptions to the Council in accordance with the Environmental Management (Fees and Charges) Regulations, 2021;
30. Ensure that, legal requirements by other authorities to which the operations of this project have relevance are complied with.

05/08/2021
Director General
NATIONAL ENVIRONMENT

NATIONAL DEVELOPMENT CORPORATION
05/08/2021
P.O. Box 2669
DAR ES SALAAM

# FORMS

# STANDARD POWER OF ATTORNEY

TO ALL IT MAY CONCERN

THAT BY THIS POWER OF ATTORNEY given on the *[insert date, month and year*],

WE the undersigned [*insert name of the company/donor*] of *[insert address of the company/donor*], by virtue of authority conferred to us by the Board Resolution No........... ............of ....................day of ....................................[*insert year*], do hereby ordain nominate and appoint [*insert name of donee*] of [*insert address of the donee*] to be our true lawful Attorney and Agent, with full power and authority, for us and in our names, and for our accounts and benefits, to do any, or all of the following acts, in the execution of tender No. *[insert tender number*] that is to say;
To act for the company and do any other thing or things incidental for [*insert tender Number*] of *[insert description of procurement]* for the [*insert name of the Procuring EntityPE*];

**AND** provided always that this Power of Attorney will not revoke or in any manner affect any future power of attorney given to any other person or persons for such other power or powers will remain and be of the same force and affect as if this deed has not been executed.

**AND** we hereby undertake to ratify everything, which our Attorney or any substitute or substitutes or agent or agents appointed by him under this power on his behalf herein before contained will do or purport to do in virtue of this Power of Attorney.

**SEALED** with the common seal of the said *[[insert name of the company]* and delivered in the presence of us this *[insert date]* day of *[insert month] [insert year].*

***IN WITNESS*** whereof we have signed this deed on this *[insert date]* day of *[insert month] [insert year]* at *[insert region]* for and on behalf of *[insert name of the company]* ……………………………………….

**SEALED** and **DELIVERED** by the

Common Seal of [*insert name of the donor/coy]*

This *[insert date, month and year*]

.....................................................

**DONOR**

**BEFORE ME:**

..............................................................

**COMMISSIONER FOR OATHS**

## ACKNOWLEDGEMENT

I [*insert name of donee*] doth hereby acknowledge and accept to be Attorney of the said [*insert name of the company/donor*] under the terms and conditions contained in this POWER OF ATTORNEY and I promise to perform and discharge my duties as the lawfully appointed Attorney faithfully and honestly.

SIGNED AND DELIVERED by the said
[*insert name of donee*] Identified to me
by ***[insert name]***
The latter known to me personally
This *[insert date, month and year*],

...................................................

**DONEE**

**BEFORE ME**

..................................................

**COMMISSIONER FOR OATHS**