

SCHULZE GLOBAL INVESTMENTS



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To Mr. Hal Boshier and Ms. Nkem Onwuamaegbu:

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Best Regards,

SGI ETHIOPIA CEMENT LIMITED
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Its Sole Director

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Environmental Impact Assessment Report

National Cement Share Company

Prepared by:

Fitsum Consultancy Services

December 2008

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Environmental Impact Assessment (EIA) Report Outline
(sections relevant to SGI's Double Bottom Line Impact Report)

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1. INTRODUCTION

1.1. General Overview

The investment climate in the country has improved since 1991 as a result of policy changes and formulation of the necessary legal codes. However, in Ethiopia in general and in DDA in particular investment in the manufacturing sector has remained at a rather low level as compared to other sectors. Therefore, in view of the manufacturing sector's importance for economic development a lot need to be done toward attracting investment into the manufacturing sector of DDA.

The DireDawa Administration has many favorable conditions for industrialization. In addition to the existing natural resources which can be used as a basis for industrialization, the Administration is relatively well developed in terms of social and economic infrastructures, as compared to other regions of the country. The strategic location, availability of basic social and economic infrastructures, better supply of technically skilled human resources as compared to most of the regions of the country makes DireDawa suitable for attracting investment.

The DDA has a number of mineral resources that could be utilized as industrial inputs and construction raw materials. However, of the various minerals so far investigated only few are utilized to some extent. Among the construction and industrial minerals limestone, sandstone, gravel for aggregate, dimension and cut stone, feldspar are the major ones. There are also indications for the existence of metallic mineral resources such as pegmatite and mica for electronic and optical uses. Except for limestone and clay, the potential of the mineral sector of the Administration is not yet developed. Considering the existing mineral resources in the Administration and assuming some to be imported from neighboring areas, a number of products that could be utilized in the construction, industrial and other sectors of the economy have been identified.

Cement is a finely ground hydraulic binding medium for mortar and concrete consisting substantially compounds of calcium oxide with silicon dioxide, aluminum oxide and ferric oxide which have been formed by sintering or fusion. When mixed with water, cement hardens both in airflow in separators of various kinds. Cement is a bonding agent for

materials and also it is a finely powdered substance, which possesses strong adhesive power when combined with water. In construction and engineering works, the word cement means hydraulic cement, which is by far different from other bonding agents such as adhesive, asphalt and commercial clay, epoxy resin, glue and mucilage. Among the cementing materials, the most common and widely used in construction is the Portland cement. This hydraulic cement is produced by burning an intimate mixture of clay and limestone materials and grinding the resulting clinker to a fine powder, usually with few portions of gypsum to retard the set. Other hydraulic cements of vital importance in construction and engineering works can be produced by using Portland cement as a base material. These include:-

- Portland blast furnace slag cement,
- Oil- well Cement,
- Natural Cement,
- Alimonies Cement, and
- Expansive Cement

Industrial minerals are defined as rocks and minerals of economic value, which are extracted, marketed, and used for their physical and/or chemical properties. This definition encompasses construction minerals, including sand and gravel, crushed rock aggregates which in industrialized countries tend to dominate both the volume and value of mineral production.

Industrial minerals have great role in national economies with few exceptions. The tonnage and value of the production of industrial minerals exceed that of metals in most industrialized countries. This fact has prompted some writers to suggest that production of industrial minerals can be used as a measure of the industrial maturity of a country, the later the point at which industrial minerals production exceeds that of the metalliferous minerals, the more recently industrialized the country has become (Bristow, 1987). Industrial minerals are highly diverse group of materials. They are used in paper, plastics, rubber, paints, fertilizers, insecticides, foodstuffs, structural products, ceramics, cement, lime, glass, chemicals, soaps, pharmaceuticals, cosmetics, bone implants, drilling fluids, catalysts, cutting tools and many other commodities, besides the traditional uses in constructions, agriculture and environmental protection.

In this case, it would seem that this is the path least developed countries should follow rather than continuing to rely on metal and fuel markets over which they have very little control. In general, industrial minerals deposits are easier to locate, found at shallow depths or at out crops, exploration and mapping is relatively simple. The difficult part is to pinpoint the area where the quality and quantity meet the commercial criteria. The availability of material testing laboratory is also an important attribute.

For most industrial minerals, infrastructure and transport costs are the most significant determinants of successful market penetration. It seems generally accepted that the larger a country, the wider the list of the natural resource & the higher the population the larger the markets. Ethiopia having a large territory and a population of more than 70 million is a very big market. There should be a mineral resource supply for the demand generated by steady growth of construction and other related industries. However, DireDawa Administration is a small region covering an area of 1200km². Its well-established road and rail connection to the center can make it to produce its natural resource more efficiently.

Generally, the mining sector is one of the niche which has been underexploited. There is substantial potential or generating foreign currency earnings and savings, contributing to industrial development and creating income, and employment opportunities in the country. Mineral production is also a significant option for diversifying the export base. Due to the above-mentioned facts, cement is an essential ingredient in the process of economic development so that It is required for virtually every type of construction activity. Due to this fact, the cement plant has a backward linkage with the mining sector and a forward linkage with the construction sector, neither industrial nor agricultural progress is not possible without it.

1.2 Background

This document presents the findings of an Environmental Impact Assessment (EIA) of the proposed National Cement Share Company establishment project. The proposed new production line will have a rated capacity of 1.4 million tones per year. In general, the new production line will reduce fuel consumption and improve efficiencies and environmental

performance.

The project should improve environmental conditions, if designed and executed well. However, if the project is not appropriately designed to meet the environmental and social requirements, it could result in increasing adverse impacts to the natural resource base in quality and quantity, landscape aesthetics and consequently poses' public nuisance. Incorporation of environmental concerns and issues in the project planning and design process is of paramount importance for sustainability of the project objectives. Environmental issues to be considered in the project implementation process are identified through environmental impact assessment process (EIA study). EIA study would enable to assess the existing environmental situation of the project areas , potential impacts expected to result due to project implementation and to propose mitigation measures to enable minimize adverse impacts and to enhance the beneficial impacts of the project.

Under the National and Regional EIA guidelines, both establishment and significant expansion of Industrial plants is included on the list of prescribed activities that require an application for permission to implement. The Regional Environmental Protection Authority has requested that an Environmental Impact Assessment (EIA) be conducted for the proposed project to support the application for a permit.

Fitsum Consultancy Services was retained by National Cement Share Company to prepare the EIA.

1.3 Terms of Reference for the EIA

The Terms of Reference for the Environmental Impact Assessment of the proposed cement plant project at DireDawa Ija-Aneni rural kebele is provided below. These have been adapted from World Bank guidelines and take account of National and regional EIA guidelines for EIA preparation.

Scope of Study

The Environmental Impact Assessment will address the following issues:

Legal Aspects

An outline of environmental policy and institutional framework including cognizance of legislation relating to mining, manufacturing and other issues that should be complied with and requirements for environmental approval that should be issued by EPA for the construction of the project.

Project Technical Details / Description

A description of the proposed project including:

The objective and nature of the project, Justification of the project, Outline of proposed project design including planning, design and development, technologies and processes that shall be used. Description of project activities during the planning, construction and operational / maintenance phases Expected product and by-products of the project (e.g. sewage for construction workers, construction rubble)

Description of the Environment

A baseline description of the present environment of the Region and proposed project site including its surrounding including the following:

a) The Bio-physical Environment:

Location of the site, Geology, Soils, Topography, Hydrology (surface and ground water features and drainage), Climate(both temperature and rainfall), Fauna and flora, Land use, Existing physical structures and infrastructure, Pollution situation (Both Physio-Chemical and Microbiological analysis of water samples), Existing water polluting discharges and River runoffs.

b) The Social – Economic Environment:

Population and settlement, Standards of living, Available skill levels; Land tenure and, Public health (including AIDS, and malaria), Local sensibilities (cultural and aesthetic), Lands and natural resources use, economic activities within both the Administration and project site.(E.g.agriculture, goods, and services, domestic property market), Cultural / historical / archaeological sites.

Impact Mitigation Measures

All necessary environmental mitigation measures will be identified in the environmental impact assessment of the construction and operational phases of the project. The EIA will contain a description of proposed measures for preventing, minimizing or compensating for any adverse impacts of the project as well as for enhancing beneficial effects.

1.4 Structure and Contents of the Report

The environmental assessment report is concise and limited to significant environmental issues. The main text focuses on findings, conclusions, and recommended actions and is supported by summaries of the data collected and citations for references used in interpreting those data. The environmental assessment report is organized according to the outline below.

- Executive Summary
- Introduction
- Description of Proposed Project
- Policy, Legal and Administrative Framework
- Description of the Existing Environment
- Significant Environmental Impacts and Impact Mitigation Measures
- Inter-Agency and Public/NGO Involvement
- List of References

2. PROJECT DESCRIPTION

General

The demand for cement in Ethiopia has been increasing and this was met by imports as there were inadequate numbers of cement producing factory in the country and installed capacity could not meet the country increasing demand. Based on this, NCSC proposed to tackle the demand of cement at national level by planting the second cement plant near by the old cement factory site.

The project proponent i.e. NCSC is shared company between Government and local investor of Ethiopia in production of Portland cement. The National Cement Share Company (NCSC) involves the construction and operation of cement plant at Ijaneni (Dire Dawa Administration), 6km away from Dire Dawa and 510km North East of Addis Abeba. The site has been selected based on an economic source of limestone, pumice and clay being available in convenient location, and considering on access to water, electric power and transportation facility. Most of cement plant produced in plant will be distributed to different consumption center via truck and train.

The Project will have a combined production capacity of 1,400,000 metric tones per annum (mtpa). The estimated project cost is USD 800,000 to be financed with share holder of USD 248,000 (31% of the total Project cost) and USD 552,000 in form of long-term debt from Construction and Development Bank of Ethiopia (CDBE).

Construction phase i.e. excavation, earthling and preparation of the plant site has already been started, and planting and construction of cement processing machine along of infrastructure facility will be started at the beginning of 2009, where as in March 2010 operation phase i.e. cement production will be commenced. While the project is being started more than 500 job opportunities will be created.

2.1. Scope of the Project

The scope of the project involves mining and transportation of raw material, cement

production (3000 tons per day) along with plantation work and infrastructure development with construction work. The details include the following.

- Mining operation (drilling, hauling/transportation, blasting, crushing activities among others);
- For conveying crushed limestone and additives; and construction of mine access roads;
- Infrastructural developments- construction of roads, health care center, recreation center, office buildings and development of ground water well
- Internal roads construction, development of green area and plantation of tree.
- Cement processing (calcining the raw materials in kiln, cooling the resulting clinker, mixing the clinker with gypsum and milling, bagging and storing the finished product)
- Construction of cement processing unit like clinkerization kiln, cement silos, clinker silo, cement and raw mill houses and the like,
- Installation of dust recycling and capturing device

2.2. Plant Capacity

The capacity of the proposed plant is 3000tpd of clinker production (0.495 mio tpa). Cement production has been considered as 2300tpd PPC (0.759 mio tpa PPC). Raw materials mix considered for sizing (with 100% coal usage) will be 77% of Limestone and 23% of Clay. Product and capacity of the NCSC is indicted in Table 2. 1.

Table2. 1: product and capacity

S/N	Product type	Production capacity (tone per year)
1	Portland clinker	930000
2	Cement	1400000

Coal consumption has been considered at 14.5 % of clinker, computed as follows:

- Specific Fuel Consumption: 800 Kcal/kg-clinker
- NCV of coal (dry basis): 5500 Kcal/kg-Coal
- Moisture in coal (as received): 10 % (average)
- Handling & Transit Losses : 2 %

2.3. General Layout of plant

One complete 3000t/d cement production lines, from limestone crushing to cement packaging, will be found in the general layout plan.

Generally speaking, the project will be satisfactory in the following technical processes and material transportation. After the establishment, the site will enjoy good surroundings inside and outside of the compound. See the technical economical index of general layout in the following Table.

Table 2.2: Technical Economical Index of General Layout

No	Title	Unit	Qty.	Remark
1	plant site area	Ha	40.1	
2	buildings area	M ²	59300	
3	pile and operation place area	M ²	35000	
4	structure index	%	23.52	
5	site road and square area	M ²	52000	
6	utilization index	%	36.49	
7	greening area	Ha	8.02	
8	greening index	%	20.00	

2.3.1. Vertical design and anti-flooding

It is even relatively in plant site, and the ground leveling will be done in continuous grounds so as to decrease earthwork and retaining walls. Water catchments around the site are not large in volume, and sewers in site can be drained out along the terrain.

2.3.2. Plant site transportation

Limestone, clay, marl, coal, iron powder, additives and gypsum are trucked in. See the transportation capacities in Table 2.3 below.

Table 2.3: Annual Transportation Capacity

Title	Source	Capacity (t)	Distance (km)	Transportation means	Direction
Limestone	in mines	1146087	1-1.5	by truck	enter
Clay	Melka jebdu	297711	9	by truck	enter
Coal	Imported	146504	—	by truck	enter
Gypsum	Dewelle town	76064	194	by truck	enter
Pumice powder	Koka & Dire-Harorety	446976	435 & 8 Respectively	by truck	enter
Bagged cement	in site	1430769	—	by truck	exit

Road in the site is designed as suburban road and the main road as double lane with a width of 7m; department approach road as single lane and with 4.0 m width; and the pavement is made of concrete. Dump trucks will be used for the transportation of raw materials up to discharge pits. Conveyor belt is used for the transportation of raw materials up to the stock pile.

Roadway bridge is used for the metering of raw materials shipped in and products shipped out from this project. Roadway bridges are located at the entrance and exit for products and raw materials.

2.3.3. Site greening

To beautify the plant surroundings and achieve green field plant site, NCSC plan to have belt greening and clustered greening, where the roadsides are greening belts and clustered green are around workshops. Local anti-dusting species especially ornamental plantation will to be planted in. Reforestation around site office building, main gate and so on, will be reinforced. The overall reforestation will be about 8 hectares, that surroundings and image of plant site will be enhanced greatly, contributing to the erection of modern plant site. So the site greening will be done as designed.

2.4. Raw material

Most of the raw materials needed for the manufacture of cement are available in Dire Dawa Administration. The basic raw materials for the production of cement are limestone, Coal, clay, pumice, and gypsum. All of these raw materials, with the exception of coal are available in the country.

2.4.1. Limestone

The limestone which belongs to the upper part of the Jurassic Antalo Formation, dips at between 30 and 40° to the east. It is intersected by sub vertical dykes of Tertiary igneous rocks comprising fine grained porphyritic Andesite-Basalt. The dykes are between 20 cm and 16 cm or more wide and are estimated to constitute around 10% of the rock mass. The average chemical composition (%) of limestone sample is given below:

Table 2.4: Average chemical combustion of Limestone (%)

LOI	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	K ₂ O	Na ₂ O	SO ₃	P ₂ O ₅	Cl
41.52	3.98	0.82	0.76	50.96	1.18	-	-	-	-	-

Moisture content of limestone is 6%. From the given composition it may be observed that limestone is high in CaO and low in SiO₂, Al₂O₃ and Fe₂O₃. For its use in cement manufacture it would require substantial compensation for these constituents for which use of clay, Pumice has been considered.

2.4.2. Clay

Clay is currently worked from small quarries in an alluvial or lateritic deposit close to the plant. A new deposit, as yet unexploited, has been identified at Mekla Jebdu, some 9 km to the west of Dire Dawa and which will be used as the source of clay for an expanded works. Moisture content of clay is 5.5 %.The average chemical composition (%) of clay sample is given below in Table 2.5:

Table 2.5: Average chemical combustion of Clay (%)

LOI	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	K ₂ O	Na ₂ O	SO ₃	P ₂ O ₅	Cl
17.45	47.86	12.12	6.71	10.43	2.50	-	-	-	-	-

2.4.3. Pumice

Koka has, until recently, been the primary source of pumice for all MCE's Cement factories, including that at Addis-Abeba. The site is near to the town of Nazareth, South of Addis Ababa. Production at this site has recently been supplemented by that being developed at Dire- Harorety, which is closer to Addis Abeba. Koka is located close to the edge of the Ethiopia Rift valley. Pumice is developed on a board north-south trending ridge in which several quarries have been opened. Hard over burden comprising rhyolite and welded tuffs several meters in thickness is developed over most of site. The Koka

pumice deposit area was studied by the Ethiopian Geological Survey in 1976 with a view to establishing its suitability for block manufacturing. Twenty pits were dug with an average depth of five meters and bulk samples were collected from each pit. The estimated reserve was 525000 tones as VEB reported in 1982, the results of geological mapping, trenching and drilling at Koka. The report pre-dates the opening of the new (southern) pumice quarry.

Harorety (Dire Dawa Administration) is one of several known recent age occurrences of pumice, volcanic ash and scoria in the Main Ethiopia Rift valley. A report “feasibility Study for Harorety (Dire Dawa Administration) Pumice Mining Project” was submitted to MCE in June 1999 by Taye Alemayehu. The report discusses the rationale for exploiting pumice at this site and includes incomplete notes on the geological investigations carried out, including geological mapping and pitting. A reserve estimation based on the data in this report (at best only a geological resource estimate) is based on an assumption that minable pumice occurs to a depth of 20 meters through a rectangular area of 1500 by 600 meters. This estimate is based on no real evidence and is considered totally inadequate. However, it is evident from local exposures and the small amount of quarrying that has taken place to date at Harorety (Dire Dawa Administration) that there are considerable thicknesses of pumice over at least part of this site. Moisture content of pumice is 12.9 %.The average chemical composition (%) of Pumice sample is given below:

Table 2.6: Average chemical combustion of Pumice (%)

LOI	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	K ₂ O	Na ₂ O	SO ₃	P ₂ O ₅	Cl
4.0	69.16	12.59	5.85	2.09	1.48	-	-	-	-	-

2.4.4. Gypsum

Gypsum is available near Dewelle town, 194 km Northeast of Dire Dawa. Moisture content of Dewelle Gypsum is 4.8 % and Purity 69%. The average chemical composition (%) of Gypsum sample is given below:

Table 2.7: Average chemical combustion of Gypsum (%)

LOI	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	K ₂ O	Na ₂ O	SO ₃	P ₂ O ₅	Cl
23.52	4.68	1.07	0.77	31.55	1.37	-	-	40.26	-	-

2.4.5. Fuel

Coal is used as fuel for this plant. Coal will be imported.

Typical Analysis of coal is given below:

- Total Moisture :10%
- Inherent Moisture :3.2%
- Ash content :14.5%
- Volatile Matter :26%
- Total sulphur :<2.0%
- Net Calorific Value :5500 kcal/kg

Fuel oil is also used for as alternative fuel. Analysis of Heavy Fuel Oil is given below:

- Specific Gravity at 60⁰ F :0.890 - 0.960
- Flash Point (P.m) ⁰F :Min 150
- Sulphur %wt :Max 3.5
- Calorific Value :Min 18500 BTU/LB
- Viscosity kinematics at 122 D.F CST :180
- Pour Point deg F :Max 65
- Carbon residue :Max 10
- Water Content, % vol :Max 0.5
- Ash % Wt :Max 0.05
- Sediment By extraction % Wt :Max 0.1

2.5. Process Description

The production of cement includes mining; crushing and grinding of raw materials (principally limestone and clay); calcining the materials in a kiln; cooling the resulting clinker; mixing the clinker with gypsum; and milling, storing and bagging the finished cement. The process results in a variety of wastes, including dust, which is captured and recycled to the process.

2.5.1. Limestone crushing and transportation

Trucked to the site from the mine, limestone and high-quality limestone are directly discharged at their discharging pit, and crushed in the PCF20.22 single-stage hammer crusher via heavy-duty apron feeder B2000×10000mm. And the crushed limestone is kept in its pile, through belt conveyor, side cantilever stacker.

Clay trucked in (size<100mm) is directly discharged at its discharging pit, and via medium apron feeder, belt conveyor sent to side cantilever stacker which will put the clay into an uniform pre-homogenization storage pile.

Crushed limestone and clay will be stored in the rectangular limestone pre-blending storage. Limestone pre-blending adopts rectangular pre-blending stockpile with side stacker stacking. The 42×196m limestone has pre-blending yard with reserve of 25000t. The stacker will be used for continuous stacking, and scraper will be adopted for reclaiming. The 42×10m high quality limestone has pre-blending yard with reserve of 500t. The 42×50m clay has pre-blending yard with reserve of 8900t. The stacker (share with limestone) will be used for continuous stacking, and side scraper charger will be adopted for reclaiming.

The limestone and clay after pre-blending will be conveyed to raw material proportioning station by belt conveyors.

2.5.2. Raw coal, gypsum crushing & pumice powder transportation

Raw coal A, trucked in is discharged directly at the coal crushing, and via medium apron feeder fed into the jiggling screen, and big coal blocks (>25mm) on the screen will be directly sent to be crushed in PCH1010 ring hammer crusher, and the crushed coal and raw coal screened out will be stored uniformly in the raw coal homogenization pile via belt conveyor and stacking trolley.

Raw coal B (≤25mm) trucked in will be directly discharged in the raw coal B pile, discharged to its hopper, and via belt conveyor stored in coal mill feeding hopper, before feeding. Gypsum trucked in is directly discharged at its pit for crushing, and via B1000×18000mm medium apron feeder will be fed into PCF1609 impact crusher. The crushed gypsum will be stored uniformly in its pile via belt conveyor, stacking trolley.

Pumice trucked in (<25mm) will be discharged directly to its discharging pit, and via double-layered rod valve, belt conveyor, stacking trolley will be stored in its pre-homogenization pile.

Raw coal transported by truck, directly discharged at its exclusive stacking yard, and conveying to shaker by apron feeder, after shaking the big coal bring to hammer crusher ,the small coal enter to belt conveyor directly. After crushing, the coal then will be sent to the combined pre-homogenization storage.

Gypsum will be directly discharged at an exclusive hopper, and crushed in the PCF1609 hammer crusher medium plate feeder B1000×18000mm. After crushing, then the Gypsum will be sent to the combined pre-homogenization storage by belt conveyors. The gypsum after pre-blending will be conveyed to gypsum feed hopper before cement mill by belt conveyor.

Pumice powder will be directly discharged at the additives shed and will be stored in pumice powder pile by front loader later will be send to the combined pre-homogenization storage by belt conveyors. The pumice powder after pre-blending will be conveyed to pumice powder feed hopper before cement mill by belt conveyor.

2.5.3. Combined pre-homogenization storage & Transportation

Crushed coal, crushed gypsum and pumice powder will be carried to combined pre-homogenization storage by belt conveyor to be stored. Combined pre-homogenization storage is 42×256m longitude storage.

The coal in the Combined pre-homogenization storage will be reclaimed by a side scrapper re-claimer with the capacity of 130 t/h. Reclaimed coal will be conveyed to the feed bins of coal mill.

The gypsum and pumice powder in the combined pre-homogenization storage will be reclaimed by a side scrapper re-claimer with the capacity of 130 t/h. Reclaimed gypsum and pumice powder will be conveyed to the feed bins of gypsum and pumice powder.

2.5.4. Raw material proportioning & transportation

Raw meal proportioning will employ three silos, and weighing belt of frequency control, the proportioning silo of limestone will be of $\phi 8\text{m}$ steel plate, while clay proportioning silo will be of $\phi 6\text{m}$ steel plate.

2.5.5. Raw mill & waste gas treatment at kiln inlet

After meeting the requirements of grind ability test, raw meal will enter into vertical mill which is MLS3726 made in china.

When raw mill is working: waste gas come from pre-heater will be blown to raw mill by high temperature fan and will be discharged by the system fan, then de-dusted and cleaned by the bag filter at kiln inlet, and finally will be released via chimney into the atmosphere by kiln exhaust fan.

When coal powder grinding mill is working: waster gas come from pre-heater will become drying source for coal powder grinding in coal powder mill. This will have a device for avoiding explosion.

When raw, coal powder mill are off: waste gas come from pre-heater will be blown to kiln inlet bag filter, finally will be released via chimney into the atmosphere by kiln exhaust fan. The Isolating damper is found in the hot air duct between pre-heater fan and raw mill before hag to isolate Kiln during hag operation.

2.5.6. Raw meal blending silo & kiln inlet feeding

Raw meal from raw mill is to be stored in IBAU silo of $\phi 18\text{m}$, impact flow meter will be employed at kiln inlet feeding, and raw meal will be carried into pre-heater system by belt type bucket elevator. The impact flow meter made in Europe.

2.5.7. Kiln pre-heater & pre-calciner system

Kiln inlet employs single line 5 stage cyclones pre-heater and KSF calciner.

2.5.8. Calcining kiln & kiln inlet

After pre-calcining processing, raw meal will be calcined into clinker in rotary kiln of $\Phi 4.3 \times 62\text{m}$, with heat consumption as 750kCal/kg-cl . High temperature clinker from rotary kiln will be cooled sharply by cold air blown in below from grid plate in grate cooler. The

temperature of clinker from grate cooler is ambient temperature + 65 C⁰ cooled and crushed clinker will be taken into clinker silo by bucket chain conveyor.

Part of high temperature exhaust gas from cooler will become secondary air; other part will become combustion air in calciner via tertiary air duct; and the rest will be released into the atmosphere after the treatment of kiln inlet electric dust collector. Fine ash from electric dust collector will be carried into clinker silo via chain conveyor and clinker bucket chain conveyor.

In order to meet the need of clinker baking, heavy oil baking system will be used as standby system in designing. There is one heavy oil tank in the plant. When lacking of coal it will be supplied with heavy oil to meet the need of clinker baking for kiln outlet and kiln inlet calciner.

2.5.9. Clinker storage & transportation

Bucket chain conveyor will be adopted for conveying clinker from cooler. A two-way gate will be adopted at the discharge of clinker bucket chain conveyor for diverting "Reject" into reject silo. Normal clinker will be transported to clinker silo for clinker storage. One Φ45m circular silo will be applied for clinker storage with effective capacity of 50,000t. One truck loading system, under "Reject" silo will be provided to evacuate the clinker and transporting to other areas of the plant or to the market. The clinker out of silo will be sent to the clinker feed hopper before cement mill by belt conveyor.

2.5.10. Cement grinding and conveying

For cement grinding purpose twoΦ4.2×14.5m cement mill will be used. Four feed hopper with belt weigh feeders for the extraction of materials will be provided for cement mill system.

Two Φ4.2×14.5m closed circuit ball mill cement grinding systems, each capable of producing 100t/h of cement at 3200cm²/g Blaine will be provided for finish grinding. The fresh feed will be mixed with rejects from the high efficiency separator and forms the total feed to the mill. The mill discharge will be conveyed by bucket elevator to the separator. The separator removes the product while the coarse rejects will be re-circulated back to

the mill for further grinding. A mill bag filter will be provided for venting of cement. Cement collected in the bag filter, will be transported to four Φ 15m cement silo with the help of air slides and bucket elevator. Provision of Hot air from cooler through a booster fan will be made for drying pumice in Cement mill/ pumice dryer.

2.5.11. Cement storage and bulking

Cement from cement mill system will be stored in 4 - Φ 15m cement silo, and truck bulking systems are demanded at side of two silos, the other two silos preserve hole for bulking systems in future. Cement will be carried to packing system from the silo bottom. The storage capacity for one cement silo will be 8000t. Bag filter at silo extraction area will be provided.

2.5.12. Cement packing, cement product shed

Cement from bottom of silos will be lifted by the bucket elevator. Then it will enter into cement packing system.

Packing will employ four sets rotary packer with 8 mouths, and cement bagged will be transported by belt conveyor to bag cement truck loader system. There will be eight belt-loaders in truck loader system, for packaged truck loading.

2.5.13. Pulverized coal preparation and weighing system

Hot air from kiln inlet ID fan will serve in pulverization of coal, hot air after filtered by cyclone will be sent to coal mill hot air inlet via hot pipe.

Two coal bins will be installed before the coal mill grinding system. There will be weighing belt under the bins. After weighing, the raw coal will go to the MPF1915 vertical coal mill for grinding. When the mill feed moisture less than 10%, pulverized coal moisture will be less than 1%. Coal feeding size will be less than 50mm and fineness will be less than 8% on 80 μ m mesh sieve. The system capacity will be 25t/h. The exhaust gas from grate cooler will be used as drying heat source of coal mill.

After grinding, the final pulverized coal will be collected by pulse bag filter and then conveyed by screw conveyor to one of pulverized coal bins for storage. The exhaust gas will be emitted to the atmosphere after cleaning. The other bin will be pulverized coal

weighing system at the pulverized coal bin bottom. After weighing by weighing system, the pulverized coal will be sent to kiln and pre-calciner respectively.

2.6. Auxiliary Part for Cement Processing

2.6.1. Compressed air station

There will be two air compressor stations in the site, that is, 7 sets of screw air-boosting compressors in all of 23m³/min as displacement and the pressure will be 0.8Mpa. One air compressor station will be set below the kiln pre-heater frame with 4 sets screw air-boosting compressor, the other which will be below the proportioning silo of cement mill shop, will meet the demands of every pneumatic valve, kiln pre-heater block-up, measuring device and pulsed bag dust collector and so on.

2.6.2. Pump House & Storage for HFO

Trucked to the site heavy oil unloading by, 4 simplex unloading pumping will be set to the heavy oil tank.

2.6.3. Boiling System for HFO

Heavy oil from its silo will be sent to the burner at kiln outlet and that at kiln inlet calciner via heavy oil heating unit, oil pump and so on.

2.6.4. Central laboratory

There will be one central laboratory (located in central control building), discharging of the normal chemical analysis and physical tests of raw materials carried in or out site, fuels, semi-finished or finished products which guarantees the product quality at each stage, and is a headquarter for regulating, managing and supervising over cement quality.

2.6.5. Electrical and Automation

A. Electric Power source

The main power supply voltage level of the project will be 66kV, and it will be led in the main substation of the plant by overhead line in single loop, and the capacity of source will no less than 25000 KVA (The actual transformer capacity will be determined after detail design with actual connected load, with 15% margin).

In order to maintain the class 1 power supply system in site, it will be used a diesel generator 800kW as the emergency supply, which will be for kiln accessory conveyor, grate cooler fan, fire pump and emergency lighting, so on. The Scheme will be as per SLD & Architechaual drawing enclosed is overriding this description

Electric Power Supply Level:

Site leading-in voltage :	66kV
MV distribution voltage:	6.3kV
MV motor rated voltage:	6.0kV
LV distribution voltage:	0.4kV
LV motor rated voltage:	0.38kV
General lighting voltage:	0.22kV
Maintenance lighting voltage:	36V

Technical economical index for Electric power supply system:

Over site power capacity :	30680kW
Power capacity of high voltage 6.0kV :	19655kW
Over site computation of active load:	21470kW
General electrical consumption of cement per ton :	100.00kW.h/t
Annual overall electrical consumption:	14000×104kWh

Electric Power supply system: The main substation 66kV/6.3kV will be designed and constructed in site. This substation will radiantly supply to Electrical Rooms and substations of the whole production line, and substation for living area with 6.3kV voltage level. The actual transformer capacity will be determined after detail design with actual connected load, with 15% margin.

There will be four electrical rooms (E.R) and through the production line: they are E.R for limestone crushing, raw mill, kiln inlet, kiln outlet and coal mill, cement mill. In these four electrical rooms there will be medium-pressure switch houses, transformer houses 6.3/0.4kV and low-voltage switch houses and so on. Besides, there will be three substations, for raw mill proportioning, cement packing and living area. The power 6.3kV of each substation will be just led in from the nearby electrical room.

Electrical rooms and Substations will employ flooring layout plan, a dis-connector will be fixed at the high-voltage side of the distribution transformer of substation while at the leading-out terminal of LV side general breaker will be fixed. Windows at each electrical room and transformer stations will be omitted to exclude mill dust and severely freezing weather in local winter, fan on the wall will blow in fresh air through screen, maintaining in slightly positive pressure. Electrical room will be equipped with fluid operated cabinet which has a heater of itself. Indoor temperature is beyond 50 C⁰ in the electrical room, which will be warmed up by electrical heater. Generally speaking, each electrical room will have two doorways, one will be of two-gate for the entrance of equipments, and the other single-gate will be for staff.

B. Production automation

Principles and proposals: Aiming to fulfill the technical requirements of modern cement production line and guarantee the stable operation of technical equipments, stability of technical parameters and product quality, to save power and enhance running rate of production line, NCSC will adopt leading technology for this project, which is dependable in performance, based on PLC and host computer (which shortened to be control system). The control system controls the main production line as supervisor, operator and branch charger combined, able to enhance the stability and maintainability of electrical equipments so as to realize the modernization in control, monitoring and operation. In limestone crushing and packing departments, PLC on-site control base and operation station will be employed as master, supervisor and operator, who signal the central control room through high-speed communication network. Managerial staff can at any time see into the actual productions in a modern way.

C. Location of special apparatus

- 1) Quality control system for raw meal: to stabilize raw meal quality and guarantee the qualification of raw meal rate, employing a monitor system QCX to optimize raw meal quality control will be taken to consideration, which consists of sampling device, multi-element fluorescence spectrum analyzer, computer, external equipment and relative software. The raw meal quality monitor system

- communicates the control system with data through the communication network
- 2) Employing infrared scanner for temperature measurement of kiln enables operator at CCR computer directly to know the kiln temperature, the distribution of attached clinker, thickness of refractory brick and also can analyze temperature curves to prevent damages to kiln from falling of refractory brick during production, so as to reduce repair of refractory brick. It consists of infrared scanner system for temperature measurement, computer, external equipment and relative software.
 - 3) Kiln inlet EP entrance demands a CO gas analyzer, O₂, CO analyzers will be set at outlet of C1 cyclone of pre-heater & CO analyzer at outlet of coal mill EP. Gas analyzer consists of sampling probe, back-flushing cabinet, pre-treatment and analyzer cabinet.
 - 4) It will be easy to be handled by CCR by providing industrial television monitors to raw materials pre-blending pile, raw mill proportioning station, cement mill proportioning station, kiln outlet and grate cooler

2.6.6. Water Supply and Drainage

A. Water Source`

Deep well is planned to get water for domestic, production and fire water consumption. The water quality and quantity are charged by the owner.

B. Water consumption

- I. Total water consumption for production: 11325.0m³/d, Including :
 - Circulation of water consumption: 11011.0m³/d
 - Direct flow consumption: 240.0m³/d
 - Water consumption at auxiliary shops: 74.0m³/d
 - Backwater in circulation: 10733.0m³/d
 - Supplement of water consumption in circulation: 278.0.0m³/d
 - Efficiency of circulation water: 97.5%
- II. Fire water makeup : 270.0m³/d
- III. Domestic water consumption: 80.0m³/d

- IV. Water consumption for watering the garden and roads: $96.0\text{m}^3/\text{d}$ Drawn from above, the total consumption of water for domestic and production systems the plant site is $768.0\text{m}^3/\text{d}$ (excluding fire water)

C. Water Source Capacity

The plant site water consumption covers the unforeseen water, which counts for 20% of it. The usual water supply is $768.0 \times 1.20 = 921.6\text{m}^3/\text{d}$. And it is $921.6 + 270.0 = 1191.6\text{m}^3/\text{d}$ when fire fighting is taken.

D. Quality & Pressure

Quality:

In circulation for the production: turbidity is $\leq 20\text{mg/l}$, the hardness of carbonate is between $80\sim 250\text{mg/l}$ (as CaCO_3 counted), $\text{PH}=6.5\sim 8.5$, temperature is $< 32^\circ\text{C}$. The quality of domestic water complies with National Hygienic Standard for Drinking Water GB5749-2006).

Pressure:

Water pressure at the production supply point is $0.25\text{-}0.35\text{Mpa}$ the shop pipe inlets and no more than 0.3Mpa at domestic water supply point for firefighting water pressure: temporary high pressure fire water supply system is employed, and the pressure and quantity will meet the fire fighting business when at fire.

E. Water Supply System

Circulation Water Supply System in Production

In order to save on water, the cooling water in each equipment will be involved in the pressure returning circulation water supply system. When the temperature of backwater of cooling water in circulation is relatively low, it can directly goes into the circulation water reservoir (two of $V=400\text{m}^3$); when temperature is high relatively, the backwater is carried to the cooling tower (GBNL3-500, 1set) via the pipe network, and the cooled water then circulates water reservoir, and sent to the circulation supply network by the circulation pumps (three sets of 2G250WFB-BD2, $Q=260.0\text{m}^3/\text{h}$ $H=55\text{m}$, $N=90\text{kW}$, two for use, the other for spare), which is meeting the cool water demands at each shop. In order to ensure the water quality, side water purifier is set, and part of backwater then enter the

automatic steel water purifier (SQ1-30, $Q=30\text{m}^3/\text{h}$, 1 set), and general water treater (WD-400A1.0ZH-F-AC, 1 set) and so on, which can refine the water quality and stabilize the circulation water quality. Circulation water loss is made up by the water source.

F. Water Supply System of Domestic, Fire Water

There is a set of high flush tank ($V=30\text{m}^3$. regulating the water quantity and pressure and 10 minutes quantity of indoor fire water), fire pump (2G200WFB-BD, $Q=180\text{m}^3/\text{h}$ $H=50\text{m}$), domestic pump (2G100WFB-E, $Q=100\text{m}^3/\text{h}$ $H=75\text{m}$), which are jointly meeting the domestic, production and fire water consumptions. In the plant site three-hour quantity of water is stored in the reservoir of domestic, fire water ($V=1000\text{m}^3$), which will be called into service when there is fire.

The outdoor hydrants are set along the road and near the cross road and the interspaces will be no more than 120m. The main pipe set with hydrants will be no less than DN100.

G. Drainage System

Plant effluent is $Q=94.0\text{m}^3/\text{d}$ and without other harmful matters except a little grease and ash, it then joints the domestic sewage treating system. Domestic sewage effluent is $Q=117.0\text{m}^3/\text{d}$.

H. Sewage Treatment

The domestic sewage (staff washing water and fecal sewage) and production effluents: due to BOD, COD and SS that break the national standard, secondary biochemical treatment is needed. In this design, it begins with pretreatment of the cesspool, then through the sewage treating station (WSZ-10 $Q=10.0\text{m}^3/\text{h}$, 1 set of sewage treating equipment). It can be discharged only after it has reached the Comprehensive Sewage Discharge Standards Class 1(GB8978-1996).

2.7. Project Emission Information with Proposed Treatment System

The crushed limestone for now is projected to be transported by truck whereas in the future it is projected to be transported inside a closed transport installation to prevent loss of materials, dust and spill over. Enclosure is important as crushed limestone falling down

from the system could pose a hazard to persons working underneath.

The storage area will contain 2x10, 000 t sufficient crushed limestone and the crushed limestone along with additives and clay stock pile will be provided with water sprays to control the dust emission.

The crushed limestone and additives will be weighed and fed in correct proportion to the raw mill to reduce the particle size down to 25 mm. The raw mill exhaust gases will be de-dusted in a bag filter with guaranteed emission level below 150 mg/m³.

Similar mitigating measures will be implemented in the clinker grinding and bagging area to remove the TSP. The homogenized mixture of fine limestone, high grade limestone and clay particles will undergo preliminary drying and will undergo initial chemical reaction in the pre-heater using the exhaust gases from the kiln and calciner. This operation cools the exhaust gases to a low temperature. Prior to discharge into the atmosphere the calciner exhaust gases will pass through an electrostatic precipitator (ESP) to remove the flue gases.

The TSP in the exhaust gas stream after the electrostatic precipitator is to conform to that guaranteed by the designer and equipment supplier and Ethiopia emission standard of below 150 mg/Nm³. The flue gas sulfur dioxide will be undetectable as sulfur is very low and almost undetectable (below 2%) in the natural gas fuel. The carbon monoxide concentration in the exhaust gas is expected to be as low as the natural gas will undergo almost complete combustion in the kiln and calciner.

The residual emission from the exhaust gas is not expected to cause any serious problem in the surrounding crop fields. During the EIA study, the team visited the crop fields around existing NCSC and found no perceptible impact of the cement plant operation. There are insignificant waste materials generated in the plant. All the dust collected in the dust collectors will be recycled into the appropriate manufacturing process stream.

No significant impact of the project is for seen on the water quality. All the process water

will be recycled and there will be no discharge of industrial effluent. The water used in the gas conditioning tower will be evaporated and discharged along with the flue gases through the stack.

The only water effluent source will be waste water from domestic/ human usage. The waste water will be treated suitably in a waste water treatment plant (WSZ-10 Q=10.0 m³/l, 1set of waste water treating equipment) before discharge into the near by soil body.

The main noise generating units are the crushers, grinding mills, fans, blowers and compressors. To control the impact of the noise from these units, there is no proposed noise controlling facility except using latest technology which guaranteed low noise generation.

NCSC has offered comprehensive pollution control measure for dust and particulate emission control as denoted in subsequent paragraph

Raw Material Preparation: At the hopper and loading point, dust collector facility will not be applied. However, the inlet dust concentration will be reduced below the set of dust particulate emission limit of the national standard (150 mg/Nm³). Thus in both these areas, the emission standard of the national emission limit of dust particulate matter will be complied with. At the expected additive crushing area for de-dusting of crusher feed discharge, belt conveyors and transfer points of belt conveyor to additive stockpile in similar situation will follow except under much lower inlet air/gas volume. The efficiency will be similar and complying with the national emission limit of dust particulate matter. At the limestone storage and transport point areas, from loading hopper to stacker belt, there is no dust control facility, but the vent dust is compliance to national emission limit of dust particulate matter of less than 150mg /Nm³.

Raw Material Grinding: The closed circuit grinding of raw material will produce powder having particle size of 25 mm. The extraction belt conveyor conveying raw material to the grinding mill will be provided with dust collector for collecting dust generated at the discharge point. Bag filter will be used to de-dust the exhaust gas and the dust

concentration in the vented air will be maintained at less than 150 mg/Nm^3 level to conform Ethiopia emission standard dust particulate matter.

Coal Grinding: In the coal grinding for de-dusting and venting of coal mill, reverse bag filter will be used and it will maintain the outlet dust concentration below national emission limit of dust particulate matter of less than 150 mg /Nm^3 .

Raw and Coal meal Handling: Bag filters collector will be provided for venting the silo (raw meal and coal meal) and kiln feed bin and the emission standards will be met.

Raw Meal Clinkering Process: Natural gas will be used as fuel. The dust particles will be carried away by the exit gases of the kiln. Electrostatic precipitators (ESP) with proper control system will be provided to bring down the No_x , So_x and dust concentration inline with the Ethiopia emission standard of below 2000 mg/Nm^3 for No_x , 1000 mg/Nm^3 for So_x and 150 mg/Nm^3 for dust. Bag filter dust collectors will be provided to reduce dust from the dust recycling conveyor and the clinker handling conveyers.

Coal Meal Calcining Process: During calcining process in the rotary kiln the combustion air will be released into the air after kiln inlet electric dust collector (ESP) and bag filter treatment. Bag filter will be used to control dust to the extent of less than 150 mg /Nm^3 of the Ethiopia emission standard of dust particulate matter. ESP will be used to minimize No_x and So_x below the Ethiopia emission standard of 2000 and 1000 mg/Nm^3 respectively.

Clinker Cooler: The cooler vent air will be passed through electrostatic precipitators to control the dust emission before venting into atmosphere inline with the Ethiopia emission standard of below 150 mg/Nm^3 .

Clinker Storage and Handling: Dust collectors, at the discharge ends of the belt conveyor and other conveyors will be provided to contain the dust emission within the national limits.

Cement grinding: A large quantity of dust will be generated during the grinding operation.

The ball Mills and high efficiency air separators will be equipped with mill bag filter for de-dusting before venting out through chimney. The dust concentration in vented air will be limited to 150 mg/Nm³ as per the Ethiopia emission standard of dust particulate matter.

Cement storage, handling and packing: Dust collectors will be provided at the silo extraction and filling points. Bag type dust collectors will be provided in the packing plant at points where dust will be generated.

2.8. A project Alternative and Envisaged Sustainability

a. Cement Plantation

Project Alternatives

Alternative 1: No project option: This would not increase domestic production and conserve foreign exchange. Therefore, it was rejected.

Alternative 2: Import already bagged cement: Importing bagged cement is not economically viable in the long term; because several companies in Ethiopia presently practice this option. It denies local employment opportunities and decreases foreign exchange. Also government restrictions on importation are increasing. The option of importing bagged cement will have the least impact of releasing dust into the environment but it is no longer politically viable and therefore it is not acceptable.

Alternative 3: Manufacturing bagged cement from raw materials (considered option): Though it has some social and environmental impacts, the proposed cement plant is expected to provide 500 job opportunities in all projects and expected to lower the cost of cement. In addition, there will be a transfer of technology associated with installation, operation of the equipment and maintenance and savings on foreign exchange, hence this alternative was chosen.

Envisaged Sustainability

All the raw materials needed for the manufacture of cement are available in Ethiopia. The basic raw materials for the production of cement are limestone, clay and gypsum. All of these raw materials, with the exception of gypsum, will be extracted from the mining lease areas which is located around 1-9km away from the project site inside the Dire-Dawa Administration boundary. Whereas gypsum will be mined from Dewelle which is located

around 194km away from the project site. The reserve of limestone quarry along with other additive quarry has been proven for greater than 80 years. The technology proposed for the construction of NCSC cement plant is the best available world wide. The development of NCSC cement will facilitate the development of Dire-Dawa Administration as a commercial center.

b. Raw Material

Project Alternatives

Alternative 1: A 'no project' scenario means there will be no mining of limestone. The implication of this option is that NCSC cement plant will have to source limestone from elsewhere. Since 77% of the raw material needed for cement production is expected to be derived from the proposed quarry, a 'no project' option as well means no NCSC cement plant. Therefore this option was rejected.

Alternative 2: This option entails the execution of the proposed project, which entails mining limestone from a dedicated quarry. This option was accepted because it will make possible the processing of cement locally.

Envisaged Sustainability

Based on the details obtained from the exploratory survey, excessive amount of limestone exists in the mining lease area (MLA). Likewise a huge amount of additive materials are also available. The present available limestone reserves of both inferred and measured category is expected to last, at the proposed annual limestone requirement of 1,146,087 tones, for >80 years, therefore the project is sustainable.

c. Water source

Project Alternatives

Alternative 1: A 'no project' scenario means there will be no source of water. This option was rejected as it counters development, since the cement plant cannot be operated without water.

Alternative 2: Source water from municipal water supply and sewage Authority (MWSSA), this option was also not feasible because water supply capacity of MWSSA cannot sustain the daily water consumption of 11,325 m³. Beside, the water tariff is expensive.

Alternative 3: Obtaining from river or stream. This entails pumping water from river or stream without damming which was also not feasible because the river/stream is seasonal so it is going to dry up during the dry seasons.

Alternative 4: Abstraction of ground water. According to ground water potential assessment, the ground water resources will be adequate to sustain the daily requirement of 11,335 m³ water by NCSC. The Administration of Hydro Geology study revealed that for the formation of main aquifer systems, tertiary basalts are overlain by the quaternary deposits and underlain by the sandstone and limestone sedimentary. The project site ground water resource is characterized by good aquifer porosity and recharge capacity. Because of this, the option of ground water utilization for daily water demand of NCSC cement plant was accepted.

Envisaged Sustainability

The area is endowed with potential ground water resource along with good quality of water. Therefore, abstraction of 11,335 m³/day water with the ground aquifer recharge capacity of 38.8 million m³ per year would be a good opportunity to satisfy the water consumption of the NCSC cement plant. Beside, the ground water quality will also minimize the cost for water treatment before it will be used.

d. Power

Project Alternatives

Alternative 1: 'No project' scenario. This was rejected because since the cement plant cannot function without power.

Alternative 2: only using natural gas, this option was rejected due to the following reasons: natural gas is not readily available in a good price and utilization of natural gas

to produce the power for electricity is not cleaned and environmentally friendly than hydro electric power of EEPCo.

Alternatives 3: using EEPCo electric power along with natural gas. This option is accepted due to the following reason: EEPCo electric power is readily available with fair price in order to be power source for most part of plant operation. Besides natural gas is also available even though, using natural gas will not be clean and environmentally friendly. Moreover, the present power load for NCSC of 12mw can be satisfied by EEPCo alone.

Envisaged Sustainability

The proposed EEPCo along with natural gas are economically, technically and environmentally sustainable. Complete reliance on EEPCo with the present ration system of power supply, will induce under capacity production of cement. So that, under this circumstance natural gas feed and stand by generator will be employed as an electric power source.

3. POLICIES, LEGISLATIVE AND INSTITUTIONAL FRAME WORK

General

Implementation of development projects should be planned, designed, and executed in accordance with the available policies and legal frameworks. This section tries to highlight some of the relevant policy issues and legislation to development projects and

environmental management. The discussion in here concerns the national development and environmental policies, legislations and sectoral strategies, institutional arrangements are considered in this section.

3.1 Environmental Policy of Ethiopia

The federal environmental protection authority prepared the environmental policy of Ethiopia in collaboration with Ministry of Economic Development and Cooperation .It was released in April 1997. The overall policy goal is to improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs (EPA, 1997). The policy among others seeks to ensure the empowerment and participation of the people and their organizations at all level in environmental management activities and to raise public awareness and promote understanding of the essential linkage between environment and development

In addition to its guiding principles, the environmental policy of Ethiopia provides sectoral and cross-sectoral environmental policies. The EIA policies included in the cross-sectoral EIA policy are:

- To ensure that EIA's consider not only physical and biological impacts but also address social, socio-economic, political and cultural conditions.
- To ensure that public and private sector development programs and projects recognize environmental impacts early and incorporate their containment into the development design process.
- To recognize that public consultation is an integral part of EIA and ensure that EIA procedures make provision for both an independent review and public comment before consideration by decision-makers.
- To ensure that the environmental impact statement always includes mitigation plans for environmental management problems and contingency plans in case of accidents.

- To ensure that at specified intervals during project implementation, environmental audits regarding monitoring, inspection and record keeping take place for activities where these have been required by the environmental impact statement (EIS)
- To ensure that preliminary and full EIAs are undertaken by the relevant sectoral ministries or departments if in the public sector, and by the developer if in the private sector;
- To create by law and EIA process this requires appropriate environmental impact statements and environmental audits for private and state development projects.
- To establish the necessary institutional framework and determine the linkages of its parts for undertaking, coordinating and approving EIA's and the subsequent system of environmental audits required to ensure compliance with conditionalities.
- To develop detailed sectoral technical guidelines in EIA's and environmental audits.
- To ensure that social, socioeconomic, political and cultural conditions are considered in EIA procedures & include in sectoral guidelines and
- To develop EIA and environmental audit capacity and capability in the EPA, Sectoral Ministries and Agencies as well as Regions.

3.1.1 The Federal Constitution of Ethiopia

The federal constitution (adopted on the 21st of August 1995) sets out important articles related to sustainable development and environmental rights article – 43 and article – 44 discuss the right to sustainable development and about environmental rights as follows :

- All persons have the right to live in a clean and healthy environment
- All persons who have been displaced or whose livelihood have been adversely affected as a result of state programmes have the right to commensurate monetary or alternative means of compensation , including relocation with adequate state assistance.

Under Article-92, the constitution discusses about environmental objectives as:

Government shall endeavor to ensure that all Ethiopians live in a clean and healthy environment.

3.1.2 Water Resource Management Policy of Ethiopia

Ministry of water Resources prepared water resources management policy of Ethiopia. The over all goal of the policy is to enable and promote all national efforts towards the efficient, equitable and optimum utilization of the available water resources of Ethiopia for significant socioeconomic development on sustainable basis. The detail objectives of the water resources management policy are:

- Development of the water resources of the country for economic and social benefits of the people, on equitable and sustainable basis.
- Allocation and apportionment of water based on a comprehensive and integrated plans and optimum allocation principles that incorporate efficiency of use, equity of access and sustainability of the resources.
- Managing and combating drought as well as other associated slow on-set disasters through efficient allocation, redistribution, transfer, storage and efficient use of water resources.
- Combating and regulating floods through sustainable mitigation, prevention, rehabilitation and other practical measures.
- Conserving, protecting and enhancing water resources and the overall aquatic environment on sustainable basis.

3.1.3 Water Supply and Sanitation Policy

The overall objective of water supply and sanitation policy is as stipulated in the Federal Democratic Republic of Ethiopia water resources management policy is to enhance the well-being and productivity of the Ethiopian people through provision of adequate, reliable and clean water supply and sanitation services and to foster its tangible contribution to the economy by providing water supply services that meet the livestock, industry and other water users demands.

3.1.4 Biodiversity Policy

The Biodiversity policy was approved in 1998. It provides for policy guidance towards the effective conservation, rational development, and sustainable utilization of the country's

biodiversity. In general, the policy consists of comprehensive policy provisions on the conservation and sustainable utilization of biodiversity.

3.1.5 Land Tenure, Exploration, and Compensation

The constitution of the FDRE states that the right to ownership of rural and urban land, as well as all natural resources, is exclusively vested in the state and in the people of Ethiopia. Article 40 of the constitution indicates that land is a common property of the nations, nationalities, and people of Ethiopia and shall not be subjected to sale or to other means of transfer.

Resettlement and rehabilitation are recognized civic rights in the Ethiopian legislation. Article 44 of the revised constitution of 1955 states that *'all persons who have been displaced or whose livelihood has been adversely affected as a result of state program have the right to commensurate monetary or alternative means of compensation including relocation with adequate state assistance.'* This compulsory legal principle is also stated in the constitution of the FDRE. *"The government shall pay compensation for property found on the land but the amount of compensation shall not take into account the value of the land."*

Hence, project plans must include an attractive and sustainable resettlement strategy, offering adequate compensation and incentives to the affected population. The main emphasis should be on maintaining an open dialogue with the people, building a trustworthy relationship between the government agencies and the population, and enhancing community participation in any project from the onset of the study up to its implementation. In this respect, Article 43 of the constitution defines the rights of all Ethiopians to participate in national development and, in particular, to be consulted with respect to policies projects affecting their community. According to a civil code *all that can legally prove existence of real right over the immovable to be expropriated qualify or are eligible to receive legally sufficient compensation.* Article 1474 of the civil code provides that compensation payment could be either in cash or in kind.

3.1.6 Hygiene and Environmental Health Policy

The health policy was issued by the then Transitional Government of Ethiopia in September 1993. The policy gives emphasis on the preventive aspect of health services. The central themes of the National Health Policy (1993) are Awareness raising and education on personal and Environmental Health care and Sanitation through information, Education and Communication (IEC), Control of disease, and Promotion of primary Health care through community participation. The Environmental Health Policy Objectives includes: To promote proper waste management system with regard to the collection, transportation and disposal of any domestic, commercial, agricultural, industrial and mining wastes including hazardous, liquid, solid, infectious and radioactive wastes.

- Establish community based hygiene education promotion.
- Advocate and promote the availability of excreta disposal facilities at household level and develop a latrine culture.
- Ensure sound and effective waste management system, (collection, storage, transport and disposal)

3.1.7 Economic Development Strategy for Ethiopia

This strategy is named and commonly known as the "Agriculture Development Led Industrialization Strategy (ADLI)". It is a two-pronged strategy incorporating, on one side, the external sector (export -led part) and, on the other, the internal sector which shows the forward and the backward-linkages between agriculture and industry. The base of the strategy is that agriculture will supply commodities for exports; domestic food supply and industrial output and expand market for domestic manufactures.

This strategy is the guiding tool for the current development of the country. The basic objectives of the strategy are:

- Sustainable economic growth
- Equity, including regional equity; and
- Self-reliance, meaning dependence on national resources and Independent National Development.

The strategy is a "road map" for the development of the Agricultural, Industrial, Mining, Science & Technology, Infrastructure, and Tourism sectors.

3.1.8 Poverty Reduction Strategy

Poverty is deeply entrenched in Ethiopia. To meet both domestic goals and the International commitment to reduce poverty by half in the medium term, the government introduced the poverty reduction strategy in 1999-2001. Targets were set for poverty oriented interventions and executing agencies were identified. The plan has served as a vehicle for resources mobilization and allocation. The second generation of the plan "Plan for Accelerated and Sustainable Development to End Poverty" (PASDEP) covers the period from 2002 to 2007. The scope of this plan is broader than the first and incorporates the well-known "Millennium Development Goals" (MDGs). The regional states, including DDA are expected to address poverty issues in accordance with PASDEP.

3.1.9 Mineral Resources Development Policy

Sustainable development should encompass sustainable use of mineral resources. This is a central policy objective of many countries, thus delivering increasing real incomes without degrading ecological systems. Though it is a challenge to the mineral sub-sector, the objective of any sustainable minerals strategy must, therefore, seek ways of satisfying society's needs by:

- a) Efficient and effective use of minerals,
- b) Maximizing the value of the resource,
- c) Minimizing waste and adverse environmental impacts, and
- d) Restoration of exhaust mine areas for re-use for agriculture, forestry, residential, industry, or other uses.

Sustainable development defined by world Commission on Environment and Development (the Bruntland commission – 1987) as “development that meets the needs of the recent without compromising the ability of the future generations to meet”.

The mineral development policy and legislation is summarized and presented as follows:

a) Constitutional Bases

The federal constitution of FDRE promulgated on August 21, 1995 lays down the general framework of the mineral domain and the role of the federal and state government in some of its provisions as follows.

- Article 40(3) of the constitution provides that *the right of ownership of land as well as all natural resources be exclusively vested in the state and the people of Ethiopia.*
- Article 97(8) of the constitution provides that *the federal government and the state shall jointly levy and collect taxes on income derived from large-scale mining operations, royalties and land rentals on such operations.*
- Article 98 of the constitution provides that *states shall jointly levy and collect taxes on income derived from large-scale mining operations, royalties and land rentals on such operations.* This has also been provided under proclamation No 33 of October 20, 1992. *“Sharing of revenue between the central government and regions”.*

b) Mineral Legislation

- Proclamation to define the powers and duties of the central and regional Executive organs of the Transitional government of Ethiopia (Proclamation No. 41/1993) of January 20, 1993
- The mining Proclamation No. 52/1993 of June 23, 1993
- The mining income tax Proclamation No. 53/1993 of June 23, 1993
- Mining operations council of ministers Regulation No. 182/1994 of April 1994
- Proclamation to define the powers and duties of the executive organs of Federal Government (Proclamation No 4/1995 of August 1995)

The Mining Amendment Proclamation No 22/1996 of August 1996 is stated as follows:

1. The clause *“may acquire without cost a participation interest of up to ten percent”* in the first sentence of Article 44 is hereby deleted and replaced by the clause *“shall acquire without cost a participation interest of two percent.”*
2. Sub-Article (1) of Article 46 is hereby deleted and replaced by the following new sub –Article(1): *“(1) The power to issue artisanal mining license and construction minerals mining license undertaken by domestic investors is vested in the Mines and Energy Bureau of National /Regional Self-Governments; while prospecting, exploration and mining licenses for all other mining operations shall be issued by the Ministry, subject to regulations approved by the Council of Ministers in respect of combined and*

mining licenses.”

3.1.10 Energy Policy of the Country

The formulation of sound energy policy is one important measure in addressing the energy problem in the country. The transitional government of Ethiopia has formulated the present Ethiopian energy policy in May 1994. The policy is intended to enhance and DDA, TIDCB-Resource Potential, project Identification & Selection, and Profile Preparation Study-foster “Agriculture Development Led Industrialization (ADLI) Strategy”.

The FDRE formulated and issued a comprehensive energy policy to fulfil the following major objectives:

- To ensure sustainable (reliable, affordable and long lasting) supply of energy;
- To remove bottlenecks inherent to energy resource development and utilization;
- To provide guidelines and strategies for the faster development and supply of energy;
- To prioritize the development of energy resources in order to attain self sufficiency;
- To increase energy utilization efficiency and reduce wastage; and to ensure environmental protection association with the production, supply and consumption of energy.

The policy gives first priority to the development of hydropower resources, followed by exploitation of natural gas deposit and exploration for oil resources. The third priority is development of agro-forestry systems in the rural areas through fuel wood plantations and afforestation. Improvement of energy efficiencies through the introduction of efficient appliances and other devices for all economic sectors and households are other areas for which due attention is given by the energy policy.

However, the energy policy has not given a clear glimpse about renewable energies (like solar, wind, etc.) development and utilization and hence there is no distinct strategy drafted in this regard. It is well know that, renewable energies can play a significant role to enhance the country’s energy supply in different ways. Firstly, these sources are indigenous and hence there is self- reliance. Secondly, those energy sources are fit to remote and small-scale application. Last but not least, they are environmentally friendly. Subsequently, an aggressive programme is essential regarding renewable energy for country like Ethiopia with more than 85% living in the countryside.

3.1.11 Industrial Policy

In order to achieve the objectives of ADLI, it is important to formulate a suitable industrialization strategy. Accordingly, industrial sector development strategy was adopted in July 2003. The fundamental principles of the strategy include: private sector led industrialization, development of export-oriented industries, strengthening the capacity of existing industries to be competitive at the national, regional, and international levels and investment promotion and facilitation with increased emphasis on foreign investment. Utilizing to the extent possible, labour intensive technologies with a view to creating employment, generating incomes and alleviating poverty.

The strategy identifies key manufacturing sub-sectors to which top priority will be given. These include: textiles and garments industries, leather and leather product industries, agro-processing industries, and construction industries. These sub-sectors are based largely on domestic resources, offer excellent export possibilities, have large and growing domestic markets and exhibit strong linkages with other sectors of the economy, especially agriculture.

3.1.12 Investment Policy

Private capital plays a significant role in the development of an economy. In recognition of this, the Government of Ethiopia has eliminated discriminatory tax and credit to private sector, simplified administrative procedures, and established a clear and consistent set of rules regulating business activities.

The present regulatory regime governing investment in Ethiopia is based on a series of investment proclamation issued at various times. The Ethiopian Investment Commission had revised the investment code at different times since the first one was enacted in 1992 in an attempt to rectify some of the bottlenecks to investment inflows. The present investment regime actively encourages both domestic and foreign participation in the economy, through a plethora of investment incentives.

Moreover, in terms of investment protection, Ethiopia has ratified the Multilateral Investment Guarantee Agency convention, providing protection against political and non-commercial risks.

The Ethiopian economy has responded positively to the reform measures and the appropriate sectoral development policies and strategies adopted by the present government. However, even though the Country's industrial sector has exhibited a significant growth mainly due to the improvement in the operating environment brought by the coherent economic policies and strategies enacted by the present government, the sector is still faced by numerous problems, including antiquated machinery and the lack of skilled personnel.

3.2 Environmental Legislation

3.2.1 Federal Laws and Regulations

Establishment of Environmental Protection Organs (Proc.No. 295/2002)

This proclamation establishes the Environmental Protection Authority (EPA), clarifies its institutional mandate and responsibilities, and aims to integrate environmental considerations into the policies and decision making of sectoral agencies through such means as the establishment of environmental units in these agencies at the federal level and the creation of independent environmental agencies at the regional level.

This proclamation also re-established the Environmental Protection Council (EPC), a cross-sectoral coordinating body that advises the federal EPA and supervises its activities. Its mandate includes (a) reviewing environmental policies, strategies, and laws proposed by the EPA and issuing recommendations to the government; (b) providing appropriate advice on the implementation of the Environmental Policy of Ethiopia; (c) reviewing and approving directives, guidelines, and environmental standards prepared by the EPA.

In accordance with the proclamation, the various government ministries are to establish 'environment units' at the federal and regional level.

Environmental pollution control proclamation(Proc.No. 300/2002) has been promulgated in December 2002. The proclamation under chapter – 2 describes control of pollution, management of municipal wastes. And under its chapter-3, it discusses environmental standards & other relevant issues thereof.

This procedure addresses the management of hazardous waste, the establishment of environmental standards for various environmental media (air, water and soil), and

monitoring pollution.

The FEPA has prepared two guidelines, namely;

- Guideline ambient environmental standards. EPA, 2003. Guidelines on environmental quality standards for air quality, surface water quality, soil and ground water quality, and noise standards.
- Standards for industrial pollution control in Ethiopia .EPA, 2003. Guidelines on permitted discharges from different types of industry and waste water discharges to open waters.

Table 3.1 Environmental Standard for Cement Manufacturing Industries (FEPA, 2003)

Limit Values for Discharges to Water	Limit Value
pH	6-9
BOD ₅ at 20 ⁰ C	25 mg/l
COD	150 mg/l
Total phosphorus (as P)	5 mg/l
Suspended solids	50 mg/l
Mineral oils at the oil trap or interceptor	20 mg/l
Limit Values for Emissions to Air	Limit Value
Parameter	Limit Value
Total particulates	150 mg/Nm ³
Sulphur dioxide(as SO ₂)	1000 mg/Nm ³
Nitrous oxide(asNO ₂)	2000 mg/Nm ³

Environmental Impact Assessment Proclamation (Proc.No. 299/2002) is promulgated in December 2002. The primary objectives of this proclamation is to make EIA mandatory for defined categories of activities undertaken either by the public or private sector or by the proponent of the project .The proclamation under its general provision Article-3 ,Sub-Article-1 states that "*Without authorization from the authority (EPA), or from the relevant regional environmental agency, no person shall commence implementation of any project that requires environmental impact assessment as determined in a directive issued pursuant to Article-5 of the proclamation.*"

Article-5 describes projects requiring EIA. Any directives provided under sub-article one of Article-5 should among other things, determine categories of;

- a) Projects not likely to have negative impacts and so do not require EIA
- b) Projects likely have negative impacts and thus require EIA. EIA guidelines have been prepared both at Federal and Regional level. These EIA guidelines follow the

conventional procedures adopted elsewhere in the world .This study has followed EIA guideline produced by both Federal and DireDawa Environmental Protection Authorities.

The EIA proclamation requires the EPA to prepare procedures, regulations, environmental guidelines, and standards to undertake EIAs. Environmental guidelines facilitate the consideration of environmental issues and the incorporation of the principles of sustainable development into developmental proposals. As a sequel to enacting this proclamation, sectoral impact assessment guidelines focusing on agriculture, transport, industry, tannery, and settlements have been prepared by the FEPA.

Forest Conservation, Development, and Utilization (Proc.No. 94/1994)

The forestry Law recognizes three types of forests – state and protected forests, regional and protected forests, and private forests. The minister and head of the regional authority have the powers to designate such forests. The law includes provisions that aim to ensure the conservation of forests and determine the system by which forest resources shall be developed and utilized. One of the objectives of the establishment of State Forests is to conserve genetic resources and the ecosystem.

Wildlife Laws (Proc.No. 416/1972 and 192/1980)

These laws provide for wildlife conservation. Four categories of protected areas are specifically demarcated by law for the protection of wildlife, comprising: National Parks (ecological, scientific and aesthetic use), Game Reserves (conserving wildlife), Controlled Hunting Areas (conservation of wildlife), and Wildlife Sanctuaries (conservation of wildlife).There are no designated conservation areas in the project area. Hunting wildlife without a permit is prohibited even outside protected areas, unless for immediate defense of human life.

Rural Land Administration and Use (Proc. No. 456/2005)

The Law defines the state ownership of rural land and the tenure rights of the land occupant including rights to ‘property produced on his hand’, rights of inter-generational tenure transfer, and rights of exchange land and limited leasing rights. Provisions are made for the registration and certification of tenure rights. Part three of the proclamation presents regulations related to the use of rural land, particularly as it relates to soil and

water conservation and watershed management. The rural land administration and land use laws are to be implemented by the regional states, based on a guiding land use Master Plan that is based on the watershed approach. The law stipulates that a holder of a rural land plot shall be obliged to use and protect the land. When the land gets damaged, the user of the land shall lose his or her use right.

3.2.2 Regional Laws and Regulations

Regional Conservation Strategy of DDA

Strategies for conservation of natural resources are instrumental to determine the extent in which economic growth and social progress could be achieved on a sustainable basis. Formulation of a strategy for conserving natural resources is, therefore, essential to improve the living condition of a society. With this regard, the DDA has given due attention to develop a strategy for sustainable management of the natural resources as they are the base for survival. The conservation strategy of the administration was prepared in March 2001.

In a strategy document the optimal interaction among, all natural, human, capital and other relevant factors, are taken into consideration in order to attain development that meets the needs of the present generation without compromising the needs of future generations.

The overall strategy goal is to improve and enhance the health and quality of the life of all people of DireDawa Administration and to promote sustainable social and economic development through the sound management and use of natural, human made & cultural resources and the environment as a whole so as to meet the needs of the present generation without compromising the ability of future generation to meet their own needs.

The strategy seeks to:

- a. Ensure that appropriate interventions to restore the present impaired regenerative and productive capabilities of renewable natural resources, and ensure that essential ecological process and life support systems are sustained, biological diversity is preserved and renewable resources are used in such a way that their

- capacity to regenerate and produce is maintained and where possible enhanced, so that the satisfaction of future generation is not compromised;
- b. Ensure that non-renewable resources are exploited in such a way that the benefits are extended as far into the future as can be managed, and minimize the negative impacts of their exploitation on the use and management of other natural resources and the environment;
 - c. Identify and develop natural resources that are currently under utilized by finding new technologies and/or intensifying existing uses;
 - d. Incorporate the full economic, social and environmental costs and benefits of natural resources development into planning, implementation and accounting processes by a comprehensive valuation of the environment and the services it provides, and by considering the social and environmental costs and benefits which cannot currently be measured in monetary terms;
 - e. Improve the environment of human settlements to satisfy the physical, social, economic, cultural and other needs of their inhabitants on a sustainable basis;
 - f. Prevent the pollution of land, air and water in the most cost effective way so that the cost of effective preventive interventions would not exceed the benefits;
 - g. Conserve, develop, sustainably manage and support DireDawa's rich and diverse cultural heritage;
 - h. Ensure the empowerment and participation of the people and their organizations at all levels in environmental management activities; and
 - i. Raise public awareness and promote understanding of the essential linkages between environment and development.

Mineral Resource development strategies of DDA

The mineral development strategies of DDA are to:

- Compile and maintain a public database on mineral production, & exploration required for planning and disseminate this within the industry;
- Increase the coverage of regional geological, hydrogeological and detailed geochemical mapping and mineral exploration;
- Adopt mechanisms for attracting investors in mineral development;

Environmental management and protection guidelines shall come under the Mine Development Strategy with immediate priorities of preparation of environmental legislation

& Continuous monitoring of mining activities.

Water Resources Strategy for DireDawa Administration

The water resources strategy for DDA is out lined below.

- a. Recognize and manage water resource as vulnerable and scarce resource.
- b. Promote effective use of water resources by interalia water conservation methods such as reduction & elimination of wastage, leakage and uncounted for water for viable economical measure.
- c. Develop and promote measures of efficient use of water by means of new technological facilities of water demand management.
- d. Promote effective and efficient means of sustainable development of groundwater and replenishment.
- e. Ensure that from all uses of water resources, water supply and sanitation for domestic purpose shall be given the priority over the other uses.
- f. Promote decentralization and localization of water resources management without affecting productivity.
- g. Promote, establish, and sustain "water resources design and engineering system" to:
 - Develop design and engineering procedures and standards,
 - Serve as a certifying center for all designs and
 - To provide clearance and guidelines for all designs in all water resource projects.
- h. Policy, legislation and standards should be set on industrial effluents, which have hazardous and toxic wastes on the environment
- i. Promote NGO's to participate in construction of water supply & irrigation projects.
- j. Ensure the accomplishment of environmental impact assessment in major water resource development project.

Energy Policy of DireDawa Administration

The national policy has a strong effect for its consideration on the Administrative energy policy to the extent adopted fully or partially. The Administration has no well-defined policy rather than that is completely adopted from the national energy policy. However, Administration Conservation Strategy has set policy and strategies for energy sector

development. The document has stipulated the following objective to augment the supply of energy commensurate with the Administration energy demand and reduce the growth rate of that demand through increasing supplies of energy and improving efficiency in its production and conversion.

The Guiding Principles are:

- To adopt an inter-sectoral process of planning and development that integrates energy development with energy conservation, environmental protection and sustainable utilization of renewable resources;
- The supply of energy to remote and isolated woredas in the region shall be based on decentralized energy supply systems in order to minimize investment cost;
- Increasing reliance shall be placed on energy efficient technologies, sustainable use of renewable resources, and the development of indigenous energy resources;
- To promote the development of the region's renewable energy resources and reduce the use of fossil energy sources both for ensuring sustainability and for protecting the environment as well as their continuation into the future;
- The private sector shall be encouraged and provided with the necessary incentives to participate in the development of the region's energy resources;
- Energy resources assessment, investment planning and least cost investment programming shall be undertaken at all levels as a joint effort made by concerned agencies; and
- Energy development shall be included at all levels of planning but especially in woreda and local development plans.

3.3 Environmental Administrative Framework

3.3.1 Federal Administration

Federal Environmental Protection Authority

In order to sustainably manage the resources of the country, the Federal Environmental protection Authority directly accountable to the council of ministers, was established by proclamation 9/1995. It is the key national level environmental agency, with a mandate to address environmental issues.

The FEPA is involved with the development of environmental policy and legislation, setting standards for environmental media, monitoring pollution, establishing EIA for

certain types of projects, environmental information systems (EIS), and undertaking capacity development in relevant agencies to ensure the integration of environmental management in policy development and decision-making.

Among the powers and duties given to the FEPA under the above proclamation and pertinent to the objectives of these guidelines are:

- To prepare environmental protection policy and laws, and upon approval, follow up their implementation;
- To prepare directives and systems necessary for evaluating the impact of social and economic development projects on the environment; monitor and supervise their implementation; and
- To prepare standards that help in the protection of soil, water and air as well as the biological systems they support, and follow up their implementation.

Thus, all project proponents and executing bodies (agencies) in the country should operate in close cooperation with the FEPA to ensure that proper mitigation measures be designed and implemented especially for projects with an adverse effect on the environment. That is, an environmental impact statement (EIS) should be prepared by project proponents and be examined, commented and approved by the FEPA.

The FEPA is the competent agency at the Federal level in Ethiopia. It is therefore, the responsibility of this Authority in the EIA process is to:

- Ensure that the proponent complies with requirements of the EIA processes;
- Maintain co-operation and consultation between the different sector agencies throughout the EIA process;
- Maintain a close relationship with the proponent and to provide guidance on the process; and
- Evaluate and take decisions on the documents that arise from the EIA process.

3.3.2 Regional Administration

DireDawa Administration

The Federal Democratic Republic of Ethiopia (FDRE) has two levels of administrative structures, Federal level government, & Regional government. There are nine Regional

governments under the Federal government. Rules and responsibilities of governments at different level (Federal, Regional, Zonal, & Woreda) have been defined by the constitution and proclamation Nos. 33 of 1992, 41 of 1993 and No.41 of 1995. Under these proclamations, duties and responsibilities of regional states are included. The power of DDA rests on the Charter (Proc.No.416/2004) promulgated to re-establish the DDA. The Regional states are structured as Regional administration, zonal, Woreda and Kebele peasant associations (PAs).Urban centers have city administrative structure and municipalities. The current project shall be implemented in the DireDawa city Administration .DireDawa is administered under city charter and directly reports to Federal Government. DDA is a region centered on the town of the DDA, which comprises DireDawa city (subdivided into 9 urban kebeles) and 32 rural kebeles.

The Administration duties and responsibilities are to:

- Manage, coordinate and control various institutions under the Administration
- Prepare social and economic development plans for the DDA, submit these to the Council Desk of the Prime Ministers Office for endorsement, and then implement these plans
- Develop, maintain and administer the natural resources of the DDA in accordance with the federal laws.
- Establish courts able to address all legal cases and maintain justice, except cases left by law to the federal court.
- Own, create, develop, and transfer properties in the Administration.

DireDawa Environmental Protection Authority

EPA of DDA was established by the proclamation No 2/2004 which was enacted in 2004 with the objective of ensuring that all matters pertaining to the regions social and economic development activities are carried out in a manner that will protect the welfare of human beings as well as sustainably protect, develop and utilize the resource base on which they depend for survival. The REPAs operates independently of the Federal EPA and report directly to the regional state governments.

It is the responsibility of DireDawa EPA to inform the Federal EPA of projects that may be of national significance. Therefore, the Federal Authority should only be involved in EIA

processes where a proposed activity may:

- Have an environmental effect across the international boundaries of Ethiopia;
- Have an environmental effect across regional boundaries within Ethiopia;
- Have an effect on an environment of national or international significance, including but not limited to natural forests, wetlands, national parks, cultural heritage sites etc...
- Have a Federal government department, the relevant regional authority or another statutory body as the proponent;
- Have the Federal Investment Authority as the investment approval body.

Alternatively, Federal EPA may have an EIA referred if agreed to between the Federal authority and the regional authority. This would typically happen in complicated EIA's where the Regional authority feels that it does not have the capacity or competency to deal with the application.

Moreover, with regard to EIA, the DDEPA is responsible for the following actions:

- Adopt and interpret federal level EIA policies and systems or requirements in line with their respective local realities.
- Establish a system for EIA of public and private projects, as well as social and economic development policies, strategies, laws, or programs of regional level functions.
- Administer, oversee, and pass major decisions regarding impact assessment of:
 - ✓ Projects subject to licensing by the regional agency
 - ✓ Projects subject to execution by a regional agency
 - ✓ Projects likely to have regional impacts

DireDawa Water Supply and Sewerage Authority

The DireDawa Water Supply and Sewerage authority was established as one of the municipal organ by the proclamation No 2/2004 enacted in 2004. The Authority primarily aimed to supply adequate potable water & provide sludge collection and disposal service to the town residence.

Sanitation and Beautification Agency

DireDawa Administration has established the Sanitation and Beautification agency by the proclamation No 2/2004 enacted in 2004. The Agency provides services, undertakes development activities and regulatory functions as well. The Agency is responsible for solid waste management, public toilet administration and urban green areas /park development.

4. ENVIRONMENT AND SOCIO ECONOMIC CONDITION OF DDA

4.1 Objectives of the EIA Study

The objectives of the EIA study are based on the overall objectives of the improvements envisaged by the National Cement Share Company regarding the establishment of new cement plant in DireDawa Administration. Accordingly, the Environmental Impact Assessment tries to:

- Identify sensitive environmental components that might be adversely

affected by the proposed project.

- Conduct environmental impact assessment of the most significant adverse impacts that would be expected to encounter as a result of the project implementation.
- Propose mitigation measures required to adverse impacts and enhance the positive ones.
- Identifying the project location using GIS by delineating the project area with GPS.

4.2 Study Methods and Data Sources

The EIA process followed data collection both from primary sources and secondary sources. Baseline data collection was done through field investigation and from review of available relevant document .Field investigation was conducted with the objectives of assessing the existing bio-physical situation of the project area, to identify the environmental components that would be affected by the proposed project .Consultation of stakeholders was conducted during the field investigation as well as discussions made at the respective sect oral offices.

During the field investigations:

- Detailed discussions were made with the communities in the project site to assess their concern on the overall proposed plan.
- On-site observations and investigations of the environmental settings of the proposed area where the intended cement plant is established.
- Delineation of the project boundaries were made using GPS.
- Consultations with relevant stakeholders were made on their knowledge and experiences of issues and problems related to the envisaged project, about significant environmental issues of concern and on their attitude towards the proposed cement project.

4.3 Environmental Features of DDA

4.3.1 General Overview

DireDawa Administration (DDA) is located in the eastern part of Ethiopia between 9° 27' and 9°49' North latitude and between 41°38' and 42°19' East longitude. The

Administration covers approximately 1332.62km². It is bounded by Oromia Regional State in the south and by Somali Regional State in the north, east, and west. The topography of the Administration varies from very steep high mountains to flat plains where the altitude ranges from 950 -2260 masl. The physiography of the Administration involves mountain ranges, hills, valley bottoms, river terraces, and flat plains.

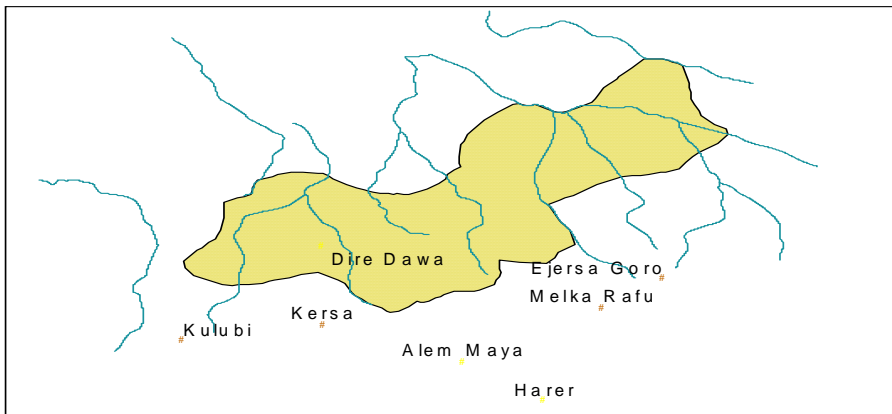
The climate of the Administration is characterized by relatively high temperature throughout the year with minor seasonal variations. The mean annual temperature is about 24.8°C and the average maximum temperature is 31.4°C, whereas the average minimum temperature is 18.2°C. The rainfall in DDA is very low and highly variable in both amount and space. The mean annual rainfall in the DDA and the surrounding areas ranges from about 1,000 mm on the south to about 500 to 600 mm in the north lowland. Almost all of the Administration, about 97%, receives less than 900 mm of rainfall.

High temperature prevalence as well as low rainfall are the climatic constraints strongly influencing the different land cover/uses in general as well as the composition of the physiognomic vegetation in particular in DDA, and scattered shrubs and grassland like *Euphorbia*, *Aloe*, *Opuntia*, *Deacaena*, *Acacia Blanites aegyptiaca* and *Moraceae spp.* are becoming the dominant types of vegetation found in the Administration. *Prosopis Julioflora* and *Petriniem* has been also expanding in the last few years at the cost of cultivated and grazing lands.

4.3.2 Climatic Conditions

There are several stations around the Administration, which have been recording different parameters of meteorological phenomena indicator, most of which are concentrated in the Western and Southwestern directions.

As the raw data indicated, the collected data are not continuous in time series base and lack consistency throughout the collection period. Distribution of the stations is shown in the figure below.

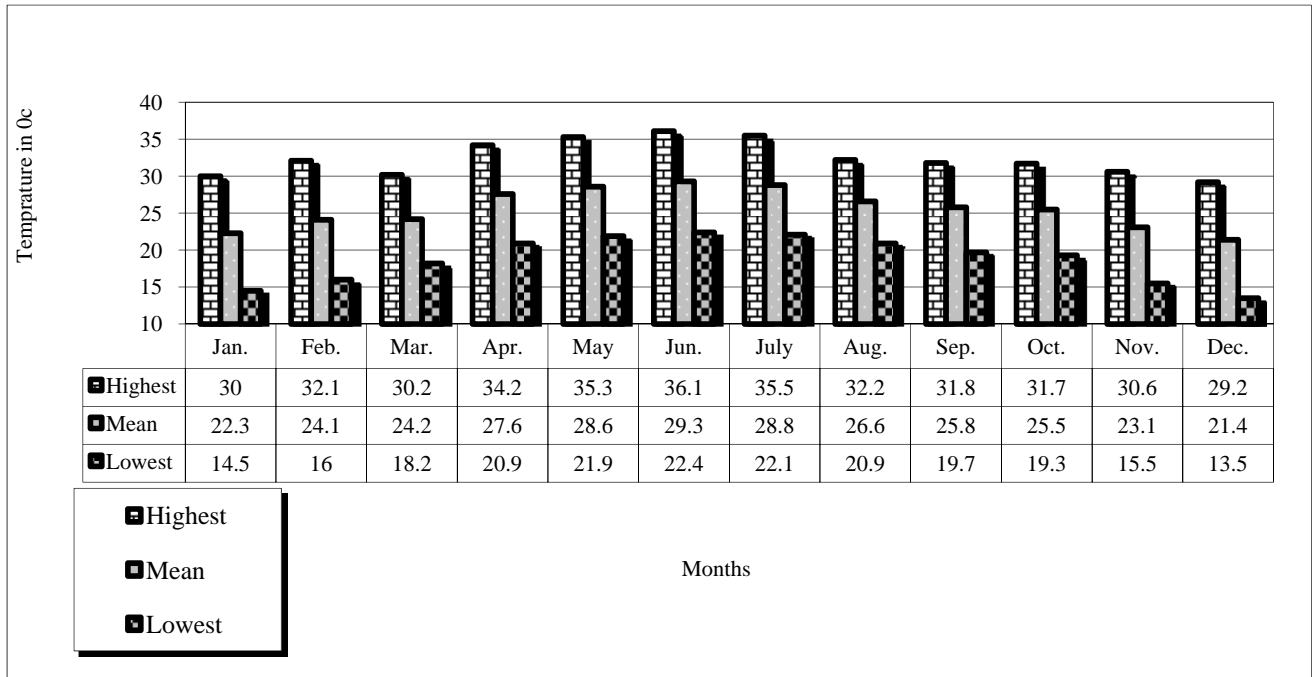
Fig. 4.1 Location of Meteorological Stations

4.3.2.1 Temperature

The long term temperature records of DireDawa station shows that the temperature differences between the maximum and minimum temperatures occur in the season. The maximum temperature (34.77°C) occurs in June and the minimum temperature (14.25°C) occurs in December. The maximum temperature alters gradually without abrupt temperature change in the season. From the long-term record, it is clear that nine months out of the year recorded between $30 - 34.77^{\circ}\text{C}$, while the remaining month's temperature varies between 27 and 29°C . Similarly, the minimum temperature ranges between $14.25 - 22.63^{\circ}\text{C}$, the coldest month being December and January. The temperature of DireDawa by itself does not hinder the growth of mid and lowland crops. However, these levels of temperature are usually related to high evapo-transpiration especially in areas where the rainfall is lower than evapo-transpiration like DireDawa.

Based on the obtained data from Water Works Design and Supervision Enterprise (WWDSE), average evapo-transpiration is much more than precipitation, i.e., $3,255$ mm with low relative humidity of 36% and 40% at elevations of $1,200$ and 1800 masl, respectively.

Fig. 4.2 Long Term Trend of Temperatures Of DireDawa Area

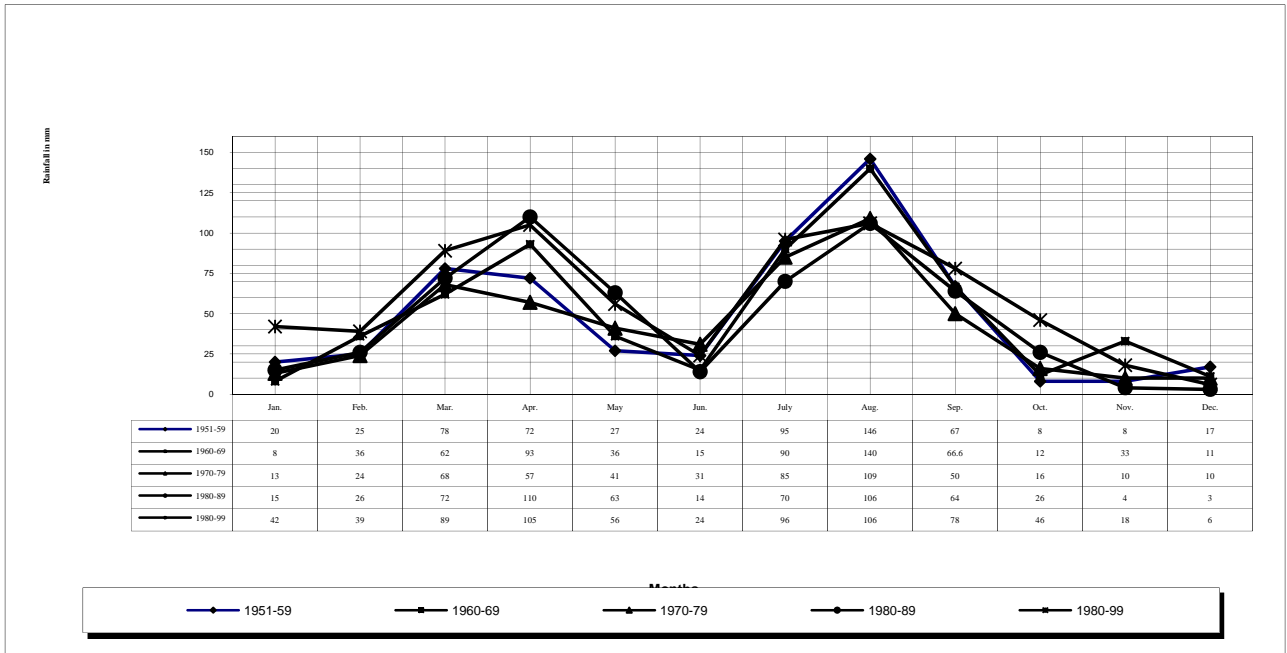


4.3.2.2 Rainfall

The recorded rainfall data to-date shows a maximum precipitation of about 947.9 mm in the year 1996 and a minimum of 357.3 mm in the year 1984. As the graph depicted, the trends of long-term rainfall the area has got weak bimodal rainfall pattern with nearly 117.71 mm peak in April and about 115.03 mm peak in August. Mean annual rainfall of the station is about 651.8 mm.

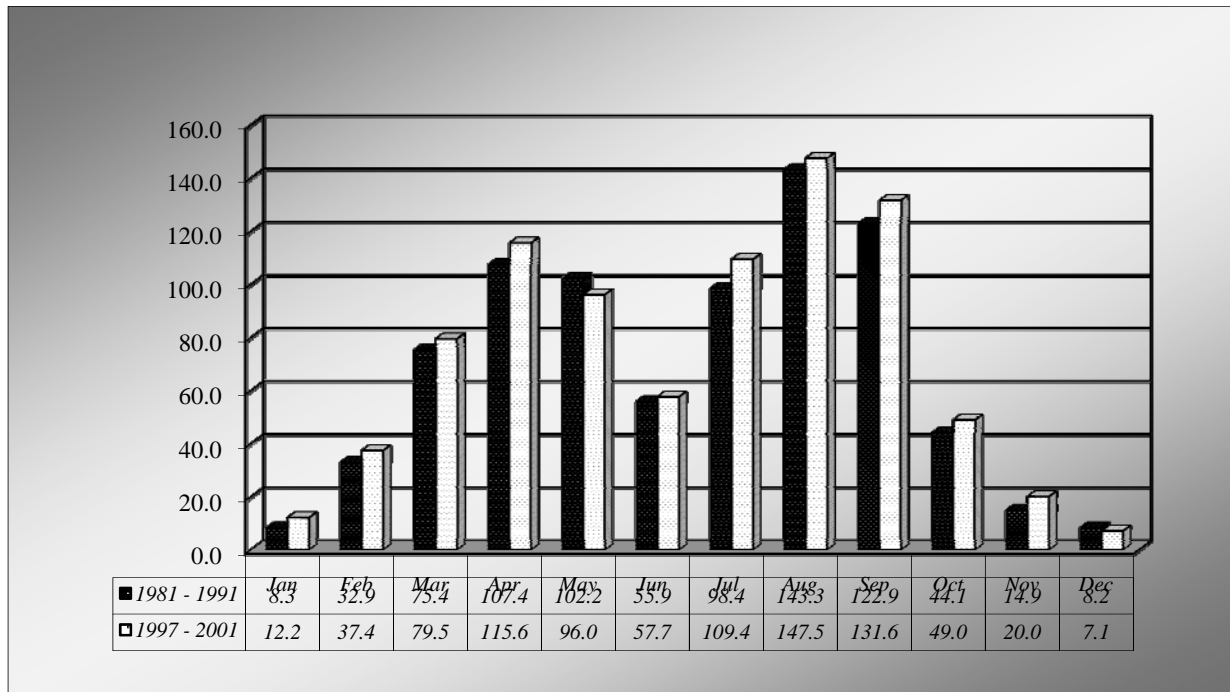
Similarly, the data that was obtained from Alemaya metrological station indicate that the *Beleg* season is March, April and May, while the *meher* season is July, August and September.

Fig. 4.3 Long Term Trend of Rainfall of DireDawa Area



The Alemaya area rainfall pattern and distribution seems similar when it is compared with that of the DireDawa rainfall pattern. The nature of the rainfall is torrential and has got poor distribution across the Administration boarder, which is a typical feature for dry land areas irrespective of the altitudinal differences.

Fig. 4.4 Mean Monthly Rainfall of Alemaya Met. Station for the Period of 1981-1991 and 1997-2001



4.3.3 Geomorphology

The DireDawa Administration is located at the eastern margin of the main Rift Valley System and classified into three distinct geomorphologic set ups as follows:

- The plateau minor area, which demarcates the southern limit of the region, has elevations in the range of 2,100-2,300 masl.
- The area of the steeped edge of the valley depression, extending from the plateau to the southern limit of DireDawa town has elevations in the range of 1,100 -2,100 masl.
- The area of the valley depression, situated in the vicinity of the town of DireDawa extending to the north, west and eastern limit of the Administration. This valley bottom lies at a relatively lower elevations of 1,000-1,200 masl. Based on the above stated geomorphological set up of the DDA, three major landforms are identified:

Mountains and Hills

These are very large units which cover >50% of the total territory. They are located mainly on the southern, southwestern, and southeastern parts and are covered by very sparse vegetation (acacia). They have >70% surface stone coverage and are used for grazing / browsing and/or have no significant use (especially those areas that are rock-outcrops or with no vegetation cover). The major soil types on the mountains are Leptosols and Regosols.

Plains

Flat plains are found in Haselisso, Jeldessa, Melka Jebdu and Gerba-Aneno areas. These are mostly concentrated in the northeastern and northwestern part of the area, with slope ranging between 0 -3% and mainly used as grazing and browsing of the pastoral livestock and to certain extent the area is under sorghum. The major soil types, which dominate in these plains, are Fluvisols and Arensols. The other plains are the undulating and rolling plains that are located throughout the Administration area especially in the middle part and are characterized by low to high lying scattered hills. Cultivation using terracing is practiced on these land units where farmers grow mainly chat. The major soil types of these areas are Regosols and to a lesser extent Cambisols.

The Valley Bottoms and River Terraces

These types of terrains are located throughout the area. These are relatively gentler sloppy areas that are found between hills and mountains. They are relatively fertile as annual floods usually deposit new fresh sediments and are usually used for cultivation of different crops. The area is located at the foot slopes of the mountain ranges and the riverbanks. The slope ranges from 2- 16%. These are the area where the rain fed as well as irrigated crop cultivation is concentrated. The major crops grown are *chat*, vegetables, and fruits. The main soil type, which dominates, is Fluvisols. In addition to these, other types of landforms such as foot-slopes, pediments, channels, levees, depressions, ridges, flood plains, etc., are also observed at different locations.

4.3.4 Hydrology

4.3.4.1 Surface Water Resources Potential of the DDA

There are no perennial large rivers in DDA, which flow throughout the year, however according to the study made by the Agricultural Development Office of DireDawa Administration in 1992 E.C., there are 130 springs with different discharging capacity and over 44 intermittent streams. In general, the main springs and rivers in DDA can be grouped as:

- Kelaad River and tributaries - catchment area = 901km²,
- Dichato River and tributaries - catchment area = 473km²,
- Lege Oda River & tributaries - catchment area = 115km², and
- Kalcha River & tributaries - catchment area = 448km²,

Kelaad River

This river and its tributaries have average elevations of 1200m at the lowlands and 1800m at the highlands with a share of 50% of the available catchment area, each. The total catchment area (planimetered) is 901km², of which 450.5km² is stretched out in the lowland part and the remaining 450.5km² is for the highland area.

The upstream part of the river is rocky hills with sparse vegetation cover, the elevation of which is slightly above 2200m above mean sea level; whereas the low land portion of the catchment lies with elevation ranges between 1400m and 1000m above mean sea level. At the lowland portion of the river, a dam site is located for irrigation development. The river width at the dam axis is nearly 160m, the streambed is covered with silt, sand, gravels, and pebbles, and this indicates that the slope of the riverbed at this location is medium. In the upper reaches of the river, it is logical to estimate the riverbed slope as steep and the riverbed is covered with boulders, big stones, and pebbles.

Dichato River

This river is crossing the DireDawa city and during high floods, it is considered as an enemy to the people residing or working on both sides of the banks. The river is used to create flood hazard to the DireDawa town. The finding of the study indicates that in the year 1985 the water depth reached some 1.8 meters at the location of 09⁰34'73" North

and 41°52'58" East with river width of 80 meters with estimated slope of 0.8%. The riverbed at the specified location is covered with fine sand, gravels, coarse sand, silt, and pebbles. The upstream reach of the river is covered with some vegetation and hilly on both sides.

The catchment area of the river is 473km² with average elevations of 1900m at the highland covering 25% of the area, 1600m at the middle land also covering 25% of the area and 1325m at the lowland portion of the area covering 50% of the total area with mean annual rainfalls of 875mm, 740mm and 616mm, respectively.

Lege - Oda River

The river is located at the eastern boundary of the study region with average elevations of 1800m at the highland part comprising 50% of the total catchment area and the remaining 50% of the area has average elevation of 1250m at the lowland with a total catchment area of 115km² and mean monthly rainfall of 830mm and 582mm, respectively.

The most upstream portion of the catchment is hilly with steep slope and covered with vegetation. The left part of the lowland (facing in the direction of flow) is also hilly with sparse vegetation.

Kalcha River

This river is located at the central part of the Administration with average elevation of 1700m at the highland and 1300m at the lowland. The highest elevation at the most upstream reach of the catchment is 2100m, whereas the lowest elevation at the lowland area is 1100m. The highland part of the catchment covers almost 25% of the area and the remaining 75% is in the lowland area.

The total catchment area of the river is 448km², out of which 112km² is for the highland and the remaining 336km² is for the lowland part with mean annual rainfall of 807mm and 604.6mm, respectively. The most upstream portion of the catchment is of steep hills covered with sparse vegetation. There are solid rock out-crops, weathered rocks and soil covers in this catchment. The highland portion of the river course is covered with boulders,

pebbles, gravels, & coarse sand; whereas the lowland portion is covered with pebbles, gravels, sand & silt which indicates a relatively flatter slope.

The surface water potential of the Administration is estimated by considering all the above mentioned rivers. By sub-dividing each of the rivers into lowlands and highlands with their respective areas; and their respective mean annual rainfall (by employing rainfall/altitude co-relation), then the surface water potentials are estimated as shown on the Table below.

Table 4.1 Mean Annual Flow of the Rivers in DDA (Mm³)

No.	Rivers	Area (km ²)	Weighted Rainfall (mm)	Mean Annual Flow (Mm ³)
1	Kelaad and all the tributaries	901	694.6	100.13
2	Dichato (& tributaries)	473	683.4	51.7
3	Lege- Oda	115	672.1	12.4
4	Kalcha & tributaries	448	655.3	47.0
Total		1937	676.23	211.23

From the above table, it can be easily observed that the mean annual run-off potential at the down stream border of the study area totaled to 211 x 10⁶m³.

4.3.4.2 Ground Water Condition of the DireDawa Area

The DDA is found at the margin of the eastern part of the Ethiopian Rift Valley. The geological formation and hydro geological conditions of the area is a function of geomorphology, on the escarpment outcrops pre-Cambrian rocks, Adigrat sandstone, Hamanalei limestone, upper sandstones and basalts, the down thrown plain (foot of the escarpment) is dominantly covered by alluvial deposits. Both the plains (down thrown block) and the escarpment are highly dissected by east-west trending faults. The groundwater occurrence, distribution and flow regime is highly governed by topography, tectonics, geological formation, aerial and topological relationship of the geological formation. Based on these major factors, the DDA can be categorized into two groundwater systems i.e. the escarpment and the foot of the escarpment (groundwater basin of DireDawa).

The Escarpment Groundwater: - The escarpment occupies the southern, southeastern, and eastern parts of the Administration. It is highly rugged areas and intensively faulted by east-west trending faults. Geologically, the western part is dominated by sedimentary formations (limestone and sandstones) at the central part south of DireDawa town sedimentary and basement rocks dominates, to the east volcanic and sedimentary rocks dominates. At the eastern part of the escarpment (from Kalicha to the east) downstream of the sedimentary formation, basement rocks outcrops and the topography highly enhances complete drainage of the groundwater of the sedimentary formation. From analysis of the ground water point inventory, which was carried out from August to September 2002 the groundwater potential of the escarpment is estimated based on springs discharge to be about 4.8 Mm³/year (151.7 l/s).

The DireDawa groundwater basin (foot of the escarpment): The foot of the escarpment (DireDawa Groundwater Basin) occupies the western part (plains) of the Administration from DireDawa town along Melka Jebdu to Hurso and to the east the plain part is practically out of DDA territory. This area is considered to have high groundwater potential, where DireDawa town water supply source is found and the where Haseliso well field the future water supply source of Harare town is located. The groundwater occurrence and distribution in the basin is mainly a function of the geological formations, geomorphology and tectonics.

The groundwater recharge of the basin is estimated about 1000 l/s (31.5 MCM/year) for both alluvial, upper sandstones and limestone aquifers. The basement rocks are not penetrated by bore holes in Basin.

- **Alluvial aquifers (Qa):** The alluvial aquifer forms extensive aquifer at DDA and North of it, west of DDA the occurrence of groundwater in this formation is limited along the alluvial fans and river channel deposits. The thickness of the alluvial sediment varies from 8.5 to 237 meters composed of clay, silt, sand, gravel and rock fragments. The ground water depth varies in the alluvial sediments from 5 to 45 meters. The discharge of wells from this formation varies from dry to a specific well discharge of 3.1 l/s/m. The transmissivity of the alluvial formation varies from eight to 700 m²/day, and the maximum transmissivity is registered at Shinile. The water quality of alluvial aquifer is

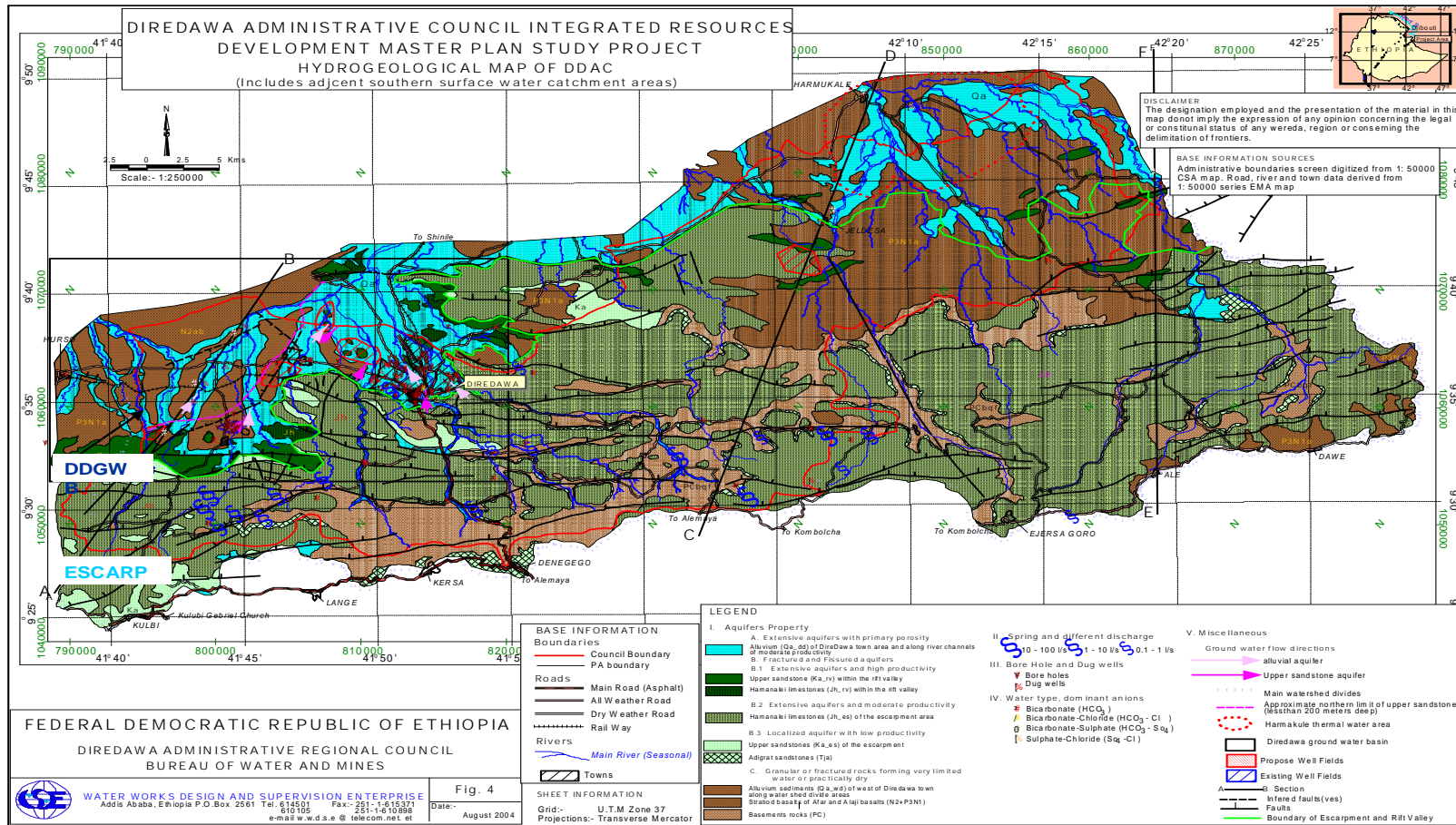
highly contaminated by human interferences, especially the alluvial water in the DDA and dug wells near the community. The total dissolved solids of polluted water are from 1000 mg/l to more than 3000 mg/l. The water type is mainly Ca-HCO₃ and Ca-Mg-HCO₃ but the water at DireDawa town area is changed by human interference to Ca-HCO₃-Cl, Ca-Na-HCO₃-Cl, Ca-Mg-HCO₃-Cl and Na-Ca-HCO₃-SO₄.

- **Tertiary volcanic rocks (N2+P3N1):** Tertiary volcanic rocks in the DDA are mainly stratoid basalts and Alaji basalts outcrops that occupy the elevated areas at the north and northeastern part of the Administration territory. Boreholes drilled on the basalts are practically dry except at Hurso area with a maximum specific well discharge of 0.01 l/s/m.
- **Upper Sandstones (Ka) (main aquifer):** The upper sandstone outcrops in a small aerial extent at Haseliso, North of DireDawa at the Airport and Northwest of DDA. The geophysical investigation results after calibrating with the drilled test wells have preliminary showed that the upper sandstone forms a strip aquifer extending from Serkama (outcrops) to Dire Jara (overlain by alluvium and basalts) in the northeast direction which could be one unit with the extensive DireDawa town area upper sandstone. The width of the strip in north direction from the foot of the escarpment is estimated in average about five kilometers. The drilled wells in the aquifer show that the thickness of the aquifer is variable. It is recorded in the Dire Jara well accomplishment report as general conclusion that the groundwater was struck from 100-120 meters and the static water level is stabilized at 50 to 60meters below the ground surface. The sandstone at the Sabiyian area also considered as confined aquifer although the pumping test results show leaky aquifer. In general, the aquifer is confined aquifer where the confining layer could be basalt, alluvium and intercalation of shale with in the sandstone. The static water level varies from 9.3 meters (Sabiyian) to 69.3 meters (Dire Jara) with the specific well discharge of 0.13 to 68.97 l/s/m. The transmissivity of the aquifer varies from 9 to 5512 m²/day with a mean of 1810.9 and harmonic mean of 88m²/day and

the storage coefficient varies from 0.003-0.005 from pumping test analysis. Two groundwater flow regions are identified in this aquifer, in the northeast direction from Serkam to Shinile direction (along the strip), which joins the groundwater flow from DireDawa town area to the north. The water quality is generally hard and the water type is Ca-HCO₃, Ca-Mg-HCO₃ and the water at DireDawa town and the Sabiyian has high chlorides and the water types changes to Ca-HCO₃-Cl, Ca-Mg-HCO₃-Cl, and Ca-Cl-HCO₃-SO₄ due to contamination of the aquifer in the area.

- **Hamanalei lime stones (Jh):** The Hamanlei limestone outcrops in the DireDawa groundwater Basin together the upper sandstone a lesser aerial extent. Drilling results show that the limestone unconformably underlies the upper sandstone. The limestone at Dire Jara area is highly fractured and crested and forms complex water bearing formation together with the upper sandstone, whereas at the DireDawa town area the lime stones are massive of low groundwater productivity and most of the wells that penetrates only the limestone are abandoned (AE 1990). The limestone at Dire jara area could not be independently characterized and the aquifer characterization for the upper sandstone applies also for the lime stones in the mentioned area.

Fig.4.5 Hydrological Map of DDA



4.3.4 Ground Water Quality

Groundwater samples taken during the hydrogeological study of DireDawa basin were analyzed. According to Ethiopian guidelines, the analyzed groundwater of each geological formation is compared and found that most of the tested water samples fulfil the desirable level in their median except hardness. All ranges of value of tested water samples fulfil the permissible level except some areas of nitrates value. The range, which exceeds the permissible level are water samples from polluted boreholes and hand dug wells.

Samples were also collected in the DireDawa town area for bacteriological analysis with the objective to evaluate the human interference condition of the alluvial and sandstones aquifers found within the town. As the result of analysis the following conclusion was drawn:

- High faecal coliform bacteria are observed in dug wells, while in bore holes in most case the faecal bacteria are zero.
- No correlation is observed between faecal coliform bacteria with nitrates, indicating that the contaminated water has taken longer time than the lifetime of the bacteria to reach the sandstone aquifer.
- The Sabiyian well field production wells water and reservoir water were found to be free of both faecal and total coliform bacteria, except PW2, which could be recent contamination or an outlier.

4.3.4.1 Pollution of the Groundwater System and Aquifers Vulnerability

The first report on the nitrate contamination of the hydro-geologic system in the DireDawa town centre was reported in 1959 with maximum nitrate concentration of 45 mg/l. Since then a number of records show that the contamination increasing from time to time. For example, in 1981 it was recorded a maximum nitrate concentration of 320 mg/l. The degree of nitrate concentration in the groundwater depends on the population density and recharge condition in the area.

There are two aquifers in DireDawa town area i.e. the alluvial and the upper sandstone aquifer. The main aquifer that is exploited for the DireDawa town water supply is the

upper sandstone. This aquifer is vulnerable to pollution due to moderate to high permeability of the alluvial sediments overlying the aquifer.

The main ground water contamination sources of DireDawa groundwater are:

- Pit latrines and septic tanks, which form aerial distribution of contamination due to their high density and form a continuum by diffusion since the town is without sewerage system.
- Solid waste and waste water disposal along Dechatu river
- Animal feed lots and irrigation areas
- Faulty constructed dug wells and not properly abandoned wells
- Waste from industries, cemeteries and fuel station, etc.

Recent drilling report indicate that wells drilled at a depth greater than 170 m in Sabian well field shows low concentration of Nitrate ions.

4.3.4.2 Status of Existing Well Fields

Dire Jara Well Field: In 1996, GIBB/ Seuereca, has conduct hydrogeological study and selected Dire Jara area as well field for Harar town water supply and subsequently, drilling results of bore holes at Dire Jara well field shows that:

- The water bearing formations are mainly fractured sandstones and lime stones
- The overlying formations, basalts and alluvial deposits (silty clay and sandy clay) are the confining layer the water bearing formations of upper sandstone and lime stone
- Mostly water was struck at average depth between 120 and 140 meters below ground level, while the static water level varies between 50 and 70 meters below ground level
- From the pumping test results, 12 boreholes have, well yield each greater than 20 l/s. currently additional drilling of production wells is underway in Dire Jara well field.

Sabian well field: Associated Engineering PLC (AE) carried out hydrogeological study in 1986 and selected potential groundwater sites of Sabiyian well field located Northwest of DireDawa town. The well field has aerial boreholes distribution and wells spaced 200-300 meters apart.

Rehabilitation and pumping test on existing wells has been performed in 2002/2003 in Sabian well field. Comparison was made between pumping test results during well accomplishment in 1989, and before and after rehabilitation works. The results are summarized as shown as below:

Table 4.2 Statistical Physico-Chemical Composition of DDA Groundwater

Water quality indicator	pH	EC, $\mu\text{S/cm}$	Na+,mg /l	Ca++, mg/l	Mg++, mg/l	Mn ⁴⁺ , mg/l	Fe++, mg/l	Cl-, mg/l	NO ₃ -, mg/l	F-, mg/l	HCO ₃ -, mg/l	CO ₃ --, mg/l	SO ₄ --, mg/l	SAR
Min	6.7	178.0	2.0	32.0	3.0	0.0	0.0	8.0	0.0	0.1	107.4	7.2	2.4	0.4
Max	8.5	3780.0	600.0	472.0	109.4	0.2	0.8	694.1	244.0	2.4	700.3	16.8	1213.0	1.8
Average	7.5	1171.9	72.3	151.9	28.6	0.1	0.1	110.9	34.0	0.6	403.7	12.0	120.1	0.5
St. Dev.	0.3	588.2	89.4	63.7	22.2	0.0	0.2	122.0	50.7	0.3	100.6	6.8	208.6	0.4
Var%	21.0	95.0	100.0	93.0	97.0	95.0	99.0	99.0	100.0	94.0	85.0	57.0	100.0	0.9
Sample No	76.0	76.0	68.0	68.0	68.0	48.0	31.0	75.0	71.0	73.0	68.0	2.0	74.0	76.0

4.3.5 Soils

The major soils types of the region are Yermosols, Leptosols, and Fluvisols. Regosols and Cambisols of different classes are also found in few areas particularly at the upper slopes of the mountain along kulubi, Kerssa and Jarso areas. Most of the soils in the steeper areas of the region are Leptosols associated with regosol and yermosols. While the dominant types of soil in the low flat (Plain) land areas are fluvisols associated with yermosols, regosol and cambisols.

In the southeastern part of the uplands, where the land is severely dissected and the sloppy lands with slop percentage ranging from 16-30 percent Leptosols are dominant. These soil are mostly at lithic phase and some times at stony phase, usually have a very shallow depth and pH of 7-8 with a texture of sandy loam to Loamy sand. The soil in the southwest Uplands is also Leptosols, but found in association with regosol and Yermols and Cambisols. These soils generally have loamy to clay loam soil texture, slightly to moderately alkaline pH and low cation exchange capacity as they have limited

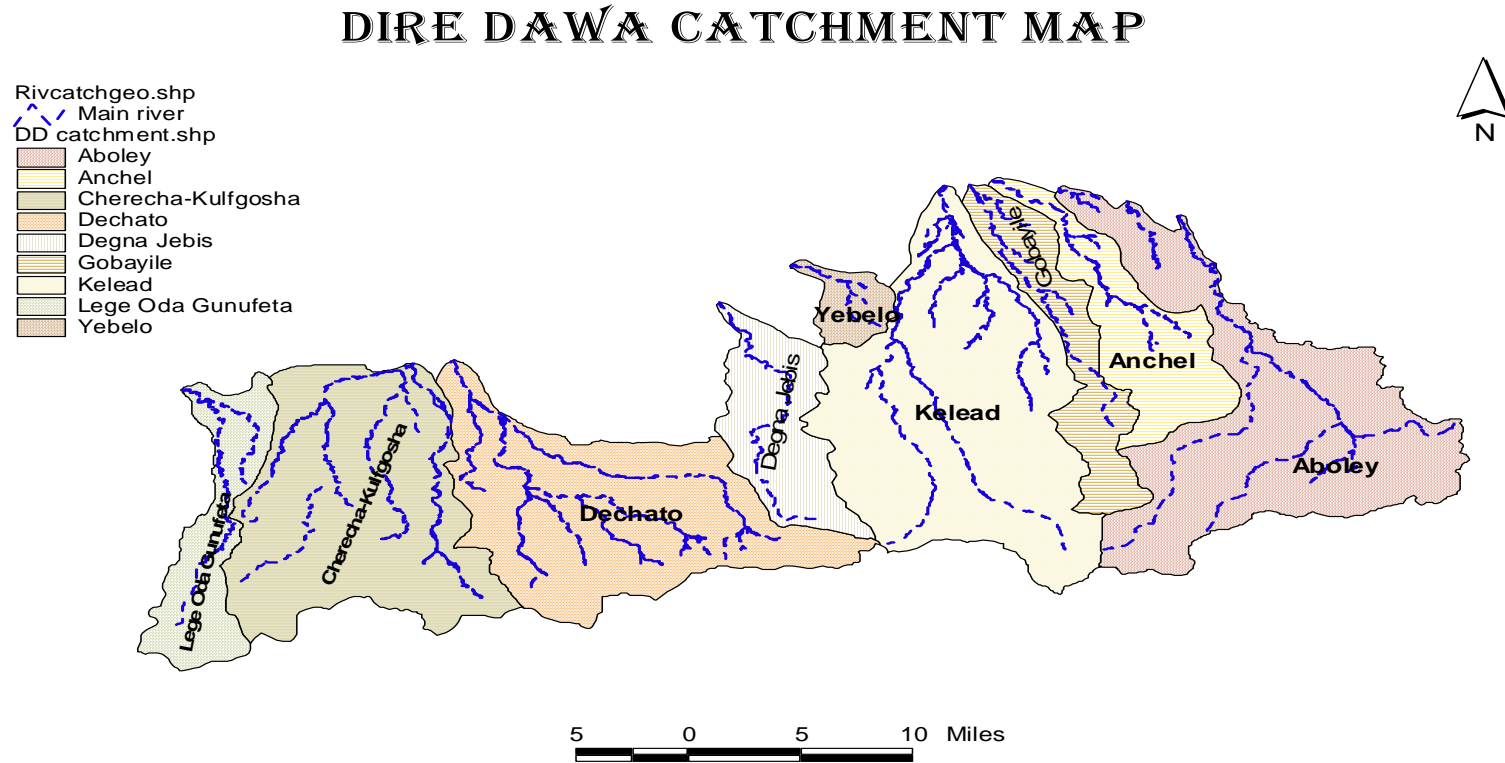
phosphorous and potassium contents. On the other hand, Leptosols found on places of steeper slopes are usually associated with regosol. They have reddish brown surface colors. These soils are highly eroded with very shallow depth, very low organic matter, and water holding capacity. The dominant soil types in the low flat lands are Fluvisols. These are alluvial soils of many classes formed through the sedimentation and deposition of surface soil materials from the sloppy areas. (Conservation Strategy of DDA.)

4.3.6 Physiography

4.3.6.1 Drainage

The study area, DDA, is located within the Awash River Basin at the foot of Wabi Shebelle-Awash Rivers' Basins' divider escarpment. The whole drainage system in the DDA is intermittent streams carrying water only after heavy rain events. They are, thus, dry wadis with sand beds. These wadis are erosive at the southern and south eastern escarpment having capacity to erode and carry heavy sediment loads including rock fragments and tree twigs that are discharged /deposited when they reach the flat plain of the DireDawa graben. The Administration is drained by 10 watersheds as shown in the figure below.

Fig. 4.6. Watersheds draining the Administration



4.3.7 Geology

4.3.7.1 Regional Geological Setting

The geological history of Ethiopia is similar to the neighboring Afro-Arabian countries. Most of the Afro-Arabian part was above sea level from the end of Precambrian era to Paleozoic for a span of about 370 million years, which was a time of intense erosion, and denudation that has resulted in peneplanation of this part of the world.

Later regional epirogenic sinking of the crust between late Triassic to early Jurassic period resulted in progressive transgression of the ocean from south east to North west covering most part of Ethiopia. This resulted in the deposition of extensive layers of sediments.

Upward motion of the crust commenced during late Jurassic that brought the crust to sea level followed by marine regression in late cretaceous. The uplift continued mid Tertiary where progressive fracturing of the crust, out pouring of molten magma, and major fault displacement occurred along the present day rift valley associated with significant volcanism. These activities were responsible for the present Ethiopian Physiographic features that can possibly be classified into the Western plateau, south eastern plateau, the main Ethiopian rift and the Afar depression.

The rock units exposed in DDA area are the result of these geologic phenomena. Precambrian rocks are represented by gneissic rocks. Mesozoic rocks are represented by sandstones and limestones where as Tertiary volcanic rocks are represented by trap basalts. Later, quaternary sediments and alluvial sediments of considerable economic importance have been laid down in some parts of the area.

4.3.7.2 Geology of the DDA

The dominant rock units exposed in DDA area are represented by:

- i) High grade crystalline basement rocks
- ii) The transgression and regression depositions of the Mesozoic era that consists of:

- ◆ The Adigrat sandstone,
- ◆ The Hamanlei Limestone, and
- ◆ The Amba Aradam sandstone.

iii) The basaltic lava flows that are related to tectonic events of the rift system and alluvial and lacustrine deposits.

The major rock units in DDA area according to their regional stratigraphic position from oldest to youngest in age are: Precambrian basement rocks consisting of various gneisses, diorite/granodiorite and related pegmatite veins; Mesozoic sedimentary rocks consisting of sandstones and limestones; Tertiary volcanics and quaternary sediments consisting of alluvial sediments, travertine, riversand deposits.

Precambrian Basement Rocks

These Precambrian basement rocks represented by high-grade Algae group rocks in the area can, generally, be classified into the major units, namely; the quartz-feldspar-biotitic gneiss, plagioclase-epidotic-hornblend gneiss and less common diorite (granodiorite) and pegmatite veins.

Biotite-Quartz-Feldspar Gneiss (PCbqf)

This is the oldest unit exposed in the south and southeastern part of DDA. The rock is generally characterized by poorly defined gneissose structures and ill-defined white and dark bands contributed by mineral segregations. The bands strike N 35° E dipping 20° towards southeast. This unit has suffered from intrusions of several basaltic dykes. The gneiss is generally very coarse grained with colours varying from light grey to pink. Petrography study revealed mineralogical composition of orthoclase (k-feldspar) 45-58%, quartz (15.25%) biotile (12%), plagioclase (8%), muscovite (2.3%), chlorite (2%), opaques (10-15%) and accessories like sphere, zircon and calcite about 1% each. Very coarse nature of this rock might preclude its application for dimension stone. However, if successful separation of mineral grains is maintained, this rock unit can also be possible source of feldspars and quartz for ceramic and glass production provided that the mineral concentrates meet the purity level required by the intended industries.

Plageoclase – Epidote – Hornblende Gneiss (PCpeh)

This is a minor unit exposed at restricted areas of Melka Kero and Kalicha. It is identified with its peculiar highly foliated nature and hosting several pegmatite veins.

Petrographic analysis revealed mineral compositions of dominantly hornblende (56-67%), epidote (2-15%), plagioclase (10-30%), quartz (5-10%), sphene (2%), calcite (1%) and traces of apatite, opaques and zircon.

This unit is, particularly, interesting for hosting several pegmatite veins that can probably be potential sources of important industrial minerals and base metals.

Pegmatite Vein

Two types of pegmatites have been identified in DDA. Simple pegmatites are usually associated to older units like Biotite-quartz-feldspar gneiss in this area. This type is usually composed of quartz, feldspars, and mica. If the sizes of the pegmatites permit, detail exploration can be planned with the intention of producing feldspar, quartz and mica (as some mica veins reach up to 15 cm diameter). The complex pegmatites on the other hand are usually associated with relatively younger units like: with low grade rocks at Kenticha and with relatively younger unit of plagioclase-epidote-hornblende gneiss at this area.

Complex pegmatites are generally known to host both industrial and metallic minerals. The complex pegmatites of Melka Kero and Kalicha localities of DDA area contain mineral compositions of lepidolite (30%), microcline (24%), plagioclase (23%), spodumene (23%), minor beryl, garnet and tourmaline. The complex pegmatites are potential sources of industrial minerals, metallic minerals and probably gemstones after proper detail exploration is conducted.

Diorite (Granodiorite) PCgd

This rock unit is exposed between DireDawa and Dengego along the main road. It is grayish white in colour and coarse grained with sub-circular outline exhibiting spheroidal weathering. This unit is composed of plagioclase (60-74%), quartz (15%), opaques (8-

10%), sericite (10%), microcline (5%), hornblende (1%) and traces of epidote. This unit is not particularly interesting for hosting any economic minerals. Its coarse nature and high sericite content might preclude its use as dimension stone.

Mesozoic Sedimentary Rocks

The Mesozoic formations exposed in this area are the transgression and regression products. These include: the Adigrat sandstone at the bottom, the Hamanlie Limestone in the middle and the Amba Aradam sandstone overlying the limestone. Parts of both sandstone can probably be sources of quartz and feldspar for ceramic and glass industries and the limestone is huge resource for cement production.

Adigrat Sandstone

The Adigrat sandstone is a transgression unit which is a terrigenous sandy and rarely conglomeratic formation having colours ranging from grayish white to yellowish brown. It is a thick unit with mineralogical composition of 30-39% quartz, up to 35% calcite cement, 15-62% potash feldspar, 4% plagioclase, 2% muscovite, 2% zircon and 2% opaque minerals.

The lower part of this sandstone with low or no calcite cement and moderate to high quartz sand feldspar content can probably be very good source of quartz and feldspar for glass and ceramic production provided that the products are technically and economically separable and chemically pure (low coloring oxides) to meet industry requirements. Trenching or clearing of the complete section of this unit from top to bottom followed by channel sampling (based on color and grain size variation) and physio-chemical test are necessary to characterize the sandstone for possible end-uses.

Hamanlei Limestone (Jh)

The Hamanlei Limestone is a marine origin sandwiched between the underlying terrigenous Adigrat sandstone and the overlying Amba Aradam sandstone. Different workers mentioned its thickness to vary from 275m to 265 meters. The limestone is generally massive and grey in color with some solution cavities filled by translucent quartz

geodes. Subordinate varieties of dark grey and yellowish brown limestones exist. Based on Gumerov Leron, there is no major difference in chemistry between these varieties, except higher opaques in the brown varieties. The grey variety, which is the dominant type, contains mineralogical composition of 80-98% calcite, 2-17% quartz and 0-1% opaque.

Average of 335 core samples representing 4,344.4 line meter indicate chemical compositions of 3.4% SiO₂, 0.6% Al₂O₃, 0.5% Fe₂O₃, 52.6% CaO, 0.8% MgO, 0.1% Na₂O, K₂O, H₂O and 41.8% loss on ignition, 0.1% Mn, 0.0%3Cl, 0.09%SO₃ and 0.01% P₂O₅, 266 of the samples were of high quality limestone, 8 were dolomitic (Mgo+4%) 52 samples were cherty (SiO₂ 5%+). Based on the above chemistry, considering ideal open pit mining conditions and enormous reserve, Leron Gumerov concluded that the DireDawa limestone meets the requirement for cement industry.

Limestone apart from cement product can be applied as raw material in various industries like in glass, filler for adhesives, rubber, stucco, paint, floor tile, paper plastic, ink, etc based on physical & chemical requirement of the final product.

The low coloring oxide (Fe₂O₃=0.5%), low SiO₂, low SO₃ and high CaO might indicate that the Limestone near DireDawa might possibly be applied in other industries as well. This has to be proved by mapping to appropriate scale, channel sampling of the whole section of the limestone, and identify horizons based on use-oriented physico-chemical laboratory and technological tests.

Amba Aradam Sandstone

Amba Aradam sandstone is a terrigenous material laid down by the time of regression unconformably upon the Hamanlei limestone. This sandstone has grain size varying from silt size through medium, coarse to conglomerate with variegated color ranging from yellow to purple to black depending on the coloring materials contained. It is well cemented with silica, clay and calcite with mineral compositions of 40-90% quartz, up to 60% k-feldspar, 5-15% plageoclase, 3-13% clay cement, 5% calcite cement and 1% opaques.

Chemical analysis lack to characterize the chemical purity of the rock unit. Based only on

the petrographic study, the high feldspar minerals content coupled with moderate to high content of quartz might indicate the possibility of liberating these minerals for ceramic and container glass manufacture if simple crushing can disaggregate the clay, silica and calcite cement and liberate these minerals successfully. The coloring agents might stick to the cementing materials and successful washing off the cementing materials might produce quality concentrate. The variegated and highly cemented medium-grained variety can probably be used as dimension stone for facing purposes similar to the commonly known as Ambo sandstone. Closer inspection of the outcrop is important as the presence of narrowly spaced joint systems might preclude this purpose. Color and block size are important criteria for its considerations.

Tertiary Volcanics

In lower Tertiary time, at the start of rifting, trap basalts intercalated with ignimbrites were laid down on the uplifted and eroded pre-tertiary surface to be followed by rhyolitic lavas and in the late tertiary by more basalt flows and dykes. Subsequent erosion dissected the volcanics into isolated outliers (Gumerov L.1981).The Alaji basalts are dark in colour, massive and aphanitic to porphyritic varieties and are aphyric flood basalts. It is exposed in north western, north eastern and central parts of the area.

The stratoid basalt on the other hand is dark grey in colour and vesicular. It is exposed at the north eastern and north western part of Dire Dawa making prominent ridges. Both varieties of basalts can be applied in the production of construction materials like selected materials, crushed stone for aggregate and other construction purposes.

Quaternary Sediments

The quaternary formation are characterized by alluvial sediments and clays, lacustrine deposit including travertine and river sand and gravel filling channels and river beds. The quaternary sediments are important sources of clay deposits for cement production and other local construction purposes. The river sand deposits and travertine are also very good construction materials that are currently used in the region.

Alluvial Sediments (Qa)

The sources of the sediments are gneisses, sandstones, limestones and basalts, which are the main geologic units of the area. Weathered parts of these rocks at higher altitudes when subjected to intense erosion and transportation lay down large volume of sediments of various grain size and mineral composition at lower attitude and flat areas of DireDawa area.

Major clay deposits lay at Gender Gay, Gende Mude Hassen, Kaba Dimtu and Melka Jebdu areas. As Gumerov L. (1981) described the clay, it is sandy and polymineralic, hydromicaceous and rarely montmorillonitic. Grain size determinations from pit samples revealed size fractions of 2.3% gravel, 28.9% sand, 68.8% silt and clay. 38.4% of the fine fraction is clay. The clay reveal average chemi-composition of SiO_2 (47.7%), Al_2O_3 (12.26%), Fe_2O_3 (6.68%), Cao (9.5%) Mgo (1.9%), Mno (0.1%), TiO_2 (0.1%), Na_2O (0.9), K_2O (1.9), SO_3 (0.03), and Cl (0.6%). The clay resource has been estimated at 2.5mt. These clays can be applied for cement production but the Melka Jebdu clay should be investigated in detail.

Travertine (Qtr)

The travertine is yellowish grey to grayish white and found associated with lacustrine sediments in areas of Lega Goro, Sabian, Lega Hare and Melka Jebdu. It is commonly known in the areas as "Yogoro Dingay" and is available but the complete and readily reaction with dilute HCl might indicate high quality carbonate rock with little or no impurities. Chemical and mineralogical analyses are important to propose possible industrial uses other than construction of houses and fences, which the travertine is currently used for.

Riverine Sand Deposits (QrS)

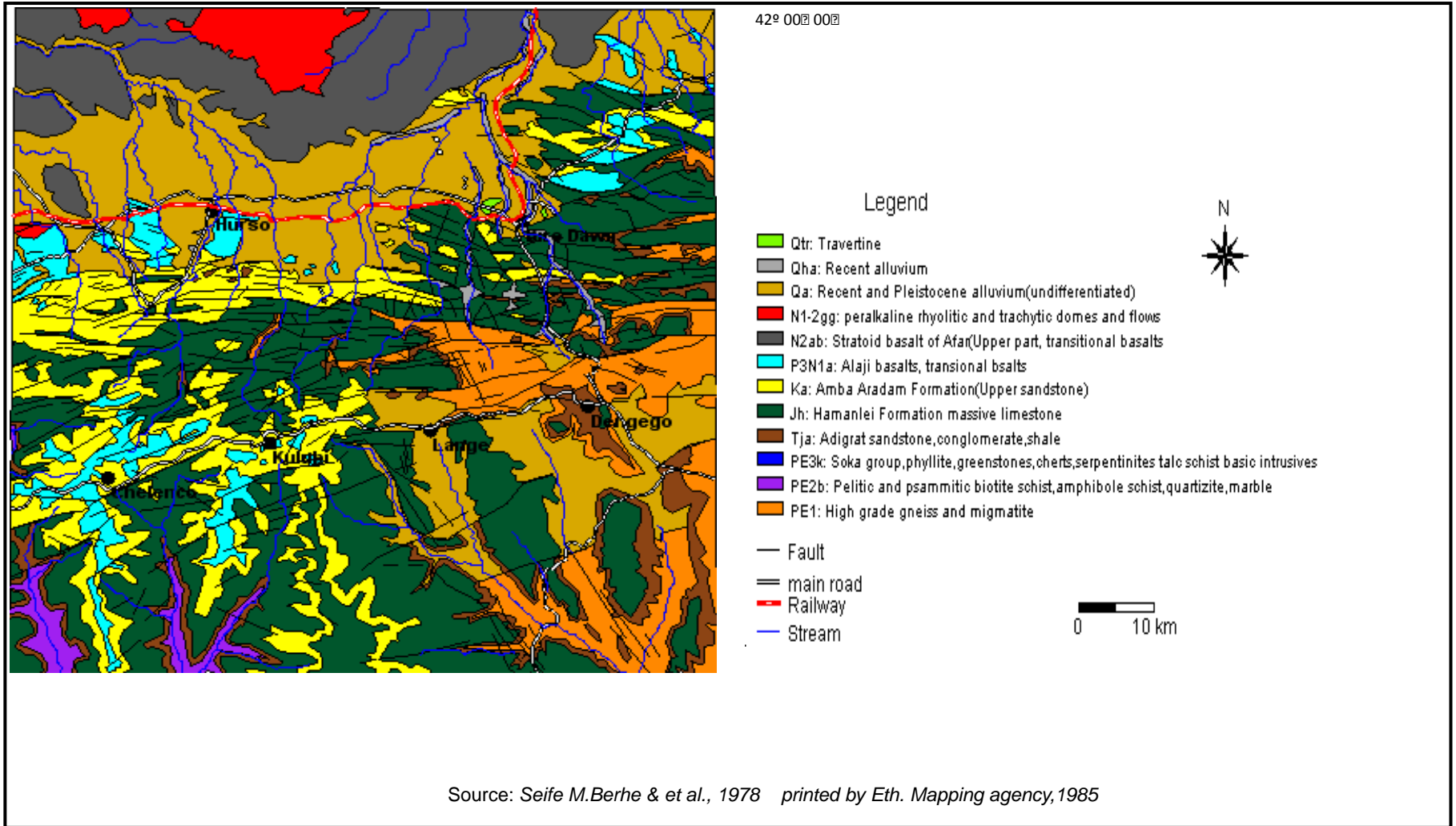
These sediments are the most recent deposits laid down by the intermittent streams of Goro, Dechatu and Lega Hare. The crystalline rocks (gneiss & sandstone) at higher topographic outliers are ideal source rocks for the sand to originate. Rock fragments intercalated with the sand are from sources of sedimentary metamorphic and volcanic rocks. Mineralogical compositions of the sand show k-feldspar, quartz, calcite, mica and opaques.

Grain size analysis of sand sample from Goro, Lega Hare and Dechatu show similarities

in having no clay fractions, low silt content, low gravel and almost all fall within medium to coarse sand fractions. But differences are seen about the sand fraction in the three rivers in that river sand from Goro show 51% medium sand & 25% coarse sand, while the sand from Lege Hare contain 83% medium, 7% coarse sand and sample from Dechatu river show 23% medium and 65% coarse sand. These results show that Dechatu river contain large proportion of coarse sand & Lege Hare river contain large proportion of medium grained sand. The Goro sand differs in having higher gravel admixtures, moderate coarse sand and half of the material is medium sand.

The sand is currently being used for construction purposes. The above results are liable to changes due to seasonal fresh supply & deposition of large volume of sediment. If successful separation of the sediment into quartz sand and feldspar maintained, it might be applicable in various industries; e.g. quartz sand (silica sand) can be applied for glassmaking (container, flat, specialty glass and fiberglass) and in non-glass uses (foundry, abrasives, filtration refractory, Metallurgical, chemicals, etc) provided that their physico-chemical properties meet required specifications.

Fig. 4.7 Geological Map of DireDawa Area



41° 29' 36"

4.3.8 Industrial and Construction Minerals Potential Limestone

This rock unit is the dominant formation in the region. The limestone outcrop at eastern suburb of DireDawa extends for about five km long. As Gumerov evaluated it, the lower part of this limestone is cherty and dolomitic while the upper most part is high quality. By definition, limestone contains more than 50% calcite or aragonite (both are forms of CaCO_3). Limestone is used in various applications like cement manufacture, lime, glass, fillers aggregate, etc. Limestone by far is used for cement production.

Cement Production

There are few cement factories in the country. The combined cement product cannot cope up with the ever-increasing demand. The present DireDawa Cement Factory is more than 60 years old & producing below its capacity. There is large market demanding cement in Somali region, Harar, Bale, Sidamo, Awash and Afar areas. Therefore, it is quite reasonable to think of additional new cement factories and expand existing factory to raise its production to supply this large market. The most important raw materials for cement production are limestone, clay, gypsum and pumice. Limestone and clay can be produced from DireDawa Administration whereas gypsum and pumice should be transported from adjacent areas. Quality requirements of limestone and clay are as described below.

Quality requirements for limestone and clay according to a Russian firm "GYPROCEMENT" are the following:

- Limestone
 - Constant CaO content with variation not greater than $\pm 2.0\%$ rarely $\pm 4.0\%$ is allowable, and
 - Humidity 5%.
- Clay
 - Siliceous module between 2.6 and 3.5 %,
 - Aluminous module between 2.0 and 3.0%, and
 - Humidity 25%

Table 4.3 Clay and Limestone Maximum Content of Deleterious Constituents

Mineral	Standard	DDA limestone (335 samples)
Magnesium oxides	5%	0.7%
Sulpheric anhydrite	1.5%	ND*
Alkaline oxides (K ₂ O + Na ₂ O)	1.2%	.2%
Phosphorus anhydrite	0.5%	0.01%(P ₂ O ₅)
Titanium oxide	2%	ND(0.036-phase II)
Chloride	0.05%	

Source: L. Gumerov, 1981. *ND - not determined.

To compare the results of the DireDawa limestone and clay to the above requirements, an average of 335 limestones and average of 107 clay sample results are presented on the Table below.

Table 4.4 Average Chemical Compositions of Limestone and Clay

Clay	Limestone (%)	Clay (%)
SiO ₂	3.4	47.7
Al ₂ O ₃	0.5	12.26
Fe ₂ O ₂	0.5	6.68
CaO	52.8	9.5
MgO	0.7	1.9
Na ₂ O	0.1	0.9
K ₂ O	0.1	1.9
Cl	0.03	0.06
SO ₃	0.09	0.03
P ₂ O ₅	0.01	ND
Mn	ND	0.1

Based on results depicted, with the exception of elevated alkali content and silica module more than 3% which can either be excluded or corrected by adding similar materials with lower values, the clay and limestone can be applied for cement production. The clay at Melka Jebdu and the extensions of the DireDawa limestone has to be fully investigated for the proposed new cement factories supported by geological mapping, coring and analysis.

The British Geological Survey (BGS) has developed a simple classification of limestone purity and this system can be used to illustrate various grades of limestone quality.

Table 4.5 Classification of Limestone by Purity

Category	CaCO ₃ %	CaO (%)
Very high purity	>98.5	>55.2
High purity	97.0-98.5	54.3-55.2
Medium purity	93.5-97.0	52.4-54.3
Low purity	85.0-93.5	47.6-52.4
Impure	<85.0	<47.6
DD limestone (av.)	93.98	52.8

According to the above classification, the average of 335 core samples falls within the medium purity category. However, some section of the limestone inters into high purity category and only one sample from four boreholes indicates very high purity (55.3 % CaO).

Aggregate

Crushed rock of limestone to a size of 150 micron is used for aggregates. Crashing and sizing to finer micron sizes (value-added) can be applied in glass, fillers and the price increases as the size decreases.

Glass Manufacture

Most glass products are designed for containers (bottles and jars) or for windows. This type of glass is known as soda-line-silica glass, reflecting its relatively simple ingredients of soda ash, limestone and silica sand. Minor impurities of iron and chromium have a significant effect on colour and quality of the glass. To manufacture white container glass might tolerate maximum Fe₂O₃ impurity of 0.04% by weight. The availability of extremely pure limestone with Fe₂O₃ content of 0.04% might entertain silica with a little elevated Fe₂O₃ content.

Limestone for flat glass manufacture should have min. 54.85% CaO, max. 0.8% MgO, 0.6% acid insolubles, 0.075% Fe₂O₃, 0.35% Al₂O₃, 0.05% sulphate, 0.1% free carbon and 0.05%

moisture (P.W. Harben, 1995).

The average values of the DireDawa limestone as compared to the above values show slightly lower CaCO_3 (94.25%), convenient MgO values, higher iron oxide (0.5%), very slightly elevated alumina, convenient SO_3 content and higher moisture content (Table 7.5). To use this limestone for glass making, corrective measures are needed to reduce the level of iron (magnetic separation or acid leaching) and moisture content. Determination of appropriate section of the limestone with higher CaO values that meet the criteria should be ascertained. If these things are corrected, it would probably be safe to produce flat glass. The silica source from sandstone and pegmatite should also be investigated. Container glass on the other hand should have max 0.1% Fe_2O_3 , 0.001% Cr_2O_3 & 0.1% moisture.

Table 4.6 Physical Specifications for Glass-Grade Limestone

Size(mm)	% Retained	% Retained Cumulative	% Passing Cumulative
1.68(12mesh)	0.0	0.0	100
1.19(16 mesh)	0.35	0.17	99.83
0.84 (20mesh)	3.06	5.20	94.80
0.3 (50mesh)	57.05	62.25	37.75
0.15(100mesh)	26.26	88.3	11.10
0.07(200mesh)	9.98	98.40	1.6
Pan	1.6	100	0.0

Table 4.7 Typical Chemical Analysis of Limestone in Glass-Batch

Mineral Composition	%	DD limestone (%) (average of 335 samples)
CaCO_3	97.8	93.98
MgCO_3	1.25	1.25
Fe_2O_3	0.095	0.50
SiO_2	0.56	3.20
Al_2O_3	0.23	0.50
Ni	<0.02	ND
Cr_2O_3	<0.001	ND
SrO	0.03	ND
MnO	<0.01	0.1

Source: *Industrial Minerals & Rocks, 6th edition.*

Average values of the DireDawa limestone contain an elevated content of silica and alumina and lower CaCO_3 content for glass manufacture. However, some portion of the limestone fall to high purity class.

Table 4.8 List of Core Samples, Analyses, and Thickness of DireDawa Limestone

Sample No.	Thickness (m)	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	CaO	MgO	Bore hole No.
151576	5.0	1.4	0.2	0.4	ND	54.6	0.1	1
151577	5.0	1.0	0.2	0.2	ND	55.1	0.1	1
151591	5.0	1.5	0.3	0.4	ND	54.6	0.3	2
151606	5.0	1.6	0.4	0.3	ND	54.6	0.3	3
151607	5.0	1.5	0.3	0.2	ND	55.3	0.4	3
151608	5.0	1.9	0.3	0.2	ND	54.6	0.4	3
151609	5.0	1.1	0.2	0.2	ND	55.0	0.4	3
151614	5.0	0.7	0.2	0.2	ND	54.8	0.8	4
151616	5.0	1.8	0.4	0.3	ND	54.3	0.4	4
151617	4.0	4.4	0.4	0.5	ND	54.3	0.4	4
151624	5.0	0.8	0.1	0.3	ND	55.1	0.4	5
151625	5.0	2.3	0.4	0.3	ND	54.3	0.5	5
151629	5.0	1.2	0.2	0.3	ND	55.7	0.3	5
151630	5.0	1.9	0.2	0.3	ND	55.0	0.4	5
151631	5.0	1.2	0.2	0.3	ND	55.0	0.4	5
156579	2.5	3.0	0.5	0.4	0.1	54.4	0.4	6
150201	5.5	3.0	0.5	0.4	ND	54.4	0.4	7
151909	5.0	2.0	0.4	0.4	0.1	54.3	0.4	8
151913	5.0	1.5	0.3	0.3	0.1	34.3	0.5	8
151914	5.0	2.0	0.4	0.3	0.1	54.8	0.4	8

Sample No.	Thickness (m)	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	CaO	MgO	Bore hole No.
151915	5.0	1.8	0.3	0.3	0.1	54.5	0.5	8
151916	5.0	1.8	0.3	0.3	0.1	54.5	0.5	
151917	5.0	1.5	0.3	0.2	0.1	54.5	1.0	8
150211	5.0	2.3	0.5	0.4	ND	54.3	0.4	9
150213	5.3	2.0	0.3	0.3	ND	54.5	0.4	9
150214	5.0	1.5	0.3	0.2	0.1	54.8	0.5	9
150216	5.0	1.7	0.3	0.3	0.1	54.4	0.5	9
150689	4.68	1.5	0.5	0.4	0.1	54.7	0.3	10
150697	5.0	1.8	0.2	0.4	ND	54.6	0.2	10
150698	6.1	2.0	0.2	0.2	ND	54.6	0.5	10
150221	5.0	2.9	0.3	0.6	0.1	54.4	0.3	11
150676	5.0	2.5	0.6	0.4	0.1	54.3	0.3	12
150677	5.0	1.8	0.4	0.4	0.1	54.8	0.3	12
150678	5.0	1.5	0.4	0.4	0.1	54.9	0.3	12
150680	5.0	2.8	0.3	0.4	0.1	54.5	0.4	12

Source: Leron Gumerove, *An evaluation of raw materials (limestone and clay for the 5th Cement plant, DireDawa, 1981.)*

This limestone falls within the high purity class of the BGS classification. The following summary indicates the proportion of the limestone of high purity class as compared to the total depth of borehole,

Table 4.9 Summary Of Borehole Depths and Proportion of High Purity Limestone

B.h No.	1	2	3	4	5	6	7	8	9	10	11	12
Depth(m)	60.4	60.4	60.0	49.0	60.4	60.6	60.0	60.0	60.0	60.0	60.0	60.0
Thickness(m)) CaO >54.3	10.0	5.0	20.0	14.0	25.0	2.5	9.8	30.0	25.3	20.54	5.0	20.0
%>54.3% CaO	16.6	8.3	33.3	28.6	41.4	4.0	16.3	50.0	42.0	34.0	8.0	33.0

The Table indicates that 4%, 16%, 50%, 42%, 34%, 8% and 33% of the limestone in boreholes number 6, 7,8,9,10,11 and 12, respectively contain limestone of high purity. This limestone, therefore, can be classified into different quality classes for different applications. However, very high purity limestone is not encountered in the boreholes.

Fillers

Mineral fillers are included in a compound to modify physical & optical characteristics. Wide ranges of materials are used for mineral fillers. They include asbestos, barite, bentonite, natural calcium carbonate (limestone), clays, diatomite, feldspar, mica, silica, talc, and other industrial minerals. The property of the final product is the result of the properties of the fillers including activity, purity, hardness, particle size, particle shape, particle size distribution, surface structure, color, density and refractive index. These requirements should be tested and assured before recommending a material for filler application.

Natural calcium carbonate (Limestone), feldspar, silica source, and mica are known to exist in DireDawa Administration. These materials have to be tested, if they can be applied in adhesives, asphalt, Bitumen's, carriers, cosmetics, fire retardants, insulation, paint, paper, plaster, printing ink, rubber, etc.

Limestone for filler application should have important characteristics of dry brightness of 80%, oil absorption 18-21%, surface area 1.5-4m²/g, bulk density 0.6-0.8 g/cm³, pH 9-9.5. In plastics, in addition it needs to have low Cu, Pb and Mn content. Particle size is also very important that application requirement is given in the Table below.

Table 4.10 Particle Size for Filler Application (μM)

Bulk	Mean	Top	Use
Coarse	22-40	420	Joint cement, Carpet, backing, asphalt roofing caulk, putty, rubber, sealants
Medium	12-22	100	
Fine	3-10	44	paper, paint, plastics rubber, paper, plastics
Ultra fine	0.7-2	10	

Source: A guide to Markets, specification & prices (P.W., Harben 1995).

It is now clear that wide range of tests is needed to characterize whether a certain materials can be applied for filler production. In addition to this, the resource of feldspar and mica is unknown as to their quantity and quality is concerned. Detail Exploration and analysis targeting the pegmatites might reveal both economic metallic minerals and industrial minerals (feldspar, mica & quartz) which can be applied for filler, glass and ceramic industries.

Sand and Sandstone

Ceramic Raw Materials

The dominant ceramic raw materials include kaolin, quartz and feldspar. Ball clay, a form of disordered plastic kaolinite, has to be imported. Kaolin occurrence is not reported in DireDawa Administration. Quartz and feldspar on the other hand are known, to occur associated with sandstones & river sand and pegmatites, respectively. In situ alteration of granite produced large quantity of kaolin at Kombolcha east of Harar. This kaolin has elevated coloring oxide for fine ceramic but can probably be applied for sanitary ware.

Both physical and chemical properties of the raw material are important criteria for ceramic industries. Ceramic or pottery grade feldspar should have 5-14% K_2O , with a maximum of 0.07% Fe_2O_3 , 200 mesh (sanitary ware), ground to 200 mesh (-75 Mm). Ceramic grade silica and quartz must have (-200 mesh) greater than 97.5% SiO_2 , <0.55% Al_2O_3 & 0.2% Fe_2O_3 . Results of four sandstone samples from DireDawa Administration (samples SST-1 to SST-4) indicate appreciably close to the above quality requirements. Additional detailed exploration sampling, analysis and evaluation is necessary to give conclusion.

Table 4.11 Chemical Composition of Sandstone Samples

Sample No	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	H ₂ O	Lo1	TiO ₂	P ₂ O ₅
SST-1	98.67	0.07	0.13	0.09	<0.01	<0.01	<0.01	0.01	<0.01	0.2	0.11	0.01
SST-2	88.84	6.68	0.52	0.04	0.01	"	"	"	0.01	2.65	0.52	5.03
SST-3	94.66	2.68	0.07	0.12	0.02	"	"	"	0.21	1.38	0.24	0.02
SST-4	95.20	2.21	0.21	0.18	0.03	"	0.32	"	0.1	0.60	0.16	0.01

Source – WWDSE – phase-II report.

All four samples show low iron content except one sample (SST-2) with elevated value. Samples SST-1 show higher silica value, whereas SST-2, 3 & 4 have slightly lower value compared to the standard. However, their Al₂O₃ is much higher except sample SST-1. In this case, the section of the sandstone where sample No. SST-1 has been taken, is within the acceptable limit of ceramic making. The higher Al₂O₃ values might be associated to clay minerals and feldspars, as petrographic description show, 5 –13% clay are contained in the samples. If successful separation is maintained, the whole section could probably be mined; otherwise, selective mining might be necessary.

The combined effect of coloring oxides (Fe₂O₃ and TiO₂) should also be studied. Its application for foundry purpose should be tested. The quartz sand for foundry purpose should have min of 98% SiO₂ (-200 & + 200 mesh) & with limits to CaO and MgO contents as well.

Glass Raw Material

Silica sand crushed or ground pure forms of sandstone can be consumed for both glass making and non-glass uses. Glassmaking includes containers, flat (plate and window), specialty glass, and fiber glass (ground and un-ground).

Non-glass uses include foundry (in molds), abrasives, fillers, chemicals, traction, roofing, refractory, metallurgy, hydraulic fracturing, filtration and other uses.

Glass grade silica sand should have minimum of 98.5%-99% SiO₂, Fe₂O₃ <0.04% (flat glass), 0.03% (flint container), 0.18% (umber container), and 0.3% (fiber glass), 0.2-1.6% Al₂O₃ with limits on alkalis and colourants. First grade optical glass needs a minimum of

99.8% SiO₂, <0.1%Al₂O₃ and 0.02% Fe₂O₃ (P.W. Harben, 1995).

The results of four sandstone samples reveal low values when compared to the above standards. This is probably due to analysis on un-treated raw samples. Analysis on washed and treated samples might reveal results comparable to the required standards. Magnetic separation and acid leaching might be necessary to get quality product.

Clay

The chemical content of the clay at DireDawa (near the present clay quarry for the cement factory) meets the requirements for cement production (Gumerov 1981). Large clay resource near Melka Jebdu and other geomorphologically favorable areas have to be investigated to supply new cement factories that might be constructed near DireDawa in the future.

High CaO and LOI content of the clay might prohibit its use for clay-brick manufacture. As Gumerov indicated, the clay is more or less sandy and polymineralic. The clay is hydromicaceous and rarely montmorillonitic. This clay with little or no appreciable kaolinite content coupled with high Fe₂O₃ (6.68% cannot be used as raw material for ceramic industry. However, these impurities for ceramics are good assets for cement manufacture. Hence, exploration and tests should only focus to this purpose.

4.3.9 Agro-Ecological Zones

Two broad agro-ecological zones, mainly based on altitude, i.e., moisture and physiography are identified as:- Dry (*Kolla*) flat and undulating to rolling plains and Moist (*Woina Dega*) hills & mountains .

Table 4.12 Major agro-ecological zones of DDA

Zones	Percentage Share (%)
Dry LowerKolla	61
Dry Upper Kolla	32
Moist Upper Kolla	2
Dry Weyena Dega	4
Moist Weyana Dega	1
Total	100

DireDawa Administration fall in six sub agro-ecological zones:

- + Hot to Warm Arid Plains
- + Hot to Warm Arid Mountains
- Tepid to Cool Arid Mountains
- + Hot to Warm Moist Mountains
- + Tepid to Cool Moist Mountains
- Tepid to Cool Sub-Humid Mountains

4.3.10 Land Use /Land Cover

According to the Woody Biomass Inventory documents the dominant land use and land cover of the DireDawa Administration is as follows:

Cultivated Land

Currently, a total of 7,300 hectares of land is estimated to be under annual crops and around 900 hectares under perennial crops. The main land -use types are: Rain-fed cultivation of:

cereals like, sorghum, maize, millet,

- oil seeds like groundnut , and

- Perennial crops like coffee, “chat” & fruits, etc. and Grazing on an improved pasture and on aftermath.

Shrub land

It is found the lowland covers an area of about 33,000 ha of land. The main land using activity in the lowland is browsing and grazing.

Grassland

Grassland is found in the southern highland of DireDawa Administration. The main land use activity is grazing. It covers an area of about 28,500ha.

Bare lands

These are areas with exposed soil surface and scattered grass vegetation. Bare land is common in over grazed and deforested areas. The main land using activity is browsing and seasonal grazing. The area occupies about 41,500 ha.

Table 4.13 Major land use system of DDA

Land Use	Percentage Share (%)
Bush land with scrub land	5.4
Shrub land	32.8
Grassland	3.8
Grass land with Rock	1.0
Intensively cultivated land	0.2
Moderately cultivated land with grass land	1.4
Moderately cultivated land	17.1
Bare soil/rock	36.1
Urban	2.2
Total	100

4.3.11 Vegetation

The DireDawa Administration vegetation cover is categorized as vegetation of arid and semi-arid lands (highly variable, including cactus scrub, thorn scrub and many woody and

sparse grasses formations). There is no climatic climax forest in the region except patches of few *Juniperus* remainants in the upper parts and some Acacia trees in the low lands. The vegetation in the region is not found in contiguous form covering large area; rather it is seen as fragmented patches of bush land, shrub land and trees in agricultural sites and hillsides.

The upper reaches of the western part of the escarpment are covered with scattered *Juniperus* open woodland with small Eucalyptus plantations. Below the escarpment and in the valleys between the ridges is cultivation with Eucalyptus homestead wood lots. The ridges are largely bare of vegetation with scattered low shrubs and grassland. The plain to the northeast are largely bare of vegetation, whilst those to the southeast are covered with low shrub land. According to the WBISPP, 2001 Study, there are about 36,365 ha of shrub land in the Administration. The main types of species that the shrub land comprises are semi-arid succulents. These are found on the lower storey foot slopes to the east of DireDawa. Succulents dominate the vegetation, which comprises *Euphorbia*, *Aloe*, *Caralluma*, *Opuntia* and *Dracaena* with scattered *Acacia* shrubs

At present, there is no natural high forest in DDA except few forest remainants found at the top of the watershed areas. Indigenous tree species such as *Olea Africana* (*weira*), *Croton macrostachyus* (*Bisana*), *Juniperus excelsa* (*Tid*), and *Acacia spp.* are seen as remainants in the field heavily pollared particularly in Adada Rural kebele . *Eucalyptus* plantation around the homesteads is also growing for energy as well as construction purposes. Acacia woodlands with a low range of diversity are typical features of the DDA low land areas. The total area covered with Acacia woodlands is estimated to be 19,000 ha. The Acacia woodland resource is mainly used for grazing, fuel wood and charcoal production, construction materials and making farm implements (DDA, Conservation Strategy, 2001).

4.3.12. Wildlife Resources

The excessive overstocking of livestock and other unregulated use of the resources seen at present is resulting in severe overgrazing, degradation of the ecological systems followed by habitat degradation. This is done at the expense of wildlife resource leading

to the loss of both fauna and flora in the natural ecosystem. The remnant woodland, shrub land, and bush land habitats of wildlife are located in the flat lowlands of the southeastern part of the Administration. These localities are specifically known as Jeldessa, Gerba-Aneno and Chirmite.

The territory of Jeldessa Peasants Association is found adjacent to Gebra-Aneno Peasants Association sharing a common kebele boundary to the east. Similarly, Gerba-Aneno is found adjacent to Chirmite lying between Jeldessa and Chirmite. These localities are generally composed of marginal land habitats unsuitable for agriculture. The past and present land use of the area is restricted to grazing and/or browsing by both wild and domestic animals.

Major mammalian species such as, Greater kudu (*Tragelaphus strepsiceros*), Lesser kudu (*Tragelaphus imberbis*), Lion (*Panthera leo*), Leopard (*Panthera pardus*), Gerenuk (*Litocranius walleri*), Dik dik (*Madoqua Saltiana*), Caracal (*Felis caracal*), Jackals (*Canis aureus*), Baboons (*Papio hamadryas*), Abyssinian Hare (*Lepus abyssinica*) and warthogs (*Phachocoreus aethiopicus*) can be mentioned as typical inhabitants of the habitat type. As part of wildlife resource, besides assessing the abundance and diversity of larger mammalian species, an attempt to identify and record wild animal species including bird species was done by WWDSE of the relevant areas within the territory of the administration. Hence, through these efforts 103 bird species were recorded in Jeldessa, Gerba Aneno and Chirmite Woodlands.

Most of the Administration's watershed, including Jeldessa, Gerba-Aneno, and Chirmite, which were once virgin woodland, are currently under over exploitation resulting in the decrease in number and eventually in the rarity of wildlife resources that depend on this habitat. Vegetation clearing for charcoal and ecological disturbance is more conspicuous in the territory of Jeldessa than the other two areas, and the same negative phenomenon holds true for the existence, distribution, and diversity of wildlife species.

Therefore, when generally viewed, this woody vegetation habitat in its present condition can be considered as ideal habitat for species of wildlife identified and recorded, and for all species of wildlife reported to occur in the locality as well, for future development action. The wildlife densities and diversities are currently quite low due to poaching and unregulated uses of their habitats. According to WWDSE study, there is a high potential for wildlife development if effective integrated and coordinated management and institutional arrangements are in place.

There were no nationally or locally known protected or conservation areas in DDA. The wildlife potential areas identified with WWDSE study are on dry and mostly marginal lands and the best option of land uses suggested here was grazing and browsing by both livestock and wildlife. Therefore, considering their potential ecological, economic, and aesthetic benefits, the natural ecosystem and biological resources of the southeastern part of DDA, particularly that of Jeldessa, Gerba-Aneno and Chirmittee Rural Kebeles needs to be set aside for wildlife, being protected and well managed.

4.4 Socio- Economic Condition of DDA

4.4.1 History and Administrative Structure

DireDawa was established in 1902 as a result of the Ethio-Djibouti (the then Franco-Ethiopian) railway line, that was built between 1897 and 1917. The railway line was the first modern type of public transport service introduced in the country by connecting Addis Ababa and Djibouti via DireDawa. The beginning of the railway operation was great opportunity that served DireDawa to make the fastest urbanization progress and quickly transform itself into a transit center for commodities exchange between the hinterlands and the outside world. The course of its urbanization is consisted of various stages of development and social changes that impacted the City's progress in terms of both positive and negative ways.

Of the most important epochs, the 1950's and 60's period represents vital era in the history of the city's development. By the time, DireDawa was configured as an emerging industrial town in the country. Its prominent industries, like the textile mills, cement, food

processing, and soft drinks factories were at full employment. Manufacturing sector was noticeable in formation of economic bases, labor engagement, and contribution to the national income in value addition and government revenue paid in the form of tax and non-tax income. The industrial sector was attractive for labor and people were migrating from various parts of the country to the city in search of job in the sector.

However, from mid 70's up to the late 80's DireDawa had been under difficult situation. The "socialist policy" of the ex-regime, the Ethio-Somali governments' war and illegal trade (contraband) has had adverse in effect that in deed darkened the glooming prospects of the city's industrial and commercial development with repercussions still reflected as constraint to ongoing reforms at present. The influx in population migration into the city for contraband reason, increased corruption, complications created in recreating improved urban management set-ups, etc are still daunting.

The early 90's history of DireDawa was turbulent due to political instability and lack of well established governance. Thus gap was persisted for more than a decade time and opportunities created by government during the interim period in economic rehabilitation and recovery from so.

DireDawa has a stable political environment now. It has received a legal entity by the proclamation No 416/2004 of the federal parliament that out rightly provided DireDawa a chartered autonomous administration status make decision on its own developmental, regulatory, & administrative affairs. At present, the administration of DireDawa encompasses 9 urban kebeles and 32 rural peasant associations forming the lower government structure under its administrative delineation. It consists of both state and municipal functions organized in separate structure.

4.4.2 Location and Land Escape

Geographically, DireDawa administration lies within $9^{\circ} 27'$ and 49° N latitude and $41^{\circ} 38'$ and $21^{\circ} 19'E$ longitude. The city of DireDawa is found at a distance of 505 km far from Addis Ababa to the east and 306 km far from Djibouti to south directions by road. The proximity to Djibouti made DireDawa an outlet for export and inlet to import transactions

carried out between the hinterlands and the outside world. Neighboring regions of DireDawa are the Somali region in the North and West, and Oromia region in the East and South directions. The entire mater plan area of the city encompasses an administrative area of 187 km². This spatial area made DireDawa the second largest urban center in the country next from Addis Ababa.

The city of DireDawa is situated just at the foots of the hills stretching from south-east to west direction by making a boarder line between the highlands of the previous Hararghe region and the vast lowlands extending up to the red sea.

The most northern and western parts of the administration is flat land and the rest areas are naturally ragged terrain land in topography. The landscape of the southeastern and southern parts of the administration is dominated by sharp edged hills (escarpments) with a slope exceeding 45 %. The slope is gentle in other parts of the administration that goes down to 0 % in the flat areas. The altitudinal difference in the entire Administration range between 950-2450 meters above sea level. The topography of the city is almost entirely flat land and attitudinally the city center is found at about 1050 meters above sea level.

4.4.3 Population

According to 1994 census conducted by the Central Statistical Authority (CSA), the total population of the DDA is projected to reach at 383,529 in July 2005, of which 192,095 (50.1%) are male and 191,434 (49.9%) are female. The majority of the population resides in urban areas, i.e., 283,773 (74%) and the remaining 99,756 (26%) lives in rural areas. Out of the total urban population of 283,773, the males constitute 142,131 (50.1%) whereas the remaining 141,663 (49.9%) are females. There are also 49,964 (50.1%) males in the rural areas out of the total rural population of 99,756, and the balance 49,792 (49.9%) are females.

The population density of the DDA is estimated to be 316.13/km². The urban area of the Administration, i.e. DireDawa, is densely populated, about 16,050.5 persons living/km². The rural area is sparsely populated; about 83.44 persons live per km². The eastern and

western parts of the Administration are relatively densely populated than the northern part, which is dominantly inhabited by pastoralists. The average household size for DDA, based on the 1994 census, is 4.7 persons per household. Rural areas have larger household sizes (on the average exceeds by 1.2 person per/household) than the urban area. Average household sizes in urban and rural parts of the Administration are 4.4 and 5.6, respectively.

The age structure of the Administration is skewed to the youth; and the number of population under 15 years of age accounts for 37.4% of the total population. The proportion of people aged 65 years and above makes up 2.35%. About 60.25% constitute those aged between 15-64 years.

The overall dependency ratio of the Administration is 66.06%, with dependency ratios of 62.16% and 3.94% for the youth and the old, respectively. There is a remarkable variation between urban and rural areas of DDA. The dependency ratio for urban areas is 56.3% whereas that of the rural areas is 101.62%.

The overall sex ratio of DDA is 102.2 males per 100 females. Sex ratio for urban and rural areas is 96.6 males per 100 females and 108.1 males per 100 females, respectively; i.e., there are more males per females in the rural areas than in urban areas.

Based on various assumptions made with regards to fertility, mortality and urbanization, the population of DDA is estimated to reach 775,964; 811,837 and 867,123, respectively by the year 2030 (Low Variant, Medium Variant and High Variant). The population of the Administration is thus, expected to double within the coming 25 years.

Oromo constituted the majority of the population of the Administration; i.e., 48%. The next largest ethnic group is Amhara followed by the Somali comprising 27.7% and 13.9% of the population, respectively. Guragie, Tigraway and Harari constitute 4.5%, 1.8% and 1.7%, in that order. The five largest ethnic groups found in urban areas of the Administration are also Amhara, Oromo, Somali, Guragie and Tigraway. Oromo and

Somali comprise the overwhelming majority in rural areas making up 85% and 14.3 % of the rural population, respectively.

The overwhelming majority (46.1%) of the population use *Oromigna* language as a mother tongue. *Amharigna* is the second largest language spoken as a mother tongue, used by 33.2 % of the population, followed by *Somaligna* spoken by 13.4 % of the population. The majority of the populations of the Administration are Muslims accounting for 63.1% of the total population. Orthodox Christians and Protestants make up 34.5% and 1.5% of the total population, respectively. Almost all of the rural populations are, however, Muslims (99.6%)

Table 4.14 PROJECTED POPULATION OF DDA

Projected Population	Low Variant	Medium Variant	High Variant
2005			
Urban+Rural	381,009	383,529	388,692
Urban	281,909	283,773	287,593
Rural	99100	99,756	101,099
2010			
Urban+Rural	451,849	457,694	468,734
Urban	343,361	347,805	356,194
Rural	108,488	109,889	112,540
2015			
Urban+Rural	527,215	537,628	555,679
Urban	411,175	419,294	433,372
Rural	116,040	118,334	122,307

Source: CSA, *The 1994 Population and Housing Census Analytical Report, 1999*

4.4.4 Social Characteristics of the Population

DireDawa serves as resident place for many national groups having different origins of residence across the country. According to CSA population census report in 1994, the

population of the city is a mixture of more than 8 ethnic groups. Of these groups, the Amhara, Oromo, Southern nations and nationalities and Somali constitute the larger composition in their population size.

Despite deferring cultural set-ups, the people of the city are well known of peaceful coexistence. Keeping all its identity (customs, traditions, culture, and multi-lingual assets) assimilation is very simple by the people that developed collaborative/cooperative culture with social intimacy and mutual assistance among themselves.

4.4.5 Economic Base

The economy of the Administration is Urban in its character, because of the overall domination of the city of DireDawa in formation of the Administration entity. According to CSA 1994 census report for DireDawa Administration, 70 % of the economic occupations were urban located and it was only 30% contributed by the rural for the entire established economic engagements in the administration. Although lack of macro-economic data is inhibiting to substantiate it figuratively, Production of manufactured goods, conveyed trade and commercial transactions and carried out service sales is incomparably large in volume and huge in value terms.

Looking into the structure of the economy, trade and service sales form the leading economic sector. According to the 1994 census report by CSA, the percentage share of occupations under trade and service sales account about 43% share of the total urban economic engagements. 65% of the engagements were micro-business activities.

Export – import is important component in trade sector. Because of its proximity to the port of Djibouti and available market infrastructures and services, export conducted through DireDawa constitutes nearly 20% share in the total export (in value terms) that the country performs each year. Import is also substantial in its volume and value as compared to what the country imports every year. Major items exported through DireDawa include coffee, fresh fruits and vegetables, chat, live animals, etc. Imported items are manufactured consumable and capital goods, petroleum and petrol by products, etc.

Manufacturing is the other vital sector in employment creation as well as production. Major industries engaged on production of commodities and processing activities include textile/garment, cement, corrugated iron sheet, food, soft drinks, natural water bottling plants, etc.

Major industrial establishments' account 19% share out of the total created economic engagements in DireDawa city while small manufacturing enterprises, like handicrafts, and construction engagements (micro-sector engagement) account 27% share of the total urban economic engagements. At present, DireDawa assumes a renaissance in industrial development. Private investment in industrial sector is relatively increasing including the establishment of large factories.

Agriculture serves as the main stay of livelihood in the rural parts of the administration. The sector is, in fact, subsistent in its mode and means of production. Crop production consists of fruits and vegetables, sorghum and maize and chat. The production system is usually challenged by uncertainties liked to climatic factor and price instabilities.

Livestock is the other important sub-sector in the agriculture of the administration. Small ruminants are most important for their adaptability to the climatic stress on feed requirements, fast reproduction and less risk. Cattle and pack animals also exist under peasant management.

Micro and small-scale enterprises are important in forming the livelihood of more than 55 % of the population in the city. MSEs Development is part of government poverty and unemployment reduction strategy in urban centers. Hence, government sector and NGOs commenced financial, technical, institutional and infrastructural supports to MSEs Operators reflected maintained in the five years plan of the administration.

Hence, self-help groups, cooperative associations, and individual operators of the MSEs Sector is increasing each year in the city.

4.4.6 Unemployment

The magnitude of unemployment is measured using an unemployment rate; and the rate is computed as the percentage of the unemployed population over the economically active population. The total unemployment rate for DDA was reported to be 24.1% in 1994. The unemployment rate was relatively higher for females, the rate being 28.9%. The corresponding figure for males was 20.6%. Unemployment was also more severe in urban areas than the rural areas.

The unemployment rate for urban areas was reported to be 35.4% while the rate for rural areas was only 3.1% (CSA, Analytical Report, 1999). About 10 years down the road, the unemployment rate in urban areas increased by about 2.6% and reached at 38% in the year 2003. Unemployment is also more severe problem in the DDA than in the country at large, whose unemployment rate in year 2003 stood at 26.1%. The unemployment rate for females in DDA was also nearly double to that of males, the rate being 47.6% and 27.4%, respectively. Age-wise unemployment was widespread among the youngest group of the Administration's population.

The total population within the administration is estimated to be 419,600 in 2007, with 74% urban dwellers and 26% rural dwellers. According to The Central Statistics Authority (CSA), the population profile for DDA is quite young, with 36% less than 15 years of age, 61% between the ages of 15 to 64 years, and only 3% over 64 years of age. The gender split is almost equal with 206,312 males and 206,021 females.

The total unemployment rate for DDA was reported to be 24.1% in the year 1994. The unemployment rate for males and females were 20.65 and 28.9%, respectively. About 10 years down the road, the unemployment rate in urban areas increased by about 2.6% and reached 38% in the year 2003.

4.4.7 Profile of Poverty

Poverty is a serious problem among majority of the population of DireDawa City. According to DDIDPO report, nearly 50% of the households in DireDawa have income below the absolute poverty margin. Unemployment accounts about 34% among the

economically active (potential) population of the city. The unemployment rate exacerbates in women, which reaches 47% while it is 22% in men.

Street children, street mothers, commercial sex workers, beggars, disabled persons, especially disabled children and orphans mainly AIDS orphaned children are considerably large in population. The number of street children exceeds more than nine thousand in the city.

HIV/AIDS is another serious problem in the administration. The prevalence rate of HIV infection is estimated around 10% amongst 15-49 years aged population. Survey results reported that the rate of transmission of the virus has subsided now as compared with previous years rates. But, concurrently the rapidly increasing population of the city and cumulative effects by the pandemic makes still HIV/AIDS severe in its impacts.

Generally, vulnerability among children and women is very high in the city. Accompanied factors like violence (both domestic and non-domestic), environmental depletion, high population pressure, etc; challenge the livings of the majority population of the administration. Development efforts are being made by GOs and NGOs to curb the problems. Few NGOs work with CBOs on HIV/AIDS, child vulnerability, human rights, governance and other programs. ACORD, JECCDO, Forum Street children Ethiopia are main NGOs operating at grassroots level and trying to enhance partnership with CBOs, where majority of them are *Iddirs*.

4.4.8 Flood Hazard

DireDawa is prone to flood hazard because of its topography and location at the foot of the escarpment of the eastern part of the Ethiopian rift valley. Though the escarpment on the southern and eastern part of the city is beneficial for the natural fault that serves as water recharging area for the ground water reserve of the cities water supply, it at the same time allows intermittent rivers that carry out water during rainy season and pass through the city. The intermittent river, Dechatu, with 202 ha of riverbed, is the biggest flood passage that dissects the city into two parts from south to north through out its length. There are also two other intermittent rivers (Butigi and Goro) on the western boundary of the city, both running to the north.

Flood attack mainly through Dechatu River has frequently happened over the history of DireDawa city. Taking only the period since 1981, there were four major flood episodes that created damage on human life and properties. Flash flood in April 1981 caused damage on Dilchora hospital, the railway station, offices, residential and business areas of the adjacent kebeles of the riverbank. In 2001, there was flood accident that damaged the railway, residential areas, and some enterprises. In May 2005, flood in the same localities had killed about 42 people and destroyed properties that worth about Birr 10 million. Of all, the worst flood damage is that of the August 6, 2006.

Very heavy rainfall that caused flood in all catchments to the city had killed 256 people, let another 244 people missing, and dislocated 9956 people. Of the displaced people, 5500 are females and 4456 are males. From the displaced victims of the flood 1500 of them were under five aged children by the time of the event. Besides, the flood has affected 10,809 people living in 17 rural peasant associations of the administrative region. According to DireDawa Road authority draft report on the flood impact assessment (joint report by various relevant federal and regional GOs and NGOs), the damage caused by the flood on various public and private urban infrastructures and business centers was estimated to be Birr 25.7 million. In addition, 2268 residential houses were destroyed and 258 ha of cropped land (farm) was devastated. There were 5524 people leaving in temporary shelter who currently re-settled in various parts of the city.

Despite commenced support to rehabilitate victims of the flood hazard by residents of the city, CBOs, donor agencies, government organizations, business enterprises, civic associations, many people and institutions from different parts of the country and abroad, the city is still prone to flood disaster and seriously desire long lasting measures as solution to significantly reduce the uncertainty level. Minimizing the high run off from far uplands to down streams critically seeks institutionalizing the problem in such a way that taken measures can mitigate the challenge and conserve the abandoning water resource for both domestic and non-domestic purposes.

4.4.9 Socio-Economic Infrastructures

4.4.9.1 Education

There are 74 primary, 9 secondary and 20 kindergarten schools in DDA. Out of the primary schools, the government owns 52 whereas the community, religious institutions, and the private sector own the remaining 20 schools. Out of the 52 government schools, 38 of them are located in rural areas, i.e., 73%. From the total number of primary schools, however, the share of rural areas is 49% and the remaining 51% are located in DireDawa town. All of the secondary schools are found in the DireDawa town and the government owns two of them while the rest are privately owned. All the kindergartens are also located in DireDawa town (Education Office of DDA). Moreover, there are two technical and vocational schools owned by the government, five private colleges, and two universities, i.e., Haramaya and DireDawa Universities.

The total number of students enrolled in primary education in 1997 E.C. are 49,422; and 27,475 of them (55.6% %) are male while the remaining 21,947 (44.4 %) are female. Out of the 49,422 students registered in the year 2004/2005, 11,434 students (22.8%) are found in rural areas and the balance 37,988 (73.2%) are in urban areas. There are 7,088 students in the first cycle secondary schools (Grade 9-10) of which 3,847 (54%) are male and the balance 3241 (46%) are female students. The number of registered students in the second cycle secondary schools are 1,009 and 401 of them, i.e., 40%, are male while the remaining 608 (60%) are female students.

The Gross Enrollment Ratio (GER) in primary education in the DDA was 72.7% in the year 2003/04. There is a remarkable gender and urban-rural disparity in GER. The GER for males and females shows a big gap favoring the males, especially in rural areas. The GER for males in the Administration is 82.5% whereas that of females is 62.5% in 2003/4; i.e., the GER for females is about 20% lower than males. The gap widens in the rural areas and the GER for females is only 29.6% while that of males is 71.9%. The gender gap in urban areas is relatively better and stood at 88.3% and 79.2% for males and females, respectively; but still far from being equally proportional. There is also disparity between urban and rural areas where the GER for urban and rural areas being 83.8%

and 51.8 %, respectively. The GER for secondary education is also extremely lower than the rate achieved for primary education, and it stood at 20.64% both for males and females; and 26.04% and 15.01%, respectively, for males and females in the year 2003/04.

The NER for primary education in DDA is 59.8% indicating that only 59.8% of the relevant/appropriate age group for primary education attends school. These ratios for male and female students are 66.9% and 52.4%, respectively. The NER for Secondary education is also low and stood at 18.8% for the Administration; 25.75% for males and 14.9% for females.

The drop out rate in primary (1-8) education, in the Administration for the year 1996 E.C. was 8.4%. The drop out rate for males is marginally higher than female, the rate being 8.5% and 8.2%, for males and females, respectively. Repetition rates for the Administration were also reported to be 3.9%.

4.4.9.2 Health

There are 3 hospitals, five health centers, 20 clinics, 34 health posts, 32 pharmacies and rural drug shops, and five rural drug vendors in DDA as of June 2005. Out of these health facilities, two of the health centers and 29 health posts are found in the rural areas while the rest are located in DireDawa town. There were also 274 hospital beds in the year 2003/04. Given the current population of the Administration, 383,529, there are, therefore, one hospital to 127,843 persons, one health center to 76,705 persons, one health post to 11,280 persons and one hospital bed to 1,399 persons. With regard to health personnel, there are 30 physicians, 3 pharmacists, 23 laboratory technicians, 172 nurses, 31 health assistances, and 4 X-ray technicians as of June 2005.

As compared to the other regions of the country, the Administration has better health facilities, and the potential health coverage ratio was estimated to be 68.92 %, when considering health centers and health posts in 1996 E.C; and the health coverage ratio increases to 100% and 123 % when HC, HS, HP are considered in the former and when HC, HS, HP and PC are considered in the later case. In 1997 E.C, the health coverage

ratio when considering health centers and health posts are estimated to have reached 76.9%.

Comparison of various health professional to population ratio with national average and the WHO standard shows that DireDawa has better health professional than the national average and close to the WHO standards. Physicians to population ratio of DireDawa which stood at 1:12,784 is by far better than the national average of 1:26,527 and close to WHO's standard of 1:10,000. Nurses to Population ratio of 1:2,229 of the Administration is also better than both the national as well as the WHO's standards of 1:2552 and 1:5,000, respectively.

The Administration is prone to malaria epidemic and it has been experiencing recuffent and sever malaria epidemics. Moreover, as diagnosed by different health facilities of the DDA, the top leading causes of morbidities and mortalities are mostly infectious and communicable diseases. According to the Health Bureau of the Administration, the following are among the top leading diseases causing morbidity during the period 2003/04.

- Acute upper respiratory tract infection
- Brancho Pneumonia
- Dysentery
- All other infective and parasitic diseases
- Gastritis and duadunits
- Tuberculosis of respiratory system
- All other unspecified malarias
- Diabetes Mellitus
- Hypertension without mention of heath
- Other unspecified anemia

4.4.9.3 Transportation and Communication

Transportation and communication facilities have a significant role to the development of the Administration as they facilitate efficient production, exchange, and distribution of goods and services as well as information and people to and from the Administration. The

DDA is served by all modes of transportation and communication with the exception of water transport.

Transportation

RoadTransport

Road transport is one of the major modes of motorized means of transportation in the Administration. The DDA is accessed with 515kms and 55kms asphalt road to Addis Ababa and Harar, respectively. It is also connected to Djibouti with an all- weather gravel link road for 313km of which about 50km is bordering the Administration. Dire Dawa is also connected to Hurso and Erer of Somali Regional State with 60km all-weather satisfactory gravel road. About 17km of this road is found within the Administration to the west of DireDawa passing through Melka Jebdu town.

All the Peasant Associations in the rural areas of the Administration are accessed by either all- weather or dry-weather roads branching from the asphalt and link roads to Harer, Djibouti, Hurso, and Addis Ababa. The all-weather RR50 standard road branching from the DireDawa-Harar road is running east to Belewa for 43km; the construction of the road to the west to Lege-oda for 35km was, however, suspended after partially covering a distance of about 14km. Dry-weather roads having a width of 4m have also been constructed using the income generating schemes (IGS) in various parts of the Administration. These roads are, however, in bad condition, due to poor quality of construction and absence of periodic maintenance. According to DireDawa Development and Improvement Project Office (DDIPO), the total length of the road system in Dire Dawa town is 187.069 km, out of which 31.14km (16.65%) are asphalt roads and the remaining 155.928km (83.35%) are non-asphalt. Most of these roads are deteriorated due to absence of periodic maintenance and long age. Only 15.02 km, i.e., 8% of the road is reported to be in good condition whereas the rest 92% of the total roads are either in fair or bad conditions.

The Administration by virtue of its size and location as a trading center has the highest road density in tens of km per 1000 persons or km per 1000km². According to WWDSE, the road density of the rural area is found to be 1.5km/1000 persons and 110.33 km/1000

km². The road density for the urban and rural areas of the Administration in general was also found to be 0.725 km/1000 persons and 194.03/1000km².

Modern and Traditional Means of Transportation

The DireDawa town is served with modern as well as traditional means of transportation. City buses and scooters are the major modes of transportation in the town. Horse driven carts are also the traditional method of transportation widely used, especially at the outskirts of DireDawa town. Camels are also a major means of transportation in the rural areas of the Administration.

Rail Transport

DDA is served by the rail transport for more than 100 years. The Ethio-Djibouti Railway Enterprise carries domestic and international passengers and freight to and from Addis Ababa and Djibouti via DireDawa. The rail line passes through the Administration for the total distance of about 25km.

Air Transport

There is an international airport in Dire Dawa town with an asphalt pavement having a runway length of 2,700m. It has also a terminal, control tower, and weather station. The airport can land huge aircraft.

Communication

Telephone, Telex, Tele-fax, and Internet services

The Ethiopian Telecommunication Corporation (ETC) provides fixed telephone, cellular mobile telephone, telex, and fax, and internet services in DireDawa town. DireDawa town has an automatic telephone communication with an exchange capacity of 21,336. There is a plan to provide telephone services to the rural communities through the Rural Connectivity Program in this year.

As of the year 2003/04, there are 11,643 and 106 telephone and telefax subscribers, respectively in the Administration. Moreover, there were 2 telex and 177 Internet

subscribers, respectively, during the specified period. The Corporation has also started to distribute cellular mobiles in June 2004, and sold out 11,418 lines in few months.

Postal Services

The Ethiopian Postal Services Enterprise provides the Postal services in the administration. It has a regional head quarter and two branches in the city. As of the year 2003/2004, there were 3150 post boxes of which 2901 (92%) of them were rented.

4.4.9.4 Potable Water Supply

Ground water is the main source of water supply in DireDawa city. The provision of water supply service is managed by Water Supply and sewage Authority of DireDawa city. Currently there are 10 deep wells and three springs so as to produces and discharges into the city's water supply system. The wells defer in service period and production capacity. Of the existing wells, seven are old wells that have been serving for more than 15 years while the other three wells are new that were established between 2005 and 2007. The wells had ground water design yield of 280 liters per second where as the actual discharge rate of the wells is about 200 liters per second at present. In addition to the wells, the lega - hare spring also discharges water into the city's water supply system. The spring produces an actual yield of 25 liters per second. With this level of discharge rate from the wells the daily distribution of water to all pressure zones from Sabian pumping station is on the average 9000-9500m³.

Distribution of water to all forms of connections is managed from six reservoirs having a total capacity of 6050m³. Privately connected customers up to the end of April 2008 were 10050. Besides, there are 250 public water points established in areas where there is high concentration of people living in congested compounds (slums) and marginal parts of the city (informal settlement areas).The average daily water consumption of privately connected customers is estimated to be 2450m³ and that of the public water points is 590 m³ per day. Besides, the unaccounted for water is 29 % at present.

There are 9,042 customers in DireDawa including Melka Jebdu, and about 20.5% of the total households have water connections. Public fountains (tabs) are also the other major mode of water supply in the town and there are 175 public fountains in the town, each serving on the average 200 houses.

The sources of water supply for the rural areas are from protected and unprotected sources constructed by the government, aid agencies, and community participation. There are 210 water supply schemes in the rural part of DDA, of which 128 (61%) of them are operational whereas the remaining 29 and 53 water supply schemes are non-functional and abandoned water supply schemes, respectively. The major reason for the abandonment of most water schemes is drying of wells, which may result from less treatment of catchments. Shortage of water is also more severe in the lowlands especially in dry seasons due to fluctuations of the water table and complete drying out of the sources because of non-availability of perennial rivers for continuous recharging of the ground water.

4.4.9.5 Sanitation

Solid Waste

Safe disposal of municipal solid waste is important for the protection of both public health and the environment. Unfortunately, indiscriminate dumping around cities and small towns in low income countries is very common and creates numerous problems such as health hazards to the near by resident through inhalation of dust and smoke from burning of waste, environmental pollution from smoke, waste leachate and gas, blockage of open drains and sewers, creating serious secondary effects relating to public health and environmental pollution, and health hazards to waste workers and pickers through direct contact with waste.

According to the report of the sanitary department of the DDA health office in 2003, nearly 42,244 kg of waste is daily disposed on the open fields and drainage ditches and this accounts for 40.2% of the total waste generated in the city per day. The rest 35.2 % and 5% belongs to the open fields and the drainage ditches respectively. It is also estimated that 40.1% of the solid waste generated is collected in the garbage bins, by side loader

and lifter trucks, 10% is buried and burned, and nearly 9.7% of the solid waste is disposed in different ways. The existing waste disposal site was used for the last few years is totally uncontrolled city disposal type, which is common in many medium sized towns of developing countries in general, and Africa in particular. In other words, refuse and liquid waste disposal sites in DireDawa are inappropriate and unprotected or ill managed. Particularly, the main solid and liquid waste disposal site just near the cemetery of the Orthodox Christians at the eastern periphery of the city is creating serious problem on the funeral attendants and residents of the area. Currently, an attempt is made to shift the disposal site to another site by the concerned bodies. However, in order to select an appropriate disposal site, further survey/assessment should be made from technical, institutional, financial, social and environmental point of view.

Table 4.15 Waste Disposal Practices In Dire Dawa

Disposal Practices	Use Garbage Bins and Side Lifter Trucks	Open Field Disposal	Open Ditch Disposal	Burned and Buried	Other	Total
Share in %	40.1	35.2	5.0	10	9.7	100

Source: Dire Dawa Health Office (2002).

According to the Health Office and Sanitation and Beautification Agency, of the total 272,000 people living in the DireDawa city 20% or (54,000 people) use the open field for defecation which in turn becomes an important vector breeding media.

Liquid Waste

The 1994 Census results of CSA indicate that 60% of the inhabitants of DireDawa city use dry pit latrines. Some of the primary schools are also highly suffering from shortage of toilet facilities that they tend to contribute to the problem of contaminating the urban environment.

A) Distribution of Latrines and Public Toilets in DireDawa

Surveys indicate that 22% of the urban population of DireDawa do not have latrine of any type, and an estimated 78% of the urban population have a toilet room or latrine of which only 25% is private and the rest 75% is communal. The total number of public latrines in

the city does not exceed thirteen. It is not only the number of latrines that matters but their standard is also poor to serve the community to the required level.

Here what amazing is, some households, with good latrines or toilet facilities prefer to use the Dechatu sand stream for defecation to their own latrines for one or another reason. There are only 2 vacuum trucks for liquid waste disposal with a capacity of vesting 16 house holds (HHs) per day indicating the seriousness of the problem in the city and this gives the ratio of vacuum truck to the total population 1:136000. The following table shows the availability of latrines and their percentage share or distribution at each kebele.

Table 4.16 The availability of latrines at kebele level in DireDawa city

Kebele	Population Size	Number of HH	Latrine		Types of latrine		Public
			Have	Have no	Private	Communal	
01 Melka Jebdu	13086	2908	2268	640	567	1701	1
02	36185	8041	6271	1770	1567	4704	1
03	26363	5858	4569	1289	1142	3427	2
04	30335	6741	5257	1484	1314	3943	2
05	30662	6813	5314	1499	1328	3986	1
06	29492	6553	5111	1442	1277	3833	1
07	35668	7926	6182	1930	1545	4637	2
08	39477	8772	6842	1930	1710	51131	-
09	30798	6844	5338	1506	1334	4003	3
Total	272, 068						13

Source: - Sanitation and Beautification Agency for Dire Dawa Administration (2004).

b) Liquid Waste Disposal Practices In DireDawa

Statistical figures obtained from DireDawa Water Supply and Sewerage Authority (DDWSA) indicate that the daily water consumption of the city is estimated to be 9 500,000 liters (2005) giving the daily per capita water consumption of 35 liter. Preliminary assessment conducted by the DDWSA also indicate that nearly 7 125, 000 liter liquid waste is generated in the city per day giving the daily per capita liquid waste generation rate of 26.2 liters.

The same way as the solid waste disposal practices, liquid waste products of the urban residential areas are carelessly discharged everywhere. It is estimated that more than 97% of the liquid waste generated is carelessly being discharged into the open fields and ditches. For details, see the Table below.

Table 4.17 Liquid waste disposal by type

Type Of Disposal	Use Septic Tank	Use Sipage Pit	Dump in Latrines	Open Field Disposal	Open Ditch Disposal	Total
Share %	2.8	1.7	12	77.7	5.8	100

Source: - Dire Dawa Health Office (2002)

The above waste disposal practices are directly or indirectly end up with the pollution of the environment particularly, it results in the deterioration of ground water resources quality, which accounts for about 96% of the water supply of the city. Besides, no system exists for removal and treatment of toxic waste products from industries.

4.4.9.6 Electricity

Ethiopian Electric Power Corporation (EEPCo) is the main electric power supplier in Ethiopia and the Corporation applies two different power systems; namely, the Inter-Connected System (ICS) and the Self Contained System (SCS). The ICS is supplied from 7 hydropowers, 13 diesels, and 1 geothermal station. The SCS consists of three hydropowers and a number of isolated diesel generators. DireDawa is within the ICS and power is distributed to the town from three substations, namely, the *Sabian*, the *Legahare* and the *Hnaz* substation.

There are 18,649 subscribers in the year 2004/04, of which 15,911 (85%) are residences whereas the balance 2,738 (15%) was subscribed by the various industries found in the town, businesses and government organizations. EEPCo recently started supplying electric power to some of the rural communities surrounding DireDawa town. Some of the schools and health posts in the rural parts of the Administration utilize the solar system and diesel generators to produce power mainly for mass media purposes and vaccine refrigerators, respectively.

4.4.10 The Farming Systems of DireDawa Administration

DireDawa Administration is densely settled in urban areas and sparsely settled in rural areas. The land use systems of the Administration can be classified based on agro-ecological conditions, crops grown in the area, livestock, and mixed farming components, socio-cultural and economic characteristics. These systems might have developed over decades or centuries in response to the natural environmental conditions as well as to socio-cultural and economic factors.

In DireDawa Administration, the rural population could be grouped into crop grower, agro-pastoral, and pastoral. The agro-pastoral systems occur in the foothills of the mountains, particularly in the southeastern part of the Administration where the farming system is agro pastoral, the main subsistence component is the out come of cropping while extensive livestock rearing is also important, nevertheless it is a subsidiary component. The main crop grown here is sorghum being followed by maize. The Sorghum/maize farming system (cultivation) occurs in the valley bottoms. Sorghum, maize, and sweet potato are the major crops grown below the escarpment in the valleys bottoms. *Chat* is also grown as an important cash crop. In this system, livestock densities are so high. Crop residues and sorghum thinning make up significant proportion of the livestock feed supply. This farming system covers nearly all the PAs under consideration.

Sorghum and maize are the dominant crops and other crops are very low in area coverage. The agricultural or farming operation is mostly traditional in which land is plowed by oxen drawn "Maresha". While some farmers do practice, hoe cultivation either due to lack of oxen or due to the topography and nature of the farm plots. In any ways the productivity of crops in the Administration, areas are low when it is compared to that of the other farming systems out side the study area. A sort of traditional small-scale irrigated agriculture is practiced all over the past producing horticultural crops and cereals such as sorghum and maize using irrigation. Based on the obtained information almost all the sources of irrigation is springs. However, due to various reasons the efficiency of the existing schemes in most cases is poor.

4.4.10.1 Agriculture

Despite the fact that agriculture plays an important role in all parts of the country, it does not play a decisive role in the DireDawa Administration economy because it does not stand by its own to support rural population, even for half a year. This is because crop productivity and production is constrained by moisture stress coupled with low level of input utilization and lack of proper farm management practices. Moreover, with proper application of all agricultural inputs to the acceptable standards, but failure to bring the soil moisture enough to support crop water requirements, definitely, will not improve the food production situation in the Administration. This notion of improving soil moisture availability at the required place, time, and amount for crop production calls for the need for irrigated agricultural practices in the Administration. Based on the data obtained from agricultural office of DDA, the average cropland holding per household is estimated to be only 0.45ha.

4.4.10.2 Irrigation

Over 7,300 ha of land is cultivated in Eastern , Southern and Western part of the Administration of DireDawa. Based on previously prepared and available documents, there are traditional irrigation activities in most part of the PA. The major crops grown are cereals, pulses, fruits and vegetable crops. About 1,450 ha. of land is developed under both traditional and modern irrigation system. As the previous studies reveal, the production situation of the major crops out side DDA such as sorghum is up to (14q/ha.) groundnut, (24.5q/ha.) peach, (80q/ha.) papaya, (200q/ha.) and sweet potato (192q/ha.), while the obtained yield of all crops harvested in the Administration is far from the crop potential.

The most limiting factor of the crop productivity is the drought situation of the area. Paradoxically the mean area of the arable land per household is less than one hectare on top of low productivity level and high population pressure.

5. BASELINE ENVIRONMENTAL AND SOCIO- ECONOMIC CONDITION

The consultants referred to the Ija Aneni rural kebele situation analysis, undertook verification visits and other literature available.

5.1 Baseline Environmental Conditions of the Project Site

5.1.1 Location

The proposed site for NCSC project is located at Ija Aneni rural kebele, Northeastern part of DDA, at a distance of about 6km from DireDawa town. The plant location is situated between $09^{\circ}35'$ N Latitude and $41^{\circ}45'$ Longitude. To meet the requirement of land for the proposed cement plant a colony is available about 40.1 hectares in abundance near the deposit. In addition, the limestone quarry is located about 1-1.5km from the proposed plant site.

5.1.2 Topography and Slopes

Topographically, Ija Aneni, the project area, comprises of diversified topographic features with an altitude varying from 1500-2000 masl. The topography can be classified in to mountain ranges, hills and gentle slopes. The mountain ranges to the West posses slopes above 30% with shallow soil and mostly covered with closed areas of scattered woody perennials and shrubs and some of them used as grazing and browsing ground for livestock.

The hills are found scattered all over the kebele with slopes between 14% and 24%. The soil depth is so shallow comprising of mainly stones and rock out-crops that are devoid of vegetation cover. While, the gentle slopes are mainly found at the central and eastern part of the kebele. These areas generally have moderately fertile and deep soils. It is in this area where rain fed as well as irrigated crop production is often exercised. Specifically, the project site falls within the gently sloping Copper belt peregplain at an attitude of 1294 meter above sea level. As a result of this the involvement for land preparation and area grading work for the proposed cement plant takes lesser materials and costs.

Fig. 5.8 Project Plant Area & Its Surrounding Landscape



Fig. 5.9 Proposed Quarry Site for NCSC Plant



5.1.3 Air

The air quality in the site is generally good. Air pollution is the occasional dust from moving vehicles along the gravel road passing through the area. This dust is highly generated during the dry seasons.

5.1.4 Noise

The noise levels within the area are consistent with those expected generally in DireDawa rural kebeles and are within acceptable limits. Noise at the plant site and the vicinity is mainly from trucks plying the road. The mining site is a rural setting of a quite atmosphere.

5.1.5 Water Resources Quality

5.1.5.1 Surface Water Quality

There is no surface water body within the National Cement project site except for the seasonal wadis the nearby quarry site, as such no stream was sampled to establish baseline conditions for the quality of water in the stream.

5.1.5.2 Groundwater Quality

No historical data exist for groundwater quality on the project site due to the fact that non-existence of boreholes on the project site.

5.1.6 Geology

The general site area belongs to Upper part of the Jurassic Antalo formations dips at between 30 and 40° to east. It is intersected by sub vertical dykes of Tertiary igneous rocks comprising fine grained porphyritic and esite-basalt. The dykes are between 20 cm and 16 cm or more wide and are estimated to constitute around 10% of the rock mass.

The geological sequence comprises:

- High grade crystalline basement rock overlain by
- Mesozoic Era transgression and regression deposition events of:
 - ✚ The Adigrat sandstone, which rests unconformably on the crystalline basement rock,
 - ✚ The Hamanlei Limestone which conformably overlays the Adigrat sandstone and at places unconformably overlays the basement rock, and

✚ The Amba Aradam sandstone which unconformably overlays the Hamanlei limestone.

Quaternary alluvial and lacustrine deposits and basaltic lava flows are found in the depressions.

5.1.7 Water Resources

5.1.7.1 Surface water

No surface water observed during the site inspection but several erosion terrains were noted on the site indicating that the site is exposed to flooding and erosion during the rainy seasons. There are Wadis that drains nearby the project site. These wadis and its associated watercourses are ephemerals and seasonal features so that only flow after heavy rains. Obviously, the high runoff generated from the surrounding hills coupled with the nature of the site terrain significantly attributes to the flooding and erosion of the site. It is therefore essential to protect the site in general and the proposed area of cement plant in particular against flooding, by providing peripheral earth ditches of adequate size. The total amount of water carried by the stream is not known and has never been sampled for its chemical content. Since the project will run during the dry season, it is expected that the operations will not have a direct effect on the dry rivers and the wadis.

5.1.7.2 Groundwater Hydrology

The groundwater level is controlled by both the topography and the local geology. Enhanced groundwater flow is depicted in stone-line zones where there is colluvial and coarse alluvial sediments overlying the solid rock. On the basis of previous studies of ground water resource potential of the area, generally ground water basin is contained in the upper and lower sand stone, limestone and basaltic aquifers, which can be categorized as consolidated aquifers. Unconsolidated alluvial aquifers consists quaternary sediments and travertine aquifers. The quaternary sediment and travertine aquifer units are mainly exposed in the plain areas of the administration. The alluvial units are mainly composed of quartz sand of fine to coarse grained in size.

The studies showed that, potential ground water in the area is generally encountered at variable depths ranging from 120-150 meters below ground surface. However, some

studies showed that static ground water level for domestic wells is in the range of some 30 meters. Such shallow ground water is obtained from quaternary sediments and travertine aquifers in the low land plains, which are used for the supply of domestic water in the rural area of the administration but with low yield.

5.1.8 Vegetation

Vegetation development in the project area is mainly governed by physiography/ altitude, climate, etc besides other factors. Vegetation in the study area is scanty except along the intermittent streams. The natural vegetation is largely scanty acacia trees and cactus. On the patchy rock outcrop areas, surrounding the project site there is very weak vegetation development since there is no soil development. At present, there is no much vegetation cover throughout the project area. This is mainly due to continuous stress on the area for fuel and construction wood and sever agricultural expansion.

The dominant vegetation covers of Ija Aneni ecosystem consists of deciduous shrubs mostly *Acacia* species like *Acccia tortilis*, *Accacia bussei*, *Accacia albida*, *Accacia cynophylla* and other perennial trees like *Azadirachta*, *Delonix*, *Ziziphus* and *Prosopis juliflora*, *Schinus molle* and *Ziziphus mauritiana* often interspersed with less frequent evergreen shrubs and succulents such as *Euphorbia*, *Aloe*, *Caralluma*, *Opuntia*, and *Dracaena spp.* on rocky out crops.

5.1.9 Wildlife

According to the information obtained from the local people there are various wildlife species in the relatively dense shrub land areas of the project site, such as Porcupine, Hyenas, Lesser kudu, and Warthog. Since the proposed cement project is established on the areas where initially devoid of vegetation cover, implementation of the envisaged cement project does not have significant effect on the wildlife resources of the project site.

5.1.10 Soil Cover

The soil in the area is a by-product of the local rock. There is no evidence of any transported soil or made ground. Hence the soil in the area is genetically related to the

limestone and the project will not import any soil hence will not vary the current conditions or chemistry of the soil.

A walkover survey showed that the area has many limestone cover outcrops. The soil cover is generally shallow to very shallow ranging from zero to about 1.5m. The soil cover is largely lateritic clay in most parts of the eastern sectors of the area. The central portion is generally composed of grey and red loam clay soil typical of the project site. The thin soil cover means that for mining purposes, soil stripping will be zero to minimal hence presenting no major problem for disposal of the same.

5.1.11 Land use

Table 5.18 Land use system of Ija Aneni rural kebele

No.	Land use type	Area in ha
1	Cultivated area	
	Rain fed	60
	Irrigated	40
2	Mountains and Hills	300
3	Area closure	40
4	Home stead and Miscellaneous land	10
	TOTAL	450

5.1.12 Sensitive and Unique Landscapes

There are no sensitive and unique landscapes in the project area.

5.1.13 Cultural Heritage

The consultants visited tourism office of the Administration and had a discussion with the office Director on the possibility of any archeological sites in the proposed NCSC mining and plant area. The Director informed the consultants that there are no known archeological sites in the proposed NCSC plant and mining area.

5.2 Baseline Socio- Economic Condition of the Project Site

5.2.1 Introduction

The overall objective of conducting a socio-economic impact assessment is to determine the possible significance that National Cement has on the socio-economic structure within the area of influence at the local level. The analysis involves the identification, analysis, and evaluation of the social and economic impacts resulting from the establishment of both a cement manufacturing plant as well as the quarry from where the limestone raw material will be mined. By definition, a social impact is a significant improvement or deterioration in people's well being or a significant change in an aspect of community concern. The impacts that have been examined include those that affect the existing natural socio-economic environment and the people living around the area.

This section discusses baseline scenario of the socio-economic status in the project area so as to conduce for identifying the anticipated impacts of the proposed project on the socio-economic environment, and clearly discusses the extent of compensation required as a result of implementation and proposed mitigation measure.

5.2.1.1 Data Collection Method

The data collection method is fully a survey method, which involved structured questionnaire filled by selected households taken as sample for making descriptive analysis. In addition to sample households, two focus groups each consisted of five women and four men were participated in the discussion held to gather qualitative data about the situation of the locality. Besides, stakeholders' were interviewed and validation workshop was conducting to gather feedback on the survey finding.

The social and economic status of the area was evaluated through primary data collection gathered from a household survey of 80 households and PRA meetings. Secondary data were collected from documents held in various offices in the administration. Details of the results are summarized and presented below.

5.2.1.2 Public Awareness and Sensitization

The Environmental Impact Statement review process was preceded by a site visit by the consultants followed by a consultative meeting for key stakeholders. The consultants therefore visited the village nearest to the quarrying site and made detailed discussion with the nearby communities about their concern and expectation about the new NCSC project.

5.2.2 Poverty in the Project Area

Long-term population growth of about 3% pa has led to the progressive subdivision of land among rural households. Today, households of 6-7% live in very small farms of less than 1ha, which can only provide about 45% of the calorific of food required. The deficit has to made up with money from cash crops, livestock products produced on farm, and off farm generating activities. In poor years, farmers rely on relief services, safety net programs, and the food for work program.

The main subsistence crop, Sorghum, has a low calorific value compared with other grains. Crop yields are low and below average for a number of reasons including, erratic rainfall, low soil fertility due to exhaustion of soils, absence of fallowing, and lack of inputs from manures and fertilizers, and flood losses. When 'Shocks' such as below average rainfall or flooding affect production, the people have no reserves to cope and rely on relief programs.

On-farm employment estimated to occupy about 12% of the farmers time. In addition, much time is spent on activities such as collecting fuel wood, water, and food crop processing. The household survey indicates that farmers spend about 40% of their time on farm related activities, 10% on religious affairs, and 50% of their time on social and market affairs. Alternative employment is difficult to get and limited to petty agricultural product trading, Collection and selling of construction stones. Household poverty is therefore deeply entrenched in the area.

5.2.3 Land Tenure

In Ethiopia, the land belongs to the state, but farmers have use rights and may lease up to 50% of their holdings from 3 to 15 years. Under proclamation No. 456/2005, Farmers also have responsibilities for conservation and maintenance of the land.

Farm sizes are small (0.5 to 1.0ha in total) and fragmented between two and three plots, one of them for the farmstead. The average land holding in the household survey was 0.54ha and about half reported that they did not have their own land but shared it with other family members. The poorest farmers are landless, usually because they were married or born after the land re-distribution of 1975 and never received a land allocation. Resettlement as well attempted to reduce the density of the population and further degradation, but this has not been successful.

5.2.4 Population

The population of the Ija Aneni rural kebele was estimated to be 4090 in 2008, incorporated into about 609 households.

The age structure of the population presents a pyramid shape with a wide base, narrowing to the top, with a high proportion (58%) in the 0 to 14 years group and less than 3% above 55 years. The economically active part of the population aged between 15 and 60 years is estimated to be 40% with a high dependency rate of children across the whole Ija Aneni rural kebele.

The majority of households are headed by men, with female-headed households about 12% in the study area (7% in the household survey). In the project area, the average household size is 8 persons. The population is predominantly Oromo, who have lived in the area for centuries, and the prevalent religion is Islam.

The educational status of people in the project area is poor. Literacy is very low with about 78% of household heads unable to read and write, and only 22% with elementary education. However, about 40% of sampled households send their children to school and of these 11% attend secondary education.

About 45% of the average household food energy requirement is dependent on rain fed Cropping. The main cash crop is chat and other household income is obtained from sales of fire wood, Sorghum straw and fattened animals. Livestock forms the principal asset for most households.

The principal source of household energy is biomass. The second energy source is wood which is collected from common lands. The third energy source is diesel (called *Kerosene* locally) which is used for lighting.

5.2.5 Settlement and Infrastructure

Settlement is concentrated on in the middle and gentle slopes of the rural kebele, the upper slopes being too steep and the lower areas affected by flooding. Settlements are clustered in hamlets with extended families and kinship groups.

The main highway from DireDawa to Harar follows the watershed of the Awash and Wabishebele river basins. Feeder roads come off the highway to serve the rural areas. Improved road communication have brought benefits intermes of easier access to markets, but has also been blamed for localized erosion and flooding due to poor road drainage. The gullies and major wadis are also important traffic roots for people and animals providing ready access into the center of DireDawa. Water supply system for the communities of project area depends on perennial streams springs and shallow hand dug wells.

Malaria is endemic in the majority areas of the project area and is reported to be series, with high level of resistance to chloroquine. Child malnutrition and intestinal diseases are also major causes of poor health and morbidity. There is only one health post and one elementary school in the Ija Aneni rural kebele.

6. POTENTIAL IMPACT AND MITIGATION MEASURE

6.1. Potential Impact

General

The project will occupy a large area of agriculture land with construction stone (about 95.82 ha). This will be a major adverse impact as conversion of agricultural land to industrial usage become.

The potential impacts of the projects are

- Construction of the plant; and operation of the rope way
- Onsite storage of the raw materials such as crushed limestone, clay and pumice.
- Dust from grinding and mixing of raw materials
- Dust and combustion by-products from the kiln,
- Dust from grinding and bagging
- Waste water used for bearing cooling, sewerage discharge from staff housing and offices
- Disposal of solid wastes
- Transfer of cement and loading.

Good quality water and sanitation will be a positive impact. Water treatment is necessary to meet the required quality standards. The cooling water used in the plant will be recycled after cooling. The management will ensure the regular supply of water from these sources.

The potential air pollution can occur at different point sources (chimney). Dust, noise and vibration problems of significant concern have been focused at in the environmental impact assessment and will be controlled by appropriate measures.

Since, mining will be undertaken in Koka and Harorety for pumice, and Dewele for Gypsum, the environmental problem associated with the activity will be handled by the Oromia and Somali regional Environmental Authority. Cement industry is one of the major sources of generation of particulates due to the very nature of activities such as crushing, grinding, conveying, drying and calcinations.

Fine powders will be handled in one form or the other in each section of the plant, and can become airborne. Two important types of pollution are considered in cement industries, air and noise. Water and land pollution are less relevant due to the insignificant influence of these factors.

Regarding air pollution, gaseous pollutants such as carbon dioxide, carbon monoxide, sulphur oxides, nitrogen oxides (all in mg/Nm³ levels) are not hazardous to human health since they are emitted below health hazard induced level, but nuisance from dust and noise pollution are predominant. The collected dust will be absorbed by the process itself, hence no treatment is required.

Positive impact (project benefit): The setting up of the NCSC cement plant in Dire-Dawa will be expected to bring the following benefits;

- NCSC cement plant will partially satisfy the domestic cement demand in the country along with establishment of the plant will lead to significant saving of the foreign exchange in which Ethiopia spends on cement importation.
- While the project starts, it is expected to contribute on reducing the price of cement as well as it will play a conducive roll to the diversified economy of the country.
- The project will transfer advanced cement processing technology to the country.
- It will be a corner stone toward the industrial development of the region. As well it will stimulate the local economy (macro economy).
- The project will offer an employment opportunity during the construction and the operation period.
- During the operation period of the project, around the NCSC cement plant site opportunities for commercial activities will be created as local sourcing of food, equipments of housing, tools etc increased.
- NCSC will conduct tree plantation and soil and water conservation (SWC) activities in order to enhance the ground water recharge.
- The project will contribute to the government coffers by way of tax.

Unavoidable or irreversible impact: Agricultural land usage, making roads and bridges, drainage canal will create irreversible damage to the ecosystem.

6.2. Identified Impact and Mitigation Measure

6.2.1. Mining operation Expected Impacts and Mitigations

The quarrying operations and subsequent haulage of the mined limestone is expected to cause impacts on the environment. The following are important.

a) Air

Air quality deterioration will be the most significant impact of the mining operation. The air flow (direction) varies with the seasons. Generally the area lies within the major north westerly wind pattern. Operations at the quarry will generate some dust during drilling, blasting, crushing, and screening to obtain the correct size, loading and transporting of raw materials. Dust will also be generated by moving vehicles and the vehicles are also likely to produce smoke as the engines are running.

Mitigation measure

NCSC is fully aware of these impacts the project will cause on the air quality. The company will deploy a grader and water bowsers on a 12-hour shift basis for road maintenance and dust suppression. Vehicle speed limit will be imposed at 20km/h to minimize dust generation. The raw materials in the dump trucks and belt conveyor will be sprayed with water as it leaves the quarry to ensure dust suppression during transportation. The machines will be maintained to decrease the emission of dust and the vehicles will also be put on regular maintenance to ensure they are in good running condition and also not to emit smoke profusely.

b) Noise

Nuisance from noise pollution will be the specific impact of the mining operation. The blasting activity, loading and transportation of the limestone will generate considerable amount of noise in the area.

Mitigation measure

Blasting activities will be restricted to daytime in the approved timing of the schedule. Loading and haulage will be restricted to the 12hr daytime operation. Unnecessary hooting of vehicles and horns will not be permitted. During blasting in the quarry site, emergency alarm will be deployed to conscious the near by dwellers.

c) Ground Water

Mining of the quarry site will not have an immediate impact on the ground water body.

Mitigation Measure

Since the operation of mining will not pose significant impact on ground water body, mitigation measure will not be required.

d) Surface Water

The exploitation area has no permanent water body or perennial river/stream. The Dechatu wade stream and the associated Goro are seasonal. Most of the time the mining operations at the quarry site will take place in the dry seasons, hence there are no immediate impacts expected from the project. However on a long-term basis, the pits will create man made lakes or water pools. The creation of pits and their subsequent flooding during the rain season and at operation closure may attract curious villagers.

Mitigation Measure

NCSC will fence off the pits and post warning signs in accordance with mining regulations. Exhausted pits will be managed.

e) Solid and liquid Waste Generation

The project will not be expected to generate much solid as well as liquid waste. However, during stripping, some vegetation matter and little soil will constitute to solid waste expected to be generated by the project. Other type of solid waste will be from human waste and related activities such as left over food and food packaging materials for workers on site. Impact of solid and liquid wastes generated from the mining operation will be insignificant.

Mitigation Measure

The stripped soil cover in the quarrying operation and associated vegetation matter will be dumped in some designated areas in order to make compost. This can later be used in the gardening process and partial filling of redundant pits.

Leftover food and food packaging material will be deposited in the dustbins, and the dust bins will be emptied at the temporary garbage bins of the administration. The company will also provide latrine for employees to use.

f) Vegetation and Fauna

Though the site to be mined for limestone has physiognomic vegetation type cover, there will be very insignificant impacts on vegetation and fauna. The mining operation will result in vegetation clearing, and this will pose an indirect impact on soil and ground water by exacerbating erosion of soil and by declining recharging capacity of ground water.

Mitigation measure

Vegetation clearing will be done according to land space requirement, so as to avoid the generation of large biomass at the same time. Afforestation program with SWC (soil and water conservation) activities will be executed by the developer.

g) Socio-economic

The mining operation will have a significant impact on socio-economic aspect by displacing from the agricultural land and so on. The quarry site will be located 1-1.5 km away from the factory. A small part of the quarry is covered by stone sellers. Stone mining is done mostly by the male youths who sell to the Dire-Dawa Administration Road Authority (DDARA) and private construction companies. An individual can sell as many as five loads in a week.

The quarry site is in the peri urban area of Dire-Dawa Administration. There are a number of people who live within the vicinity of the quarry site. These people are mostly poor and rely on subsistence agriculture and illegal quarrying, and these peoples will be displaced and may need relocation at a future date as mining moves closer to the settlements.

Mitigation Measure

Since negotiation regarding to leasing of land is being handled by the Dire-Dawa Land Administration Authority (DDLAA), the necessary rules of the government will be conducted for resettlement and compensation of the displaced farmers. Due to attention is being given for proper compensation to the displaced farmers; the affected person will be employed on per the qualification and experience.

h) Soil resource

Mining of the quarry site will pose significant impact on the soil resource by aggravating soil erosion and disturbance, over burden removal of soil, pit lakes occurrence and land degradation.

Mitigation Measure

Erosion control measures will be put in place, which will protect exposed surface with vegetation cover. About 13 hectares in areas south of the mine will be refilled and the remaining will be used as water reservoirs to be used for reforestation and other purposes. The overall pit slope will be maintained to avoid bench failure, and the pit lakes will be useful in groundwater recharge. The surface soil layer will be stored separately from the rest of the overburden soil. The entire periphery of the mine will be banded and garland drainage provided to avoid inrush of surface water during rainy season.

i) Other Social and Environmental Aspect

While the service years and performance of the mining operation become increased, the following impacts will be expected significantly;

- Creation of breeding grounds for disease vectors
- Health problems associated with dust / atmospheric emissions
- Influx of people in search of employment and market speculators
- Escalation of HIV/AIDS issues in locality
- Occupational safety and health Impacts

Mitigation measure

- Inspection for the presence of disease vectors and help in strengthening of local health facilities through public enlightenment and direct contributions in terms of provision of infrastructures, etc.
- Use of covered conveyor, Landscaping of exposed areas / use of water browsers to control dusts. Machinery will be maintained in good conditions to minimize emissions. Workers will be equipped with gas respirators and safety goggles.
- A comprehensive influx management and community development plan will be put in place to cover the entire cement development project of which this project is a component part.
- A HIV/AIDS awareness and prevention program will be put in place to guide staff control their conducts. Support NGOs to empower inhabitants of communities to take informed decisions about sexual behaviours. Strengthening of healthcare system to provide voluntary counseling and testing for workers / members of host communities.
- Hazardous working conditions will be eliminated. Health clinics will be put in place and ambulances provided for emergency evacuations.

6.2.2. Cement Production Identified Impacts and Mitigations

I. Construction Phase Cement Production

The negative impacts caused by the construction of cement plant will be temporary and will no longer exist after the construction work is completed.

a) Air

Movement of trucks and heavy-duty equipment to and from the project area, as well as construction work and stockpiling of earth materials, will contribute to dust emissions.

Construction activities will also result in the removal of vegetation that will expose and loosen soil which can become airborne with medium to strong winds. This will add fugitive dust to the area, which is already dust-prone because of previous land clearance.

The transport of aggregate for road and drainage culver construction will also contribute to the fugitive dust levels. Construction vehicles will emit air contaminants such as Co, nitrogen and sulphur oxides (i.e. No_x and So_x) as well as dust particulates.

Mitigation measure

Most of the dust generating activities during construction last for about 12 weeks, while up to execution of the excavation work. Watering of stripped road surfaces along which construction vehicles and trucks travel will control dust emissions by up to 70%. A full-time watering truck will be maintained on site for watering road surfaces as needed to minimize fugitive dust emissions. Over-saturated conditions, which will cause outgoing trucks to track mud onto public streets, are to be avoided as watering will not be necessary on days when there is rainfall. Vehicular speed limit of 25 km/hr will be observed in order to minimize dust generation. Stock piling of earth materials for construction will be carried out within temporarily constructed enclosures to limit fugitive dust. Vehicles transporting earth materials will be covered en-route. Mixing equipment will be sealed properly and vibrating equipment will be equipped with dust removing devices. Stockpiles of fines will be covered on windy days.

A monitoring program for dust will be developed to assess the effectiveness of control measures in meeting ambient air quality standards. Dust masks will be provided to operators in order to protect them from dust impacts.

b) Noise

Noise pollution will be expected during site preparation and construction with the use of heavy machinery and earth moving equipment, and during piling, slab installation and basement concreting.

Mitigation measure

During site preparation and construction activities noise from heavy machines and earth moving equipments will be minimized by limiting and regulating activities to the hours between 7 pm and 6 am, where construction work will be in close proximity to residential

areas. Construction machinery and vehicles will be serviced at regular intervals in order to keep noise to minimum level.

As it is appropriate, workers will be equipped with earplugs or earmuffs, and wearing will be enforced. Employees will be trained on noise abatement and PPE (personal protective equipment) practice. Adhere to FEPA and DDAEPA noise standards.

c) Vegetation

Site preparation and construction activities will result removal of significant vegetation.

Mitigation measure

To compensate for loss of vegetation cover, NCSC will facilitate afforestation programme. Vegetation will be cleared in sequence while the construction phase of NCSC cement plant and infrastructure in order to avoid generation of large biomass at the same time. Community members will be allowed to harvest useful portion of the vegetation.

d) Traffic, Transportation and Access Roads

Site preparation and construction activities will increase the movement of heavy vehicles and construction equipments, which allow traffic jam or the disruption of traffic flow.

Mitigation measure

Scheduling the construction work will help to minimize disruption to traffic flow along the main road of Dire Dawa to Addis Abeba and the movement of materials and heavy equipments will be done when the traffic flow is less, between 1pm and 6pm. Separate inlet and outlet routes (road) will be enforced for trucks moving into and out of the factory. Speed limit will also be enforced for all vehicles approaching the NCSC turning location. Traffic warden will be stationed at strategic location where the NCSC road connected with the main road. Arrangements for parking and storage of material will be made on-site as it is feasible for efficient operations. Properly trained flag persons and roadside signs will be used where the movement of heavy machinery and construction equipment may cross the main road.

e) Solid and liquid Waste Management

Solid waste generated from the site preparation and construction activities will include construction debris; solid waste generated from the construction camp and decommissioned equipment/structures.

Mitigation measure

Construction sites generate considerable waste and provision will be made for suitable separation and storage of waste in designated and labeled areas throughout the NCSC cement project.

Collection and disposal of wastes will be made by the contractor at an approved site, as it will be recommended and approved by the Sanitation and Beautification Agency (SBA) of Dire-Dawa Administration. Any hazardous waste will be separated and stored in areas clearly designated and labeled, for future entombing and disposal as it will be directed by the Environmental Protection Authority (EPA) of Dire-Dawa Administration. Training on how to dispose food and drink containers with regard to the need to protect the coastal environment will be conducted. Decommissioned structures will be properly disposed of at the regional landfill in consultation with the Sanitation and Beautification Agency (SBA) of Dire-Dawa Administration.

f) Public Health and Safety

Site preparation and construction will involve transportation and storage of significant volumes of construction material; and proper disposal of construction spoil and any hazardous waste. Fugitive dust and construction noise levels will be anticipated and will also be public health issue.

Mitigation measure

Proper disposal of construction spoil and any hazardous waste will be stored in areas clearly designated and labeled. The contractor will offer dust mask and ear muffs as it is appropriate.

II. Operational Phase Cement production

a) Noise

Noise produced in the grinding mills, crusher and compressor will be low. In the NCSC plant, noise is likely to be high in raw material grinding and cement milling operation and in the compressor room. The noise which will be generated from this room will cause a significant impact on workers and surrounding residents if it will exceed the permissible levels. Noise will also reduce the labour productivity and will cause lack of attention which will lead to accidents.

Mitigation measure

The NCSC cement project will utilize the latest technology, which will guarantee low noise levels. Noise will further be attenuated by the use of Mufflers and silencers as dampeners. Equipment, machinery and tools will be serviced regularly to ensure low noise emission. Sections like compressor raw and cement mill where the noise level is high, ear protection to operators or workers will be offered by the NCSC, occupational safety standard will be pursued in terms of the wearing of ear muffs.

b) Air

The air emitted from cement processing contains dust and SO_x, NO_x, and CO_x which can negatively affect the air quality of the area.

Dust

Vent Air from Blending Silos:

Compressed air is used for blending the raw meal powder in blending silos. Some amounts of dust particles are entrapped in this air at the time of vent from these silos. This dust being raw material is required to be removed and will be recovered before releasing the of vent air into the atmosphere.

Mitigation measure

Vent air from blending silo contains fine particulate matter of raw materials. In order to remove dust entrapped in vent air from blending silos dust collector like bag filter will be

installed. The clean air will have dust less than 150 mg/m^3 , which is below the set of dust particulate emission limit of the National standard.

Vent Air from Raw mill (Raw meal Grinding):

Raw meal is prepared by dry grinding of limestone and other raw materials in a conventional ball mill, grinding of raw materials will produce powder having particle size of 90 microns. Due to presence of moisture in raw material during unusual weather conditions, it is required to vent out the hot exhaust gases from kiln pre-heater for maintaining the dry conditions in ball mill, and efficient operation of the mill. The amount of gases to be vented in the mill depends upon the amount of moisture to be dried. The dust entrapped in the exhaust gases air stream, if it is not removed efficiently before it exits into the atmosphere it will create pollution problems inside the plant and affects the machinery. The particulate, therefore, will be removed from the gas/air stream.

Mitigation measure

Vent gases from Raw Material grinding mill contain fine particulate matter of raw material.

Here also a most efficient dust collector i.e. bag filter of adequate capacity will be installed. The cleaned air having particles having concentration less than 150 mg/Nm^3 will be discharged via chimney into the atmosphere by kiln exhaust fan, as per the Ethiopia emission limit of dust particulate matter.

Vent air from Cement Mill (Cement meal Grinding):

Inter-grinding of cement clinkers and Gypsum is performed in Cement grinding mill, For the efficient operation of the grinding mill, a certain amount of air is required to be vented out from the Mills, which will take away the heat generated in the process of grinding, which otherwise will affect the quality of the cement. Dust entrapped in the exhaust air/gas stream will be effectively removed, before it is released to the atmosphere.

Mitigation measure

A most efficient dust collector like mill bag filter of adequate capacity has been installed.

Cleaned air having particles of concentration less than 150 mg/Nm^3 will be discharged through ventilation to atmosphere, as per the national emission limit of dust particulate matter.

Vent air from cement silo

Cement from cement mill is stored in cement silo beside via cement silo extraction point bulking is done. At the point where extraction and filling of cement exercised dust generation will be posed. Since this dust has a value will require management.

Mitigation measure

Dust collection will be offered by NCSC at the silo extraction and filling point. Most efficient bag filter will be used to de-dust the dust concentration in the vented air, and it will be maintained at less than 150 mg/Nm^3 level to conform Ethiopia emission standard of dust particulate matter.

No_x, So_x and Co_x

No_x and So_x emission from chimney of rotary kiln:

Raw meal is calcined into clinker in rotary kiln, with heat consumption as 750k ca/kg-cl. High temperature clinker from rotary kiln is to be cooled sharply by cold air blown on below from grid plate in grate cooler. During this process No_x is formed from Nitrogen in the air under the high temperature condition of the kiln. No_x production is reduced in a low oxygen environment, but the kiln can not be operated at low oxygen concentration as it will negatively affect the quality of the clinker and cause damage in the electrostatic precipitator (ESP) due to the presence of Co. Similar to No_x, the So_x formation of atom is also under gone. Carbon monoxide (Co) will be released during coal fuel burning under insufficient oxygen condition and this indicates incomplete combustion of the fuel.

Unlike No_x, Co_x and So_x formation of dust particulate matter will also be formed in combustion process of kiln. Therefore, vent air from kiln combustion i.e. No_x, So_x, Co and dust if it is not managed before it is released into atmospheric air it will significantly affect air quality of the area.

Mitigation measure

Vent out air during the process of clinkerization in the kiln will have toxic and hazardous nature as compare to the other processing section. Nevertheless, adequate mitigation measure such as electrostatic precipitator (ESP) and bag filters will be installed. Therefore all vented out air from kiln inlet will be de-dusted and treated by ESP and bag filter. The filter will be designed and guaranteed for outlet dust emission level of less than 150 mg/Nm^3 , No_x emission level of less than 2000 mg/Nm^3 and So_x emission level of less than 1000 mg/Nm^3 in line with the national emission standard. Moreover, low No_x emitting burner will be installed to reduce No_x emission level, No_x reduction will be achieved by firing limestone under reducing atmosphere and No_x reduction will be achieved by recycling kiln No_x gases to use in the pre-heaters and pre-calciner.

The So_x levels will be expected to be quite negligible because the sulfur content in the coal and fuel oil is below 2-3%. Co will be controlled by the kiln complete combustion process of coal and it will be reduced at high temperature of kiln. Beside to this, carbon monoxide concentration in the exhaust gas will be expected to be low as the natural gas will undergo almost complete combustion in the kiln. While on operation the kiln air speed will be kept to minimum using a grid plate air lock with variable speed. The air velocity at cyclone pre-heater from where emission starts will be kept low. Due to this lower flue stack (chimney) speed solid particulate which could be air born will be maintained.

Dust air from coal mill (coal grinding):

Due to presence of moisture in coal, it is required to vent out the hot exhaust gas depending upon the moisture, if the dust entrapped in the exhaust gases air stream, is not removed efficiently before it exit into the atmosphere, it will create pollution problems inside the plant and affect the machinery and keep up the plant. The particulates therefore will be removed from the vent out air.

Mitigation measure

Bag filter (dust collectors) will be provided to bring down the dust concentration with in the Ethiopia emission standard of dust particulate matter (150 mg/Nm^3) i.e. recycled (waste)

gas come from pre-heater will be blown to kiln inlet bag filter to collect the coal mill dust before it will be released via chimney into the atmosphere.

Other Emissions

- The other emission which is Fugitive emission is neither quantified nor predictable as these are not generated in normal process but only when there is either leakage or other abnormal conditions like material handling. In the normal working the fugitive emissions outside the factory premises are not visible and will not add particulate solid particle to atmosphere. However in case of leakage of material and in case of unloading material, the emissions are totally localized and are limited to vicinity of the source only. These are contained immediately.
- The other secondary emission is from Diesel Generator (D.G) sets by burning of diesel oil when electrical power is not available. This occurs only during power cuts. These generators are only standby arrangements and have no much effect on the atmosphere. The Stack height of generator has to be kept sufficiently higher than the nearest buildings and as per norms.

General Mitigation Measure

- Good housekeeping, tree plantation, water spray, closed bucket elevators are used by unit to control this type of emissions.
- Covered storage sheds will be made for raw materials, so that there will not be any dust release.
- All conveyors will be closed type and thus there will not be any dust release from this conveyor. Routine preventive maintenance of these conveyors will be carried out to avoid incidental release of dust.
- Constant house cleaning efforts will be applied to maintain a clean plant. Housekeeping of all ventilating equipments, the day-to-day dusting and handling equipments etc.
- Make up air supply system will provide a positive means to combat the dust problem inside the factory building. Adequate windows fresh air supply will be provided so that working stations and operating level will be provided with clean and comfortable atmosphere.

c) Water Resources

Deep well is planned to get water for the source of domestic, production and fire water; and the water quality and quantity will be charged by the owner. Total water consumption of the NCSC estimated to be 11325.0m³/d.

Surface Water

Given that there is no surface water body on the project site, the issue of direct surface water contamination resulting from the development will not be expected. The main component of the site will be located on an area that is generally undulating surface. At present the area demonstrates land that has been cleared of trees due to agricultural activities conducted and fire wood in the past.

The development of the cement plant will have the potential to increase runoff over land generated by rainfall. The drainage channels and the paved areas around the factory complex will definitely increase water runoff during the wet season.

Mitigation measure

The developer proposes to minimize these impacts by embarking tree planting exercise in a manner that will add beauty to the surroundings and will act as a wind barrier. As well it will help to decrease the surfaces run off while at wet season. Drainage channel will be constructed to minimize surface run off and it will be discharged into the nearby stream.

Ground Water

Continuous large scale abstraction of groundwater without a sustainable recharge to the aquifer will lead to groundwater depletion in the long term. Abstraction of groundwater at NCSC Cement Project site will be maximum, thus will lead to significant fluctuations in groundwater levels. The question of groundwater depletion in this case does arise. Probability of ground water contamination during waste (effluent) discharge will be insignificant.

Mitigation measure

The developer proposes to enhance the ground water recharging capacity within the area by planting more trees in a manner to minimize surface run off, so as to percolate to the ground and give such an area a look of natural surrounding.

To prevent groundwater pollution from sewage effluent, Sewage will be piped into septic tanks, which when filled up will be dislodge using sewage trucks to be treated in a sewage treatment before it will be discharged into the nearby stream.

d) Soil resource

Soil contamination from acidic rain of No_x and So_x will be expected. The reason for this will be oxidization of No_x and So_x i.e. a vent out flu gases from chimney with the atmospheric oxygen will be create oxidized No_x and So_x , and while at the wet season acidic reaction of water with oxidized No_x and So_x will create acidic rain. Nevertheless the contamination of soil will be insignificant as No_x and So_x emission is controlled before it vent out from the chimney as well as the short length of wet season.

As stated in the description of physical environment, the nature of the soil at the project site is to some extent prone to erosion. Where appropriate, surface runoff from areas of disturbance and areas with high runoff coefficients, will be directed by correctly designed drainage systems during and after construction.

Mitigation measure

Most efficient ESP of adequate capacity will be installed to control this No_x and So_x emission. Moreover the formation of No_x and So_x acid rain depend on the length of wet season (rainy seasons). The impact will no longer see in turn to pose a serious risk while at the short period of wet season.

For the run off water, a network of internal drainage channel will be designed according to the characteristics of peak flow in the area to collect water into a sedimentation tank, prior to discharge through an existing stream. The following design concepts will be applied at NCSC.

- The total area which include in site drainage system will be defined.
- The erodibility of any unlined drain will be defined.
- The drainage system will have interception point before it will be discharged into the nearby stream.
- An acceptable design storm will be identified with regard to return period.

e) Vegetation

So_x and No_x are oxidized in the air and react with rain water to create acidic rain, which impact the growth of the vegetation cover. A couple of hours of exposure to air contaminated with So_x at 1-2 ppm can hurt leaves. For sensitive vegetations, the concentration of 0.15 - 0.30 ppm can cause chronic toxic. Low class vegetations are the most sensitive to So_x. However, due to low quantity of So_x and No_x emission from the NCSC the impact on vegetation will not be hazardous.

Mitigation measure

Most efficient ESP of adequate capacity will be installed to control this No_x and So_x emission. Moreover, the formation of No_x and So_x acid rain depend on the length of wet season (rainy seasons). The impact will no longer expect in turn to pose a serious risk on vegetation due to the presence of long dry season.

f) Human health

The air emitted from cement processing, contain dust and So_x, No_x and silicate which can negatively influence human health. In general, cement dust does not cause lung diseases, but if in the cement dust there is more than 2% of free silicate, diseases can occur after many years of exposure. However, the silicate concentration from NCSC dust is insignificant. Therefore, the probability to occur disease from free silicate will not be expected from NCSC cement production.

So_x and No_x are stimulative gases. Contact with eyes can produce acids. So_x and No_x can get into human bodies through the respiratory organs or digestive system after being

diluted in saliva. Finally they will be transferred into blood. Contact with dust, SO_x and NO_x can produce suspended acidic particles, which can reach capillaries and transferred to the lymphatic system if the size is less than 2-3 μm . SO_x can get into the body through the skin and can cause basicity transformation, as a result of which the basic reserve in the blood is reduced, Ammonia is eliminated with the urine and basicity is eliminated with the saliva. Moreover, the toxicity of SO_x is shown by uncontrolled transformation of protein and sugar, lack of vitamin B and C and inheritance of oxidizing enzymes.

The absorption of large quantity of SO_x can cause diseases of the blood producing system and also the metabolic producing system, which strengths the transformation of Fe (II) into Fe (III). Therefore massive emission of SO_x as well as NO_x will cause metabolic disorder on the health of the society and workers. Nevertheless, due to low quantity emission of SO_x and NO_x from the factory, the impact will be insignificant.

Mitigation measure

Impacts of dust, SO_x , NO_x , silicate etc. on human health is very insignificant. Where as NCSC will use electrostatic precipitator (ESP) and bag filter with high performance in turn to de-dust and treat the emission of SO_x , NO_x , dust, silicate etc. below the national emission limit before released into the atmosphere. Apart from this, as appropriate workers will be equipped with personal protective equipment (PPE), and wearing will also be enforced especially for employers work in raw and coal meal clinkerization section (kiln).

g) Socio-economic

The small part of the project is covered by stone sellers and farmers. The project will displace 35 farmers and stone sellers. This scenario will pose a negative impact on socio-economic condition of the society. This is an irreversible loss.

Mitigation measure

Since negotiation regarding to leasing of land is being handled by the Dire-Dawa Administration, the necessary rules of the government will be pursuit for resettlement and

compensation of the displaced farmers. Due to attention is being given for proper compensation to the displaced farmers; the affected person will be employed on per the qualification and experience.

h) Impacts associated with solid wastes:

Domestic waste water of the NCSC will contain a high concentration of suspended solid, organic matter (BOD, COD, SS) and bacteria. It is necessary to treat the waste water before discharge.

Generally, there will be almost no industrial waste water from the cement plant. The water supplied to the conditioning tower will evaporate and expanded into the air through the stack. The water used for cooling, bearing etc. will be recycled.

Solid waste such as spilled cement, wooden pallet, etc. which will be penetrated during manufacturing process will not have significant impact.

Mitigation measure

In order to disinfect the BOD, COD and SS of the waste water, NCSC will offer domestic waste water treatment plant before it will be discharged from the compound. BOD, COD and SS concentration of the discharged waste water from the treatment plant will be less than 25 mg/l for BOD, 150 mg/l for COD and 50 mg/l for SS in line with the set limit of waste water discharge of Ethiopia standard for cement factory.

Industrial waste water will not require treatment since the waste water will be recycled and evaporated the air through the stack. Waste such as cement bags, wooden pallets etc. will be reduced at the source, reused or recycled. Spent mill balls and ceramic brick lining used in the kiln will be recovered and reused.

i) Impact associated with wind direction:

The factory will be located on a site that is about 6km away from Dire Dawa. Since the wind direction is 190⁰ most of the year the dust which is emitted from NCSC will blow towards the residential area for most parts of the year. The location had previous legal occupant, the people from the nearby were using it for subsistence agriculture and stone selling.

Mitigations

To minimize the impact of wind on the near by dweller, tree plantation will be undertaken. Beside to this, the dust will be minimized by ESP device.

j) Other Social and Environmental Aspect

- Impacts of accidental spillages:
- Conflict due to loss of agricultural land/income derived from land
- Disruption of livelihood as a result of loss resources
- Gender disparity in adverse social effects benefits
- Social tension due to unprecedented influx of people
- Danger of escalation of HIV/AIDS and sexually transmitted diseases (STDs)
- Road traffic hazards due to approx. 1000 truck/vehicle movement per day

Mitigation measure

- The integrity of storage facilities will be ensured, Drip pan will be made available where necessary, Surface storage will be avoided, and underground storage tanks will be properly lined and monitored periodically
- NCSC will provide reasonable compensation for lost. Liaise with the Administration to help and provide alternative sites to the displaced farmers.
- As much as possible, junior staff will be sourced from qualified members of the local communities. Skill acquisition program will be established to assist members of the project-affected communities to acquire useful skills. A micro-credit scheme will be put in place to assist locals that may take up to trading/self-employment.
- Special programs (e.g. 'female sexuality & HIV', 'women in agriculture', etc.) will be put in place to target local women .Compensations will be paid directly to women for

agricultural land owned by them. Preferential treatment of women will be encouraged where necessary taking into consideration their particular role and circumstances

- NCSC will develop an influx management plan with communities. Training workers to respect cultural sensitivities in the host communities will be done. Participating in with local communities during festivals such as Easter, Epiphany, Christmas, Eid ceremonies, New Year Festivals, etc. and also improving basic facilities/utilities such as water supply, school, and health infrastructure/supply will under go. NCSC will Put in place 'early warning' mechanisms to identify potential source(s) of tension/prevent them from escalating.
- A HIV/AIDS awareness and prevention program will be put in place to guide staff control their conducts. Support NGOs to empower inhabitants of communities to take informed decisions about sexual behaviors. Strengthening of healthcare system to provide voluntary counseling and testing for workers /members of host communities will under go.
- Road signs will be placed at appropriate locations to alert motorist along the highway. Speed limits will be enforced for all vehicles approaching the NCSC cement factory. Traffic warden will be stationed at strategic locations to guide traffic, especially around and within the factory site. Separate inlet and outlet routes will be provided for trucks moving into and out of the factory

7.0 COMMUNITY CONSULTATION

Consultation visit were paid to the community of Ijaneni rural kebele Administration that will be affected by the proposed project.

Nearly all communities are dependent on a stone selling and agricultural production. Stone selling has been practiced by tradition system. Most of the stone sellers are association with and with out legal permission. Apart from stone selling the communities practice crop production. The dominant crop that is grown in the area is sorghum. Generally, this socio-economic base is natural resource. While on the meeting with the communities there concern and wishes, is summarized in below.

7.1 Communities concerns

- Non-indigence's from other regions may be took most jobs and dominate most of the business. The inability of indigence's to raise money to start business is one of the major concerns.
- The other major concern of the Ijaneni communities was lack of water, especially during the dry season. They demanded to have a reliable source of potable water with in the communities or from the NCSC cement plant.
- Another important concern of the communities was lack of school, as they are desperately in need of primary school.
- Complain from some communities members regarding compensation program.
- Most people mention the possibility that migrant might bring diseases that are not common in the area.
- Change in culture and values, most people fear that the culture and value or people will be lost over time. Already general respect for elders, decent dressing and chastity are being eroded.
- Safety problems from the increasing numbers of big trucks used in construction work.
- Transportation of raw materials from the quarry and transportation of bagged cement from the factory will cause congestion on the public road and also pose a danger to their cattle, sheep, etc...

- Fear of injury and damage from flying stone and noise from explosive during blasting in the quarry.

7.2 Community expectations

Views on expectation of what the proposed project should bring to the people were unanimous and the people ranked them in the following order of priority.

- Getting priority to be employed.
- Getting water.
- Getting health care facility.
- Getting security



Fig. 7.1 Study Team at Ija Aneni Kebele with NCSC representatives (consult-1)



Fig. 7.2 Group Discussion With Community Members of Ija Aneni kebele (consult-2)



Fig.7.3 Meeting with Ija Aneni Kebele Officials (consult 3)



Fig. 7.4 Ija Aneni Kebele Manager (Ato Muktar) With Representatives of –Study Team, NCSC(Mr. Ahu) & DDEPA (Environmental Expert Ato. Yonas Befekadu) (Consult-4)

8.0 ENVIRONMENTAL MANAGEMENT AND MITIGATION PLAN

8.1 Air Quality Management

All process gas/air flow will be de-dusted in high efficiency Electrostatic precipitators (ESPs) or bag filters. The filter will be designed and guaranteed for out let dust emission level of under 150 mg/Nm^3 , the proposed emission standard. Provision will be made for the future addition of a third collecting field in the ESPs if emission levels need to be further reduced.

The main transport system, i.e. the raw material in the dump truck, is projected to be sprayed with water as it leaves the quarry to ensure dust suppression during transportation, and also the long term project of 1.5 km long limestone conveyor, will be projected as an enclosed design covered belt or enclosed buckets to prevent dust emission during transport of the material. The discharge point will be vented through a de-dusting bag filter.

The TSP in the exhaust gas stream after the electrostatic precipitator is guaranteed by the designer and the equipment supplier at less than 150 mg/Nm^3 . The flue gas sulphur dioxide concentration will be undetectable as sulphur content is very low (almost undetectable) in the natural gas. The carbon monoxide concentration in the exhaust gas is expected to be low as natural gas will undergo almost complete combustion in the kiln and calciner. The No_x concentration in the exhaust gas will be expected to be insignificant because of low No_x emitting burner installation. Assimilation of the exhaust emission will be facilitated after discharge in a high stack.

8.2 Occupational Health Management

The crushed limestone and sandstone will be transported inside a closed system to prevent loss of materials, dust and spill over. The enclosure will ensure protection against hazardous accidents to workers. Further workers will use personal protective equipments as appropriate.

8.3. Quarry Land and Waste Management

A conceptual mining plan based on technical and economic considerations has been put in place to ensure a sustainable mining operation. The entire deposit will be mined up to 15m depth. The block will be mined section by section, so that as one section is exhausted, it will be refilled and afforestation undertaken. Prior to that, the topsoil will be removed first then it will be stored in safe place and it will be using for afforestation. The top soil will also be used for refilling of the open pit to fill the top cover. The refilled pit also served for afforestation.

The solid waste generated such as cement bag, wooden pallet etc will be reduced at the source, reused or recycled.

The following are considered for waste minimization

- I. The exhaust gases from raw material grinding and clinker and cement grinding will be treated in filters, electrostatic precipitators or gravel filters. All the collected dust can be recycled into the production process.
- II. Fugitive emissions from transportation and storage will be reduced by good house keeping and monitoring the materials exposed to the open air. Disposal of wastes water will be substantially reduced by using closed loop process for cooling water.

8.4 Energy Conservation

The concept of waste minimization is not new in Dire-Dawa Administration. This will be incorporated in the project. The following are considered for energy conservation.

1. Cement production is characterized by very high energy consumption.
2. Measures for energy consumption reduction are important. Off gases from the kiln and calciner can be used for pre-heating the material feed.

The energy and cost savings realized by the dry process which is recommended for NCSC originate from pre-heater and pre-calciner systems, which will combine raw material pre-heating and calcining to reduce energy consumption. These systems have been considered for the plant.

8.5 Institutional and Training Requirement

The management has given top priority to mitigate issues identified in the exercise as well as the control and mitigation measures as discussed earlier. Further it is aware that improvement of the environment has a direct bearing on the economic benefits and industry has a responsibility to society not only to assure product availability but also to improve the health and quality of life.

Regarding the economic benefits, first as there is the direct value of the collected dust which will otherwise have been cease and unavailable, in terms of its potential for cement making or selling as cement.

Secondly, there is the benefit of improved productivity of the working personnel. It is clear that a worker will prefer to work in a clean environment rather than a dusty atmosphere. In terms of cost, the improved productivity contributes to improved profits. Controlling dust can prevent dust contamination of trees, crops and residents around the plant. The management of NCSC will provide specifications of 1) electrostatic precipitators 2) bag filters 3) noise suppressors so that the efficiency of the equipments and their effectiveness can be verified.

There will be a separate budget for the cost of O & M of the equipments necessary for monitoring air quality, noise quality & water quality.

The management plan should be seen as a protection against environmental degradation for long term benefit to the society towards achieving sustainable environmental quality standards and continued socio-economic development.

The environmental management plan must include monitoring, proper training, operation and maintenance. The management has given top priority to these activities and sufficient budget has been provided. Unless the quality control and the production process are efficiently handled and proper infrastructure and facilities are ensured the plant will be uneconomical.

Hence a section for waste minimization and energy conservation has been included to ensure these.

8.6 Training in Environmental Management

This is the most important area. Unless proper training for environmental monitoring and effective operation and maintenance of the control equipment are ensured, the whole exercise will be fatale. The NCSC management has carefully planned a budget for training in this area.

8.7 Environmental Unit of the Factory

The factory staff in quality control and production will be trained for environmental analysis. Regular monitoring will be carried out to establish base line data and assure compliance with environmental quality standards. The staff will be adequately qualified. The monitoring data will be sent to all concerned parties once every year.

8.8 Public Participation

The management has held several public meeting with the local people who will be involved directly and indirectly.

Since the land will be acquired by the Administration of Dire-Dawa, the formalities of acquiring land from the public will be proceeding as the rule of the Administration. The public has been made aware of the potential economic importance of the cement plant. The owners and tenants will be adequately compensated as per the rules.

They will be trained and provided with jobs. Some of them will be engaged in business during the development stage and also after the completion of the project. The property value will be appreciated when the cement industry is completed. Women will be provided with various kinds of jobs. Social needs are manifold depending upon the ability of the person. There will be many personnel who will be working in different capacities. The establishment of this project will create various job opportunities like supply, road development, commodities trade and in general will offer broad economic benefit to the people of Dire-Dawa.

8.9 Third Party Handling/Involvement in Monitoring Program

The monitoring equipments i.e. Air quality, noise pollution and water quality will be provided by the NCSC. The necessary monitoring analysis has been budgeted.

Permit/clearances are required to be issued by the Dire-Dawa Administration Investment Office and Infrastructure Construction Works Authority for the cement project and its plantation. Water mines and energy office for raw material mining. Environmental Protection Authority concerning on environmental issue. Land Administration Authority for leasing the mining area and plantation area.

9. MONITORING PLAN

Equipments for continuous monitoring and recording of particulate levels in the stack will be installed. Direct measurement of particulate levels at the stack and at the plant boundary levels will be carried out at least every three months, and the calibration of the continuous monitor will be checked at this time. Monitoring for SO_x and NO_x will be carried out quarterly. When operational, the dust emission in kiln and clinker cooler exhaust gases will be measured directly and corrective actions to be taken to maintain the level 150 mg/Nm^3 .

The BOD, COD and SS of the waste water effluent will be monitored on a regular basis. The suspended solids concentration will be measured monthly by the treatment provided. The monitoring data will be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. These records of the monitoring results will be maintained in an acceptable format. These will be reported to the Dire-Dawa Administration Environmental Protection Authority and relevant parties as required.

10. COORDINATION WITH VARIOUS ORGANIZATIONS

During the process of preparation of this report a number of local and national organization were consulted and coordination maintained. Certain recommendations and components of the conclusion suggest future follow up coordination with various organizations.

The organizations which have been contacted already and regularly leased with include DDEPA, FEPA, DDLAA, Ijaneni rural kebele Administration, EEPCo, land owners and others who have given their written no objection to the project.

The necessary coordination and consultation (verbally) with concerned organizations and people will be continued in future during the construction and operation of NCSC to ensure environmental and social harmony.

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