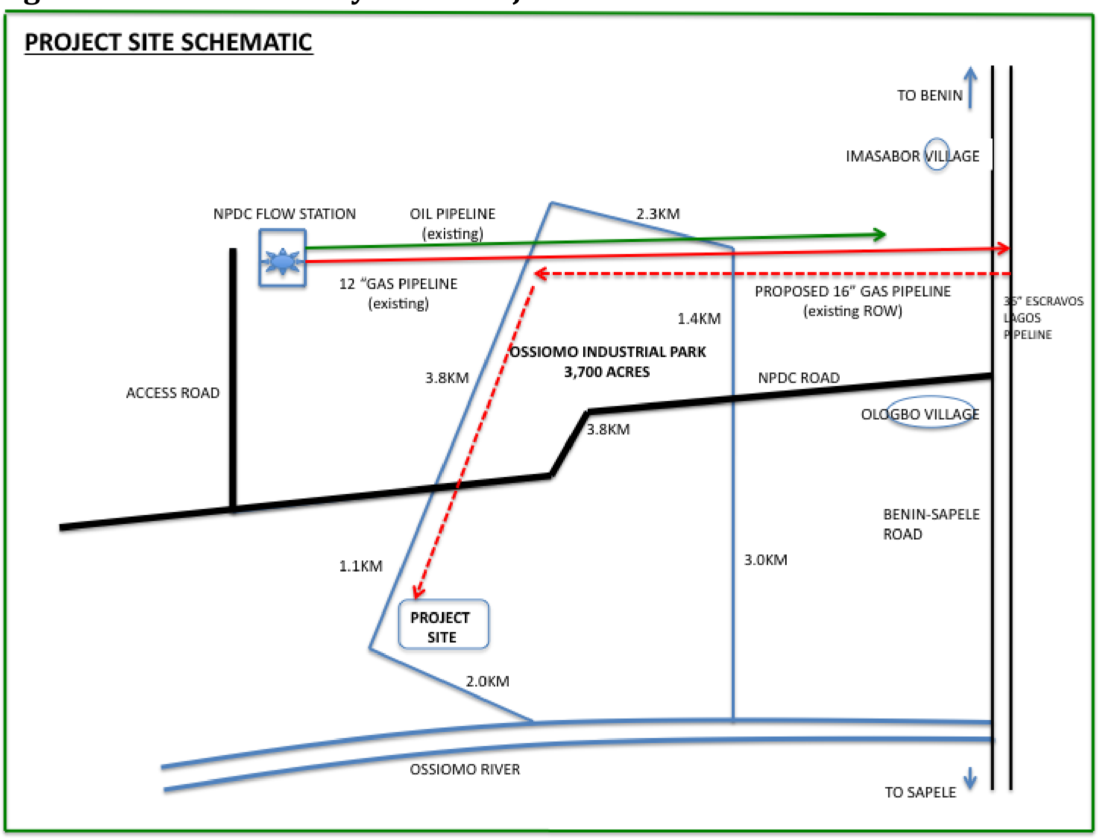
5. DESCRIPTION OF THE EXISTING ENVIRONMENT

5.1 PROJECT LOCATION

The Project site is located within the Ossiomo industrial park which lies between longitude 05° 39' 8" to 05°39' 6" E and latitude 06° 4' 17" to 06° 4' 6" about 35 km south west of Benin City.

The Project will be located on 200 acres of plot within Ossiomo industrial park located in approximately 35 km south west of Benin City, the capital and about 35 km from Koko port which will provide marine access for equipment import and products export (Figure 5.1).

Figure 5.1: Schematic Layout of Project Site



The Project proposes to use the existing NPDC Road which links the site to the Benin – Sapele motorway for access and egress from the site. However, the Sponsors propose to construct a new road to provide direct access to the site in the medium term.

Plate 5.1 Benin – Sapele Motorway (March 2010)

Plate 5.2 Marine Access to Project Site (Google)

Plate 5.3 Ossiomo River Access to Project Site (March 2010)

Plate 5.4

Ossiomo River Access to Project Site (March 2010)

5.2 BASELINE DATA

The information source is based on a combination of literature review, field studies, and laboratory analyses. The literature review encompassed background information on the climatic condition of the area including recent environmental studies. Literature was sourced from the Project Sponsor, the Nigerian Meteorological Agency, the Federal and State Ministries of Environment, State Ministry of Lands and Agriculture. Additional data sources includes published articles in journals, gazettes, and technical reports, maps, internet, etc. which in all cases were cited and duly acknowledged. Field sampling efforts covered the entire Project site.

Field survey was conducted for air quality, noise levels, water, sediment, soil, vegetation and wildlife. In addition, public consultation and socio-economic surveys were held in the communities around the site. Table 5.1 presents the sampling stations and geographical coordinates for each environmental attribute.

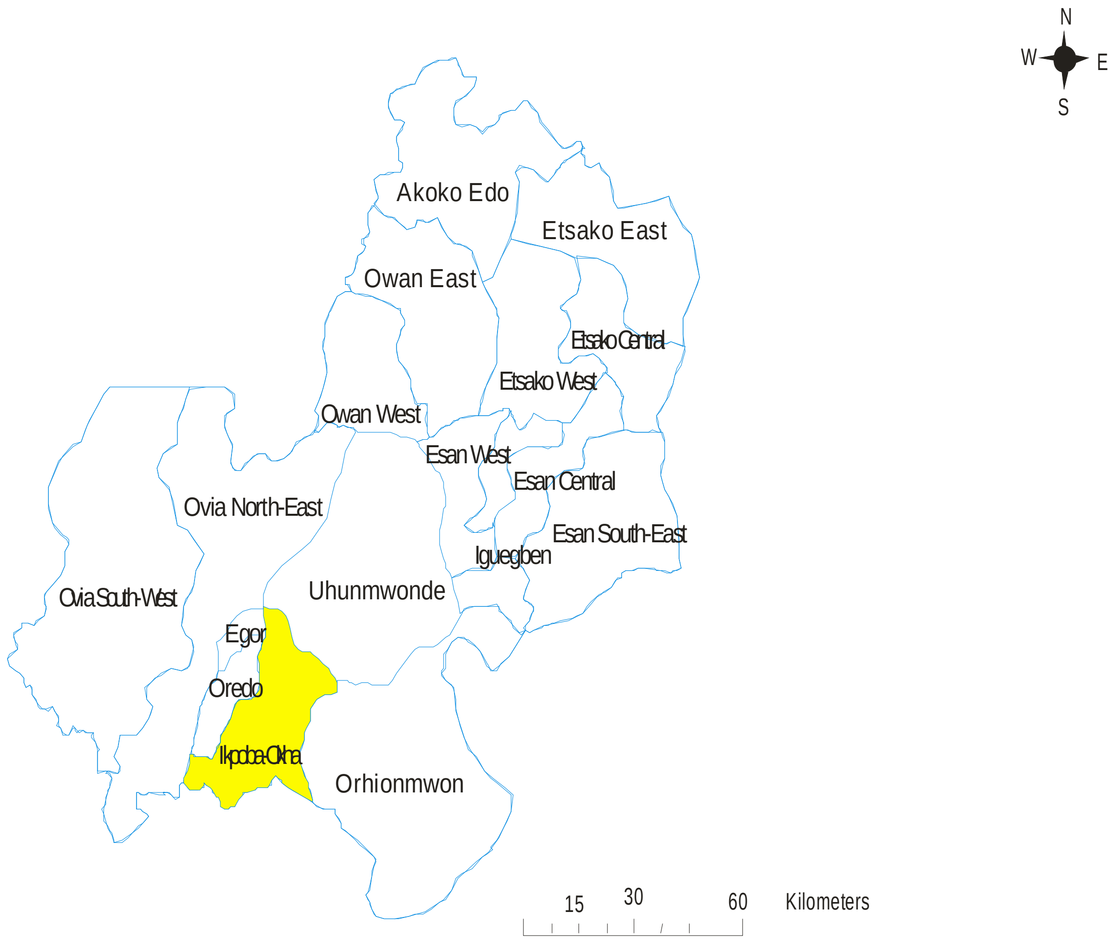


Figure 5.2: Map of Edo State showing Ikpoba-Okha Local Government Area

Table 5.1: Coordinates of Sampling Points

Environmental Media	Code	Latitudes (N)	Longitudes (E)
Soil and vegetation (Plant)	SVI	6.070327	5.65339
	SV2	6.06962	5.65458
	SV3	6.069148	5.65662
	SV4	6.066588	5.65259
	SV5	6.056712	5.65458
	SV6	6.064836	5.65690
	SV7	6.061973	5.65229
	SV8	6.062309	5.65438
	SV9	6.063051	5.65630
	SV10	6.071461	5.65201
	SV11	6.068426	5.65833
	SV12	6.063368	5.65758
Soil &Vegetation (Pipeline Route)	SVI	6.12096	5.65514
	SV2	6.11495	5.655391
	SV3	6.10768	5.655391
	SV4	6.09967	5.65589
	SV5	6.08665	5.65589
Water and Sediment	WS1	6.06846	5.65829
	WS2	6.05830	5.62290
	WS3	6.05355	5.66343
	WS4	6.05386	5.65758
	WS5	6.11495	5.655391
	WS6	6.11495	5.655391
	WS7	6.1 1495	5.655391
	WS8	6.11495	5.655391
	WS9	6.05352	5.61769
	WS10	6.05276	5.61673
Groundwater	GW1	6.070714	5.65258
	GW2	6.067556	5.65808
	GW3	6.064368	5.65188
Air Quality and Noise	AQ1	6.06204	5.06321
	AQ2	6.05526	5.61 164
	AQ3	6.05740	5.61281

	AQ4	6.05807	5.61326
	AQ5	6.06314	5.62362
	AQ6	6.06325	5.62540
	AQ7	6.05334	5.61176
	AQ8	6.0473	5.61021
	AQ9	6.05830	5.62290
	AQ10(control)	6.06842	5.66046

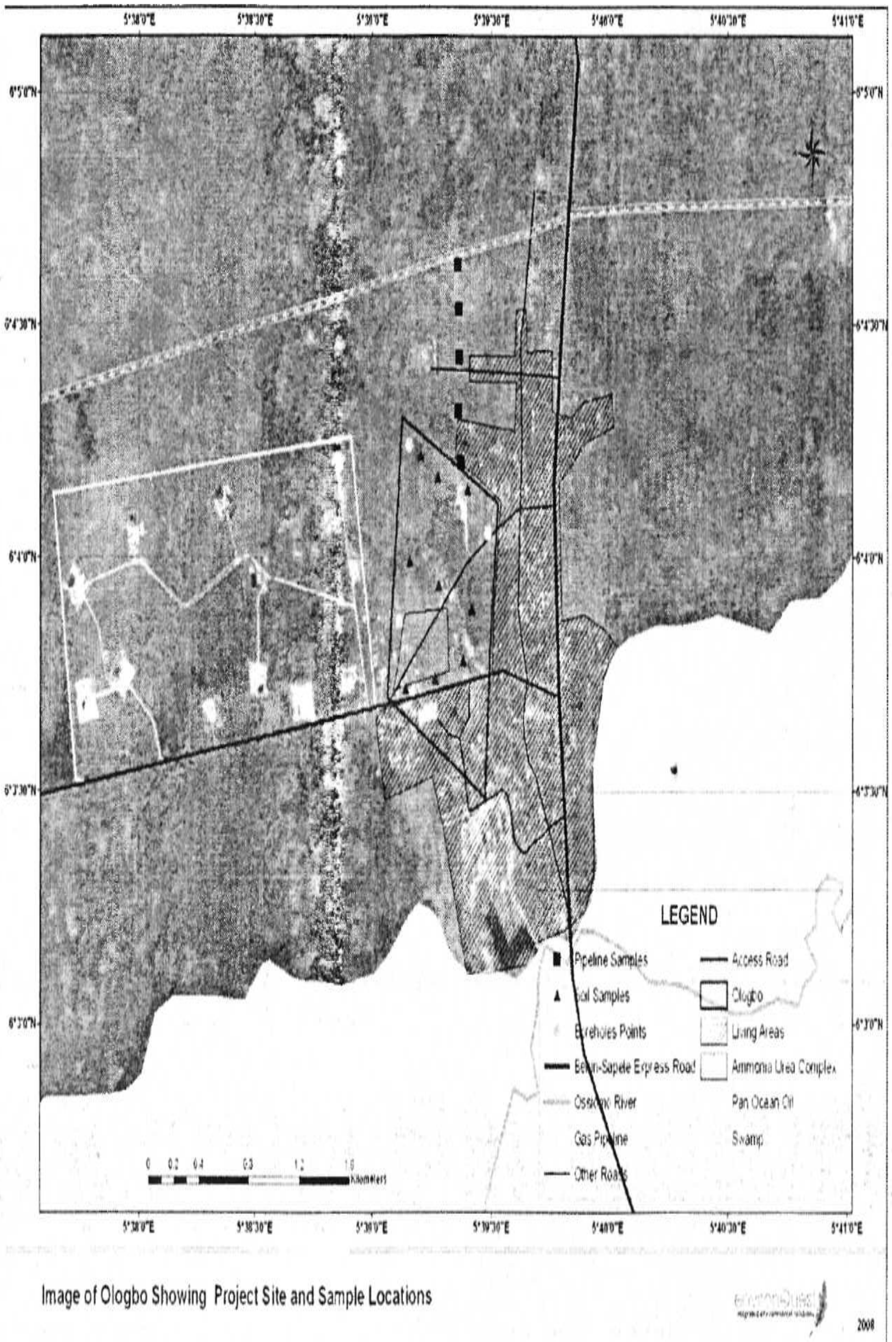


Figure 4.2: Map of study area showing sampling stations (air quality, noise, soil, vegetation, ground and surface water)

5.3 ENVIRONMENTAL BASELINE

5.3.1. CLIMATE AND METEOROLOGY

The climate is an equatorial bimodal system with an alternating wet and dry season influenced by its proximity to the Atlantic Ocean, wind patterns and sunshine. The area is dominated by two major air masses: the warm and dry topical continental air mass from the Sahara (harmattan wind) in the dry season months (November to February), and the humid tropical maritime air mass from the Atlantic Ocean (South-Westerly Monsoon winds). The two air masses are separated by a zone called the inter-tropical discontinuity zone (ITDZ). Oscillation of the ITDZ brings about the variations in the weather and climatic conditions in the project area.

Rainfall

The study area is characterized by high rainfall due to its proximity to the coast of the Atlantic Ocean and its dominating influence on the tropical maritime air mass and the associated southwesterly monsoon winds. Meteorological data for the' period 1996 to 2006 shows that July has the highest mean rainfall (403.0 mm) while the month of January recorded the lowest (17mm). Double maxima rainfall with peaks in July and September occurs in the Project area.

Temperature

Temperature in the Project area is influenced by the sun, wind regime and nearness to the Atlantic Ocean. The annual temperature cycle is characterized by two peaks and two minima. The annual high temperature occurs in March/April while the annual low occurs in November/December. A seasonal cooling trend coincides with the peak of the rainfall. Mean monthly temperature value ranges between a minimum of 25.3°C and maximum of 28.2°C, while relative humidity is high throughout the year, with cloud cover. The high relative humidity is due to the proximity of the area to the ocean.

Table 5.2: Mean monthly meteorological data for Benin (1996-2006)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean Monthly Temp °C	26.8	27.5	28.2	27.9	27.6	26.6	25.3	25.4	25.8	25.5	27.7	27.6
Mean Rel. Humidity %	80	83	82	82	83	87	91	90	90	92	83	78
Mean rainfall (mm)	17	25	103	141	212	254	403	336	369	251	46	25

Source: NIMET 2006

Wind

The wind pattern follows the movement of the ITDZ. During the wet season, the most dominant wind directions are westerly and the southwesterly, and is usually moisture bearing. In the dry season months, the dominant wind is easterly and northeasterly. The wind speed is slightly higher in the wet season when the southwesterly wind is active than in the dry season.

Table 5.3: Mean month wind speed (knots) over the study area

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002	2.6	3.8	3.8	4.1	4	3.2	3.2	4.3	3.7	3.9	4.2	3.4
2003	2.3	3.7	4.1	4.4	4.5	4.1	_	_	3.9	_	3.5	3.4
2004	2.9	3.8	5.2	4.9	4.4	3	3.5	4.1	3.9	_	4.2	3
2005	2.7	3.6	5.2	4.8	4.4	2.9	3.2	41	3.9	-	4.1	3

Source: Federal Department of Meteorological Services

5.3.2 Ambient Air Quality

The mean concentration of pollutant gases within the study area is presented in Table 4.4. The values measured for were lower than the national ambient air quality standard. PM values were higher in the dry season compared to the wet season. The lower value recorded in the wet is attributed to the high relative humidity which reduces the residence time of PM in the air (Oguntoyinbo 1992). In terms of seasonal variation, no significant difference was observed in the readings of the two seasons in most parameters observed. The high value of THC observed in sampling station 8 could be attributed to the hydrocarbon emission from the adjacent PanOcean facility and the NPDC flow station about 3KM and 5KM from the Ossiomo site, respectively. The observed values for CO could be due to vehicular emissions and bush burning.

Table 5.4: Mean ambient air quality around the Project area

Station	Dry Season					Wet Season				
	THC (µg/m³)	CO (ppm)	SOx (ppm)	NOx (ppm)	PM (µg/m³)	THC (µg/m³)	CO (ppm)	SOx (ppm)	NOx (ppm)	PM (µg/m³)
AQI	1.06	1.36	0.03	0.07	67.80	1.10	1.20	0.03	0.07	67.80
AQ2	ND	1.60	0.01	0.01	49.70	0.92	1.50	0.01	0.01	52.50
AQ3	0.8	2.30	0.01	0.02	53.80	0.65	2.00	0.01	0.01	50.85
AQ4	0.4	1.00	0.01	0.02	68.40	0.40	0.85	0.01	0.02	68.40
AQ5	ND	1.00	0.01	0.01	53.10	0.35	1.10	0.01	0.01	55.75
AQ6	0.7	1.20	ND	ND	68.10	0.60	1.20	0.01	0.01	65.40
AQ7	1.1	1.50	0.01	0.03	73.40	1.10	1.00	0.02	0.01	70.30
AQ8	1.9	3.80	0.02	0.04	103.00	2.10	2.75	0.01	0.03	98.50
AQ9	1.1	1.60	0.02	0.03	87.40	1.10	1.60	0.02	0.03	87.40
Control	2.8	2.70	0.03	0.06	115.30	2.80	2.70	0.03	0.06	78.52
NAAQS	160	11	0.1	0.04	250	160	11	0.1	0.04	250

NAAQS = National Ambient Air Quality Standard

Noise

Ambient noise levels were measured within and around the project site using Quest Technologies Sound Meter QS7200 to record the equivalent continuous noise levels(Leq). The mean ambient noise values ranged from 43.22 - 69.6 dB(A) for the dry season and 41.6 - 68.5 dB(A) for the wet season (Table 4.5).

Table 5.5: Mean noise level in the project area

Station	Dry Season (dB(A))	Wet Season (dB(A))	NAAQS*
N - 1	47.7	48.2	8 hour/90 dB(A)
N-2	43.2	41.6	6 hour/92 dB(A)
N-3	44.5	45.1	4 hour/95 dB(A)
N - 4	54.3	52.1	2 hour / 100dB(A)
N-5	53.8	53.1	1 hour / 105dB(A)
N-6	59.4	61.2	
N - 7	51.3	48.4	
N - 8	68.1	68.5	
N-9	63.2	60.2	
N- 10	69.6	66.9	

5.3.3 Geology and Hydrogeology

Geology

The various formations in the geology of Edo State are the Benin, Bende Ameki, Ogwashi-Asaba, Imo and Nsukka. The geology of the project areas is characterized by deposits laid during the tertiary and cretaceous periods. The area is underlain by sedimentary rock constituting part of the Benin formation which is made up of over 90% massive, porous, coarse sand with clay/shale interbeds having high groundwater retention capacity. Soil particles vary from coarse grained to fine grained in some areas, poorly sorted, sub-angular to well rounded particles with lignite streaks and fragments.

Hydrogeology

The Project area conforms to a typical basin hydrology. The groundwater is recharged by infiltration from rainfall and neighboring surface water body (River Ossiomo). Consequently the groundwater rises during the wet season and drops in the dry season. The lithology of the monitoring borehole (BH) revealed that the surface formation (topsoil) to a depth of 1.5ft is predominantly sand. The sand fraction overlies silty clay material of about 9 ft. The silty clay material is underlain by sand which becomes coarser with increasing depth as the water bearing zone is reached. The aquifers were all unconfined and shallow.

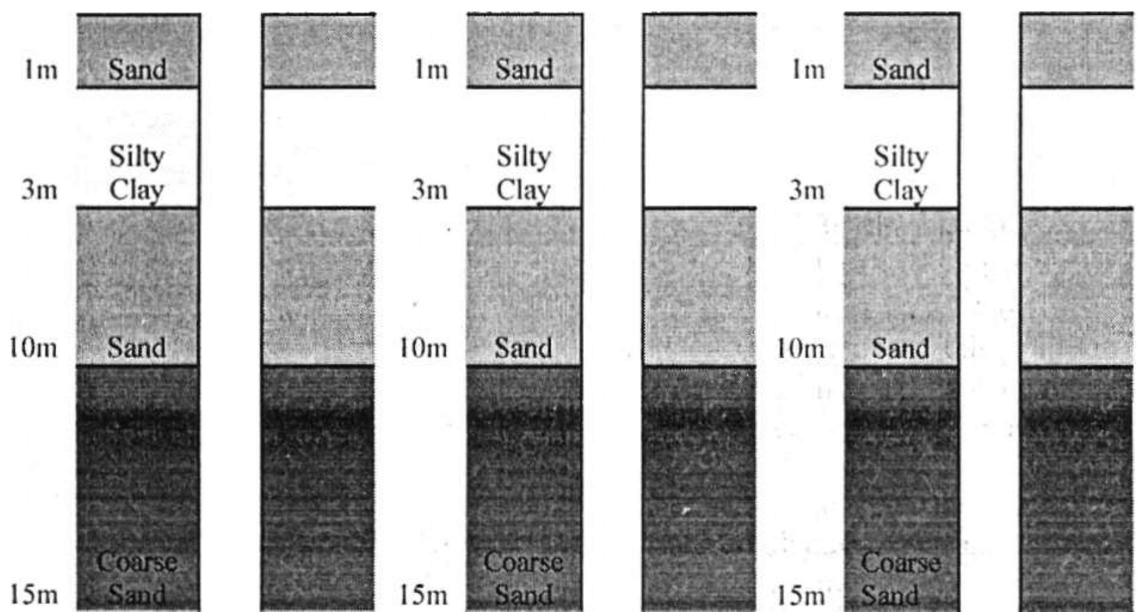


Figure 5.4: Borehole Logs

The static water pressure in the boreholes showed that groundwater flows in south-west direction.

5.3.4 *Groundwater Quality*

Groundwater physico-chemical data is presented in Table 4.6. The pH of the groundwater is acidic over the two seasons, with higher values in the wet season (mean = 5.37) than in the dry season. The turbidity of the water is higher in the wet season compared to the dry season with mean concentrations of 5.98 NTU and 3.65 NTU respectively. Total dissolved solids (TDS) were within the FMEH&UD limits though higher in the wet season than the dry season. This may be attributed to increase in the water table and subsequent dilution of the groundwater. Electrical conductivity values were higher in the wet season with a mean of 99.93µScm-1 than in the dry season (56.46µScm-1).

The oxygen parameters, particularly biological oxygen demand (BOD_5) were lower in the wet season compared with the dry season. Dissolved oxygen was within regulatory limit. The concentration of total hydrocarbon content (THC) was generally low, indicating that there is no organic contamination of the groundwater aquifer. The total petroleum hydrocarbon content (TPH) was below detection level in the groundwater samples. There is no evidence of hydrocarbon contamination in groundwater. Heavy metals concentrations in the groundwater indicated that toxic metals (Pb & Cr) were very low and in BH3 was not detected at all. All the metals fell are within permissible limits (WHO 1971). The coliform content of the groundwater were low.

Table 5.6.: Mean physio-chemical characteristics of groundwater in the dry and wet seasons

1. Parameters	Dry Season				Wet Season				l-'KI'A Limits
	GVVI	GW2	GW3	Mean	GW1	GW2	GW3	Mean	
pH	4.2	4.8	4.6	4.53	5.58	5.42	5.1	5.37	6.5-8 5
E/Cond. (µS/cm))	49.03	46.24	74.12	56.46	98.2	109.5	92.1	99.93	na
TDS(mg/l)	25.99	12.1	24.72	20.94	79.3	79.3	79.3	79.3	500 mgl^{-1}
TSS(mg/l)	3	4.2	3.16	3.45	5.62	5.62	5.62	5.62	10mgl^{-1}
Turbidity (NTU)	2.94	3.9	4.12	3.65	5.1	4.64	8.2	5.98	1.0mgl^{-1}
HCO_3^- (mg/l)	<0.01	<0.01	<0.01	<0.01	0.12	0.24	0.12	0.16	2.
DO(mg/l)	6.6	5.2	4.3	5.37	4.7	5.6	4.85	5.05	7.5 mgl^{-1}
BOD5(mg/l)	4.1	5	4.1	4.4	2.6	2.12	2	2.24	0mgl^{-1}
Cl- mg/l)	16.66	15.42	17.28	16.45	10.6	22.45	14.3	15.78	3.
S04 (mg/l)	2.94	3.02	3.15	3.04	4.26	8.52	9.6	7.46	50 mgl^{-1}
NH_3 (mg/l)	0.11	0.26	0.22	0.2	0.34	0 .18	0.42	0.31	<1.0 mgl^{-1}
NO_3 (mg/l)	0.39	42	51	31.13	0.28	0.28	0.28	0.28	10 mgl^{-1}
Total PO_4 (mg/l)	0.02	0.95	0.02	0.33	0.01	0.32	0.15	0.16	5 mgl^{-1}
Alkalinity (mg/l)	<0.01	<0.01	<0.01	0.01	0.01	12.1	0.01	4.04	n.a
Hydrocarbon	4.	5.	6.	7.	8.	9.	10.	11.	12.
THC (mg/l)	0.12	0.07	0.05	0.08	0.05	0.09	0.1	0.08	0.05 mgl^{-1}
Metals	13.	14.	15.	16.	17.	18.	19.	20.	21.
Na (mg/l)	12.65	10.65	10.6	11.3	4.23	10.25	7.82	7 43	200 mgl^{-1}
K^+ (mg/l)	6.32	5.36	4.85	5.51	3.74	6.78	4.72	5.08	22.
Mg^{2+} (mg/l)	1.45	1.72	2.4	1.86	0.92	0.78	0.82	0.84	23.
Ca^{2+}(mg/l)	13.26	12.64	11.92	12.61	5.16	5.16	5.16	5.16	24.
Cu (ppm)	0.01	0.01	0.05	0.02	0.01	0.01	0.02	0.01	0 1 mgl^{-1}
Zn ppm)	0.43	0.38	0.51	0.44	0.1 1	0.09	0.15	0.12	5.0 mgl^{-1}
Fe (ppm)	1.55	0.58	0.55	0.89	0.18	0.12	0.1	0 13	1.0 mgl^{-1}
Cd (ppm)	<0.0l	<0.01	<0.0I	<0.01	0.01	0.02	0.01	0.01	0.01 mgl^{-1}
Ni (ppm)	<0.00I	<0.001	0.001	<0.00I	0.02	1.02	2 02	1.02	0.05 mgl^{-1}
Pb (ppm)	0.01	0.01	0.01	0.01	0	0	0.01	0	0.05 mgl^{-1}
Cr (ppm)	<0.01	0.01	<0.01	<0.01	0.02	0.75	0.09	0.29	25.
Microbiology	26.	27.	28.	29.	30.	31.	32.	33.	34.
THB (cfµ/ml) x10^4	1.71	1.25	1.4	1.45	1.12	1.05	1.15	1.11	35.
THF (cfµ/ml) x10^2	0.32	0.2	0.25	0.26	0 11	0.12	0.34	0 19	36.
Coliform	0.2	0.15	0.12	0.16	0.14	0.12	0.18	0.15	0mgl^{-1}

	Dry Season		Wet Season		Limits
Na (mg/l)	3.45	2.14	2.82	2.25	200 mgl^{-1}.
K^+ (mg/l)	1.72	1.45	1.40	1.34	
Mg^{2+}(mg/l)	0.59	1.62	0.52	0.70	
Ca^{2+} (mg/l)	1.74	1.72	1.12	1.31	
Cu (ppm)	0.01	0.01	0.01	0.01	0.1 mgl^{-1}

Table 5.7: Mean physio-chemical characteristics of surface water in the dry and wet seasons

Zn (ppm)	0.07	0.03	0.07	0.03	5.0 mgl^{-1}
Fe (ppm)	0.15	0.16	0.14	0.12	1.0 mgl^{-1}
Cd (ppm)	• 0.01	• 0.01	• 0.01	• 0.01	0.01 mgl^{-1}
Ni (ppm)	0.02	0.01	0.02	0.01	0.05 mgl^{-1}
Pb (ppm)	<0.0I	<0.01	<0.01	<0.0I	0.05 mgl^{-1}
Cr (ppm)	0.01	0.03	0.01	0.03	
Microbiology					
THB (cfμ/ml) $x10^4$	2.20	2.69	1.80	2.30	
THF (cfμ/ml) $x10^2$	0.26	0.31	0.45	0.52	

5.3.5 Sediment Physico-chemistry

Textural Composition

Figure 5.3 presents the result of the grain size analysis of sediment samples, withsand being the most prevalent (with 63% frequency of occurrence) over the two seasons. The textural composition showed that the sediment is dark grey sandy clay.

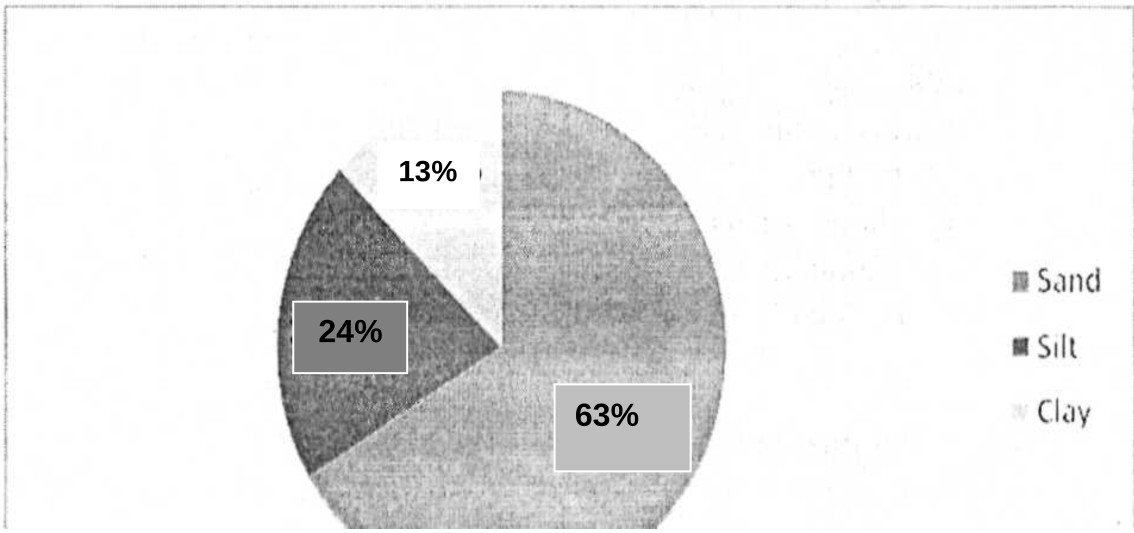


Figure 5.5: Textural variation of the sediment from study area

Chemistry

The pH of the sediment samples is acidic with mean seasonal values of 4.2 - 4.5 for R. Ossiomo and 4.1 -4.2 for R. Agba respectively. Acidic pH has the tendency to reduce fish population and decrease biodiversity. The concentrations of organic matter content expressed as Total Organic Carbon (TOC) was high in the sediment samples while nitrogen and total phosphorus (P) were equally high over the two seasons (Table 4.8).

Heavy Metals

The concentrations of the metals were low and within regulatory limit while chromium and vanadium were not detected. The Zn levels in the dry and wet seasons were 0.61 mg/kg and 0.68 mg/kg respectively for River Ossiomo while iron content was 1.24 mg/kg and 1.15 mg/kg. The values obtained may be due to faeces and animal dung that flow into the water. Bryan (1971) documented that the introduction of sewage into receiving water body may result in increased level of iron in the water body. Other heavy metals were recorded in trace amount.

Hydrocarbon Contents

The total petroleum hydrocarbon (TPH) was below detection limit in the sediment samples. Microbiological characteristics of sediments sample. The total heterotrophic bacteria (THB) in the sediment were 2.2 x 10s and 1.8 x 105 cfμ/g for R. Ossiomo for both seasons while R. Agba recorded higher values. Microbial isolates include Achromobacter sp, Escherichia sp, Enterobacter sp, and Achromobacter sp.

Table 5.8: Summary of physicochemical characteristics of sediment

Parameters	**Dry Season**		**Wet Season**	
	R. Ossiomo	**R. Agba**	**R. Ossiomo**	**R. Agba**
PH	4.2	4.1	4.5	4.2
E/Cond. (μS/cm))	37.5	32.38	21.85	37.5
TOC %	8.4	3.17	5.7	8.4
CP mg/kg)	10.87	13.33	11.21	10.87
$S0_4$ (mg/kg)	24.0	18.64	25.42	22.1
NH_3 (mg/kg)	0.37	0.27	0.42	0.31
$N0_3$ (mg/kg)	26.51	18.43	26.8	23.2
Total P04 (mg/kg)	39.2	22.1	34.35	24.3
Total hydrocarbon content (mg/kg)	0	0	0.1	0
Metals	37.	38.	39.	40.
Na (mg/kg)	4.45	3.16	3.72	3.15
k+ (mg/kg)	2.71	2.35	2.14	2.1
Mg^{2+}(mg/kg)	1.69	1.62	1.78	0.59
Ca^{2+} (mg/kg)	1.74	1.72	1.12	1.74
Cu (ppm)	0.12	0.01	0.01	0.12
Zn ppm)	0.61	0.03	0.68	0.07
Fe (ppm)	1.24	0.16	1.15	0.24
Cd (ppm)	0.01	<0.01	O.01	0.01
Ni (ppm)	0.02	0.01	0.02	0.02
Pb (ppm)	0.01	<0.01	<0.01	<0.01
Microbiology	41.	42.	43.	44.
THB (cfμ/ml) x105	2.2	2.69	1.8	2.3

5.3.6 Soil Studies

The texture and grain size distribution of topsoil and subsoil did not show any marked difference over the two seasons. Topsoil is brown and silty with traces of decaying plant matter for both seasons. The predominant texture is loamy sand with high porosity and permeability which encourages easy percolation into groundwater. The grain size analysis showed that sand aggregates predominates in both top and subsoil with mean value of 66.4% (Figure 4.5).

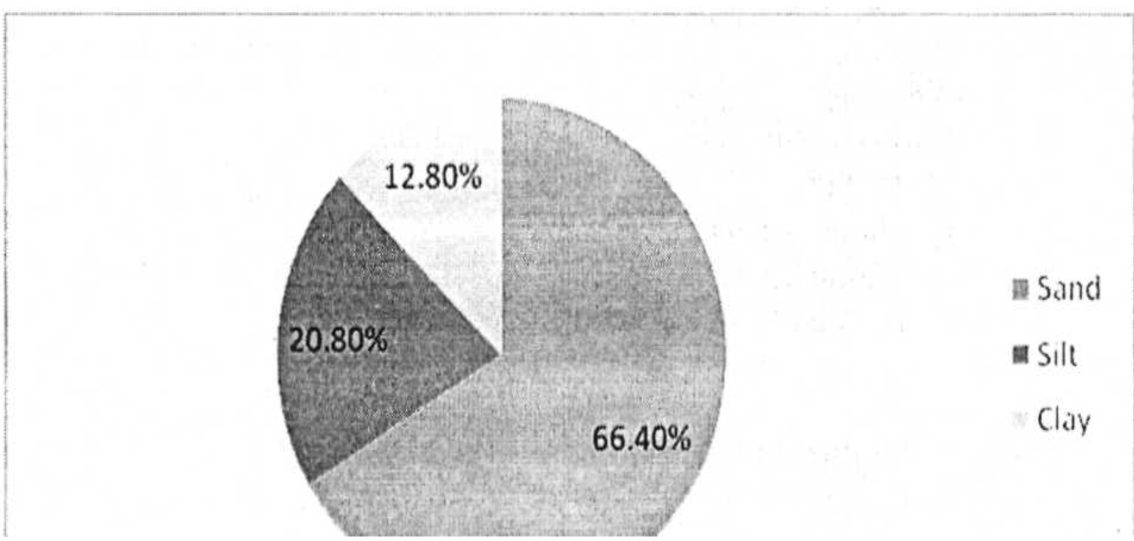


Plate 5.5: Soil texture in the study area

The physico-chemical characteristic of soil in the study area is presented in table 4.9. The pH of the soil ranged from 6.8-6.9 for topsoil and subsoils within the project area while the mean pH for soil along the pipeline route is 6.7 and 6.8 for wet season and dry season respectively. The soil within the area is slightly alkaline. The organic carbon ranged from

2.3 - 3.5% for the topsoil and the subsoil during the dry season and 2.4 to 2.9 % during the wet season. The high observed along the pipeline route during the dry season could be attributed to better aeration that encourages organic matter mineralization.

Total nitrogen content of the soils ranged from 21 - 25.3 % in the dry season compared to the wet season 22.1 - 26.5%. These values are within values obtained for normal agricultural soils. The available phosphorus content of the soil is also normal for agricultural soils. Among the exchangeable cations (Na, K, Ca, Mg), Na content is higher with mean values of 14.3 and 15.1 mg/kg for topsoil and subsoil respectively. The mean Na value recorded for the pipeline route is higher in the dry season (13.3 mg/kg) than the wet season (12.7 mg/kg). The higher values may be attributed to high evapo-transpiration which deposits the metals on the soil surface as the water evaporates. Potassium (K) values showed the same seasonal distribution pattern as sodium. Calcium values (range 4.0-4.8 mg.kg) are considered low for optimum crop production.

Heavy Metals

Seasonal concentration recorded for iron (Fe) was high compared with other heavy metals for topsoil (13.9 mg/kg), subsoil (12.2 mg/kg) and pipeline route (13.5 mg/kg). Heavy metals content were generally low for both seasons.

Microbiology

The total heterotrophic bacteria count of the soil ranged from 1.2x 108 - 1.32x 108 in the dry season and 1.25xl08- 1.7 xlO8 cfµ/g in the wet season. The pipeline route recorded mean values of 1.8 x 108 and 2.1 x 108 for dry season and wet season respectively. Predominant heterotrophic bacteria in the area include Pseudomonas, Bacillus, Flavobacterium, Enterobacter and Clostridium.

Total Hydrocarbon Content

The total hydrocarbon contents of the soils in the Project area were low. The values obtained were less than 1.0 mg/kg. These low values indicated that the soil is not contaminated with petroleum hydrocarbon.

Table 5.9: Mean physiochemical characteristics of soils in the dry and wet seasons

Parameters	Dry Season			Wet Season		
	Topsoil (0-15c m)	Subsoil (25-S0cm)	Pipeline Route (150cm)	Topsoil (0-l5cm)	Subsoil (25-50cm)	Pipeline Route (150cm)
PH	6.8	6.9	6.8	6.9	6.8	6.7
45. TOC (%)	3.5	2.3	3.1	2.9	2.4	3.3
Total N (%)	25.3	21.9	25.9	26.5	22.1	24.5
Avail P	22.0	25.6	21.7	21.2	26.4	21.7
THC	0.2	0.2	0.2	0.2	0.1	0.2
TPC ppm	0.001	<0.001	<0.001	0.002	0.001	0.001
Na mg/kg	14.3	15.1	13.3	13.4	14.8	12.7
K mg/kg	6.4	5.4	5.9	6.8	5.2	6.1
Ca mg/kg	4.0	4.4	4.0	4.8	4.8	4.0
Mg mg/kg	5.6	4.8	5.4	6.2	5.1	5.3
Heavy Metals (mg/kg)						
Fe	13.9	12.2	13.5	12.8	12.6	13.6
Cr	0.2	0.1	0.3	0.4	0.1	0.4
Cu	1.0	1.1	1.1	0.9	1.2	1.1
Ni	0.2	0.2	0.2	0.3	0.1	0.2
Pb	0.4	0.3	0.5	0.5	0.2	0.6
Zn	1.0	2.4	1.1	1.1	2.1	1.2
Microbiology						
Total Bacteria xl08 cfμ/g	1.32	1.2	1.8	1.7	1.25	2.1
Total fungi x 104 cfμ/g	3.0	1.8	2.2	3.0	1.5	2.4

Land Use Pattern

Land use in the area is predominantly agricultural and bush fallow is extensively practiced. Agricultural productivity in the area is rainfall dependent thus the farming season is dictated by the amount of rainy days. Cropping, which is mostly mixed consists of crops like cassava, yam, pineapple, okra, tomato, banana, plantain and maize. Bush burning is usually employed for site clearing as it allows for the regeneration of green grass.

5.3.7 Vegetation

The plant communities in the Project area are typical rain forest, with three strata comprising trees, shrubs and herbaceous layers. There is a significant difference between the various plant communities studied in terms of composition and habit. The greater proportion of the study area is covered by bush fallow (Plate 4.1). The mean canopy height of the bush fallow vegetation is 20 m. The canopy is open and the scattered trees have wide spreading crowns. The commonest trees include Ceiba pentandra, Alstonia boonei, Anthocleista vogelii and Elaeis guineensis (Table 4.10). Shrubs include species such as Baphia nitida, Alchomea cordifolia and Harungana sp. The herbaceous layer is covered by many weeds but dominated by guinea grass (Plate 4.1). The second plant community consists of the wetlandvegetation represented by the riparian vegetation along the River Ossiomo. The dominant species found along the floodplain include Anthocleista vogelii, Berlina grandifoliola, Raphia hookeri, Hallea ciliata, Combretitm sp, Alchomea cordifolia, Ceiba pentandra.

Plate 5.6: Vegetation in the project area

brasiliensis) tree and Gmelina plantations. Arable crops planted include cassava, fluted pumpkin, Celosia, maize, pepper and okra. Common weeds include Panicum maximum, Ageratum conyzoides, Pennisetum sp, and Scoparia dulcis.

Economic trees in the project area include rubber {Hevea brasiliensis) and Gmelina {Gmelina arborea) (Plate 4.2). The survey reveals that a portion of the study area was once devoted to the cultivation of Gmelina and rubber trees. Only parts of these once extensive plantations remain due to management issues and parasitic invasion by the Loranthaceae family.

Plate 5.7: Economic important species in the project area

Table 5.10: Composition of trees and shrubs at the proposed site (dry and wet season).

Family	Scientific Names	Habit	% Frequency	Life-form
Euphorbiaceae	Alchomea cordifolia	Shrub	18	Nanophanerophyte
Asteraceae	Chromplaena odorata	Shrub	85	Therophyte
Hippocraleaceae	Hippocralea pal/ens	Shrub	9	Microphanerophyte
Icanciniaceae	Icacinia trichantha	Shrub	5	Geophyte
Fabaceae	Baphia nilida	Shrub	8	Microphanerophyte
Gutti ferae	Harungana sp.	Shrub		Nanophanerophyte
	Glyphaea b re vis	Shrub	3	Nanophanerophyte
Connaraceae	Cnestis ferraginea	Shrub	8	Nanophanerophyte
Rubiaceae	Mitracarpus villas us	Shrub	1	Therophyte
	Alchornea laxiflora	Shrub	10	Nanophanerophyte
	Mallolits oppositifolius	Shrub	8	Nanophanerophyte
	Diodia scantier)	Herb	18	Therophyte
Sterculiaceae	Waltheria indica	Herb	2	Therophyte
Tiliaceae	Triumfelta cordifolia	Herb	3	Therophyte
Poaceae	Paspalum maximum	Herb	4	Hemicryptophyte
	Sclera verrucosa	Herb	6	Hemicryptophyte
	Pennisetum piirpnreum	Herb	2	Hemicryptophyte
	Bambusa vulgaris ,	Herb	2	Hemicryptophyte
Uimaceae	Trema orientalis	Tree	2	Microphanerophyte
Bignoniaceae	Newbouldia laevis	Tree	3	Microphanerophyte
	Albizia zygia	Tree	15	Mesophanerophyte
Moraceae	Musanga cecropioides	Tree	2	Mesophanerophyte
	Myrianlhus arboreus	Tree	1	Mesophanerophyte
Apocynaceae	Rauvolfia vomitoria	Tree	6	Microphanerophyte

	Voacanga africana	Tree	1	Microphanerophyte
Arecaceae	Elaeis guineensis	Tree	5	Mesophanerophyte
	Manniophyton fulvtim	Climber	7	Nanophanerophyte
Loganaceae	Anthocleista vogelli	Tree	3	Mesophanerophyte
Smilacaceae	Smilax kraussiana	Climber	3	Geophyte
	Calamus decratus	Climber	1	Climber
Combretaceae	Combretum racemosum	Climber	4	Nanophanerophyte
Poaceae	Paspalum conjugatum	Creeper	10	Creeper
Melastomataceae	Heterotis erecta	Creeper	15	Creeper
Commelinaceae	Commelina erecta	Creeper	5	Creeper

Table 5.11: Population density of key economic tree species

Scientific Name	**Common Name**	**Population Density**
Gmelina arborea	Gmelina	500±15
Hevea brasiliensis	Rubber tree	14±5
Alstonia boonei	Stool wood	9±6
Nauclea diderrichii	Opepe	16±5
Elaeis guineensis	Oil palm	43±17
Bombax buonoposenze	Red silk tree	7±4
Raphia hookeri	Wine palm	2000±25
Symphonia globulifera		12±4
Anthocleista vogelli	Cabbage tree	9±3
Tectonia grandis	Teak	36±8

Pycnanthus angolense		9±5
Musanga cecropioides	Rain tree	8±4
Myrianthns arboreus		16±6

5.3.8 Biological Resources

Phytoplankton flora

Phytoplanktons are minute plants drifting at the mercy of the surface currents on which other aquatic creatures depend for their living. Eleven species of phytoplankton in three divisions were encountered during sampling; these are Bacillariophyta (diatoms), Chlorophyta (Green algae) and the Cyanophyta (blue green algae). These groups were represented by 5, 4, and 2 species respectively. Table 4.12 shows the diversity, relative abundance and spatial distribution of the flora at the sampling stations. The bulk of the algae population (48%) is made up of bacillariophyta (diatoms). There was no systematic spatial trend in the number of species at the different stations; species richness index was generally high at all the stations.

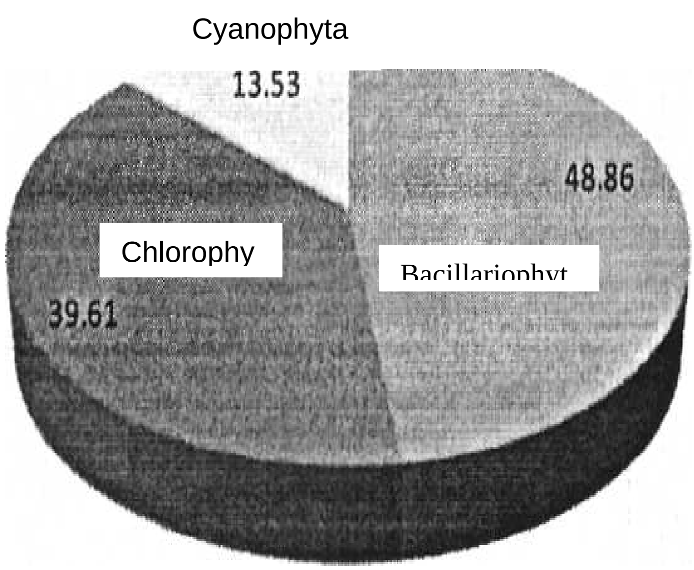


Figure 5.6: Abundance of phytoplankton in the water bodies of the study

The total amount of phytoplankton in the water also known as the "standing stock" was moderate. Like all plants, phytoplankton contains chlorophyll, so the amount of chlorophyll in the water is a good indication of the amount of phytoplankton. In general, the biomass of photosynthetic pigments was high across the sampling stations. On the average the concentrations of chlorophylls was 38.65 mg/m^3 Total chlorophyll was dominated by chlorophyll c, thus reflecting the dominance of diatoms in the Dora

Table 5.12: Species composition, distribution and relative abundance of phytoplankton

Taxonomic List	Dry Season		Wet Season		Total
	R. Ossiomo	R. Agba	R. Ossiomo	R. Agba	
Bacillariophyta					
Aulacoseira gramdala	5	2	6	5	18
Coscinodiscus lineata	1	5	5	4	15
Navicula radiosa	6	4	4	6	20
Nitzschia agnewii	8	6	0	0	14
Surrirela elegans	9	7	5	9	30
Chlorophyta					
Closterium rostratum	6	8	9	5	28
Penium sp	4	4	5	6	19
Spirogyra sp	3	4	4	4	15

Vol vox africana	5	6	4	5	20
Cyanophyta					
Anaebania sp	4	4	3	5	16
Oscillatoria orndta	2	0	5	5	12
Abundance	53	50	50	54	207
Species number(S)	11	10	10	10	
Margalef s Diversity index (D')	1.75	0.94	0.94	1.93	

Zooplankton fauna

Zooplankton of inland waters derives its membership mainly from the Protozoa, the Rotatoria, the Cladocera, and the Copepoda. In addition, there are occasional minor elements contributed by ostracod crustaceans, water mites, larval mollusks, mysid crustaceans and the larvae of insects. 15 species of zooplankton, which consist of Crustaceans and the Rotifera, were observed in the water body of the study area (Table 4.13). The dominant were crustaceans made up of the cladocera and copepods. Cladocera were represented by eight (8) species, while the Copepods and Rotifers were represented by five (5) species respectively. The Crustacean plankton accounted for 71% of the total population of the zooplankton while the Rotifera constituted the remaining 29%.

Table 5.13: Specie composition, distribution and relative abundance of zooplankton

Taxonomic List	Dry Season		Wet Season		Total
	R. Ossiomo	R. Agba	R. Ossiomo	R. Agba	
Copepoda					
Tropodiaptomits laurentii	2	0	1	1	4

Ectocyclops compaclus	5	1	0	2	8
Eucyclops serrulatus	4	2	2	3	11
Macrocyclops albidus	6	1	2	0	9
Microcyclops varicans	2	4	0	2	8
Cladocera					
Bosmina longirostris	1	1	2	0	4
Alona affinis	5	0	2	0	7
Alona bukobensis	4	1	0	1	6
Alona eximia	0	2	0	1	3
Alona holdeni	0	3	0	2	5
Alona verrucosa	1	2	1	0	4
Chydorm sp	2	1	4	2	9
Kurzia longiroslris	2	0	5	0	7
Rotifera					
Brachionus caudatus	1	2	2	2	7
Brachionus calyciflorus	4	1	2	0	7
Brachionus diversicornis	5	2	0	1	8
Brachionus falcalus	0	5	0	2	7
Epiphanes macroura	1	4	1	0	6
Abundance	45	32	24	19	120
Species number(S)	15	15	11	11	
Margalefs Diversity index (D')	1.45	0.92	0.88	0.9	

Macrobenthic invertebrate fauna

Macrobenthos are organisms that are either wholly or partly attached to the riverbed. They include a diverse assemblage of plants and animals whose distribution is dependent upon many environmental variables i.e. physical, chemical and biological factors (Fagade & Olaniyan, 1973). The benthic ecosystem is a very important component of the aquatic ecosystem, because it assists in the degradation of the organic component that sinks to the sediment, as well as serving for monitoring the condition of the sediment whenever the environment is impacted. Due to their nature as slow moving or sessile animals they will either tolerate the pollution or die (Fagade 1971). A total of twenty (20) individuals were

Taxonomic List	Dry Season	Wet Season	Total

encountered during the study. These include Annelida, Insecta and Decapoda. The data shows that the community consists of diverse assemblage of macroinvertebrates, (Table 4.14). Spatial distribution of the species shows that both river bodies have high population density and species diversity.

Table 5.14: Specie composition and relative abundance of macrobenthic fauna in water bodies

	R. Ossiomo	R. Agba	R. Ossiomo	R. Agba	
Annelida					
Oligochaeta					
Eiseniella tetrahedra	2	1	0	1	4
Tubifex tubifex	1	1	0	1	3
Ilirudinca					
Helobdella pimotata I'meata	1	0	1	0	2
Insecta					
Colcoptcra					
Baetis sp	1	1	0	2	4
Cloeon bellum	0	1	1	2	4
Hydroporus sp	1	1	1	1	4
Diptera					
Chaoborus sp	0	2	2	1	5
Clinotanypus maculatus	2	1	0	0	3
Corynoneura sp	1	1	1	0	4
Cricolopus sp	1	0	2	1	4
Odonata					
Anisoptcra					
Ophiogomphus sp	1	1	2	1	6
Orthethrum cancellation	0	0	0	0	2
Oxygasler curtisii	0	1	2	0	4
Decapoda					
Caridina cifricana	1	0	1	2	5
Desmocaris trispinosa	1	2	2	3	8
Abundance	13	13	14	15	62
Species number(S)	11	11	10	10	
Margalefs Diversity index (D1)	1.25	1.25	4.85	4.85	

Wildlife

Mammals encountered in the study area include brush-tailed porcupine 9Atherurus africamis), squirrel, (Rufobrachium), black rat (Rattus rutins), three stripped mouse {Hbyomys trivirginatus) bush pig 9Potamochoerus larvatus). Reptiles observed include chameleons, monitor lizards, geckos and snakes. Amphibians observed include frogs and toads including the African tree frog. Birds observed include the Grey Heron (Ardea cinered), Cattle Egret (Bulbulcus ibis), Black Kite (Milvus migrans), Grey Kestrel (Falco ardosiaceus), and Palm-nut Vulture (Gypohierax angolensis). Seasonal changes were observed in the avifauna associated with the study areas. While mosl species seen during the dry season were still around there were a few notable absences. These included the Cattle Egrets (Bubulcus ibis), Bush Sparrow (Petronia dentata), Pin-tailed Whydah (Vidua macrura), and Tambourine Dove (Turtur tympanistria).

Plate 5.8: A Species of Bird in the Study Area Cattle Egret {Bulbulcus ibis)

5.4 Socio-economic Baseline Data

The objective of the socio-economic baseline survey conducted in April 2008 was to determine the socio-cultural, demographic and quality of life of the population around the Project site. Structured questionnaire interviews and group discussions were used primarily to obtain necessary information from households and other target groups. Other sources of information included similar studies, existing records in the local government and other public institutions.

5.4.1 Settlement Pattern

Ologbo is a border town located between Edo and Delta States, approximately 33km from Benin City (Figure 4.1). The three communities that make up Ologbo are Imasabo (hamlet), Oghobaye (small town) and Ologbo Central (small town). Neighbouring communities/small towns include Obayantor (Edo State) and Ugbenu (Delta State).

Ologbo central and Oghobaye are dispersed settlements while Imasabo is linear with houses along the access road. The communities are located within 10 kilometer of the Ossiomo industrial park. From Benin City, the communities are arranged in this order - Imasabo, Oghobaye and Ologbo Central with Imasabo being closest to Benin City.

5.4.2 Population

In Edo State, there are 264 settlements with 1,000-5,000 people and 70 settlements with 5,000- 20,000 people (NDDC, 2006). The even gender distribution of population in Ikpoba-Okha LGA reflects the State's population distribution. The total population of Ikpoba-Okha LGA is 371,106 (2006 Census). Projected population of the 3 communities are as follows ((NPC, 2001) :

Ologbo central	10,022
Oghobaye	5,000
Imasabo	299

5.4.3 Demography

Respondents interviewed during the survey were within ages 11-75years. 27.6% were below 30 years, 25% are within 31-40 years and 17.3% are above 60 years. Most members or head of households are within the working class. A larger proportion (69.2%) of the individual respondents were married, while 20.5 % were single, 2.6 % divorced and 7.7 % widowed. The study showed that Christianity was the predominant religion in the communities (79.4%) as expected of communities in the south-south zone. Table 4.15 shows the ethnic groups of respondents.

Table 5.15: Ethnic Background of Respondents

Tribes	%
Bini	35.7
Esan	4.5
Itsekiri	8.4
Igbo	5.2
Yoruba	3.2
Urhobo	14.9
Ijaw	0.6
Kwale	7.8
Others	19.5

5.4.4 Education

Educational level is one of the key determinants for measuring standard of living. The survey showed that indigenes have a relatively high literacy level (78%), with secondary education (51%), higher institutions (12%), and primary education (25%). The highest rate of literacy level was from Ologbo central while the least came from Imasabo.

5.4.5 Occupation

Majority (71.6%) of the residents are employed or self-employed (own business), 10.3% housewives, 9.6% students/apprentices, while about 4.5% are retired. About 3.2% were unemployed. Among those employed, sources of income include farming (59.1%), petty trading (18.8%) artisan jobs (14.8%), civil service (4.7%), fishing (1.3%) and other sources (1.3%). The predominant occupations are farming (59.1%), petty trading (18.8%) and artisan jobs (14.8%). The dominance of the informal sector has implications for income levels in the communities. This is because the informal sector is plagued by low productivity and low incomes. Recent studies in Nigeria and other parts of sub-Saharan Africa show that whereas the informal sector accounts for as high as around 75% of the employment, the sector accounts for only 25% of the income. Subsistence farming is practiced for household consumption and excess from produce sold to generate income. There are small-scale enterprises such as oil mill and garri processing (cassava product).

Plate 5.9: Farmer returning with produce **Plate 5.10 Palm kernel**

5.4.6 Current Local Income Levels

The survey showed that low income earners with average monthly income of less than N10,000 (US$65) were more. Income levels varied between males and females in the community. 59% of the respondents earned less than N10,000 (US$70) per month, 31.3% earned N10,000 - 40,000 (US$65 – 258). It was reported by respondents that average monthly expenses exceeds N10,000 (US$65) per month, indicating a relatively high cost of living in the area. Further analysis shows that a greater share of the income goes into food and transportation. Other expenditures from income include education, medical services, waste disposal and utilities like telephone, water, electricity etc.

5.4.7 Housing

Housing in the region is predominantly of poor quality. The walls of most (95%) of the houses in Imasabo were made of mud/mud brick (Plate 4.6). At Ologbo central, cement walls are more common (96%). The mean household size was 7; this suggests a fairly high household density. The average number of families in a house varied from 1 to 8 families, and average number of years respondents have lived in the area was 25 years. Majority (54.5%) of the respondents dwell in multiple room buildings ('face-me-face-you'), 35.7% in bungalow and 7.1% in flats. This is a reflection of the low socio-economic position of the local residents.

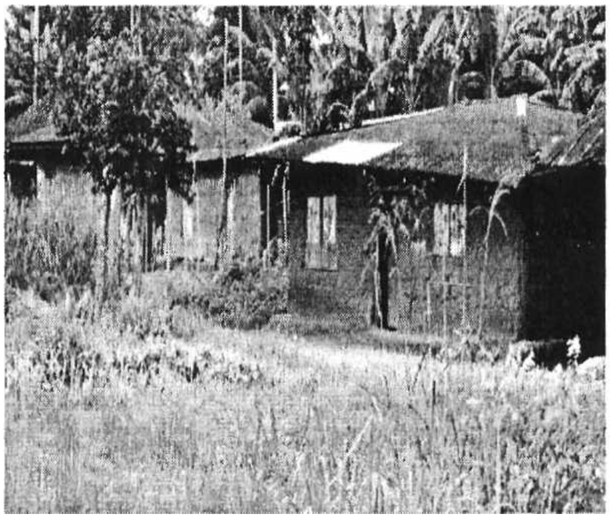


Plate 5.11: Typical Housing in Imasabo **Plate 5.12 NDDC borehole in the**

5.4.8 Water Supply & Sanitation

Drinking water sources reported by respondents include yard wells (45.4%), community wells (29.6 %), stream/river (5%), public tap (15.1%) and water vendors (5.3%). Access to safe water is not common with communities in the region - it is estimated that only 20- 24 % of rural communities have access to safe drinking water (NDDC, 2006). Nevertheless, the people seem to be satisfied with the quality of water as many (80%) reported no problems with water quality.

Poor access to adequate water facilities has had general implication for the general health environment, economic activity and sustainable livelihoods in the region sanitary facilities arc mostly pit latrine dues to the lack of adequate water supply. The communities lack proper drainage and flooding is common occurrence during the raining season. Refuse are usually disposed within compounds or burned (National Bureau of Statistics 2005).

5.4.9 Traditional& Historical Resources

Leadership

The Enogie a prince in the Benin Kingdom is the traditional head of Ologbo. He is assisted by the appointed chiefs 'Edionwere'. The community women -"Ikhwevbo" are headed by the Enogie's wife. Women rarely hold titles in the Benin Kingdom, but do have right to own farmlands.

The youths are organized into groups with leaders incorporated into a Community Relations Committee (CRC) which serves as a liaison with the community and promotes conflict resolution.

Festivals

Igwe festival is an annual thanksgiving rite performed by communities in the Benin Kingdom. The festival begins at the palace of the Oba of Benin before the other towns that are subjects to him. Igwe is the most popular and significant festival in Bini kingdom.

5.4.10 Health Problems & Facilities

Malaria, cholera, dysentery, typhoid, skin problems, diarrhea were the common health problems reported in the communities. Malaria accounts for most illness at 40% and is responsible for school absenteeism and low productivity at work. Occurrence of skin diseases, chicken pox and diarrhea among the respondents was very low. Ologbo central has a Primary Health Care centre with 8 beds, 5 nurses and a medical doctor who visits twice a week. The centre caters for the residents of the area but drugs are in short supply. There are also private clinics and maternity centers in the area. Cases requiring more sustained medical intervention are referred to the Benin General Hospital. The ratio of healthcare facility in the region is 1:9,800 covering 44Km^2.

The usage of healthcare facility is shown in Table 4.16. This preference shown by respondents, for private facilities (55.78%) is probably due to higher service quality from the private providers compared with state institutions which tend to be less equipped and less efficient. Very few people reported the use of traditional and religious centers for medical treatment.

Table 5.16: Respondents' Sources of health care

Health Facilities	%
Private Clinics	55.78
Public Facilities	31.98
Traditional Centre	2.04
Religious Centre	1.36
Others	8.84

5.4.11 Educational Facilities

Across the region, nearly all schools are in a state of disrepair, requiring major rehabilitation. Regional analysis shows a ratio of one school per 14,679 people and one school for every seven settlements. There is only one secondary school in Ologbo central, other communities have primary schools. Children in the Imasabo walk some distance to Oghobaye to attend school; this poor access to schools could impact human capital development and poverty alleviation, in the long term.

5.4.12 Energy

The communities are connected to the national grid, which provides power for about 90% of households. The usage of generator was not common. In the event of power outage, candles and kerosene lamps are the common lighting sources. Regional data shows that only 34% of people use electrical lighting while 61 % use kerosene lamp or lantern. Fuel wood and kerosene are the common energy sources for cooking. The primary energy source in the region is firewood (73%) followed by kerosene (24.8%) and gas (1.2%) (Federal Office of Statistics 2005)

5.4.13 Roads

Ologbo has good road network that transverse the various communities, the roads are in fair conditions. The major access road is currently being upgraded with drainages and culverts by NDDC at the Ologbo central axis.

5.4.14 Community Concerns and Expectation

There is high level of support for the Project by the host communities as majority of the respondents (93.4%) were favorably disposed to the siting of the ammonia-urea plant nearby.

Employment

The community expects that the Project will enhance their standard of living by providing job opportunities for indigenes, especially male and youths.

Infrastructural development

The communities expects as infrastructural development - potable water supply, improved power generation, good roads, industries, schools, equipment for mechanized farming, increased market for the farm products. They also believed that the Project would boost economic activities in the communities and bring about general development.

5.5 Waste Management

Wastes will be treated and disposed of according to an approved waste management plan. During the lifetime of the project, the wastes to be removed and disposed of during maintenance of the pipeline ROW would be overgrowth and illegally dumped wastes. Vegetation clearance will be performed four times a year by hand. No herbicides will be used. It is expected that local inhabitants would remove overgrowth debris resulting from maintenance activities for use as a fuel source. Nonetheless, provisions will be made for the management of this overgrowth debris, including possible accumulation and burning.
The storage and use of hazardous materials will be in accordance with Ossiomo Health, Safety and Environment (HSE) procedures and FMEH&UD regulation S. I. 15 - National Environmental Protection Management of Solid and Hazardous Wastes Regulations (1991). Their treatment and final disposal will be according to the Waste Management Plan, which will conform to local HES regulations. Chemicals that will be used include:

- lime,
- phosphoric acid,
- bleaching powder, and
- decolourant polyelectrolyte