



Shell Petroleum Development Company of Nigeria Limited
Operator for the NNPC/Shell/TEPN/AGIP Joint Venture

ENVIRONMENTAL IMPACT ASSESSMENT

OF

**SOKU GAS PLANT-SAN BARTH MANIFOLD PIPELINE
PROJECT**

(FINAL REPORT)

SEPTEMBER 2013



TABLE OF CONTENTS

	PAGES
Status Page	i
Table of contents	ii
List of Tables	vii
List of Figures	ix
List of Plates	xi
List of Abbreviations and Acronyms	xiii
List of Appendices	xv
Executive Summary	xvi
Acknowledgment	xxxix
List of EIA Preparers	xl

CHAPTER ONE

INTRODUCTION

1.1	Background	1
1.2	Scope and Objectives of the EIA	2
1.3	Legal and Administrative Framework	2
	1.3.1 Regulatory Agencies/Institutions	2
	1.3.2 National Legislation	3
	1.3.3 State Regulations	4
	1.3.4 International Agreements, Protocols and Conventions	4
1.4	Terms of Reference for the EIA	5
1.5	Declaration	6
1.6	Structure of the Report	6

CHAPTER TWO

PROJECT JUSTIFICATION

2.1	Project Background	7
2.2	Project Objectives	7
2.3	Need for the Project	7
2.4	Envisaged Benefits	8
2.5	Envisaged Sustainability	8
	2.5.1 Economic Sustainability	8
	2.5.2 Technical Sustainability	8
	2.5.3 Environmental sustainability	8
	2.5.4 Social Sustainability	8
2.6	Project Alternatives	9
	2.6.1 Overall Project Alternatives	9
	2.6.1.1 Option 1: No Project Option	9
	2.6.1.2 Option 2: Replacement of Existing Pipeline	9
	2.6.1.3 Option 3: Construction of Two Deeply-Buried and Water-Covered Pipelines	9
2.7	Estimated Value of the Project	9

**CHAPTER THREE****PROJECT DESCRIPTION**

3.1	Nature of the Proposed Project	10
3.2	Existing Facilities in Relation to the Proposed Pipeline	10
	3.2.1 Soku FS-Soku GP stretch	10
	3.2.2 Soku GP-Soku New San Barth Manifold	12
3.3	Concurrent Development	14
3.4	Proposed Project Activities	15
	3.4.1 Application Standards	15
	3.4.2 RoW Surveys/Land Acquisition	16
	3.4.3 Pipeline Construction	16
	3.4.3.1 Pipeline Route Survey / Land Acquisition	17
	3.4.3.2 Materials Selection	17
	3.4.3.3 Pre-mobilisation Inspection and Mobilisation	20
	3.4.3.4 Survey and Staking of Pipeline Routes	20
	3.4.3.5 Probing for existing Facilities	20
	3.4.3.6 Clearing and Grading	20
	3.4.3.7 Excavation, Trenching and Dredging	20
	3.4.3.8 Pipeline Coating	21
	3.4.3.9 Pipe laying	22
	3.4.3.10 Backfilling and Reinstatement (Re-vegetation)	22
	3.4.3.11 Special Crossings	23
	3.4.3.12 Construction of Pig Launchers/Receivers	24
	3.4.3.13 Construction and Installation of Protective Covering	24
	3.4.4 Commissioning and Operations	24
	3.4.4.1 Pigging and Hydro testing	24
	3.4.4.2 Operations/Maintenance	24
	3.4.5 Pipeline Safety (Cathodic Protection)	25
	3.4.6 Decommissioning and Abandonment	25
3.5	Waste Generation/Handling	26
3.6	Project Schedule	27

CHAPTER FOUR**BASELINE ENVIRONMENTAL CONDITIONS**

4.1	Biophysical Baseline Data Acquisition	28
	4.1.1 Desktop Research	28
	4.1.2 Field Sampling and Laboratory Methods	28
4.2	Socio-Economics Baseline Methodology	28
	4.2.1 Data Collection	28
	4.2.2 Data Analysis	30
4.3	Health Baseline Methodology	30
	4.3.1 Secondary Data Acquisition	31
	4.3.2 Qualitative Data Collection	31
	4.3.2.1 Group Interviews	31
	4.3.2.2 Key Informant Interviews	32

	4.3.2.3	Direct Observation	32
4.4		Biophysical Baseline Environmental Conditions	33
	4.4.1	Geomorphology/Topography	33
	4.4.2	Climate and Meteorology	33
	4.4.2.1	Insolation and Cloud Cover	33
	4.4.2.2	Wind	35
	4.4.2.3	Temperature	37
	4.4.2.4	Rainfall	39
	4.4.2.5	Relative Humidity	40
	4.4.3	Air Quality and Noise	42
	4.4.4	Soil Studies	46
	4.4.4.1	Soil Physical Properties:	46
	4.4.4.2	Soil Chemical Properties	47
	4.4.5	Vegetation and Biological Diversity of the Study Area	55
	4.4.6	Wildlife/Invertebrate Fauna	62
	4.4.7	Aquatic Studies	66
	4.4.7.1	Physio-Chemical Analysis Result of Surface Water in the Study Area	66
	4.4.7.2:	Aquatic Ecology	73
	4.4.8	Fish and Fisheries	88
	4.4.9	Hydrogeology	91
4.5		Socio-Economic Baseline	97
	4.5.1	Population and Socio-Demographic Characteristics	97
	4.5.1.1	Population Size, Growth and Distribution	97
	4.5.2	Livelihood Structures and Local Economy	103
	4.5.2.1	Occupation, Employment and Income Generating Activities in Project Area	103
	4.5.2.2	Household Expenditure and Consumption	108
	4.5.3	Natural resource acquisition, ownership and management	108
	4.5.3.1	Land Tenure, Use and Management	108
	4.5.4	Social Infrastructures and Services	110
	4.5.4.1	Educational Facilities	111
	4.5.4.2	Electricity and Power Supply	113
	4.5.4.3	Transportation and communication Facilities	114
	4.5.4.4	Potable Water Supply and Sanitation Facilities	114



	4.5.4.5	Housing Type, Pattern and Quality	117
	4.5.4.6	Healthcare Facilities	119
	4.5.4.7	Financial Organisations/Institutions	120
	4.5.5	Historical Perspective of the Communities and Cultural Properties	127
	4.5.5.1	Settlement/Community, History and ethnicity/Tribe	127
	4.5.5.2	Religion, Customs, Belief Systems and Heritage	131
	4.5.6	Local Governance, Social and Community Structure	136
	4.5.6.1	Traditional Administration /Power Structure	136
	4.5.6.2	Conflicts and Conflict Resolution in Project Communities	142
	4.5.7	People’s Perception, Fears and Expectations of the Project	142
4.6		Health Status	146
	4.6.1	Socio-Demographic Characteristics	146
	4.6.2	Morbidity and Mortality Pattern	148
	4.6.3	Nutritional Status and Immunization	149
	4.6.4	Access to Safe Drinking Water	150
	4.6.5	Access to Sanitation Facility	153
	4.6.6	Waste Management	154
	4.6.7	Housing Characteristics	154
	4.6.8	Air Quality	157
	4.6.9	Knowledge of HIV/AIDS and Sexual Behaviour	157
	4.6.10	Health Care Infrastructure	158
	4.6.10.1	Soku Cottage Hospital	158
	4.6.10.2	Elem Sangama Comprehensive Health Center	159



	4.6.10.3	Kula Primary Health Care Centre	160
	4.6.10.4	Abonnema General Hospital	162
	4.6.10.5	Tertiary Health Care	162
	4.6.10.6	Medical Emergency Evacuation System	162
	4.6.10.7	Alternative Health Care	162
4.7	Consultation		164
	4.7.1	Introduction	164
	4.7.2	Objectives	164
	4.7.3	Identification and Involvement of Key Stakeholders	165
	4.7.3.1	The Primary Stakeholders	165
	4.7.3.2	The Regulators	165
	4.7.4	Scoping Workshop	165
	4.7.5	Community Concerns	166
	4.7.6	Future Consultations	167

CHAPTER FIVE

ASSOCIATED POTENTIAL ENVIRONMENTAL IMPACTS

5.1	Introduction		168
5.2	Impact Identification and Evaluation		168
	5.2.1	Impact Identification	168
	5.2.2	Impact Qualification	171
	5.2.3	Impact Rating	171
	5.2.3.1	Legal /Regulatory Requirements (L)	171
	5.2.3.2	Risk (R)	171



	5.2.3.3	Frequency of Impact (F)	173
	5.2.3.4	Importance of Affected Environmental Component and Impact (I)	173
	5.2.3.5	Public Perception (P)	174
5.3	Description of Impacts		186
	5.3.1	Pre-Construction Phase	186
	5.3.1.1	Land Acquisition	186
	5.3.1.2	Mobilization to Site	187
	5.3.1.3	Site Preparation (Vegetation Clearing)	188
	5.3.2	Construction Phase	192
	5.3.2.1	Recruitment of Labour	192
	5.3.2.2	Excavation of Pipeline Route	192
	5.3.2.3	Pipeline Welding/Filing and Stringing	195
	5.3.2.4	NDT of Welds	195
	5.3.2.5	Pipeline Laying	195
	5.3.2.6	Backfilling	196
	5.3.2.7	Hydrotesting	197
	5.3.2.8	Piling for Construction of Manifold	197
	5.3.2.9	Pipeline Commissioning	197
	5.3.3	Demobilization Phase	197
	5.3.4	Operations and Maintenance Phase	199
	5.3.4.1	Pipeline Operations	199
	5.3.4.2	Inspection and Refurbishment of Facilities	199



200	5.3.4.3	Surveillance
200	5.3.5	Decommissioning Phase
200	5.3.5.1	Dismantling and Site Clean Up
202	5.3.5.2	Rehabilitation

**CHAPTER SIX
MITIGATION MEASURES**

204	6.1	Introduction
204	6.2	Selected Control Measures

**CHAPTER SEVEN
ENVIRONMENTAL MANAGEMENT PLAN**

225	7.1	Introduction
225	7.2	Objectives of the EMP

CHAPTER EIGHT

270		Conclusions
-----	--	-------------

REFERENCES

271	
-----	--

APPENDICES

284	
-----	--



LIST OF TABLES		Pages
Table 3.1:	Summary of existing pipeline facilities along Soku FS-Soku GP stretch	10
Table 3.2:	Summary of Existing Pipeline Facilities along Soku GP-San Barth Stretch	11
Table 3.3:	Pipeline design standards	14
Table 3.4:	Wastes expected from proposed pipeline project	21
Table 4.1:	List of Communities within the Project Area	24
Table 4.2:	Field Meteorological Data Soku Gas Plant to San Barth Manifold Project	30
Table 4.3:	Summary of Rainfall Statistics for Selected Stations in the Niger Delta	34
Table 4.4:	Mean Monthly Rainfall and Number of Rainy Days in Port Harcourt (1993-2001)	34
Table 4.5:	Air Quality Characteristics for Soku Gas Plant Pipeline Project EIA	38
Table 4.6a:	Nigerian Ambient Air Quality Standard	39
Table 4.6b:	National Ambient Air Quality Standards of USEPA & WHO	39
Table 4.6c:	Noise Exposure Limits for Nigeria	40
Table 4.7a:	Wet Season Soil Physico-chemical Properties of Project Area	45
Table 4.7b:	Dry Season Soil Physico-chemical Properties of Project Area	46
Table 4.8:	Plant Elemental Composition (mg/kg) of Rhizophora spp	52
Table 4.9:	Disease Symptoms, Severity Indices and Causative Organisms in the Study Area	53
Table 4.10:	Plant Density of Dominant Economic Plant Species in the Study Area	54
Table 4.11:	Checklist of Birds Recorded from San Barth – Soku Study Areas	55
Table 4.12:	Physico-chemical Characteristics of Surface Waters along Soku Gas Plant-San Barth Manifold Pipeline Route	59
Table 4.13:	Some Heavy Metals Content of Surface Waters of the Project Area	64
Table 4.14a:	Diversity of Phytoplankton of the Project Area (Wet Season)	66
Table 4.14b:	Diversity and Relative of Phytoplankton of the Project Area (Dry Season)*	67
Table 4.15:	Phytoplankton Community Composition Parameter of the Project Area	70
Table 4.16a:	Diversity and Relative Number of Zooplankton of the Project Area (Wet Season)	71
Table 4.16b:	Diversity and Relative Number of Zooplankton of the Project Area (Dry Season)	72
Table 4.17a:	Relative Abundance of Benthos in Aquatic Systems in the Project Area (Wet Season)	75
Table 4.17b:	Relative Abundance of Benthos in Aquatic Systems along the Project Area (Dry Season)	76
Table 4.18	Physico-chemistry and Microbiology of Sediments from Soku – San Barth study area	77
Table 4.19a:	List of Shellfish of the Project Area	79
Table 4.19b:	List of Fin Fish of the Project Area	79
Table 4.20:	Elevation Corrections of the Borehole Points in Soku – San Barth area	82
Table 4.21:	Physico-Chemical and Microbiological Characteristics of Groundwater	



	from Soku – San Barth Study Area (Wet Season)	84
Table 4.22:	Distribution of Households in Soku-San Barth Communities by Size.	86
Table 4.23:	Levels of Educational Attainment in the Niger Delta States	91
Table 4.24:	Summary of Infrastructures and Social Amenities Available in Project-Affected Communities	
	109	
Table 4.25:	Traditional Governance and Community Structure in Soku, GP-San Barth Manifold Pipelines Communities	
	122	
Table 4.26:	Benefits from Oil and Gas Production in Project Communities and Further Expectations	
	126	
Table 4.27:	Distribution of Marital Status and Occupation amongst Household Heads	
	130	
Table 4.28:	Morbidity Pattern among Children in Project Area	
	130	
Table 4.29:	Anthropometric Measurement of Under-Five Children in the Communities	
	131	
Table 4.30:	Access to Improved Drinking Water Sources and Sanitation Facilities	
	132	
Table 4.31:	Ownership and Use of Mosquito Nets in Project Area	
	137	
Table 4.32:	Sexual Behaviour and HIV/AIDS Knowledge in Project Area	
	138	
Table 5.1:	Identified Project Impacts in Soku GP-San Barth Manifold Pipeline Project	
	149	
Table 5.2:	Probability of Occurrence	
	152	
Table 5.3:	Consequence Categories	
	152	
Table 5.4:	Frequency Rating and Criteria	
	153	
Table 5.5:	Importance Criteria	
	153	
Table 5.6:	Public Perception Criteria	
	154	
Table 5.7a:	Impact Assessment (Pre-Construction Phase)	
	155	
Table 5.7b:	Impact Assessment (Construction Phase)	
	157	
Table 5.7c:	Impact Assessment (Demobilization Phase)	
	160	

Table 5.7d:	Impact Assessment (Operations and Maintenance Phase)	161
Table 5.7e:	Impact Assessment (Decommissioning Phase)	162
Table 6.1a:	Impact Mitigation (Pre-Construction Phase)	181
Table 6.1b:	Impact Mitigation (Construction Phase)	187
Table 6.1c:	Impact Mitigation (Demobilization Phase)	192
Table 6.1d:	Impact Mitigation (Operations Phase)	194
Table 6.1e:	Impact Mitigation (Decommissioning Phase)	195
Table 7.1a:	Environmental Management Plan (Pre-Construction Phase)	181
Table 7.1b:	Environmental Management Plan (Construction Phase)	190
Table 7.1c:	Environmental Management Plan (Demobilization Phase)	199
Table 7.1d:	Environmental Management Plan (Operations Phase)	202
Table 7.1e:	Environmental Management Plan (Decommissioning Phase)	204

LIST OF FIGURES

	Pages	
Figure 3.1:	Soku-San Barth Pipeline Layout	10
Figure 3.2:	Layout of Soku FS – Soku GP stretch and the node coordinates	11
Figure 3.3:	Layout of Proposed Soku GP – New San Barth Manifold pipeline	12
Figure 3.4:	Layout of Proposed and Existing Facilities	13
Figure 3.5:	Sketch of Soku Gas Plant-San Barth Manifold Pipeline Cross-section	17
Figure 3.6:	Project Schedule for Soku Gas Plant -San Barth Manifold Pipeline Project	22
Figure 4.1a:	Twenty-two year (1983 - 2005) Monthly Averaged Insolation	28
Figure 4.1b:	Monthly Averaged Percentage Daylight Cloud Amount in Port Harcourt Area (1983-2005)	29
Figure 4.2:	Monthly Averaged Wind Direction at 50 m above the Surface of the Earth in Port Harcourt Area (1983 – 2005)	30
Figure 4.3:	Wind Rose and Wind Class Frequency Distribution on the Surface of the Earth for Port Harcourt Area (1993 – 2001)	31
Figure 4.4:	Temperature and Relative Humidity of Soku GP-San Barth Manifold Project Area	32
Figure 4.5:	Monthly Average Minimum and Maximum Temperatures, Temperature Range and Sunshine Hours for Port Harcourt/Onne/Bonny Axis	33
Figure 4.6:	Daily Average Rainfall and Relative Humidity, for Port Harcourt /Onne/Bonny Axis	35

Figure 4.7:	Exchangeable Cations Concentration of the Study Area	41
Figure 4.8:	Spatial Variation in pH and Temperature	61
Figure 4.9:	Spatial Variation in Total Alkalinity and	61
Figure 4.10:	Spatial Variation in BOD and COD in	61
Figure 4.11:	Spatial variation in Total Hardness in	62
Figure 4.12:	Spatial Variation in Total Organic Carbon and Total Hydrocarbon Content of Surface Waters in the Project Area	62
Figure 4.13:	Spatial Variation in Nitrate ion and Nitrite	63
Figure 4.14:	Spatial Variation in Phosphorus of Surface	63
Figure 4.15:	Spatial Variation in Sulphate and Sulphite	64
Figure 4.16:	Spatial Variation in Cr ³⁺ , Cr ⁶⁺ & Cu ²⁺ of Surface	65
Figure 4.17:	Spatial variation in Fe ²⁺ , Fe ³⁺ & Zn ²⁺ of Surface Waters in the Project Area	65
Figure 4.18:	Relative Abundance of Major Families of Phytoplankton in the Project Area	69
Figure 4.19:	Spatial Variation in Total Phytoplankton Count and Number of Species of Phytoplankton in the Project Area	69
Figure 4.20:	Linear Relationship between Total Phytoplankton Count and Number of Species of Phyttoplankton in the Project Area	70
Figure 4.21:	Relative Abundance of Major Families of Zooplankton in the Project Area	73
Figure 4.22:	Spatial Variation in Total Zooplankton Count and Number of Species of Zooplankton in Aquatic Systems of the Project Area	73
Figure 4.23:	Relative Abundance of Major Families of Benthos in Aquatic Systems of the Project Area	74
Figure 4.24:	Spatial Variation in Total Benthos Count and Number of Species of Benthos in Aquatic Systems of the Project Area	74
Figure: 4.25:	Lithologs of the Boreholes at San Barth Axis.	81
Figure 4.26:	Lithologs of the Boreholes at Soku Axis.	82
Figure: 4.27:	The Groundwater Flow Direction at Soku – San Barth Study Area	83
Figure 4.28:	Distribution of Respondents by Marital Status	87
Figure 4.29:	Age & Sex Structure of Households	87
Figure 4.30:	Distribution of Respondents by Age	88
Figure 4.31	Distribution of Respondents by Gender in the Communities	89
Figure 4.32:	Distribution of Respondents by Levels of Education	90
Figure 4.33:	Distribution of Respondent’s Spouses by Levels of Education	90
Figure 4.34:	Distribution of Respondent’s Children’s Levels of Educational attainment	91
Figure 4.35:	Distribution of Respondents by their Occupation	92
Figure 4.4.1:	Population Pyramid (Age-Sex Structure) of Study Population (n=919)	129
Figure 5.1:	Risk Assessment Matrix	152
Figure 5.2:	Impact Value and Rating Colour Code	154

LIST OF PLATES	Pages
Plate 4.1: Group Interviews at Soku	26
Plate 4.2: Administration of Questionnaire in Kula	27
Plate 4.3: Mangrove Vegetation in the Study Area	48
Plate 4.4: Freshwater Vegetation in the Study Area	49
Plate 4.5: Harvested Fuel wood	49
Plate 4.6: Freshwater Swamp Forest Close to Soku Gas Plant	50
Plate 4.7: Mangrove in the impacted area in Soku	51
Plate 4.8: Leaf Spot Disease of Rhizophora Mangle within the Study Area	53
Plate 4.9: Fiddler Crab Observed in Lucky Town	56
Plate 4.10: Hammerkop (<i>Scopus umbretta</i>) in the Study Area	57
Plate 4.11: Little Egret (<i>Egretta garzetta</i>) in the Study Area	57
Plate 4.12: Goliath Heron (<i>Ardea cinerea</i>) Observed in the Study Area	57
Plate 4.13: Grey Heron Observed in the Study Area	58
Plate 4.14: One of the Groundwater Monitoring Boreholes Drilled in the Study Area	81
Plate 4.15: Fishing Instruments/Gears (Hooks) commonly used in the Soku Area	92
Plate 4.17: Sawn Timber in Soku Environment being transported to Port Harcourt for Sale	93
Plate 4.18: Fishing boats at Luckyland (left) and Newtown (right)	94
Plate 4.19: A Markets at Soku community	95
Plate 4.20: A 6-Classroom Block Community Primary School, Soku 100	
Plate 4.21: The UBE 6-Classroom Community Comprehensive Secondary School, Soku 100	
Plate 4.22: Blocks of 10 Single Rooms for The Teachers At The CSS Soku 100	
Plate 4.23: Primary and post primary schools infrastructures at Elem Sangam 101	
Plate 4.24: Primary and Post Primary School Structures at Kula 101	
Plate 4.25: One of two water schemes in Soku community 103	
Plate 4.26: Water Borehole Facilities at Elem Sangama. 104	
Plate 4.27: Streams/ponds as source of water in the fishing communities 104	
Plate 4.28: Pier toilets as main sewage system in project communities 105	

Plate 4.29:	Refuse dump at the banks of the river at Soku and Kula communities.
105	
Plate 4.30	Houses along the waterfront in study communities
106	
Plate 4.31	Modern housing type in Soku community
106	
Plate 4.32:	Housing type in the fishing/trading settlements.
107	
Plate 4.33:	The Soku Cottage hospital under lock and key during the field study
107	
Plate 4.34	Paved and Concretized walkways/streets in Soku Community
114	
Plate 4.35:	Paved walkways in Elem Sangama
114	
Plate 4.36:	View of Opuonongi Community
114	
Plate 4.37:	Luckyland Fishing Port
115	
Plate 4.38:	New Town Fishing and trading Port
115	
Plate 4.39:	A cultural procession typical of Soku.
117	
Plate 4.40	Canoes for Water Transport at Kongomaboko
128	
Plate 4.41:	Rainwater Collection at Kula Community
132	
Plate 4.42:	A Non-functional Water Facility at Freetown
133	
Plate 4.43:	Discarded Drilling Chemical Drums for Water Storage at Apiboko
134	
Plate 4.44:	A Toilet in Newtown Community
135	
Plate 4.45:	Open Dumping of Refuse in the River at Kongomaboko
135	
Plate 4.46:	Built-Up Housing Structures at Elem Sangama
136	
Plate 4.47:	Housing Structure at Kula Community
136	
Plate 4.48:	A Thatch House at Pinaro, a Fishing Settlement
137	



Plate 4.49:	Fish drying in Kala-onogi	138
Plate 4.50:	Firewood in Opu-onogi Waterside	138
Plate 4.51	Empty Ward in Soku Cottage Hospital	140
Plate 4.52:	Elem Sangama Comprehensive Health Center Under Lock	141
Plate 4.53:	Kula Primary Health Care	141
Plate 4.54:	New Health Center Under Construction in Kula Community	142
Plate 4.55:	Herbal Medicine Displayed for Sale in Luckyland	143
Plate 4.56:	Stock of Medicines of an Itinerary Medicine Vendor in Opropokiri	143
Plate 4.57:	A Young Boy with Wrist Dislocation Managed by a Bonesetter in Apiboko	143

LIST OF ABBREVIATIONS AND ACRONYMS

µg/l	Microgram per liter
µS	Micro Siemen
AAS	Atomic Absorption Spectrophotometer
AG	Associated Gas
AGG	Associated Gas Gathering
AIDS	Aquired Immune Deficiency
ALARP	As Low As Reasonably Practicable
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
BOD	Biological Oxygen Demand
BOD ₅	5day-Biochemical Oxygen Demand
BOGT	Bonny Oil and Gas Terminal
Ca	Calcium
CBO	Community Based Organisation
Cd	Cadmium
CDC	Community Development Committee
CEC	Cation Exchange Capacity
CFU	Colony Forming Unit



CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CP	Cathodic Protection
Cr	Chromium
DO	Dissolved Oxygen
DPR	Department of Petroleum Resources
E & P	Exploration and Production
EC	Electrical Conductivity
EGASPIN	Environmental Guidelines and Standards for the Petroleum Industry in Nigeria
EGGS	Eastern Gas Gathering System
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPC	Engineering Procurement and Construction
Fe	Iron
FBE	Fusion Bonded Epoxy
FGD	Focus Group Discussion
FMEEnv	Federal Ministry of Environment
FS	Flow Station
GMoU	Global Memorandum of Understanding
GP	Gas Plant
GPHSL	Greater Port Harcourt Swamp Line
HIA	Health Impact Assessment
HIV	Human Immunodeficiency Virus
IA	Industrial Area
ISO	International Standards Organisation
JV	Joint Venture
Km	Kilometre
KI	Kidney Island
LGA	Local Government Area
LGSP	Liquified Gas Supply and Processing plant
LLWL	Low Low Water Level
mfd	Manifold
Mn	Manganese
Na	Sodium
NAOC	Nigeria Agip Oil Company
NCTL	Nembe Creek Trunk Line
NDT	Non Destructive Testing
NGOs	Non-governmental Organisation
Ni	Nickel
NLNG	Nigeria Liquified Natural Gas
NORM	Natural Occurring Radioactive Materials
OML	Oil Mining Lease
Pb	Lead
PE	Polyethylene
PPE	Personal Protective Equipment



PRA	Participatory Rural Appraisal
RoW	Right of Way
SPDC	The Shell Petroleum Development Company of Nigeria Ltd
SPM	Suspended Particulate Matter
SS	Suspended Solids
TDS	Total Dissolved Solids
TDS	Total Dissolved Solid
THC	Total Hydrocarbon Content
ToR	Terms of Reference
TSP	Total Suspended Particles
TSS	Total Suspended Solids
TSS	Total Suspended Solid
VOC	Volatile Organic Carbon
WHO	World Health Organisation
Zn	Zinc

LIST OF APPENDICES

- Appendix 1 Laboratory Analytical Methods and Procedure
- Appendix 2 Social Impact Assessment Questionnaire
- Appendix 3 Health Impact Assessment Questionnaire
- Appendix 4 Soku Pipeline Map
- Appendix 5 Crude Oil SHOC, General Purpose Grease SHOC and Bentonite SHOC





EXECUTIVE SUMMARY

The Project Background

The Shell Petroleum Development Company of Nigeria Limited (SPDC), on behalf of the Joint Venture partners (Nigerian National Petroleum Corporation, Nigerian Agip Oil Company, and Total E&P) intends to embark on the Soku Gas Plant–San Barth Manifold Pipeline Project to meet the business objectives of oil and gas supply.

The project area spreads from Akuku Toru Local Government Area in Rivers State to Nembe Local Government Area in Bayelsa State in the Niger Delta. The project traverses six main communities and several settlements across two local government areas. The local government areas are Akuku-Toru in Rivers state and Nembe LGA of Bayelsa State. Some of the communities are Soku, Elem Sangana, Kula, Benema and Offionoma.

The following indicate the start point and termination for the three pipelines:

- **Line 1:** (Liquid Pipeline): 12" x 22 km (11.13 mm wall thickness), starts from Soku Gas Plant and terminate at new San Barth Manifold.
- **Line 2:** (Liquid Pipeline): 10" x 4.5 km (11.13 mm wall thickness), start from Soku Flowstation and terminates at Soku Gas Plant.
- **Line 3:** (Associated Gas –AG Pipeline): 10" x 4.5 km (11.13mm wall thickness), start from Soku Flowstation and terminate at Soku Gas Plant.

The International Standard Organisation (ISO) reference conditions for Soku Gas Plant include the following;

- Condensate: Should not spill to the environment.
- Gas: No gas leak.
- Flare: Should not be above the regulatory limit.
- Effluent Monitoring: Proper monitoring of the effluent discharge, not to exceed the regulatory limit.
- Sewage (Liquid): Treatment plant exists for the handling of the liquid waste.
- Sewage (Solid): Managed to ensure minimum impact on the environment.

The geographic coordinates for the 12" x 22km Soku- New San Barth manifold start point is; 461218.5 Eastings and 72858.09 Northings, while the geographic coordinates at the end point is 469592.1 Eastings and 56148.36 Northings.

The geographic coordinates for the two 10" x 4.5km Soku flowstation – Soku Gas Plant (Associated Gas and Liquid) Pipeline start point is 463522.08 Eastings and 72048.34 Northings. While the geographic coordinates at the end point is 461218.45 Eastings, and 72858.08 Northings.

The total area of the project is 79.5 hectares.



Declaration

The Shell Petroleum Development Company of Nigeria Limited (SPDC), in her capacity as the technical operator of the NNPC/Shell/TEPN/Agip Joint Venture (JV) and on behalf of her partners, proposes to construct two 10" x 4.5 km pipeline from Soku FS to evacuate oil and Associated Gas from Soku GP; and a 12" x 22 km pipeline to transfer the oil, co-mingled with Soku GP condensate, to New San Barth Manifold in the NCTL network; and hereby declares her intention to abide by the existing international and national laws and regulations regarding environmental protection during the project.

The management of SPDC is committed to the implementation of the Environmental Management Plan (EMP) proposed in this EIA report and avows that it has prepared this EIA report using the best available expertise in personnel, equipment, national and internationally acceptable methods.

Scope and Objectives of the EIA

The proposed project will be executed in conformity with SPDC's policy on the preservation of the environment. However, in order to fully protect the environment during project implementation, an Environmental Impact Assessment (EIA) has been commissioned, which is the subject of this report.

The general scope of the EIA will cover all the activities that constitute the project. It will outline the techniques and methodologies to be used in data generation and gathering, including the description of the data sources; and impact identification, prediction, evaluation and management.

The EIA studies sought to establish the baseline conditions of the project area, identify /evaluate the potential environmental, social and health impacts of the project and develop cost-effective mitigation measures and appropriate Environmental Management Plan (EMP).

Legal and Administrative Framework

The project proponent complies with all environmental statutes/regulations / conventions. Therefore, the proponent has identified all relevant statutory legislations, laws, conventions, etc., that are applicable to the proposed pipeline project. Also, the relevant regulatory agencies at all tiers of governance in Nigeria have been identified and shall be carried along in the execution of the proposed pipeline project.

Terms of Reference for the EIA

The ToR for the EIA of the Soku Gas Plant–San Barth Manifold Pipeline Project was developed through extensive stakeholder consultation at the initial stages of project conception, and approved by DPR. The consultation was organized in order to identify and define the project activities and aspects that may have significant environmental effects as well as scope the environmental baseline data needed as basis for impact assessment. The EIA will establish the environmental issues associated with the project; predict their impacts and magnitude; suggest and evaluate project alternatives; and recommend mitigation measures and Environmental Management Plans (EMP) to ensure environmental friendliness and sustainable development.

Project Objectives and Need for the Project

The need for the project is lies satisfying the project objectives and these include:

- ensuring evacuation capacity for Soku Oil;
- Evacuating Soku Gas Plant (LGSP) Condensate;
- satisfying DPR requirements for Soku Gas Plant; and
- securing Licence to Operate (LTO) for Soku Gas Plant (LGSP).

The project is particularly pertinent in order to evacuate Soku FS oil and Soku GP condensate in a manner that will discourage illegal ‘bunkering’ along the route from Soku GP to NCTL San Barth Manifold. This will enable unconstrained production of the Ekulama fields and simultaneously meet the Federal Government of Nigeria statutory flares-down directive. To satisfy this need, crude oil from Soku FS will be co-mingled with condensates from Soku GP and eventually be separated at Bonny Oil and Gas Terminal.

Envisaged Benefits

The envisaged benefits of the proposed project shall include the under listed:

- Increase in crude oil output from SPDC east operations;
- Significant increase in Nigeria’s GDP from increased crude oil export and revenue;
- Unconstrained oil and gas production from the Ekulama field;
- Increase in revenue to the project communities from local content dividends;
- Increase in project communities’ access to development intervention projects;
- opportunities for reduction of environmental pollution occasioned by aged pipelines;
- Contribute to reduction in gas flaring.

The estimated value of the project is about U\$232 million for a total length of 31 km

Envisaged Sustainability

The envisaged sustainability of the project include:

Economic Sustainability: exploitation of the enormous reserves in the Ekulama fields, implementation of GMoU’s.

Technical Sustainability: SPDC’s decades of experience and proven ability to construct and maintain oil and gas pipelines.

Environmental sustainability: implementation of environmental management plan.

Project Alternatives

Project alternatives were considered with respect to the overall project concept and the route includes:

Option 1: No Project Option: use of existing old pipelines with impaired integrity, which is counter to global best practices, hence rejected on the grounds of technical, economic, reputational and environmental non-sustainability.

Option 2: Replacement of Existing Pipeline: involving excavating and replacing the existing old pipelines that the proposed project is intending to substitute. This was

rejected because it entails a longer route, more communities, and larger environmental footprint.

Option 3: Construction of 2 nos. Deeply-Buried and Water-Covered Pipelines: this is the proposed project and it entails a shorter route and achieve comingling of condensate that would have required a separate pipeline.

Concurrent Development with the Proposed Project

Alongside the proposed pipeline project, two associated gas (AG) pipelines constructions shall be carried out. These include the replacement of 12" X 15 km Soku – Ekulama AG pipeline and a new 12" x 22 km Soku AG line. The replacement works shall run on the same ROW with proposed Soku GP oil Export pipeline up to Ekulama 2. The replacement pipeline shall evacuate Ekulama field AG to Soku Gas plant for further processing in line with SPDC's plan to stop all gas flaring, thereby preserving the environment.

Baseline Environmental Conditions

Climate and Meteorology

The climate of the study area is humid tropical and it is characterized by dry season which occur between November and March, and wet season from April to October. Mean monthly rainfall is 600mm. Mean monthly relative humidity values are slightly high for the wet season months (approximately March to November) with the highest values occurring within the months of July to August. During the fieldwork for the wet season data gathering for the present study (August 2011), relative humidity values ranged from 95.0 - 100%.

Air Quality and Noise

The air quality in the area within and around the ROW appears good as all the major pollutants were below regulatory limits. The major sources of pollutants investigated in this study were carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), hydrogen sulfides (H₂S), volatile organic compounds (VOC) and suspended particulate matter (SPM). The ambient noise within the ROW were less than 48.2 dB(A) and below the FME_{env} limit of 90 dB (A), mainly the noise was generation mainly by boat movement and human activities.

Soil Physico-chemical Properties

The soils at depths of 0-15 and 15-30cm have silty texture, poorly drained and generally wetland soils and typical of hydromorphic soils. Soil bulk density of the surface and subsurface pipeline ROW soils ranged from 0.98 to 1.17g/cm³ and 1.03 to 1.19 g/cm³ respectively.

Exchangeable cations was moderately high at both surface (30.90 to 226.00mg/kg with a mean of 109.70 mg/kg) and subsurface, = 22.11 to 211.72 with a mean of 88.72 mg/kg).



There was high chloride concentration ranging from 66.05 to 2477.07mg/kg in the surface and 87.17 to 1604.00mg/kg, while others were relatively much lower. For instance, nitrate contents ranged from 1.44 to 130.11mg/kg and 0.58 to 151.02mg/kg at the surface and subsurface respectively. Nitrate contents of the soils from the ROW were slightly lower compared to the control soils, especially at the surface. Sulphate content ranged from 14.20 to 302.08mg/kg and 10.22 to 290.00mg/kg at the surface and subsurface respectively in the pipeline ROW soils. Mean phosphate contents for the surface and subsurface pipeline ROW soils were 29.24 and 35.04 mg/kg respectively

Heavy metal concentrations in both surface and subsurface soils were moderately low, e.g., mean cadmium contents were 2.63 and 2.86 mg/kg for pipeline ROW soils and 0.83 and 0.97 mg/kg for control soils respectively. The contents of other heavy metals (Fe, Cr, Ni, V and Pb) are not indicative of pollution as their levels are below their respective threshold limits.

Total organic carbon (TOC) content of soils along pipeline ROW ranged from 0.22 to 0.51% and 0.01 to 0.29% at surface and subsurface respectively. Total petroleum hydrocarbon in soils sampled from the pipeline route ranged from 0.20 to 0.44mg/kg at the surface, but not detected at the subsurface. The hydrocarbon utilizing microbial flora count were low and did not indicate significant hydrocarbon contamination.

Vegetation and Conservation studies

The vegetation found in the study area is mangrove swamp forest with mangrove plants and their associates constituting >90%, except on old dredge dumps where freshwater plants can be found. The predominant species include the dwarf red mangrove (*Rhizophora mangle*), tall red mangrove (*Rhizophora racemosa*) and white mangrove (*Avicennia africana*). Others include *Acrostichum aureum* (mangrove fern), *Paspalum vaginatum* (mangrove grass), *Machaerium lunatus* and *Dalbergia ecastaphyllum*. The plants are harvested for fuel wood local building construction industry and canoe building, medicinal uses, etc. The vegetation is generally healthy except for few incidences of leaf spot.

Observations revealed that the mangrove swamp has been very much devastated near the Soku flowstion and Gas Plant areas due to previous oil spills and fire. Some areas within the mangrove swamp forest had been disturbed by dredging/pipeline laying and oil/gas wells drilling activities leading to the formation of dredge spoil dumps, which have been colonized by *Mariscus ligularis*, *Paspalum pes-capre*, *Ficus* sp., *Anthocleista vogellii* and *Alchornea cordifolia*. On levee crests and around communities particularly Krikakiri, crop plants like plantain (*Musa paradisiacal*), oil palm (*Elaeis guineensis*), coconut (*Cocos nucifera*), sugar cane (*Saccharum officinalis*), Mango (*Mangifera indica*), pawpaw (*Carica papaya*) were being cultivated. The freshwater areas particularly at the Soku Gas Plant also had raffia palms (*Raphia hookeri*), Abura (*Halea stipulosa*), baphia (*Baphia* sp) and cabbage tree (*Anthocleista vogellii*).

Wildlife/Invertebrate Fauna



The terrestrial invertebrate fauna observed or collected from the Soku-San Barth ecosystems include arthropods e.g crustaceans (crabs). The crabs seen were not only few in number but of small sizes. Few molluscs were recorded in in previously oil spill areas within the study location. The mangrove soil fauna was made up mainly of decapod crustaceans. They include small individuals of the marsh crab (*Seserma huzardi*), and purple mangrove crab (*Goniopsis pelii*). Only few individuals, usually of small sizes, were seen in the area sampled. Very few live gastropod molluscs were observed throughout the entire area and during the period of study. The common arthropods include ants (Hymenoptera), beetles (Coleoptera), grasshoppers (Orthoptera), termites (Isoptera), true bugs (Heteroptera), springtails and snowflies (Collembola), true flies (Diptera), butterflies (Lepidoptera), spiders (Araneae) and millipedes (Chilopoda). These organisms were also seen in low population on the mangrove plants.

The only conspicuous vertebrates in the entire Soku – San Barth area were birds. Other vertebrates include a few species of reptiles and mammals. The reptiles observed in the communities (Ekulama I & II, Krikakri, and Lucky Town) and mangrove swamps include a few individuals of lizards, skinks and an unidentified species of snake near Ekulama II. The avifauna was represented by several species of egrets, ducks, herons, kingfishers, bulbuls, finches and birds of prey. Mammals recorded include a few species of rodents (Squirrels, rats) and monkeys (Mona monkey).

Aquatic Studies

Aquatic physico- chemistry: Surface water temperature was between 24.7 and 26.9°C. Alkalinity ranged from 15.99-51.99mg/l while the concentrations of suspended solids varied from 10-60mg/l. The biochemical oxygen demand levels varied between 5.04mg/l and 5.63mg/l, while chemical oxygen demand ranged from 6.0 - 7.6mg/l. The total hardness of surface water along Soku Gas Plant-San Barth Manifold Pipelines route displayed a spatial variation. THC was recorded in all the sample locations in low concentrations (0.24-0.65mg/l) while TOC levels fluctuated between 5.48 and 7.89mg/l.

Nitrite concentration were generally low suggesting that the study area is tending towards eutrophication. Phosphorous levels ranged from 0.003 to 0.131mg/l. Sulphate and sulphide levels in the study area indicate that these levels fluctuate from 6.652 to 121.205mg/l for sulphate and from <0.002 to 2.404mg/l for sulphides. The heavy metals contents of surface water analysis show that V, As, Hg, Mn, Se and Ag were not recorded in the study area while Cr, Cu, Fe and Zn were recorded in different concentrations.

Aquatic Ecology: Five major families of phytoplankton were recorded; namely Baccillariophyceae, Dinophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae. Baccillariophyceae was the dominant family and constituted 43% of the total number of phytoplankton. In all, the dominance pattern of the various families of phytoplankton was, Baccillariophyceae, Chlorophyceae, Cyanophyceae, Xanthophyceae and Chrysophyceae.



The identified zooplankton fauna were categorized into protozoa, cladocera, decapod crustacean, rotifers, copepods, euphaiacea and larval/nymphal stages of insects. The copepods were the dominant zooplankton and contributed 33% of the zooplankton. Cladocerans were the second dominant zooplankton with respect density and were represented by six (6) species.

One hundred and seventy-two (172) macrobenthic organisms were encountered and these belong to five (5) major taxonomic groupings, namely polychaetes (37%), crustaceans (31%), insects (12%), bivalves (10%) and gastropods (10%).

Fisheries: Few fishers were noticed in the study area and there were no commercial fishers. The artisanal fishers dominate in the study area and they operate in dug-out wooden canoes which may or may not be motorized. Fishing gears were largely made of long setlines, circling nets and seine nets of different mesh sizes varying between ½", 1", 1½", 2", 2½ and 3" (1.0 mm to 5.0 mm). They are usually set and allowed to stay for up to one hour before they are removed with the catch. A total of 51 species of fish belonging to 21 families of finfishes and shellfishes were recorded in the study area.

Sediment chemistry: The sediment pH ranged between 4.26 and 5.96, while electrical conductivity values ranged from 377.0 - 4409µS/cm indicating saline conditions. The cations were dominated by calcium (37.02 – 1704mg/kg), potassium (146.1 – 1031.0mg/kg) and Sodium (60.60 – 397mg/kg). The heavy metal concentrations (Ni, Pb, Cr, Zn) were below their respective DPR target levels while Cd ranged from 1.76 to 22.90mg/kg. The organic carbon concentration (0.01 – 0.25mg/kg) and total hydrocarbon content (0.06 – 0.77mg/kg) were comparable to the concentration in the soils of the study area. The microbial loads of the sediments were low with bacterial population count of 4.3 – 6.6 x 10⁴ cfu/g and fungal population count of 3.8 – 5.7 x 10⁴ cfu/g.

Geology and Hydrogeology

Soku Gas Plant and San Barth Manifold are located in Akuku Toru local government area of Rivers State, Nigeria. Geologically, the site is lying in the southern border of the modern Niger Delta. It is underlain by the lowermost chronostratigraphic unit of the Niger Delta – the Akata Formation. The formation is characterized by uniform open marine prodeltaic dark-grey shale with lenses of sandstone and siltstone. The shale contains plant remains and some mica especially in the upper part of the formation. The river systems in the project site forms the tributaries through which the Niger River empties into the Atlantic Ocean. The Islands are mainly sandy ridges. Precipitation is by rainfall which exceeds 260 cm annually. The aquifer system is usually phreatic and water table is always close to the surface.

The terrain is flat with a slope of 1-2° coastal mangrove swamps, with patches of freshwater around human settlements. At Soku –San Barth site the groundwater flow has been affected mostly by topographic factors. All six monitoring wells show shallow static water levels, with values ranging from 0 m around BH 3 and 4 to 4.6 m in BH 6. They are highly prolific. The groundwater flow was established to be in the SS direction. The aquifer in the study area is sensitive to contaminants because of tidal flow.



Groundwater

The pH values ranged from 4.8 to 6.2 indicating that the ground waters are acidic in recation. The electrical conductivity of the ground water ranged from 299 - 26400 μ S/cm with corresponding total dissolved solid values of 143.9 to 15540mg/kg. These values indicate fresh water to salty water characteristics. The salinity levels ranged from 0.1‰ to 16.1‰. The heavy metal concentrations for Cr, Pb, Ni, Zn, Cu were low while the concentrations of Cd, V, As, Hg, Mn Se and Ag were below their respective detection limits. The slightly elevated levels of Fe (0.928 – 25.64mg/kg) compared to DPR target level of 0.3mg/kg is due to the geochemistry of the Niger Delta ecosystem. No faecal coliforms were recorded in the groundwater.

Socioeconomic Status

Study Area and Methods

Seventeen communities consisting of sixteen from Akuku Toru Local Government Area (AKALGA) in River State, and one community (Oluasiri) from Bayelsa State were identified as Soku-San Barth Pipeline Project Communities. Three (3) out of fifteen (15) visited settlements in the project area (Kula, Elem Sangama and Soku) were relatively big settlements with large human concentrations as opposed to the many others that were small fishing camps. The project area traverses a difficult terrain with only few of the settlements existing in close proximity.

Data on Socioeconomics of Communities to be impacted by the Pipeline project was gathered following scoping Workshop, consultations, field surveys, and review of existing reports, maps and literature. During survey questionnaire was administered by personal interviews at the level of the households and key informants while Focus Group Discussions (FGDs), were conducted with Women Groups (WGs), Youth Groups (YGs) and Community Development Committees (CDCs).Thirty (30) respondents (households and key informants) were successfully administered with questionnaire during the survey. Other primary data were generated from the FGDs. A walk-through (triangulation) and ground-truthing within the communities helped to cross-check information gathered in respect of status and functionality of available infrastructure. Photographs of some of the infrastructure, the human environment and other landmark issues were taken and discussed appropriately.

Data were analyzed with descriptive statistics of frequency tables, percentages, cross-tabulations and graphs. Epi- INFO/SPSS computer packages provided assistance in analyzing and formatting presentations. Some qualitative data were analyzed as text-based information in tables.

Population:

The 1991 population census has the population of the bigger and permanent communities as follows: Kula (13,018 made up of 6,559 males and 6,459 females) and Soku (2,801 made up of 1,327 males and 1,474 females). These are the most densely populated with an average of 197 persons per square kilometer in the study area. There is the fishing and trading ports of Pinaro with less than 100 persons and are tagged



sparingly inhabited. Many of the settlements, including Kula, Soku and the proximate Elem Sangama have continuously witnessed increased oil and gas activities, and consequently have attracted higher number of persons despite their remote locations. The area is presently characterized with illegal oil bunkering and as such the settlements in and around the project area are presently harbouring many people. The most distant and remote communities and some fishing settlements which had witnessed inter-communal conflicts and militant activities have on the other hand had reversed and decreased population in recent times.

The size of families differed from community to community and was expected to have been influenced in large measure by the cultural attitude of the people, economy of the settlement and educational status/awareness of the resident population amongst other factors.

The survey revealed that the average household size in the Soku – San Barth communities was 6.70. This value compares well with a size of 6 estimated for Communities in Niger Delta (NDDC, 2006). Several reasons account for the large household sizes in the study area in particular and the Niger Delta region in general. First is the recognition of marriage as a basic cultural institution for procreation in the communities. Marriage is a socio-cultural norm that is highly recognized in the area and persons that marry do so sometimes at a relatively early age. Second is the fact that most males married more than one wife in the area, with some of them keeping and maintaining several concubines. This suggests freedom and permission to high amorous (sexual) promiscuity among both sexes giving rise to high number of fertile intercourse amongst the people.

More than one half (58.0%) of the respondents were married as opposed to approximately 19 percent that were single (Freetown community has over two-thirds of its inhabitants as single parents) and each married male had an average of one wife. About 23 percent of the respondents were either divorced/separated from their spouses or widowed

The male and female populations in Kula, Ekulama II, freeman, Opropokori, and Luckyland revealed that persons aged below 25 years were more in number than older people. This is an overwhelming preponderance of the younger ones in the population. Approximately 81 percent of all household members were aged below 18 years as opposed to less than a fifth (19.0%) that is 19 years and above. The overall implication of the age profile is that the population is young and growing. The age distribution of the respondents indicated that most of those surveyed are adults of at least 20 years old; almost a quarter (24.2%) of all respondents were aged 20-29 years, while another group (19.3%) were in the 30-39 years age bracket. Those aged 40-59 years however, constituted over one half (51.3%) of the respondents. Amongst the older persons in the population, barely 5.2 percent were aged 60 years and above. In terms of gender, sex distribution of the population in the project environment reveals an overall sex ratio of 1:1. According to the 2006 census, in Akuku-toru LGA (AKULGA), the males slightly outnumbered the females, consistent with the overall Rivers State sex structure of 52.3 percent males and 47.7 percent females and a sex ratio of 109.5 (FGN Official Gazette,



2007). For every 100 females therefore, there are to be found almost 110 males. However, the survey carried out in the course of the Niger Delta development Master Plan process shows that there are more males (54.0%) than females (46.0%) in the Region.

Education

Literacy level in the communities was adjudged sufficiently high. Approximately 95 percent of the total population of the proposed project area has some form of education, with more than half of the people (51.9%) in Kula, Ekulama II, Freetown, and Opropokori having attempted/completed the post primary (secondary) education. About 21.1 percent and 6.2 percent on average also had the primary and tertiary education respectively. Approximately 16 percent of the inhabitants possess vocational/technical education, qualifying beneficiaries for some employment. Some of them have acquired some skills in the oil and gas industrial sector. Approximately 5 percent of the inhabitants have no formal education (NFE).

The modal educational attainment of respondents' spouses was the post-primary (46.3%), followed by primary education (29.4%) and then tertiary educational attainment (15.3%). Approximately 6.5 percent have no formal education while those with vocational/technical skills accounted for 2.4% of the spouses. Literacy and educational attainment of household members also indicated that about 51.8% of the boys and 48.2% of the girls are presently attending various schools within and outside the study area. Approximately 33 percent and 41.0% of the children of school age in the households are currently attending primary and secondary schools. Similarly, about 21.7% of the children are attending post secondary school (tertiary). However, the levels of vocational training and skills and technical education of respondents' children in the area was not very insignificant (4.3%).

Livelihood Structures and Local Economy

The settlements/communities predominantly engaged in fishing. Other significant economic activities included trading, logging (lumbering), and civil service. Farming is not a prime occupation because there are no arable lands and livestock are hardly reared, except in Kula, and Opropokiri with mixed mangrove and pockets of freshwater forest lands where food crops are grown at subsistence levels. The occupational distribution of the inhabitants of Kula, European Quarter (Ekulama II), Freetown, Opropokiri, Newtown and Luckyland showed that on the average, about 57.8 percent are into fishing, 15.3% are into trading while approximately 7.0% are civil servants. Those involved in business/contracting constituted 4.1% with the remaining 16.1% living as students/apprentices and unemployed. The number of persons involved in fisheries is more in the smaller fishing and/or trading ports than in the mainland permanent communities of Soku, Kula and Opropokori. The type of fishing carried out in the communities was artisanal and on a small-scale usually in shallow waters. However, there are some of the fisher folks who fish in deep waters of Sombreiro, St. Bartholomew, Santa Barbara, St. Nicholas, Brass Rivers and the Atlantic Ocean engine powered boats. Migrant inhabitants of these settlements engage in diversified income-generating

activities including logging, trading, and transportation by boats, harvesting of forest products, and fishing.

The male folks are more involved in the fishing occupation while the women take to collecting resources like pelagic organisms (periwinkles and oysters) and firewood from swamp forest for sale. The women set hooks and nets on and along the creeks to catch stray fishes and periwinkles. The fishing gear in common use includes various forms of nets, hooks and traps. Shifts in occupation have resulted in abandonment of the traditional occupations of fishing and farming for livelihoods in the recent past. Fishing and agriculture have suffered some environmental and social challenges following oil mining activities and neglect of the communities by successive governments. Presently many youths and other able-bodied men and women get their livelihood from illicit activities in oil bunkering, hostage-taking of oil workers and sabotage of oil pipelines. Others endlessly seek for rent on land from crude oil corporate companies in the area.

Income Distribution and Levels

The income levels estimated showed that about a quarter (25.0%) of households in Soku earned ₦10,001–₦15,000 in a month, while almost two fifth (18.8%) of the population earned above ₦50,000 in a month. Residents, who are into business and contracting however, earned better incomes that averaged, ₦200, 000.00 in a year. However, the frequency of getting such businesses was unpredictable.

A quarter (25.0%) of the respondents covered in this survey at Kula reported earning incomes within the range of ₦15,000 to ₦20,000; ₦25,00 to ₦35,000; and ₦45,000 – ₦50,000 in a month respectively. Panel discussions with fisher folks revealed that on a good day, each fisherman made income of between ₦5, 000.00 and ₦10, 000.00 daily. This income range being based on income that is not quite regular left us with no other option but to estimate a reliable income range of about ₦20, 000 to ₦30, 000 as most realistic net income from fishing in a month. While the price of fish varies with the season of catch and quantity of fish caught, other pelagic resources had more predictable unit prices. A 25Kg bag of periwinkles (*Esam*) was bought for between ₦1, 000.00 and ₦1, 200.00 and then sold for between ₦1, 500.00 and ₦1, 600.00, in distant markets.

Household Expenditure and Consumption

Food was listed by 75.0% of heads of households as the most important spending priority, with *entertainment* ranked the least by (3.0%) in priority in the communities. Spending on *Education* was ranked the second most important household expenditure item 56.0% of the respondents. Many parents spend much in getting their children educated outside their immediate environment. Healthcare (5.0%), energy (5.0%), and transportation (5.0%) were rated low in their expenditure priority lists. It was difficult to estimate accurately how much individual households spent on these items per month due to reluctance of respondents to provide accurate record on these non-durable consumer items.

Households in fishing settlements had few residential properties. In the permanent communities of Soku, Elem Sangama and Kula households owned properties/assets and

accessories. The most utilized source of domestic energy was the wood-fuel, used mainly for the cooking of meals. The mere absence of electrical energy makes the use of fuel-wood energy inevitable in almost all the households. Households sourced their firewood from the surrounding mangrove forest. People preferred to use red mangrove to using white mangrove in cooking meals and smoking fishes. A canoe full of red mangrove firewood costs between ₦10, 000.00 and ₦20, 000.00.

Land Tenure, Use and Management

By providence, in and around the proposed project communities and settlements, availability of land resource is very limited because of overwhelming influence of hydrology; myriads of rivers, creeks and creek lets that fan-across the terrain, leaving very limited solid land space used for either habitation, road construction, social development or cultivation purposes. Consequently, the available small land surface is held in very high regard by the inhabitants. The regard is heightened by individuals, families and communities owning lands intended to be used for oil wells and facilities. Two forms of land-ownership are common in the project area: *family* and *communal land ownership*. The reward for use of land is the rent payable to the rightful owner.

Social Infrastructures and Services

Permanent communities of Soku, Elem-Sangama, and Kula have more basic infrastructures and amenities, many of which have been provided by the oil and gas companies (SPDC and her partners). They have done this as part of their Corporate Social Responsibility (CSR) in compliance to best industry practice and to strengthen the Global Memorandum of Understanding (GMOU) they signed with the communities. The smaller fishing settlements/ports lack the most basic infrastructures. For instance in Luckyland and Newtown there are hardly any infrastructures.

Educationally, Soku, Elem Sangama, and Kula have a number of public and privately-owned primary and post primary schools that provide education to the children and wards of the inhabitants of the communities. These schools relatively have capacities and structures that can be adjudged adequate for their pupils/students and teachers in 2008/2008 academic session. Soku community has a primary school. In the fishing communities, there are no public primary or post primary schools in Newtown, Luckyland, Pinaro, Kongomaboko and Apiboko.

All the project communities are located in the rural areas and are not connected to the national grid of the Power Holding Company of Nigeria (PHCN). The presence of electricity supply in the mainland communities is dependent on the benevolence of Oil and Gas Companies, especially where the communities are host to their operations. Communities of Soku, Elem Sangama, and Kula have received donations of giant generators by SPDC, Chevron, Texaco and Niger Delta Development Commission (NDDC) over the years.

Transportation (Bridges, Jetties, Embankment) and Communication Facilities

The project area is therefore, accessible only through water. Transportation into the area is through hand-dug canoes (by residents in the villages/fishing camps particularly and for inter/intra community movement) and the popular fibre or outboard engine boats usually fitted with various grade of HP engines. There are makeshift wooden and



dangerous jetties at the waterfront for incoming boats in Soku and other fishing settlements. Soku, Elem Sangama and Kula as well as the fishing settlements contend with coastal flooding and erosion but only Elem Sangama and Kula have embankments while that for Soku initiated by the NDDC in 2006 is yet to be completed.

Potable Water Supply and Sanitation Facilities

More than any other amenity, water facilities can be found in all but the fishing settlements but paradoxically, not many of the facility can be found functional at any one time. Soku community has been provided three water facilities (two boreholes and a mono-pump), and yet there was scarcity of potable water for drinking as at the time of visit. Elem Sangama has two gigantic water facilities provided by SPDC and the NDDC, one of which is still functional. Newtown was the only fishing community found with some water from a borehole while the others travel long distances to nearest oil facility (Ekulama flow station) to obtain drinking water. Some inhabitants make do with water from ponds suspected to be contaminated. Across the project communities, proper sanitation and hygiene is also not observed. Human faeces (excrement) are discharged into the rivers and creeks through pier toilets while in some of the modern houses there are private conveniences/sewage systems which are connected to the river/creek for disposal. Solid wastes from homes are also easily deposited at the banks of the river/creeks, which in addition to being un-aesthetic is conducive for vector-borne infestations/diseases.

Housing Type, Pattern and Quality

The housing pattern, type and structure within the study area reflect the coastal rural setting. Old traditional houses are aligned with modern bungalows and duplexes. The old traditional houses are built in rooms, with modal walling made of molded cement blocks or bricks and roofing materials made of corrugated iron sheets (zinc). A good number of them is also constructed with wooden/plank and thatch materials especially in the fishing settlements.

The modern houses are built in flats with modal walling made of molded cement blocks or bricks and roofing materials made of long span corrugated Aluminum sheets. The indigenous population of the project communities own and live in their personal houses/dwellings. Many of these houses operate on multi-tenements and have shared facilities (particularly the kitchen) located outside the main buildings.

Financial Sources and Organizations/institutions

There are many informal financial organizations in the project area. The local population use traditional banking - through thrift clubs - to raise capital to finance the purchase of fishing gear and household goods. There are a number of unregistered social groups, trade associations and cooperative societies in the communities. Some of these are sub-groups of a larger union based in Abonemma, and membership is drawn from across communities. The groups are mainly thrift and credit clubs focusing on fishing, fish and net trading businesses.

Historical Perspective of the Communities and Cultural Properties

Most of the project communities are kalabari except Oluasiri that is Nembe. They have varied foundations or origins. Elem Sangama is an Ijaw community that speaks Kalabari and shares boundaries with Soku, Oluasiri and Okanami communities. It is also the boundary town between Rivers and Bayelsa states. Inhabitants are adherents of the Christian religion with some indigenous members remaining members of traditional religion. Traditional worship takes place in both community and many family shrines that exist in the study area.

The Kalabaris have rich and well established cultural and traditional institutions. Inhabitants of each community and settlement are easily discernable by their folklore and songs. Womanhood and marriage are two respected cultures of the Kalabari people and by extension its constituent communities and settlements. The Kalabari ethnic group has its value system, taboos and social norms.

Traditional Administration /Power Structure

The *Kalabari Sekobiri* is the General Assembly which constitutionally consists of the *Amanyano* of Kalabari, the Kalabari Council of Chiefs and the male citizens. This assembly is the ancient constitutional institution of the people, a constitution that is unwritten, but very well embedded in ancient traditions, customs, rights and privileges and cherished by the people. The monarchy, represented by the *Amanyano* is constitutionally the fountain of justice, head of both the executive and judicial systems and patron of the highest cultural cult or society, the Kalabari *Ekine-Ogbo*.

The day-to-day administration of Kalabari communities is however, vested on government-recognized community development committees (CDCs). Both the CDC and the youth group have the community's mandate to interact with government agencies and private organizations like the oil companies operating within their domain. The women groups ably led by vibrant women leaders are in charge of feminine affairs and contribute their quota to the community's development.

Conflicts and Conflict Resolution in Project Communities

Conflicts and contentious issues are resolved in the various project communities by dialogue among the traditional head (*Amanayabo*), the Council of Chiefs, the Community Development Committees, Youth and Women groups. In the event that a community member running foul of the law, the issue is handled from the lower organ- the youth or women group and the deviant is punished according to the gravity of the offence. Smaller crimes could lead to monetary fines, according to the nature and gravity of the offence. Serious cases therefore involve meting out serious punishment, including being handed over to the police.

People's Perception, Fears and Expectations of the Project

The welcome the project and are expecting as follows:

- creating more employment opportunities for people in the area;
- helping to boost the economy of the communities ;
- implementation shall accelerate the rate of development in the project communities through community development infrastructures;



- pipeline ROW is expected to open up new canal in the mangrove swamp along which fishing can profitably be carried out later in the life of the project;
- Income of land owners and families whose lands will be used for the laying of the pipelines will be enhanced (empowerment) by the project;
- more scholarships to be granted to sons and daughters of families in the communities and settlements by SPDC;
- left over sand should be used to backfill the swamps for building and construction of concrete walkways.

Health Status

Socio-Demographic Characteristics

The project communities were classified as: *major towns*, which are the renowned 'traditional' communities in the project area that were listed by the National Population Commission (NPC), they include Soku, Elem Sangama, Kula and the Oluasiri communities; and the *satellite settlements* include Krikakiri, Kala-onogi, Opu-onogi, Ababoko, Opukiri, Freetown, European Quarters, Newtown, Luckyland, Kongomaboko, Apiboko, Pinaro and Opropokiri. They are basically fishing settlements with few homesteads that serve as the operational bases for occupational fisher-folks from the major communities, and itinerant fisher-folks that have migrated from Andoni, Ijaw areas of Rivers State, and Ibibios from Akwa Ibom State. Some of the satellite communities like Freetown and Luckyland that are close to major oil facilities, also host young women and traders that derive their livelihood from their proximity to the oil facilities.

Fishing was the commonest occupation among household heads in the area. Most of the household heads were or had been married. Virtually all the household heads in the study area were Christians by religion, and about two-thirds were of the indigenous ethnic group. The average (median) number of persons per household was 5, which compares well with the National mean Household Size of 4.9 and 5.2 for Rivers State (inclusive of Bayelsa State) reported in the 1991 National Population Commission census reports. Regarding education, the 2008 National Demographic and Health Survey (NDHS) reported that the South South zone had the lowest percentage of persons who had never been to school, 8% among males and 15% among females.

Morbidity and Mortality Pattern

The prevalence of three commonest causes of ill health among children under-five years of age in the project area indicated that fever due to malaria remains an important consideration. Up to one-fifth of under-five children recorded a febrile illness in the two weeks preceding the survey. It is noted that this prevalence was higher than the national median of 15.9%. Though the prevalences of diarrhoea and ARIs (mainly due to pneumonia) were less in the region than the National figures, they were no less significant as causes of ill health among children.



Analysis of the Weekly Epidemiology Report for the period of the field study in August 2011, published by the Federal Ministry of Health on epidemic prone diseases, showed that Cholera and Cerebro-Spinal Meningitis were rare in Bayelsa and Rivers State. However, the cumulative number of measles cases in the two States totaled about 220, though there were no fatalities recorded.

Nutritional Status and Immunization

The levels of stunting (Height-for-Age), wasting (Weight-for-Height) and under-nutrition (Weight-for-Age) among under-five children in the project area were reported to be lower than the South South and National averages. Notwithstanding, the prevalence rates were high in particular for stunting, which is a reflection of long-standing poor diet and low socio-economic status, and also points deplorable environmental conditions in the communities. Anecdotal information gathered during the fieldwork indicate that the local staples were cassava, yam and plantain, which were often complemented with fish and shell foods, the major agricultural produce of the people. Several respondents, especially in Luckyland, pointed to a worsening food security situation, due to frequent oil spills that have reduced the fish and periwinkle yields in the area.

Access to Safe Drinking Water

Access to an improved source of drinking water i.e. piped source within the dwelling or plot, public tap, tube well or borehole, and protected well or spring in the project area appears to be higher than the national average. Though, disaggregated data suggests that the 'riverine' communities have poorer access. Information obtained from the field during Group Interviews showed that, while boreholes were common among respondents in the major towns, most of the respondents from the satellite settlements reported that they relied on rain water and hand-dug wells.

Most of the water facilities in the communities were provided by the government and its agencies like the Niger Delta Development Commission, and others by the oil companies as part of their social responsibility to the communities, or as part of the remediation for an oil spill. All the public water facilities provided by the government and its agencies were noted not to have any plan for their maintenance. It was also noticed that members of the communities often used discarded drums of drilling chemicals as water storage containers that have the potential of chemical contamination.

Access to Sanitation Facility

According to the 2008 NDHS Report, the proportion of households with access to improved toilet facility was 6.1%, 19.6% and 22.7% in Bayelsa State, Rivers State and South South zone respectively. Social infrastructure has been noted to be sparse in the Niger Delta especially in the remote, often riverine areas, similar to the project communities. Direct Observation during fieldwork revealed that the jetty-type (over-hung) toilets were common in the project communities, and more in the fishing settlements than in the major towns. Responses from the group interviews also indicated that access to a proper toilet facility was better in the major communities.



Jetty-type or over-hung toilets grossly contaminate surface water, and are not technically considered a proper toilet facility. It was also observed that some households in the major communities practiced the channeling of sullage from water-flush toilets into the surface water bodies because of the problem posed by the high ground water level in the communities.

Waste Management

The wastes generated in the communities were observed to be mainly refuse and other domestic wastes. These wastes were often dumped close to residential accommodation, or at the bank of the river, where they sometimes served for land reclamation and/or shoreline protection. Leachates from the wastes can however become a source of contamination of water bodies..

Housing Characteristics

From Direct Observation, the preponderant form of building materials in the major communities (such as Elem Sangama and Kula) was cement block walls and corrugated iron roofing sheets. This contrasted with the housing conditions observed in the satellite fishing settlements (such as Pinaro), which were mainly mud walls with thatch roofs, or mud walls with corrugated iron roofs.

The 2008 NDHS Report showed that not many households in the project area own insecticide-treated mosquito nets (ITNs) or reported that household members sleep under them.

Air Quality

The results of the outdoor air quality measurement were basically within FME_{env} levels. Industrial activities are commonly the source of pollution of out-door air quality, while indoor air quality is usually compromised by domestic or related activities. The use of firewood and other bio-mass fuel as domestic fuel is a major cause of indoor air pollution, with wide-ranging health implications. Firewood is a common source of fuel for domestic use in the Niger Delta. An average of 73% of households in Niger Delta communities use firewood as their primary energy source.

Knowledge of HIV/AIDS and Sexual Behaviour

According to the 2008 NDHS Report, men and women of reproductive age in Rivers and Bayelsa States recorded proportions higher than the National median for those with multiple sex partners within a year. Despite this, the proportion of men with comprehensive knowledge of HIV/AIDS within the region is relatively low at 37.0% for South South, even though higher at 42.8% for Rivers State and 76.2% for Bayelsa State when compared to the National figure of 44.9%.

Anecdotal information from the project communities suggested that it is perceived that a man is culturally permitted to engage in extra-marital affairs while fidelity in marriage was for women. Some of the project communities, especially the satellite communities like Freetown and Luckyland that are close to oil and gas facilities, have a history of accommodating Commercial Sex Workers (CSWs), when there is a major project.



Project-induced influx of migrant population including working class population and “camp followers” is usually associated with an increase in the prevalence of HIV/AIDS and other STIs in the area.

Health Care Infrastructure

Soku and its neighbouring communities are served by the *Soku Cottage hospital*, located within the recommended 20-minute travel time from each of the catchment communities. The cottage hospital was built by SPDC, but handed over to the Akuku-Toru local government council for management. As at the time of field study, the health facility had the full complement of equipment and staff expected for a comprehensive health center. However, the hospital was grossly under-utilized, not helped by the fact that it was open for at most two weeks in a month, and never had a 24-hour service. The poor utilization and truancy were however blamed on the crisis in the area.

Elem Sangama and its neighbouring communities are served by the *Elem Sangama Comprehensive Health Center*, built by SPDC, but handed over to the Akuku-Toru local government council for management. As at the time of field study, the health facility a monthly consultancy by a medical doctor, made possible by the community’s health committee. However, the pharmacy lacked most of the essential drugs, and did not have a proper drug revolving fund. Like the Soku cottage hospital, the Elem Sangama comprehensive health center was grossly under-utilized, and was open for a few hours, on specific days. This poor utilization is in spite of the staff residential quarters being built close to the health center. The staff of the health center blamed the poor utilization on the past crisis in the area.

Kula and its neighbouring communities including the satellite communities of the project area are served by the *Kula Primary Health Care center*, located within the recommended 20-minute travel time from each of the catchment communities. The Kula health center had a staff strength that is up to the required number for a primary health center in Nigeria. Most of the medical equipment donated to the health center by SPDC were non-functional; but the staff were committed in ensuring that basic services were provided, and were ready to put in extra duty shifts. This perhaps explains the high level of utilization of the facility, as a daily average of three patients was treated in the facility, in the second quarter of 2011. The Rivers State government is however, constructing a new model primary health care center in the community.

Abonnema General Hospital is the nearest secondary health care facility in to project communities. It is situated at Abonnema, the Akuku-Toru LGA headquarters, which is within 50 minutes by speedboat ride away from the proposed project area. It has the manpower and facilities expected of a secondary health care facility; with the capacity to attend to out-patient and in-patient care, surgery, and accident and emergency care. However, the utilization of the facility was noted to be below expectation, due to a variety of reasons, amongst which was staff truancy.

None of the health care facilities in the communities had a boat ambulance, and were not served by the Rivers State Emergency Medical Service. Individuals make their own



private arrangement in convening their sick and wounded for emergency treatment. It would cost as much as seventeen thousand Naira (N17,000) to charter a boat to convey a critically sick patient, from most of the communities to Port Harcourt for specialist care at the Braithwaite Memorial Specialist Hospital or the University of Port Harcourt Teaching Hospital.

Alternative health care, in the form of Patent Medicine Vendors and traditional medicine practitioners (especially Traditional Birth Attendants and Bone-setters) were observed in the project communities, especially in the satellite fishing settlements that lacked a health facility within the community.

Consultation

The consultation process for the EIA was undertaken at an early stage of the project and helped to develop the scope of issues addressed on the proposed project activities. This consultation was accorded high priority as to capture and address issues and concerns of stakeholders and any other legislative issues. The consultation with the identified stakeholders for the Soku Gas Plant - San Barth Manifold Pipeline project was designed to be a continuous process throughout the development and operation of the facilities.

A scoping workshop was held in Port Harcourt and served as the first interactive session organized by the proponent of this project -the SPDC, with various stakeholders and communities involved in the project. The project communities are listed in the Socio-economics and Health sections of this report. The project communities are from the Akuku-Toru LGA of Rivers State and Oluasiri in Nembe LGA of Bayelsa State.

The main objectives of the consultation for the Soku Gas Plant - San Barth Manifold Pipeline Project are as follows:

- Maintaining effective communication between SPDC and the project communities.
- Assuring full commitment to implement mutually accepted and sustainable community development Projects.
- Facilitating communication and understanding between the various stakeholders and SPDC.
- Gaining support and buy-in from all relevant stakeholders
- Complying with mandatory statutory requirements;
- Identifying issues relevant to the project which are likely to cause impacts;
- Avoiding conflict with the primary stakeholders by addressing issues promptly;
- Ensuring that any apprehension and disenchantment about the project with respect to environmental impacts are given the required attention by sensitizing, and mobilizing the project communities to express their concerns vis-a-vis the potential impacts of the project;
- Providing a link between the communities and SPDC in order to obtain early notification of any changes in the environment as a result of the project;
- Understanding stakeholders' views of the project with respect to the present environmental conditions in the area and any changes thereof in the future;



- Assessing the participation of the project communities in maintaining and sustaining the beneficial impact of the project;
- Maintaining continuous interaction with the project communities to obtain early warning information on the physical, chemical, biological, health, and social components of the environment to resolve detrimental consequences during the construction and operational phases of the project;
- Identifying legacy issues associated with previous activities in the locations prior to their abandonment.

The proponent (SPDC) shall continue to consult with all relevant parties throughout the execution of this project. Significant comments from communities/individuals consulted would be given due attention until the contract closes out for the proposed Soku Gas Plant – San Barth Manifold Pipelines Project.

Associated Potential Environmental Impacts

There are a number of approaches for the prediction and evaluation of impacts. The ISO 14001 method was selected for the identification and evaluation of impacts for the proposed Soku GP-San Barth Manifold Pipeline Project.

The high and medium negative impacts for the project are as follows:

- Reduction of access to land and its resources
- Encroachment on culturally sensitive sites
- Third party agitations
- Legacy issues
- Opportunity for income generation
- Improved health status/quality of life
- Water traffic accidents.
- Pirates/ armed bandit attacks/ kidnappings
- Contamination of surface water from release of petroleum products
- Disruption of fisheries activities
- Increase in surface water turbidity
- Community agitation
- Injuries and deaths
- Increase in morbidity
- Sexually transmitted infections including HIV/AIDS
- Destruction of vegetation
- Exposure of workers to wildlife attack
- Loss of wildlife habitat
- Increase in erosion of the cleared area
- Increase in access for hunting
- Hazardous Waste generation
- Availability of fuel wood
- Noise and vibration
- Habitat fragmentation
- Increase in Social vices



- Opportunities for Employment
- Improved health status and quality of life
- Recruitment of Labour
- Damage to archeological artifacts
- Change in topography of the area
- Acceleration of erosion
- Destruction of fauna habitat.
- Alteration of soil profile (acidification)
- Soil Acidification from Dredge spoil Deposition
- Flooding
- Reduction in air quality
- Visual impairment from high intensity welding flash
- Radiation burns and sickness from exposure to radioactive emissions
- Blockage of waterways and possibility of maritime accidents
- Disruption of fisheries activities
- Alteration of soil profile/river bathymetry
- Hearing impairment from noise
- Contamination/ pollution of surface water / land
- Fire/blow-outs from process up-sets
- Mental stress and illness
- Contamination of water, sediments and soil from oil spill
- Destruction of Assets and Properties from any Fire Incident
- Increase in access to hunting and fuel wood
- Shift from traditional occupations to other activities
- Third party agitation
- Impairment of air quality
- Loss of job opportunity

Mitigation measures were put in place to bring the negative and adverse impacts to as low as reasonably practicable. The beneficial positive impacts shall be enhanced by applying SPDC's policies of ensuring the development of its areas of operation via its Global memorandum of Understanding (GMoU).

Environmental Management Plan

SPDC recognizes that the development of an effective and integrated Environmental Management Plan (EMP) facilitates better achievement and demonstration of sound environmental performance. Moreover, environmental management is seen as the means of ensuring that the commitments specified in this EIA are properly managed and that unforeseen or unidentified impacts of the proposed project are detected and managed.

In line with SPDC HSE policy of good environmental practice, an achievable EMP of the Soku-San Barth Pipeline Project has been designed in accordance with existing regulatory specifications.

ACKNOWLEDGEMENT

The Shell Petroleum Development Company of Nigeria Limited (SPDC) wishes to acknowledge the opportunity granted by the Government of the Federal Republic of Nigeria through the Federal Ministry of Environment (FMEnv) and the Department of Petroleum Resources (DPR) to conduct this EIA for the Soku Gas Plant-San Barth Manifold Pipeline Project in recognition of the National Regulatory Requirements and Standards, the Shell Group and International Specifications.

We appreciate the cordial working relationships we had with Federal Ministry of Environment, Department of Petroleum Resources (DPR), Rivers State Ministry of Environment, and Local Government Representatives from Rivers, and the elders, Chiefs and Youths of all the project communities / settlements and for their various roles towards the successful conduct of the EIA. The efforts of the project team and Consultants in putting this EIA together are also greatly commended.



EIA PREPARERS

MABOTES Nigeria Limited Baseline Personnel

Prof. P.A Akomeah (Botanist)	Vegetation /Team leader
Dr .M.O. Osuide (Chemist)	Air Quality
Dr. H. Isitekhale (Soil Scientist)	Soil
Dr. Afam Anene	Aquatic (Surface water/ Sediment/Hydrobiology /fishes)
Dr. C. Oke	Wild life /Animal Ecology
Mr. F. Ossai (Geologist)	Hydrogeology/Geophysics
Mr. M. O. Ojile (Environmental Management)	SIA
Dr. B. Ordinoha (MBBS)	HIA /First Aider
Mr. E. M. Abai	Surface Water/ QAQC
Mr. S. C. Morah	Project Manager/ Air Quality
Mr. Oscar Tango	Safety Officer
Mr. Uwadinsu Prosper	Borehole Driller
Mr. Friday Esejowo	Borehole Driller
Mr. Okei A.	Borehole Driller
Mr. Emmanul. Obiero	Borehole Driller

Baseline Review and Impact Assessment



Dr. Chibuogwu Eze	Biophysical
Mohammed Hamadina	Biophysical
Dr. Andrew Aboje	Biophysical
Dr. Chris. O. Emerole	Socio-economics
Dr. Seye Babatunde	Health

SPDC Personnel

Oby Moore	Environment Manager
Ebun Umoren	EIA Team Leader
Peter-Claver Nwaiwu	Impact Assessment SME
Onyeka Obiora	Impact Assessment Adviser
Uche O Chukwura	Project EIA Inspector
E.S.K. Uzoma	Project Supervisor
Ebere Nebedum	HSE Officer
Richard Amaewhule	HSE Officer
Simon A.	Geomatics
P.E. Bature	Security Adviser

Regulators/ Community Consultants

Mr. Daniel Obani	FMENV
Mr. Isaac Nwankwo	Rivers State Ministry of Environment
Mr. Davies Fiala	Community Consultant
Mr. Sobia Awara	Community Consultant
Dr. Nwabueze Ebere	Community Consultant
Mr. Ibe Enyinaya	Community Consultant





CHAPTER ONE

INTRODUCTION

1.1 Background

The Shell Petroleum Development Company of Nigeria Limited (SPDC), on behalf of the Joint Venture partners (Nigerian National Petroleum Corporation, Nigerian Agip Oil Company, and Total E&P) intends to embark on the Soku Gas Plant–San Barth Manifold Pipeline Project to meet the business objectives of oil and gas supply.

The project area spreads from Akuku Toru Local Government Area in Rivers State to Nembe Local Government Area in Bayelsa State in the Niger Delta (Figure 1.1). The map showing of the proposed project area in Rivers and Bayelsa States respectively and the surrounding areas is presented in appendix 4. The proposed project right of way is as indicated on the left corner of the map. The project traverses six main communities and several settlements across two local government areas. The local government area in Rivers state is Akuku-Toru and the communities are Soku, Elem Sangana, Kula, Benema and Offionoma. The local government area in Bayela state is Nembe and the community is Oluasiri. The proposed project is the construction of a 12” x 22 km oil pipeline from Soku Gas Plant to San Barth Manifold (mfd). The pipeline will start from Soku Gas Plant (GP), and shall run parallel to the existing EGGS-1 pipeline up to the Old Ekulama Junction Manifold, from where it shall continue along the existing 18” Ekulama 2 Flowstation (FS) – Soku GP AGG pipeline, and branch off close to the Ekulama 2 FS (without getting into the flow station). It will pass through the New Ekulama Junction Manifold and terminate at the San Barth Manifold along the Nembe Creek –Cawthorne Channel Trunk Line (NCTL). The total area of the project is 79.5 hectares.

The following indicate the start point and termination for the three pipelines:

Line 1: (Liquid Pipeline): 12” x 22 km (11.13 mm wall thickness), start from Soku Gas Plant and terminate at new San Barth Manifold.

Line 2: (Liquid Pipeline): 10” x 4.5 km (11.13 mm wall thickness), start from Soku Flowstation and terminates at Soku Gas Plant.

Line 3: (Associated Gas –AG Pipeline): 10” x 4.5 km (11.13mm wall thickness), start from Soku Flowstation and terminate at Soku Gas Plant.



Figure 1.1: Location of Rivers and Bayelsa State

1.2 Scope and Objectives of the EIA

The proposed project will be executed in conformity with SPDC’s policy on the preservation of the environment. However, in order to fully protect the environment during project implementation, an Environmental Impact Assessment (EIA) has been commissioned, which is the subject of this report.

The general scope of the EIA will cover all the activities that constitute the project. It will outline the techniques and methodologies to be used in data generation and gathering, including the description of the data sources; and impact identification, prediction, evaluation and management. The following categories will be covered:

- Baseline Data Acquisition
- Literature Review
- Field Work
- Laboratory Analysis
- Data Analysis and interpretation
- Consultation/Stakeholder Engagement
- Evaluation and Prediction of Potential Impacts
- Determination of Appropriate Mitigation Measures
- Environmental Management Plan
- Report Preparation

The objectives of the EIA study are as follows:

To establish the baseline conditions of the project area with respect to the biophysical, social and health environment.



To identify and evaluate the potential impacts of the project activities on the biophysical environment of the area.

To identify and assess the potential socio-economic effects of the project on the livelihood patterns, including impacts on cultural properties, social infrastructures, natural resources and values of communities in the area.

To identify and evaluate health impacts that may be associated with different activities of the project.

To develop cost-effective mitigation measures for significant impacts and appropriate Environmental Management Plan (EMP) for sustainable development.

1.3 Legal and Administrative Framework

The project proponent complies with all environmental statutes/regulations / conventions.

Therefore, the proponent has identified the legislations, laws, conventions, etc., that could be relevant to the proposed activity and these are detailed below.

Regulatory Agencies/Institutions

The study area is located across Rivers and Bayelsa States of Nigeria, therefore the two states have jurisdictions over the proposed activity. The proponent is also bound by industry-specific legislation within the oil and gas industry in Nigeria. The federal agencies that oversee the environmental aspects of oil and gas industry activities include:

Federal Ministry of Environment (FMEnv);

Department of Petroleum Resources (DPR);

National Oil Spill Detection and Response Agency (NOSDRA); and

Nigerian Maritime Authority (NMA).

At the State level, the relevant agencies include:

Rivers State Ministry of Environment

Bayelsa State Ministry of Environment

National Legislation

In Nigeria, there are specific laws, guidelines and standards that are applicable to every development including pipeline project. A summary of the relevant laws, guidelines and standards for infrastructure development include the following:

The Environmental Impact Assessment (EIA) Act No. 86 of 1992.

Department of Petroleum Resources (DPR) Environmental Guidelines and Standards for the Petroleum Industry in Nigeria, (revised Ed.) 2002.

Department of Petroleum Resources (DPR) Mineral Oils Safety Regulations 1997

FEPA (now FMEnv) EIA Procedural Guidelines, 1995

S.I.8 - National Environmental Protection (Effluent Limitations) Regulations of 1991

S.I.9 – National Environmental Protection (Pollution Abatement in Industries and Facilities Generation Wastes) of 1991

S.I.15 – National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations of 1991

The Petroleum Act No. 51 of 1969

The Oil Pipeline Act and Oil and Gas Pipeline Regulation of 1995

Control of International Trade on Endangered Species (CITES) Act of 1985

Land Use Act of 1978

National Inland Waterways Authority (NIWA) Act 13 of 1997

Factory Act 1992

Revised National Health Policy, 2004

National Health Act 2005



National Guidelines and Standards for Environmental Protection 1991
The Petroleum (Drilling & Production) Regulations of 1969
Associated Gas Re-injection Act of 1979
National Emergency Management Agency (Establishment, etc.) Act 1999;
National Master Plan for Public Awareness (PA) on Environment and Natural Resources Conservation in Nigeria 1990;
Harmful Wastes (Special Criminal Provisions etc.) Act 1988;
Mineral Oils (Safety) Regulations 1997;
Oil In Navigable Waters Act 1968;
Endangered Species Act No. 11, 1985.

These laws are relevant in ensuring that the various aspects of the project such as land acquisition, site preparation, mobilization and transportation, excavation of pipeline route, welding and stringing, pipeline laying, hydrotesting, etc are carried out in a manner that ensures the protection of the human, biophysical, and socio economic aspects of the environment.

State Regulations

Bayelsa State Environment and Development Planning Authority Edict 1998
Public Health Law – CAP 103 of the Laws of Eastern Nigeria 1963
Bayelsa State Forestry Law 1998
Bayelsa State Land Use (Environmental Degradation/Protection) Charge Law 2005
Rivers State Environmental Protection Law, Edict No.2 of 1994
Interim Guidelines and Standards on Pollution Control and Management in Rivers State, 2002
Rivers State Forestry Laws (Cap 55) of 1975

International Agreements, Protocols and Conventions

The international conventions, protocols and agreements relevant to the execution of the proposed project include the following:
Convention on the Territorial Sea and Contiguous Zone. Adopted on 29th April, 1958 in Geneva, ratified by Nigeria on 18th June 1962
African Convention on the Conservation of nature and Natural resources adopted on 15th September 1968 in Algiers, and ratified by Nigeria on 16th June 1969
Paris Convention Concerning the Protection of the World Cultural and National Heritage (World heritage Convention), which was adopted.
Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES); adopted on 3rd March 1973 in Washington DC
The Abidjan Convention for Co-operation in the Protection and Development Of the Marine and Coastal Environment of the West and Central African region, which was adopted on 23rd March 1981 and ratified on 6th June 1984
The Vienna Convention for the protection of the Ozone Layer, which was adopted on 22nd March 1985 and ratified on 31st October 1988
Montreal Protocol on Substances that deplete the Ozone Layer (Note: the protocol was amended on 29 June 1990 in London A second set of Amendments were adopted in Copenhagen in November 1992; and entered into force on 1994). Adopted on 16th September 1987;ratified on 31st Oct. 1988
Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal, which was adopted in 22nd March 1989 and ratified by Nigeria on 13th March 1991.



International Convention on Oil Pollution Preparedness, response and Cooperation. Adopted in London on 30th November 1990 and ratified on 25th May 1993.

Framework Convention on Climate Change. This convention was adopted on 9th May 1992, and Nigeria ratified it on 29th August 1994

Nairobi Convention on Biological Diversity. Adopted on 22nd May 1992 and ratified on 27th August 1994.

1.4 Terms of Reference for the EIA

In compliance with the EIA Procedural Guidelines of 1995, the Project Proposal and Terms of Reference (ToR) were submitted by SPDC to the Department of Petroleum Resources (DPR) for approval.

The ToR for the EIA of the Soku Gas Plant–San Barth Manifold Pipeline Project was developed through extensive stakeholder consultation at the initial stages of project conception, and approved by DPR. The consultation was organized in order to identify and define the project activities and aspects that may have significant environmental effects as well as scope the environmental baseline data needed as basis for impact assessment. The EIA will establish the environmental issues associated with the project; predict their impacts and magnitude; suggest and evaluate project alternatives; and recommend mitigation measures and Environmental Management Plans (EMP) to ensure environmental friendliness and sustainable development. The summary of the scope of the EIA as contained in the TOR is as follows;

Literature Review

Detailed description of the project

Baseline Data Collection

Field work and laboratory analysis

Impact identification, prediction and assessment

Determination of Appropriate Mitigation

Development of an Environmental Management Plan (EMP) and Monitoring Measures

Decommissioning /Abandonment Plan

1.5 Declaration

The Shell Petroleum Development Company of Nigeria Limited (SPDC), in her capacity as the technical operator of the NNPC/Shell/Total/NAOC Joint Venture (JV) and on behalf of her partners, proposes to construct two 10” x 4.5 km pipeline from Soku FS to evacuate oil and associated gas from Soku GP; and a 12” x 22.4 km pipeline to transfer the oil, co-mingled with Soku GP condensate, to New San Barth Manifold in the NCTL network; and hereby declares her intention to abide by the existing international and national laws and regulations regarding environmental protection during the project.

The management of SPDC is committed to the implementation of the Environmental Management Plan (EMP) proposed in this EIA report and avows that it has prepared this EIA report using the best available expertise in personnel, equipment, national and internationally acceptable methods.

1.6 Structure of the Report

This report is divided into chapters as follows:

Chapter One introduces the study and gives background information;

The Project Justification and Project Description are detailed in Chapters Two and Three, respectively;

The baseline bio-physical, socio-economic and health conditions are discussed in Chapter Four;

The identified potential and associated impacts of the projects are discussed in Chapter five; Chapter Six contains the mitigation measures proffered for the identified potential impacts;

The environmental management plan is detailed in Chapter Seven; while

The conclusions are presented in Chapter Eight.

CHAPTER TWO

PROJECT JUSTIFICATION

2.1 Project Background

The Shell Petroleum Development Company of Nigeria Limited (SPDC), as the operator of the NNPC/Shell/Total/NAOC joint venture and on behalf of its partners, plans to embark on further development of oil and gas reserves in SPDC's Soku Gas Plant-San Barth in the Ekulama field.

The pipeline project being proposed offers an alternative to the evacuation of oil from Soku Flowstation (FS) to Bonny Oil and Gas Terminal (BOGT) through the Greater Port Harcourt Swampline (GPHSL) Trunkline that has problems with material integrity and third party activities. In addition, it provides an alternative to the evacuation of condensate from Soku Gas Plant (GP) that used to flow through the existing 18" Ekulama II–Soku GP Pipeline via the Nembe Creek–Cawthorne Channel Trunk Line (NCTL) that has also been rendered unserviceable by third party activities.

The proposed project is a pipeline construction project consisting of two legs. The first is the construction of a 10" x 4.5 km pipeline from Soku FS to evacuate oil to Soku GP. The second leg is the construction of a 12" x 22 km pipeline to transfer the oil upon mixing it with the condensate at Soku GP to the New San Barth Manifold on the NCTL; and along the way, receive the crude from Ekulama II and Ekulama I from Soku Gas Plant to the New San Barth Manifold.

2.2 Project Objectives

The key objectives of the project are:

To provide evacuation capacity for Soku Flowstation liquids and AG to Soku Gas Plant via two 10" x 4.5 km pipelines

Evacuate Soku Gas Plant (LGSP) Condensate via a 12"X 22 km pipeline from Soku Gas Plant (LGSP) onwards to the recently completed Nembe Creek Trunk Line (NCTL) at San Barth Manifold.

To satisfy DPR requirements and maintain Licence to Operate (LTO) for Soku Gas Plant (LGSP).

2.3 Need for the Project

The proposed project will convey oil from the Soku Flowstation to Soku Gas Plant where it will be commingled with the condensate to make it less attractive to third party activities from Soku GP to NCTL San Barth Manifold. This will enable unconstrained production of the Ekulama field. The condensate-crude oil mixture will eventually be separated, and the produced crude exported.

2.4 Envisaged Benefits

The envisaged benefits of the proposed project shall include the under listed:

- Increase in crude oil output from SPDC east operations;
- Significant increase in Nigeria's GDP from increased crude oil export and revenue;
- Unconstrained oil and gas production from the Ekulama field;
- Increase in revenue to the project communities from local content dividends;
- Increase in project communities' access to development intervention projects;
- Increase in opportunities for reduction of environmental pollution occasioned by aged pipelines;

2.5 Envisaged Sustainability

The envisaged sustainability of the project is categorized as follows:

Economic Sustainability

Significant quantities of oil and gas are contained within the SPDC's Ekulama field. This project is therefore expected to ensure continuous availability of oil and gas for the company's numerous customers. It will ensure continuous partnering with citizens of the project communities in terms of local content and GMoU.

Technical Sustainability

The proponent is an Exploration and Production (E & P) operator with several decades of experience, and proven ability to construct and maintain the Soku Gas Plant-San Barth Pipeline. There shall be strict adherence to nationally and internationally acceptable engineering design and construction standards, and innovative technologies that are technically sound and environmentally friendly.

Environmental sustainability

Pipeline construction techniques and other oil and gas field development projects vary according to the environment, and are guided by regulatory and engineering design standards. Pipelines in marshy/swampy areas and water crossings would have a yard-applied concrete coating over the corrosion inhibitor coating. Environmental protection shall be the guiding principle at every phase of this project execution. This would ensure maintenance of SPDC's integrity, and ensure that incidents that could negatively impact the environment are reduced to as low as possible.

The incorporation of the findings and recommendations of this EIA at the appropriate stages of the project development and strict adherence to the EMP shall ensure environmental sustainability.

2.5.4 Social Sustainability

Shell Petroleum Development Company ensures is continuous partnering with the citizens of project communities in terms of local content and Global Memoranda of Understanding. This shall ensure the social sustainability of the proposed project. It will ensure continuous partnering with citizens of the project communities in terms of local content and GMoU.

2.6 Project Alternatives

Project alternatives were considered with respect to the overall project concept and route. These alternatives are discussed in detail below.

Overall Project Alternatives

Option 1: No Project Option

This is a situation in which the existing old pipelines with impaired integrity are allowed to stay. This option runs counter to global best practices in the management of pipelines and would amount to damage to the reputation of SPDC and her partners including the Federal Government of Nigeria. It would encourage frequent spills into the environment that would raise conflict and friction between the company and the project communities. This option, on grounds of technical, economic and environmental defaults was not acceptable to SPDC, the proponent of this project.

Option 2: Replacement of Existing Pipeline

This would involve excavating and replacing the existing old pipelines that the proposed project is intending to substitute. This option would involve a longer route to achieve the same purpose. This option was equally not acceptable to the project proponent.

Option 3: Construction of Three Deeply-Buried and Water-Covered Pipelines

This option involves the construction of two 10” x 4.5 km pipeline from Soku FS to evacuate oil and Associated Gas to Soku GP. The second leg is the construction of a 12” x 22 km pipeline to transfer the oil upon mixing it with the condensate at Soku GP to the New San Barth Manifold on the NCTL. These pipes would be buried to a depth of 4.5 meters in a rostrum-shaped trench with a surface width of 8.0 meters. The excavated trench with the pipes would be backfilled with the spoil to a depth of 1.5 m from the surface, leaving an overlying water column. The overlying water is intended to make it difficult for illegal ‘bunkering’. More so, as the liquid flow within the pipes would be a mixture of crude and condensate; it will be less attractive to illegal ‘bunkering’. Therefore, this option is the preferred one.

The preferred option of construction of two deeply buried and water covered pipelines is preferred also because it is technically achievable by the proponent. The construction of these pipelines in deep trenches covered with water is also aimed at reducing to a significant level vandalism of pipelines with the associated adverse effect on the economy of the nation and the environment of the area.

2.7 Estimated Value of the Project

The estimated value of the project is about U\$232 million.

CHAPTER THREE

PROJECT DESCRIPTION



Nature of the Proposed Project

The Shell Petroleum Development Company of Nigeria Limited (SPDC) intends to embark on the Engineering, Procurement and Construction (EPC) of:

10” x 4.5 km Soku Flowstation –Soku Gas Plant Oil Pipeline;

10” x 4.5 km Soku Flowstation –Soku Gas Plant Gas Pipeline

12” x 22 km Soku-New San Barth Manifold Oil Pipeline; and

Associated facilities such as riser hangers, tie-ins, pig traps, manifolds, cathodic protection, etc.

The specific details of the facilities include the following:

Soku FS – Soku Gas Plant 10”x4.5 km (Oil Pipeline)

Soku FS – Soku Gas Plant 10”x4.5 km (Gas Pipeline)

Soku Gas Plant – Ekulama II Tie-in Point (underground) 12”x16 km

Ekulama II Tie-in Point – Ekulama I Tie-in Point (underground) 12”x3 km

Ekulama I Tie-in Point – New San Barth Manifold 12”x3 km

A total of 6 nos. pig traps along the pipeline.

One of the 10” x 4.5 km pipeline will evacuate Soku Flowstation liquid to Soku Gas Plant to be co-mingled with condensates at the Soku Gas Plant. The second 10” x 4.5 km pipeline will evacuate associated gas from Soku Flowstation to Soku Gas Plant. The co-mingled crude oil and condensate will then be transported via the 12” x 22 km pipeline, from Soku Gas Plant to the San Barth New Manifold, to be bulked into the NCTL trunkline. The pipeline will also receive crude from Ekulama II and Ekulama I flowstations downstream the Soku GP.

The 12” x 22 km pipeline will follow a new RoW of 30m width, running alongside the existing EGG-1 route up to the old Ekulama junction manifold, from which it continues within the new RoW of 15m width along the existing 18” Ekulama 2-Soku GP AG line route up to Ekulama 2 FS. The pipeline then continues within a new 10m-width RoW alongside of Ekulama delivery line route to the new NCTL San Barth manifold. The pipeline will traverse 24 rivers/creeks, but will not cross any existing pipelines or forest reserve (Figure 3.1).

Existing Facilities in Relation to the Proposed Pipeline

Soku FS-Soku GP stretch

The oil delivery line from Soku FS to Soku GP will follow adjacent to the existing SPDC RoW (for existing 18” AG gas line and existing 10” condensate line from Soku FS to Soku gas plant), with an approximate length of 4.50km and 5 rivers /creeks crosses (Table 3.1). The pipeline route is shown in Figure 3.2 and defined by the coordinates for nodes of ABC, while the details of existing facilities are:

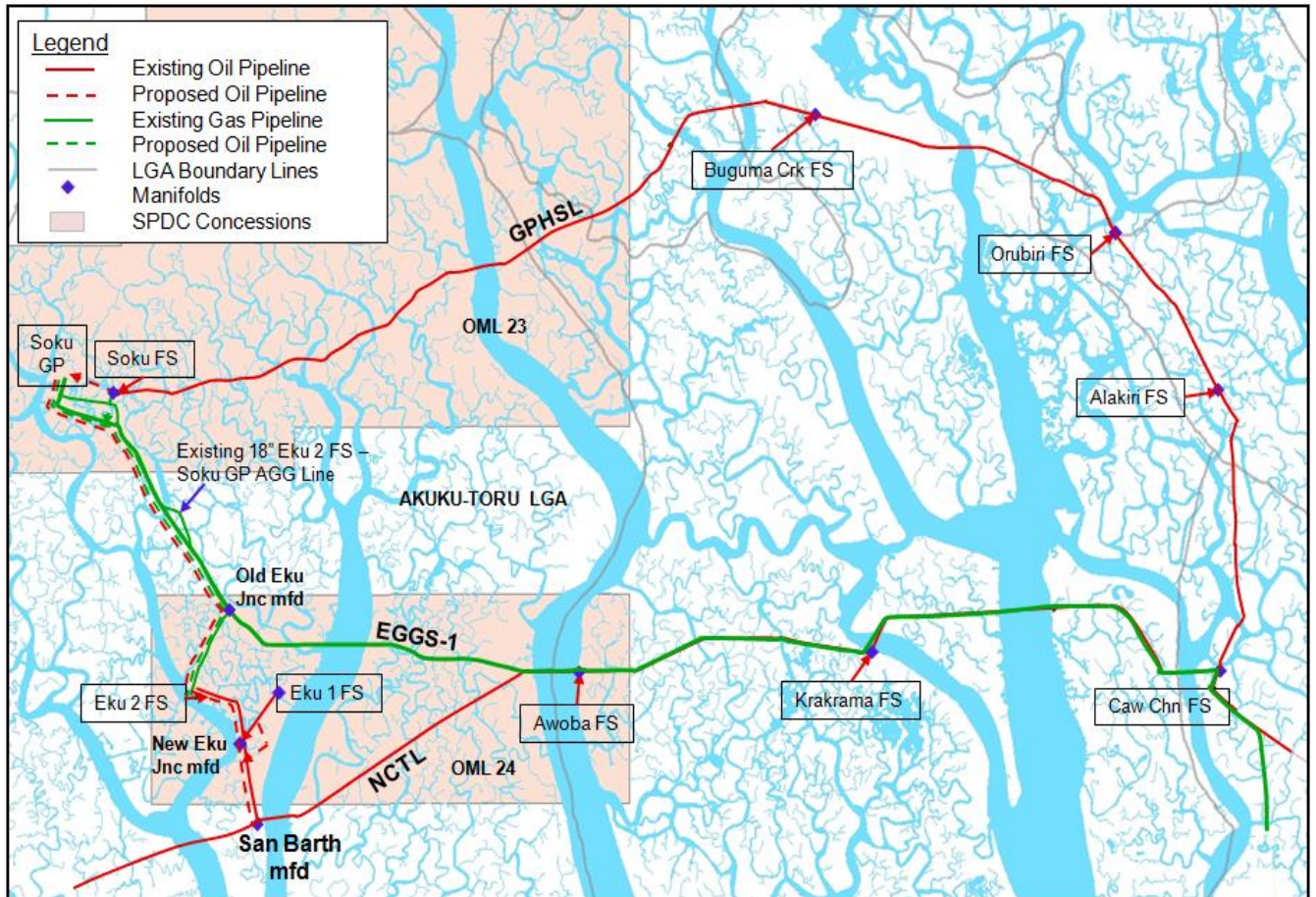


Figure 3.1: Soku-San Barth Pipeline Layout

Table 3.1: Summary of existing pipeline facilities along Soku FS-Soku GP stretch

Pipeline Section	Approx. Pipeline Length	No. Of Existing Pipelines	Name of Existing Pipelines	No. Of River Crossings	Average Width of Crossing
A-B	0.83km	6	18" 18" Soku FS to Soku GP HP AG 28" Santa Barbara MFP to Soku GP 18" Ekulama FS-Soku GP AGG 8" Belema AGG GP to Bonny Gas (EGGS1) 10" Soku GP to Soku FS condensate line	1	30.64m
B-C	3.37km	2	18" 18" Soku FS to Soku GP HP AG pipeline 10" Soku GP to Soku FS condensate line	4	70-90m



Node ID	Eastings	Northings
A	461218.45	72858.08
B	461164.43	72156.53
C	463522.08	72048.34

Figure 3.2: Layout of Soku FS – Soku GP stretch and the node coordinates

Soku GP-Soku New San Barth Manifold

This stretch will follow an existing 18” Ekulama II–Soku GP AG export pipeline, which was installed in 2000 for gathering associated gas to the Soku Gas Plant (GP) for further processing and transmission to LNG Plant in Bonny. There is also the Greater Port Harcourt Swamp Line (GPHSL) that evacuates condensates from Soku Plant to the Bonny Oil and Gas Terminal (BOGT).

The proposed 10” Soku FS oil delivery conveying crude oil from the flowstation to Soku Gas Plant will commingle with the condensate and then run from Soku GP to San Barth manifold the proposed 12”x22km pipeline. This Pipeline shall also receive the crude oil of Ekulama II and Ekulama I where crossing their adjacent areas at the relevant tie-in points. The 12” Soku-San Barth pipeline will follow the existing EGGs-1 route up to the old Ekulama junction manifold, then continues along existing 18” Ekulama 2-Soku GP AG line route up to Ekulama 2 FS and joins the Ekulama delivery line route to the NCTL San Barth manifold. The details of facilities found along this stretch are shown in Table 3.2 and the schematic diagram of the route is shown in Figure 3.3.

Table 3.2: Summary of Existing Pipeline Facilities along Soku GP-San Barth Stretch

Pipeline Section	Approx. Pipeline Length	Nos. of Existing Pipelines	Name of Existing Pipelines	Nos. of River Crossings	Average Width of Crossing
A-B	0.83km	6	18” SokuFS to Soku GP HP AG 28” Santa Barbara MFP to Soku GP 18” Ekulama FS-Soku GP AGG 8” Belema AGG GP to Bonny Gas (EGGS1) 10” Soku GP to Soku FS condensate line	1	30.64m
B-X	0.40km	1	40” Soku GP to Bonny Gas (EGGS1)	Nil	Nil
X-D	2.68km	1	40” Soku GP to Bonny Gas (EGGS1)	4	65-128.57m
D-F	3.45km	3	18” Ekulama FS-Soku GP AGG 8” Belema AGG GP to Soku GP 40” Soku GP to Bonny Gas (EGGS1)	1	73-113.34m



F-H	2.15km	1	40” Soku GP to Bonny Gas (EGGS1)	4	1-236.18m
H-I	2.59km	3	18” Ekulama FS-Soku GP AGG 8” Belema AGG GP to Soku GP 40” Soku GP to Bonny Gas (EGGS1)	5	46.43-90.22m
I-T	0.90km	2	40” Soku GP to Bonny Gas (EGGS1) 18” Ekulama FS-Soku GP AGG	2	24-33.57m
T-S	2.36km	2	18” Ekulama FS-Soku GP AGG 8” Belema AGG GP to Soku GP	2	41.32-46.74m
S-R	0.08km	1	8” Belema AGG GP to Soku GP	Nil	Nil
R-Q	1-90km	4	8” Belema AGG GP to Soku GP 10” Ekulama 2 FS to San Barth MF Delivery line 12” Ekulama FS to Ekulama 2 FS AGG 6” Ekulama 2 FS to Ekulama FS (Gas)	4	13.09-32.58m
Q-P	0.44km	2	8” Belema AGG GP to Soku GP 10” Ekulama 2 FS to San Barth MF Delivery line	Nil	Nil
P-O	0.38km	1	10” Ekulama 2 FS to San Barth MF Delivery line	1	134.67m
O-M	0.74km	2	10” Ekulama 2 FS to San Barth MF Delivery line 8” Belema AGG GP to Soku GP	NIL	NIL
M-N	2.90km	2	10” Ekulama 2 FS to San Barth MF Delivery line 8” Belema AGG GP to Soku GP	NIL	NIL



ID	Eastings	Northings
A	461218.5	72858.09
B	461164.4	72156.54
X	461046.5	71656.92
D	463591.4	70907.8
F	465341.9	67994.92
H	466767.2	66442.84
I	468401.7	63934.8
T	467843.0	63268.06
S	466792.6	61163.42
R	466834.6	61082.73
Q	468653.6	60547.14
P	468739.3	60121.3
O	468795.1	59744.72
M	468943.5	59027.18
N	469592.1	56148.36

Coordinate System: Nigerian Mid-belt

Figure 3.3: Layout of Proposed Soku GP – New San Barth Manifold pipeline

Concurrent Development

Alongside the proposed pipeline project, two associated gas (AG) pipelines constructions shall be carried out. These include the replacement of 12” X 15km Soku – Ekulama AG pipeline and a new 12” x1.5km Soku AG line. The replacement works shall run on the same RoW with proposed Soku GP oil Export pipeline up to Ekulama 2.

The replacement pipeline shall evacuate Ekulama field AG to Soku Gas plant for further processing in line with SPDC’s plan to stop all gas flaring, thereby preserving the environment. This replacement became imperative due to several tap-in points and undiscovered bunkering points, the existing 18” Ekulama 2 – Soku GP AG pipeline cannot be restored to its original purpose of evacuating associated. The AG pipelines have been covered by a separate EMP. As a result of this concurrent AG pipeline project, the RoW upto Ekulama 2 FS will be expanded to 30 m. Beyond Ekulama 2 FS to New San Barth, the RoW will be 15 m. This will result in additional land take to accommodate the AG pipeline.

The layout of the proposed pipeline project, with respect to existing/proposed oil and gas pipeline facility, is shown in Figure 3.4. The proposed Soku GP to San Barth oil pipelines will transverse across mangrove swamps from Soku GP via the Ekulama 2 FS and terminate at San Barth mfd along the NCTL line in Rivers State. There is an existing SPDC Right of Way (RoW) along the proposed route occupied by existing pipelines (Figure 3.4)

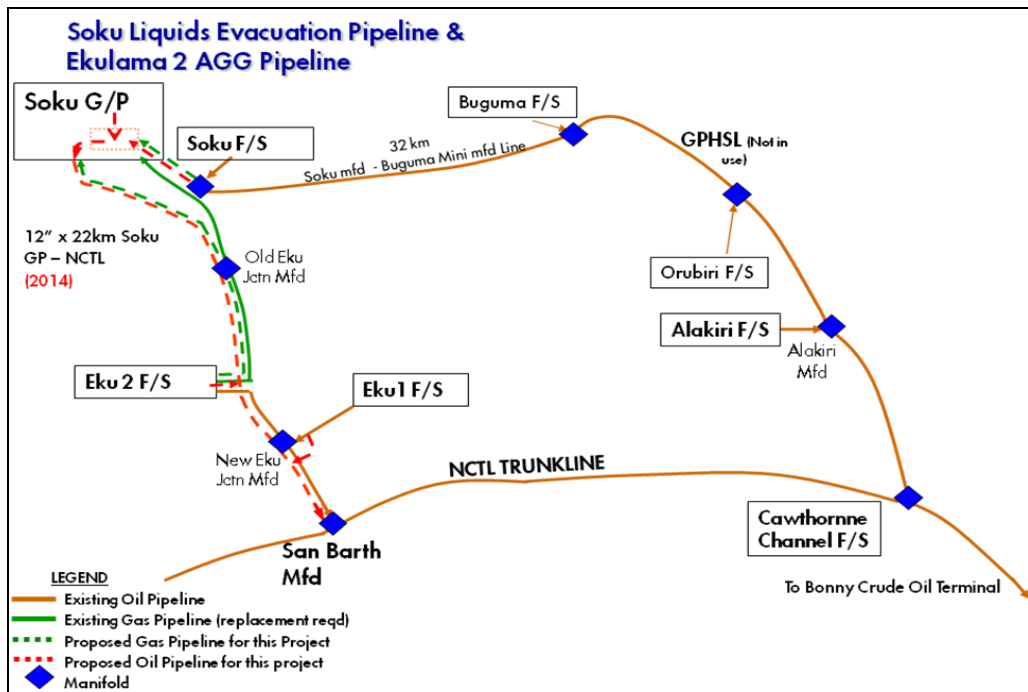


Figure 3.4: Layout of Proposed and Existing Facilities

Proposed Project Activities

Application Standards

Several methods of pipeline construction exist, but the choice of methods depends on the ecology of the project area. The construction of the pipeline, however, must comply with statutory and industry codes and standards. The design of the proposed pipeline shall conform to all applicable national, industry, international and Shell standards. A summary of the applicable standards are listed in Table 3.3.

Table 3.3: Pipeline design standards

Pipeline Sections	10” SokuFS-Soku GP(AG)	10” SokuFS-Soku GP(Liquid)	12” Soku GP –San Barth
Pipeline grade	API 5L Grade X52	API 5L Grade X52	API 5L Grade X52(River Crossing) and X65(Swamp)
Pipeline nominal diameter	10"	10"	12”
Pipeline Wall Thickness	11.1mm	11.1mm	11.1mm(River crossing) 8.7mm(Swamp Crossing)
Maximum Flow rate of Process Stream	20.248 (mmscfd)	35,000 bpd	104,000 bpd
Maximum operating pressure of the process stream	12bar	65(barg)	65(barg)
Pipeline Design Temperature	80°C		
Maximum Operating Temperature	20 to 80°C		
Specific Design Codes and applicable standards	The order of precedence for codes and standard applied on the project are as follows: 1. Nigerian National Standards		



	2. Project Deviations from Standards 3. SPDC Standards 4. Shell Group Standards (DEP's and HSE Standards) 5. International Standards (ASME/ ANSI, ISO, API...) 6. Other Industry Standards and Guidelines		
Construction methodology	Survey, bush clearing, trenching, dredging, thrust boring, welding & Lay, backfill (partial), hydrotest, gauging and hydrocarbon introduction.		
Corrosion allowance etc.	3mm		

RoW Surveys/Land Acquisition

The Right of Way (RoW) of the proposed Soku – San Barth oil pipeline shall run along an RoW of existing pipelines for the whole stretch of the route. However, there shall be additional landtake of 30m wide new RoW from Soku FS to Soku GP, and Soku GP to Ekulama 2, but beyond this point to San Barth Manifold, the width the new RoW shall be 15 m. As a result, a total of an estimated 80 ha of land will be acquired as the new RoW along the entire length of the proposed pipeline route.

Pipeline Construction

Pipeline construction/laying will be via welding activities on the laybarge, floating the welded pipeline strings on floaters on the prepared trench, lowering the pipeline on the trench and partially backfilling thereafter. The Soku Gas Plant– San Barth mfd pipelines project will transverse land and swamp terrain. The key construction activities are as listed below:

Pipeline Route Survey (including route selection and verification) /Land Acquisition

Pipeline coating and procurements

Construction of pre-cast concrete pipeline protective cover

Mobilisation (including pre equipment and personnel inspection and certification)

Transportation (The proposed project area in swamp location. Journey Managent Plan shall be implemented)

RoW bush clearing and de-stumping (site construction works)

Excavation, Trenching and thrust boring

Pipeline Stringing & laying

Welding

Field joint coating

Installation of concrete pipeline protective covering

Trench backfilling

Pigging

Hydro-testing

Radiographic Testing

End facilities works at Soku Gas Plant, Soku Flowstation, Ekulama & San Barth

Commissioning (Actual introduction of hydrocarbon)

RoW Re-instatement

Demobilisation

For the onshore swamp pipe lay, the crew is typically housed in Houseboats that are towed along as pipe lay barge move progressively. These Houseboats serve as temporal commmute daily to the worksite from their villages.



The pipeline activities entails the clearing of the additional right of way (5m way leave), excavation of the pipeline trench, laying and welding of the line pipes, backfilling of excavated trench, installation of pressure protection/Leak detection facilities and pressure testing of the complete pipeline.

The pipeline shall be built in accordance with SPDC standard construction specifications- Volume 2, section 25, relevant government and other regulatory standards. Specific details of the activities under these categories are as follows:

Pipeline Route Survey / Land Acquisition

The Route for the pipeline shall be selected and surveyed to ensure consistency with the philosophy of shortest possible distance between start and end points with environmental, social, health, economic and technical considerations. This is to reduce the exposure of communities to potential hazards associated with high-pressure pipelines, and the risk of third party interference.

Prior to commencement of work on the pipeline site, the pipeline route shall be surveyed to ascertain the availability of landed area for the installation of the pipeline. This would be done using survey equipment, which will have no adverse effects on the environment. Based on the findings from the route survey, it may be necessary to acquire additional land for the construction work. This is necessary for installation of the new lines as well as movement of equipment during construction.

Materials Selection

Materials of appropriate grades have been selected for the pipelines to ensure the highest integrity to withstand the anticipated pressure and environmental conditions without risk of failure. The pipeline shall be coated with three-layer polyethylene (PE) anti-corrosion coating and a yard applied concrete coating over the anti-corrosion coating where stability is an issue (as determined by calculations). Coating shall be carried out in a pipe coating yard before transportation to the site. Line pipes, fittings and other pipeline construction accessories shall be transported and stored in such a manner as not to impact on the integrity of the materials. The API 5L X 52 pipes grade of linepipe shall be used. List of equipment as minimum include;

Lay Barges complete with coating and Non destructive Test facilities.

Swamp excavators (long and short booms)

Dredgers ((Suction and cutter dredgers)

House boats complete with medical, sewage, catering facilities.

Marine vessels (landing crafts, crew boats, tug boats, shuttle barges

Material barges

Lifting cranes

Various welding machines

Air compressors

Fuel barges

Diesel generators

Muster barges

Communication equipment

Survey equipment

The approved welding methods to be used are Gas Tungsten Arc Welding (GTAW) with Electrode –ER 80S SHIELDED METAL ARC WELDING (SMAW) with cellulosic (E-6010 & E-7010) and Low hydrogen (E-7016, E-7018, E-8016, E-8045).

The chemicals to be used will also include Developer and fixer. The following are the chemicals involved in the process;

Developer and fixer for Non destructive testing of welded joint

Crude Oil

AGO

Bentonite

PMS (Petrol)

AGO (Diesel)

Grease

Lubricant

The general description for the proposed pipeline is presented in Table 3.4 below. The respective Material Safety Data Sheet (MSDS) of the chemicals is presented in appendix 5.

Table 3.4: General Description for the Proposed Pipeline

Parameter	Value for Liquid pipelines of 12 “ x 22km Soku-New San Barth 10” x4.5km Soku Flowstation-Soku Gas Plant	Value for Associated Gas pipelines of 10” x4.5km Soku Flowstation-Soku Gas Plant
Design pressure	99 Barg	50 Barg
MAOP	65 Barg	12 Barg
Test Pressure	1.25 x Design Pressure (99 Barg)	1.25 x Design Pressure (99 Barg)
Process temperatures:	Minimum 15 deg C Maximum 30 deg C Normal 25 deg C	Minimum 15 deg C Maximum 30 deg C Normal 25 deg C
Station equipment design temperature range	0 to 80 deg C (when not operating)	0 to 80 deg C (when not operating)
Test fluid	Inhibitor Water	Inhibitor Water
Valve operation	Manual	Pneumatic
Velocity range target	to 2.5 m/s	5.0 to 20m/s
ASME/ANSI Class	600#	300#
Fabrication	Seamless or SAW	Seamless or SAW
Coating	PE/Concrete	PE/Concrete
Length	10” x4.5km and 12 “ x 22km	10” x4.5km
Cathodic Protection	Impressed current CP System	Impressed current CP System
Design Code	ANSI B31.4 and relevant Shell design and Engineering Practice (DEPs)	ANSI B31.8 and relevant Shell design and Engineering Practice (DEPs)
Design Factor	0.60	0.60
Maximum Corrosion Allowance	3 mm	3.9mm with mitigated corrosion at 80% inhibitor availability
Pipeline separation distance	5 - 10 m	5 - 10 m
Pipeline Roughness	0.03mm	0.03mm
Design Life	30 years	30 years
Pipeline wall thickness	11.13mm for both Liquid Pipelines	11.13mm



<p>Pipeline sizing</p>	<p>Pipelines are sized via hydraulic Simulation to maximize crude volume of: 104 kbpd for the 12 x 22km Soku – New San Barth, 30kbpd for the 10” x4.5km Soku Flowstation to Soku gas Plant</p>	<p>Pipelines are sized via hydraulic Simulation to maximize crude volume of: 20mmscfd for 10”x 4.5km Soku Flowstation to Soku gas Plant.</p>
------------------------	--	--

The ISO reference conditions for Soku Gas Plant include the following:

Condensate: Should not spill to the environment.

Gas: No gas leak

Flare: Should not be above the regulatory limit

Effluent Monitoring: Proper monitoring of the effluent discharge not to exceed the regulatory limit.

Sewage (Liquid): Treatment plant exists for the handling of the liquid waste.

Sewage(Solid):Managed to ensure minimum impact on the environment

Pre-mobilisation Inspection and Mobilisation

Prior to mobilisation, SPDC shall carry out pre-mobilisation inspection of all equipment/personnel to be mobilised to site. All equipment and personnel mobilised to site shall be certified fit for purpose, the capabilities ascertained and approved by SPDC before deployment to site. Key construction equipment to be mobilised include: Back hoe, Side boom, Prime mover, Trailer, Self loading truck, Crane, Crew bus, 4WD truck, Welding sets, Flushing pumps, Hydro testing unit, Generators, Compressors, Bending Machine, Grit blasting unit, Oxy acetylene torch, Line up clamps, Cold cutter, X-ray units, Thrust boring machine, etc. Additional equipment for swamp and river crossing activities may include, lay, pull and supply barges, swamp buggies, dredger, boats, etc. Contractor shall provide material barges for the equipment transportation to and from site and also for storage, tug boats, landing crafts, crew boats etc. All these will be certified suitable for carrying out the proposed project in the swamp.

Survey and Staking of Pipeline Routes

Survey shall be carried out to re-establish and clearly mark out boundaries of the permanent RoW and temporary working strip required for construction activities.

Probing for existing Facilities

Along existing RoW and at brown field locations, existing facilities shall be identified and located using drawings and pipe detectors. Manual excavations at appropriate intervals shall confirm exact positions. Inspection of each exposed location shall be carried out and a permanent mark placed on all exposed lines and facilities to indicate which are to be removed and which are to be left in place.

Clearing and Grading

Clearing, grading and stripping the RoW shall be done to prepare the areas where the new line shall be laid. Grading operations shall be carried out only on dry land. The RoW shall be cleared for its complete width. At road crossings, removal of topsoil shall be kept to a minimum, and surface materials shall be removed (where necessary) only at the time of crossing installation. Adequate room for handling of materials and equipment on site shall be provided.

Excavation, Trenching and Dredging

Thrust boring shall be used at river crossings. The pipe trench shall follow the selected pipeline RoW as surveyed and staked out, prior to vegetation clearing. The trench shall be excavated to the minimum widths based on the pipe diameters and the number of pipes to be installed in each trench (Figure 3.5). The finished trench shall be free of roots, stones, or other hard objects which may damage the pipe coating. Provision shall be made for dewatering, as may be required. Dredging of the rivers for pipeline installation will be through the use of cutter dredgers, while partial backfill of excavated materials will be the use of cutter and or suction dredgers.

Pipeline Coating

The pipeline will be coated with external anti-corrosion 3-layer hot applied Polyethylene (PE) Coating, and a concrete weight coating to provide stability and mechanical protection. Field joints will be coated with heat shrink sleeves and concrete. The following densities shall apply in the project:

Polyethylene (PE) density ---1840 kg/m³ (according to SPDC “Standard Pipelines and Flow lines Design Manual”)

Concrete Coating density--Low density concrete of 2400 kg/m³

The coating system for risers shall consist of the following materials:

Metal primer

Bonding agent

Elastomeric sheet or strip

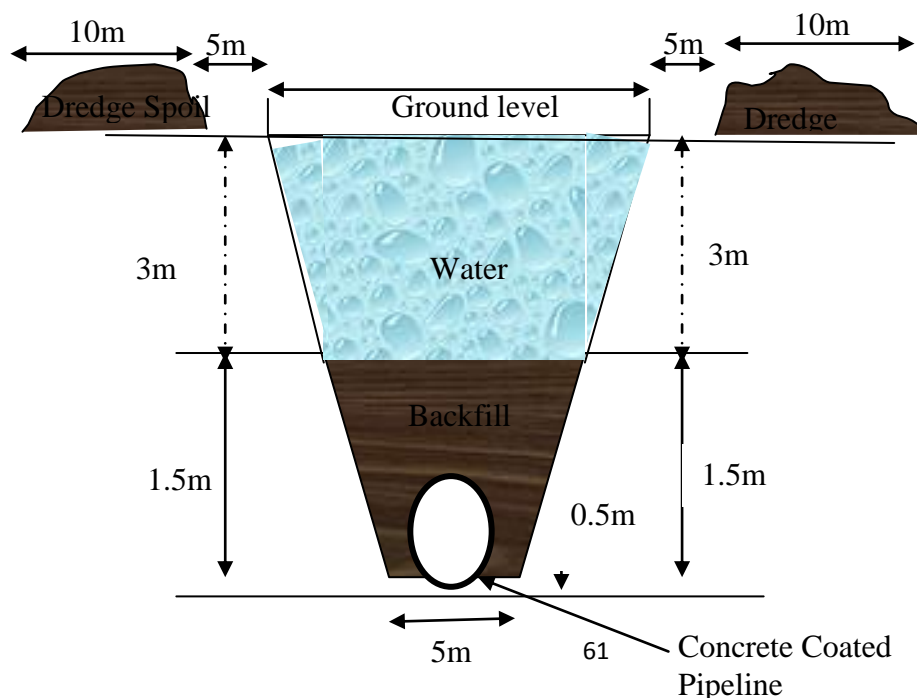


Figure 3.5: Sketch of Soku Gas Plant-San Barth Manifold Pipeline Cross-section

The elastomeric coating shall be vulcanized Polychloroprene and be suitable for operation in the Nigerian environment and climate. New pipelines shall not be internally lined but corrosion inhibitors will be used for Soku Flowstation - Soku Gas Plant (LGSP) AG pipeline as per "Material Selection Report.

Pipe laying

Pipe laying and field joints tie-in will be through the use of floaters. The Tie-in lists will address the tie-in points of the new pipelines with the existing facilities. Procedures will be developed individually for each particular tie-in to the existing operational facilities so as to minimize and where possible eliminate disruption to delivery line operations.

In locations where a shutdown is inevitable, efforts will be made to scheduled tie-in to coincide with flow station maintenance programmed shut downs (where possible), to reduce deferred oil. For security purposes the lengths of pipeline above ground will be kept to an absolute minimum.

At the beach approaches, thrust boring methods will be required to guarantee adequate cover for the pipeline and to ensure that the ecology of these locations as well as the morphology of the beach seashore and natural profile is not adversely affected as much as possible.

Backfilling and Reinstatement (Re-vegetation).

The trench shall be backfilled in layers not exceeding 15 cm deep at each layer/interval and uniformly compacted. The backfill material (free of stones, sticks, roots, debris and any other material which might possibly damage the pipe coating and/or initiate corrosion) shall be crowned (heaped up) along the trench line such that the top of the trench shall remain constantly below Low Low Water Level (LLWL) of the waterbody. Where tracked equipment is used for backfilling operations, such equipment shall not be allowed to traverse along, across or over the installed pipelines. Reinstatement of vegetation outside the RoW shall be carried out as soon as practicable after completion of backfilling. All possible measures shall be taken to enhance the reinforcement of mangrove forest and other vulnerable areas to prevent any undesirable successional changes. Soil stabilisation measures may be necessary to encourage the regrowth of vegetation. The topsoil (surface material that would have been stripped and set aside prior to excavation) shall be reinstated. Where necessary, the cleared areas around the pipeline route shall be re vegetated with indigenous species.

Excavating 4.5m and backfilling only 1m leaving the ditch as water way is the best option which serves two other purposes apart from discouraging illegal bunkering;

1. The open channel becomes a navigable water way promoting the economic activities of the communities it traversed.
2. It can serve as a drainage canal capable of evacuating flood around its catchment areas.

Special Crossings

At medium river and creek crossings the depth of cover from the top of pipe to natural bed level shall be 1.50m minimum (or 4.5m from LLWS) and in the case of major river crossings it shall be increased to a depth below river bed of up to 3 m.



All pipeline crossings including but not limited to rivers, creeks, and pipelines shall cross at an angle as close as possible to 90° but under no circumstances shall the crossing be at an angle less than 60°. If necessary a local diversion shall be introduced into the pipeline heading to provide an appropriate crossing angle.

Cathodic Protection (CP) test facilities shall be installed at each crossing. For major crossings there shall be at least one each side, where excessive flooding can occur two shall be provided to ensure one is always accessible. The CP system design may call for additional test facilities at some crossings. Where the pipeline crosses another steel pipeline, service or feature, test facilities shall be installed to both, in order to facilitate interference testing and remedial works in respect of the CP system(s).

During the construction phase of the pipelines, sacrificial anodes shall be installed as a safeguard against corrosion. Cathodic protection potential (on potential) surveys will be carried out to test for the effectiveness of corrosion protection of the pipelines. The anodes will later be decommissioned in the post construction phase for the impressed current system to be in place. Then, a polarized potential (on/off) survey will be conducted to test the effectiveness of the impressed cathodic protection.

Construction of Pig Launchers/Receivers

Pig launchers and receivers will be installed to facilitate the pigging operation for a multitude of reasons including gauging, commissioning, batching, cleaning and also running intelligent pigs to determine the internal condition of the pipes. They will be installed at the pigging manifold systems/facilities at Soku Flowstation (FS), Soku Gas Plant (GP) and San Barth Manifold including all facilities necessary for the safe operation/ergonomics. These include all associated piling, structural works and modification works to the existing piping and walkways, platforms, drain systems etc. Designs shall be according to the DEP's & Standard Construction Specifications.

Construction and Installation of Protective Covering

As part of the measures being taken to protect these pipelines against third party intrusion, it is being planned to cover the pipelines with a reinforced concrete covering. These concrete coverings shall be made of precast Grade 30 reinforced concrete. The section shall be that of a U-channel. These covering shall be constructed at the contractor's yard in movable sizes, then transported to site and installed.

Commissioning and Operations

Pigging and Hydro testing

Pre-commissioning of the pipeline will commence after mechanical completion with hydrotest and pigging (foam pig, gauging etc) and thereafter introduce hydrocarbon. The pipelines shall be pigged and callipered to ensure that there are no defects due to construction. The pipeline is then tested to ensure it meets the pressure requirements. Pipeline hydrotest water shall be obtained from the water borehole/ storage tanks in Soku gas plant and shall be flowed into the pipeline till the line is filled with water. An estimate of about 4,300m³ of water would be used for hydro-testing. The test water would be sent to Bonny Terminal via the NCTL, from where it would be disposed off in line with statutory regulations.

Operations/Maintenance

Hydrocarbon evacuation capacity through the Soku GP – San Barth mfd pipelines trunkline is estimated at a maximum of 67 mbopd from Soku GP, Soku FS and Ekulama 1 & 2 FS via the



San Barth mfd along the NCTL to Bonny Terminal, and 28 mmscf from Ekulama 1 & 2 FS and Soku FS to Soku GP.

Corrosion protection and material selection will be based on a target design life of at least 25 years. The pipeline operating procedures shall include regular pipeline integrity inspections and a pipeline wall-thickness check inspection programme, which ensures adequate monitoring of the pipe wall thickness and consequent maintenance/repair of the pipeline. Operation and Maintenance manual will be produced, discussed and handed over to the Pipeline Asset team with two years spares.

Pipeline Safety (Cathodic Protection)

The external corrosion protection shall be provided by a combination of anti-corrosion coating and cathodic protection. An impressed current CP system shall provide backup to the corrosion coating. The system shall be designed in accordance with DEP 30.10.73.31-Gen. and Standard Construction Specification, Section 27.A two year span. Sacrificial anode system shall be installed to protect the new lines during the construction till end of the commissioning.

The main lines will be electrically isolated from pigging facilities and flow lines by monolithic CP isolation joints located above ground. The isolation joints shall be protected against surge through installation of an electric current surge diverter.

An external anti-corrosion coating comprising FBE, PE and Adhesives shall be applied to the line pipes and bends. Concrete weight coating shall also be applied to the line pipes to induce negative buoyancy effect required for swamp and river crossings. Heat shrink sleeves shall be used for field joint coating.

All pipelines should be designed with electrical resistance (ER) corrosion probes for corrosion monitoring at manifolds and at stations. Sacrificial anodes shall be installed as a safeguard against corrosion. Cathodic protection potential (on potential) surveys will be carried out to test for the effectiveness of corrosion protection of the pipelines. The anodes will later be decommissioned in the post construction phase for the impressed current system to be in place. Then a polarized potential (on/off) survey will be conducted to test the effectiveness of the impressed cathodic protection. Probes must come with retractor for insertion and retrieval. All probes must be fitted at appropriate places preferably between 3, 9 and 12 'O' clock positions. However, three probes should be installed at areas where it will not affect pigging as well as areas where they will be easy to monitor.

Decommissioning and Abandonment

At the end of the entire project, the gas line shall be decommissioned and abandoned. The current abandonment method is:

Flushing the line

Vacuum drying the line

Leaving the line in the ground

After the installation of the new AGG line, the existing 18" Ekulama 2 FS – Soku GP AGG pipeline would be flushed to de-oil and free all contaminants. The pipeline would be preserved and put on use for standby for reuse in emergency situations. At the end of the service life, all facilities associated with the 18" Ekulama 2 FS – Soku GP AGG at Ekulama 2 FS and Soku GP including the pig launchers/ receivers and structural supports around the manifolds/ tie-in points would be cut off and removed. All buried sections of line will be excavated, cut into manageable sizes and taken to SPDC IA before it is disposed at an approved steel recycling plant.

This procedure is subject to change in future as technology develops.

Waste Generation/Handling

During the execution of the proposed project activities various types of wastes will be generated. The guiding principles for the general handling/management of waste include: segregation of waste at the point of generation; reduction of the amount of wastes generated; recycling of wastes (where possible); if possible, reuse of the wastes; and treating of toxic / hazardous wastes before disposal.

The types of wastes that will be generated during the construction activities shall be classified as solids, liquids, or gaseous wastes. The handling of the wastes shall be in line with the standards and procedures of SPDC field operations. Wastes that can be re – used are recycled while the more hazardous ones such as medical wastes are thermally destroyed. Others such as sewages are treated and disposed safely. Appropriate technology is employed in managing waste dump sites.

The types of wastes expected from the execution of the proposed project are outlined in Table 3.5.

Table 3.5: Wastes expected from proposed pipeline project

Waste Type	Source of Waste	Disposal Option
Food wastes	kitchens and catering facilities on the houseboat	By means of a register community Contractor to approved site
Construction Materials waste	Pieces of line pipes(Ferrous metal scrap), broken concrete, corrosion materials, on the right of way etc	Passing through the construction contractor to SPDC KI
Welding wastes	electrodes residuals and stab ends)	Via the construction contractor to approved SPDC/Government dump sites.
Settling pit sludge	Pipeline hydro-test	Via the construction contractor to approved SPDC/Government dump sites.
Wastes of off-track equipment and construction machinery	wiping rags fouled with oils, waste oils, oil filters)	Through the construction contractor to approved SPDC/Government dump sites.
Sanitary waste	From houseboat toilets	By a registered community Contractor to approved site
Domestic waste	GSM recharge cards, paper waste, water bags/bottles etc	Using a register community Contractor to approved site

Electrical and medical waste	Electrical maintenance works(dead bulb, waste lead acid batteries unimpaired, with contained electrolyte etc) and medical/clinic	Via the construction contractor to approved SPDC/Government dump sites.
Vegetation debris from land clearing	Woods, leaves, sticks, plant roots, etc.	Via the construction contractor to approved SPDC/Government dump sites.
Hydrotest waste water	Used pipe cleaning water	Via the construction contractor to approved SPDC/Government dump sites.

Project Schedule

The planning and implementation schedule (Contract Award, Engineering Design, Procurement, Mobilization/site works and Ready for Startup (RFSU)) for the Soku-San Barth Manifold Pipeline Project is shown in Figure 3.6

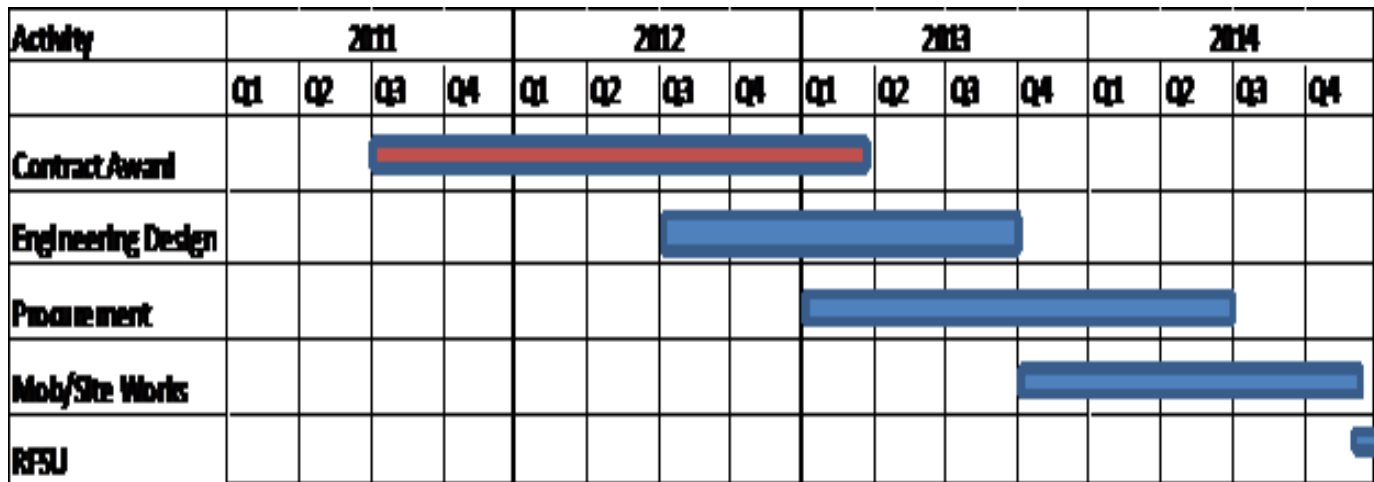


Figure 3.6: Project Schedule for Soku Gas Plant -San Barth Manifold Pipeline Project



CHAPTER FOUR BASELINE ENVIRONMENTAL CONDITIONS

The baseline environmental conditions of the proposed project area are described in this chapter; these include the biophysical, social and health environment. The baseline information was acquired through consultations, literature review, field surveys, laboratory and statistical analyses. The acquired data ensured adequate description of the existing environment of the proposed project location and environs.

The geographic coordinates for the 12” x 22km Soku- New San Barth manifold start point is; 461218.5 Eastings and 72858.09 Northings, while the geographic coordinates at the end point is 469592.1 Eastings and 56148.36 Northings.

The geographic coordinates for the two 10” x 4.5km Soku flowstation – Soku Gas Plant (Associated Gas and Liquid Pipeline) start point is 463522.08 Eastings and 72048.34 Northings. While the geographic coordinates at the end point is 461218.45 Eastings, and 72858.08 Northings.

4.1 Biophysical Baseline Data Acquisition

4.1.1 Desktop Research

Desktop research was used to establish environmental information from secondary database. Consulted materials include published textbooks, articles, existing studies and engineering reports commissioned by the proponent. The citation of all literatures and publications consulted is provided in the references.

4.1.2 Field Sampling and Laboratory Methods

The various methods used for field data gathering and laboratory methods are as stipulated by the Federal Ministry of Environment (FMEnv) and Department of Petroleum Resources (DPR). The description of the various methods and procedures used are included as Appendix 1. Fast changing parameters such as pH and acidity were measured in situ, and heavy metals were also fixed at point of collection to enhance quality assurance.

4.2 Socio-Economics Baseline Methodology

4.2.1 Data Collection

Preliminary investigations were made through consultations, field surveys, and review of existing reports, maps and literature. The field work was carried out between 2nd and 8th August 2011. Data was acquired using personal interviews in administering structured questionnaire and Focus Group Discussion (FGD) for socio-economic structures and activities. This was sequel to the Scoping Workshop and selection of settlements/communities of primary interest within the entire influence zone of the proposed pipeline project. The communities in the project area for the social impact assessment are listed in Table 4.1. They include 16 communities from Akuku-Toru LGA of Rivers State and one community from Nembe LGA of Bayelsa State.

Representatives of SPDC FMEnv, DPR, Rivers State Ministry of Environment (RSMEnv), Bayelsa State Ministry of Environment and representatives of the affected communities were invited to witness the field data gathering exercise.

Three (3) out of fifteen (15) visited settlements in the project area (Kula, Elem Sangama and Soku) were relatively big settlements with large human concentrations as opposed to the many others that were small fishing camps. The project area traverses a difficult terrain with only few of the settlements existing in close proximity. Three settlements were covered in

one day or two depending on the spatial distribution/size and population of the settlements. Oluasari and Kula communities could not be accessed for reasons of insecurity and difficulty of logistics.

Questionnaire was administered by personal interviews at the level of the households and key informants while Focus Group Discussions (FGDs), were conducted with Women Groups (WGs), Youth Groups (YGs) and Community Development Committees (CDCs).

Table 4.1: List of Communities within the Project Area

S/N	Community	Oil Field	Local Government Area (LGA)
1	Soku	Soku	Akuku-Toru
2	Elem-sangama	Soku	Akuku-Toru
3	Oluasiri*	soku	Nembe
4	Kula*	Ekulama	Akuku-Toru
5	Krikakiri	Ekulama	Akuku-Toru
6	Kala-onogi	Ekulama	Akuku-Toru
7	Opu-onogi	Ekulama	Akuku-Toru
8	Ababoko	Ekulama	Akuku-Toru
9	Opukiri	Ekulama	Akuku-Toru
10	Freetown	Ekulama	Akuku-Toru
11	European quarters	Ekulama	Akuku-Toru
12	Newtown	Ekulama	Akuku-Toru
13	Luckyland	Ekulama	Akuku-Toru
14	Kongomaboko	Ekulama	Akuku-Toru
15	Apiboko	Ekulama	Akuku-Toru
16	Pinaro	Ekulama	Akuku-Toru
17	Opropokiri	Ekulama	Akuku-Toru

* Communities conditionally left out in the survey

Thirty (30) respondents (households and key informants) were successfully administered with questionnaire during the survey. Other primary data were generated from the FGDs.

A walk-through (triangulation) and ground-truthing within the communities were used to cross-check information gathered in respect of status and functionality of available infrastructure. Photographs of some of the infrastructure, the human environment and other landmark issues were taken and discussed appropriately.

4.2.2 Data Analysis

Data were analyzed with descriptive statistics including frequency tables, percentages, cross-tabulations and graphs using Epi-INFO and SPSS computer packages. Qualitative data were analyzed as text-based information in tables. Considering the fact that human population grows exponentially rather than linearly, the exponential growth model defined below was adopted.

$$P_n = P_o (1 + r)^n$$

Where:

- P_n = Projected population;
- P_o = the base year population;
- r = Annual growth rate of the population (3.4%)
- n = time lapse, in years



4.3 Health Baseline Methodology

Health baseline information for this EIA study includes:

Data required to establish the health status of members of the communities;

Data required to ascertain the presence and level of occurrence of risk factors that influence health status; and

Data required to assess the robustness of the health system, in terms of the status of the health infrastructure and quality of health services that are accessible to members of the communities.

This information does not only serve as baseline prior to the commencement of the proposed project, but are required as reference for future assessments during and beyond the project cycle. They are also needed for the evaluation of the possible health impact of the pipeline project on members of the affected communities. The information would also be used to propose possible mitigation measures for the identified hazards of the project, even as efforts are made to further boost the benefits of the project.

The baseline health information was derived from secondary data extracted from existing data sources such as published survey reports and research journals, and archives of routine health services data; and primary data collected from field studies in the communities within the proposed project area. Field studies, which were conducted on 2nd-7th August 2011 in the 17 communities in Rivers and Bayelsa States (Table 4.2.), relied on Rapid Appraisal techniques based on qualitative research methodology

Secondary Data Acquisition

Secondary data sources were consulted for the description of the baseline health conditions of communities in the Soku-San Barth Pipeline Project area

Qualitative Data Collection

Rapid Appraisal (RA) methods were adopted for the qualitative research. These methods included:

Group Interviews with members of the community;

Key Informant Interviews (KIs) with community leaders and health workers at community health facilities; and

Direct Observation techniques for assessment of social and health infrastructure.

Group Interviews

Group Interviews were held with a non-random, purposively selected members of the each community visited. The Group Interviews were held with community members that consented to meet at the palaces of the Community Chiefs and at other agreed venues (Plate 4.1).

A semi-structured questionnaire (Appendices 2 and 3) was used to elicit information on household details including socio-demographic characteristics, information of causes of morbidity and mortality, health-seeking behaviour, access to sanitation facilities; and knowledge and practices of respondents regarding selected health risk factors including alcohol consumption and HIV/AIDS.

Between six and ten persons participated in responding to the interview questions. Responses were taken collectively as a single unit of analysis.



Plate 4.1: Group Interviews at Soku

Key Informant Interviews

Key Informants were also identified and interviewed using the semi-structured questionnaires used for the Group Interviews. Two Key Informants were purposively selected among the community and opinion leaders in each of the communities visited during the field study (Plate 4.2).

Direct Observation

Direct Observation techniques were used to inspect and assess:

- the quality of health services in the health facilities that serve the communities, using a checklist
- the practices of patent medicine dealers and Traditional Birth Attendants in the communities; and
- the environmental health conditions in the communities with respect to housing characteristics, water supply sources, refuse disposal and sanitation facilities.

The HIA team, assisted by a local guide moved round the communities, taking note of these and taking photographs where possible. Informal discussions were held with staff of the health facilities visited and with the alternative health care practitioners.



Plate 4.2: Administration of Questionnaire in Kula

Efforts were also made during the field study to ensure that the health-specific parameters of surface water, underground water and air quality were measured by the relevant Bio-Physical Study teams, according to the required standards. The results of these were used for the final assessment of the possible health impact of the project.

4.4 Biophysical Baseline Environmental Conditions

4.4.1 Geomorphology/Topography

The area is a flat coastal terrain with a slope of 1-2o, made up of predominantly mangrove swamp, with patches of freshwater forest (found around settlements and waterlogged during the rainy season). The swamp areas have intrinsic water systems forming part of the lower Niger Delta. The soils are under water most of the year resulting in the development of very deep peaty sandy clay surfaces. The sub soils are grey mottled peaty clays (Chikoko).

4.4.2 Climate and Meteorology

The study area is located in the humid tropical Niger Delta region of Nigeria, characterized by distinct wet and dry seasons. The dry season occur between November and March while the wet season is from April to October. The field work undertaken for this study from 2nd to 8th August 2011 fits into the wet season.

The climatic information for the project area is based on the analysis of the climatic data of the study area collected from NIMET Oshodi, for Port Harcourt, Onne and Bonny because of their proximity to the Soku – San Barth area. The climatic data spanned from 1983 to 2005. Meteorological data were also collected at six locations within the study area during the field data gathering process.

4.4.2.1 Insolation and Cloud Cover

The earth's seasons are controlled by changes in the duration and intensity of solar radiation or insolation. These two factors are in turn influenced by the annual changes in the position of the Earth's axis relative to the Sun. The top of the atmosphere receives the maximum insolation during March and September equinoxes. Annual average for the period 1983 - 2005 is 10.5 kW/m²/day (Figure 4.1a and 4.1b). Annual averaged global insolation at the earth's surface is 4.2 kW/m²/day, and averaged clear sky insolation is higher at 6.15 kW/m²/day. Thus, the atmosphere attenuates about half of the incident radiation at the top of

the atmosphere through scattering, absorption and reflection. The respective direct normal radiation and diffuse radiation are 3.13 and 2.06 kW/m²/day. While the clear sky insolation and diffuse radiation follow the annual pattern of the top of the atmospheric insolation, the global insolation and direct normal radiation to a great extent, is determined by the cloud since they follow the pattern of the sky clearness index, K. Solar insolation drives the annual temperature cycle and the rainfall patterns observed on the earth’s surface. Thus, it is the rainy season months with their thick cloud cover that record the lowest maximum temperatures while the dry season months, despite the low angle of the sun, record the highest maximum temperatures. There is thus a correspondence between the period of low angle of incidence of the sun and the period of low minimum temperature. However, the period of high altitude sun does not correspond to the period of high minimum temperature.

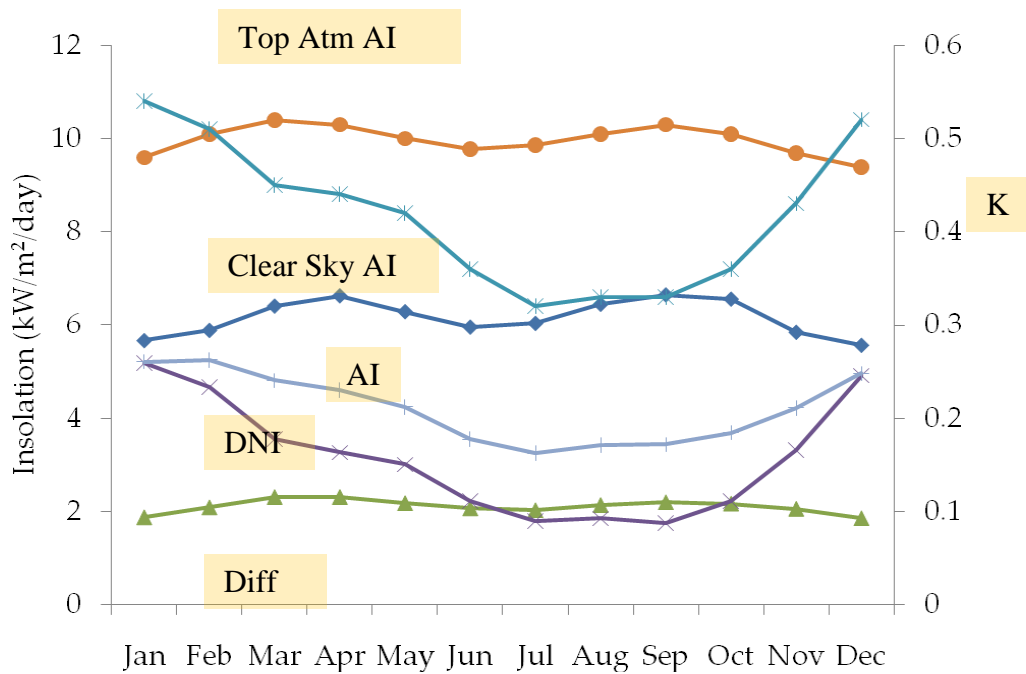


Figure 4.1a: Twenty-two year (1983 - 2005) Monthly Averaged Insolation

Source: NASA (2011)

Top of the Atmosphere Insolation (Top Atm AI), Global Insolation (AI), Clear Sky Insolation (Clear Sky AI), Direct Normal Radiation (DNI), Diffuse Radiation (Diff) in kW/m²/day Incident on a Horizontal Surface and the Sky Clearness Index (K) for Port Harcourt, Onne and Bonny (7.5°N and 4.5°E)

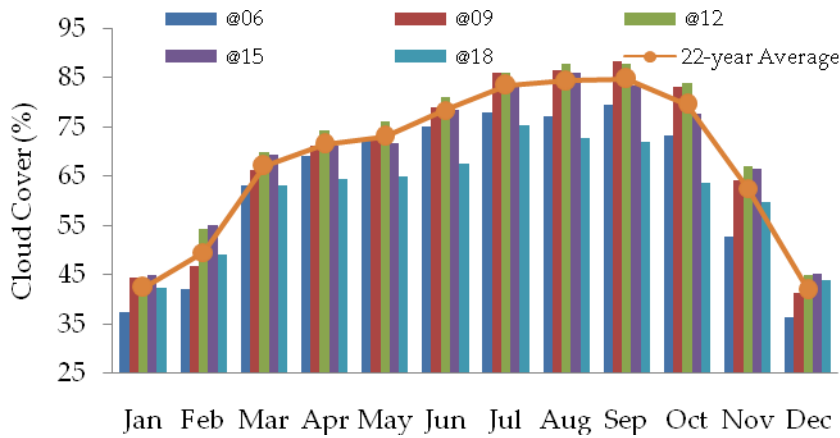


Figure 4.1b: Monthly Averaged Percentage Daylight Cloud Amount in Port Harcourt Area (1983-2005).
Source: NASA (2011).

Absorption of solar radiation and the subsequent generation of heat at the ocean's surface largely produce water vapour. In the atmosphere, this vapor is converted back into liquid form when air masses rise and lose heat energy and cool. This process is responsible for the development of most clouds and also produces the rain that falls to the Earth's surface. The clouds in turn modify most of the solar radiation through the processes mentioned earlier. Figures 4.1a and 4.1b above show clearly that the cloud cover follows a reversed annual cycle of average solar insolation. It is high during the rains exceeding 75% and barely reaching 65% during November and March but clearly below 55% from December to February, the heart of dry season. The diurnal cycle is also indicated as the annual average goes through 63% at 06 GMT to 71.5% at 12 GMT and drops to about 61% at 18 GMT. The 22-year average cloud cover is about 68.4%.

4.4.2.2 Wind

There are two main air masses which alternate with the seasons. During the dry season, the Northeast winds predominate while the Southwest winds are dominant during the wet season (Folorunsho and Awosika, 1995). The highest wind speed is normally recorded at the onset of the wet season when early rains are torrential and accompanied by squalls, lightning, and thunder. The wind speeds are however lower in the nights than the days. During the wet season field study (August 2011), the prevalent winds were south-westerly (SW), and the wind speed ranged from 0.1 to 3.4 m/s. During the dry season field data gathering, the prevalent winds were north-easterly (SE), and the wind speed ranged from 0.6 to 3.7 m/s (Table 4.2).

Southerly and South-westerly winds are prevalent in Port Harcourt/Onne/Bonny zone. Figure 4.2 shows the wind direction at the respective GMT times at 50m height over the period 1983 – 2005. In the months of June to September, the wind stream is restricted to about 220° (which corresponds to the wind blowing from SW direction). From the beginning of the dry season in November through March to the wet season including August, there is a wide scatter in the daily distribution of wind direction. It is seen that from the morning (0730 GMT) to the afternoon (1330 GMT), the direction is from 120° to 160° corresponding to south easterly direction while from late evenings through early morning at 0430 GMT, the direction is from 180° to 220° corresponding to southerly- southwesterly.

Table 4.2: Field Meteorological Data Soku Gas Plant to San Barth Manifold Project

Param.	Rainy Season						Dry Season*					
	AQ 1	AQ 2	AQ 3	AQ 4 Eku I. II	AQ 5 Luckyla nd ,	AQC 01 Contr ol, (close to Russi a)	1	2	3	4	AQ 5	Contr ol
Wind Speed, m/s	2.5	3.4	0.1	2.0	0.3	2.0	2.7	3.7	0.9	3.2	0.6	2.5
Wind Direction	SW	SW	SW	SW	SW	SW	NE	NE	NE	SW	NE	NE
Temperature , oC	24.6	26.1	26.9	25.0	25.5	27.1	24.2	26.0	27.1	25.4	25.2	27.0
Atmos. Pressure, mB	1052	1051	1051	1053	1050	1050	1052	1051	1051	1053	1050	1050
Relative Humidity , %	100	95.9	100	100	100	95.0	63	59	61	58	57	60

*Sources: Environmental Impact Assessment for Gbaran - Soku EGG-11 Gas Development Project. Draft report (2006)
 Environmental Impact Assessment of Nembe Creek Trunkline Replacement Project. Final report (2006)

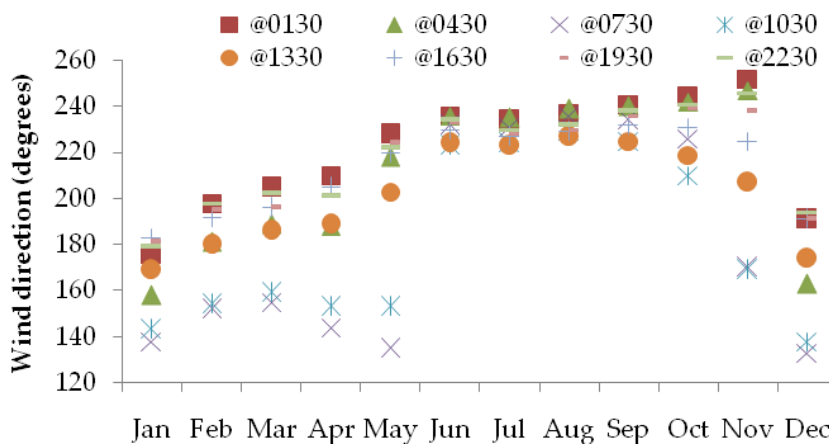
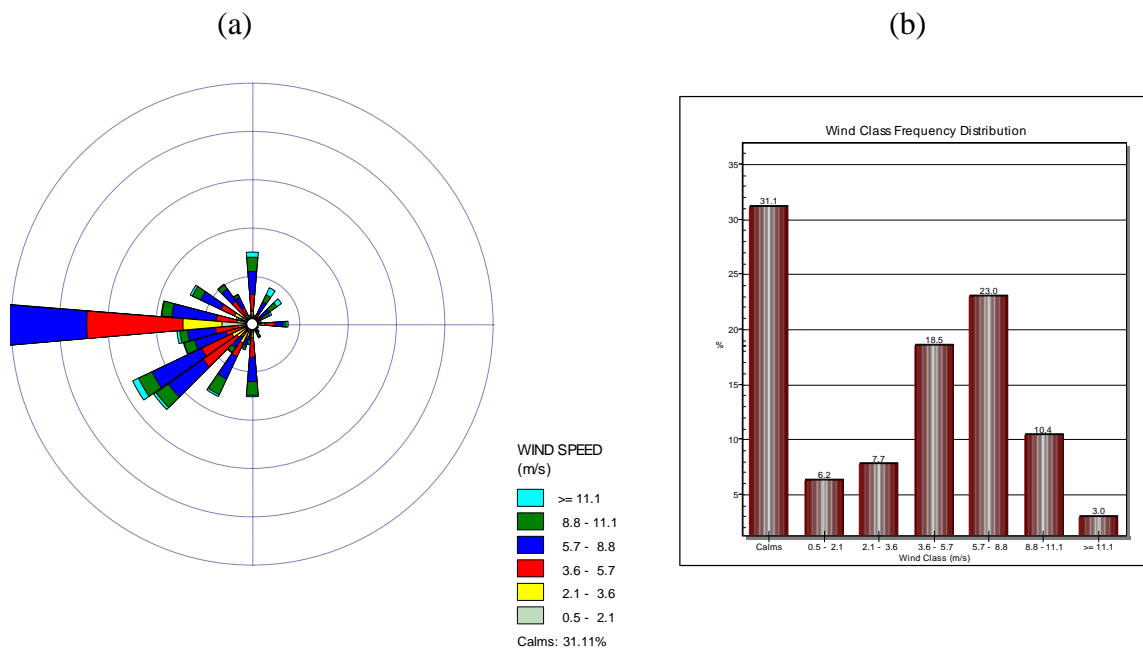


Figure 4.2: Monthly Averaged Wind Direction at 50 m above the Surface of the Earth in Port Harcourt Area (1983 – 2005).
 Source: NASA (2011).

The wind rose for the area shows the predominance of South-westerly and South- South-westerly winds as shown in Figure 4.3a which reflects the observed south westerlies during field work in August, 2011. The windspeed class frequency distribution is plotted in Figure 4.3b. The modal speed is between 5.7 – 8.8 m/s but a greater percentage (31.1%) of the winds

are calm. The outdoor wind speed recorded during the field work ranged 0.1–3.4m/s which is during the rainy season and 0.6 – 3.7 m/s during the dry season. These are within the historical range for calm wind to 3.6 m/s which constitute about 47% of the winds.



Source: NIMET (2011).

Figure 4.3: Wind Rose and Wind Class Frequency Distribution on the Surface of the Earth for Port Harcourt Area (1993 – 2001)

4.4.2.3 Temperature

Latitude is the main determinant of temperature. Other determinants like atmosphere, ocean currents, and altitude also influence temperature. The type and density of clouds influence the amount of solar radiation that reaches the Earth's surface. Some parts of Nigeria often experience overcast skies during the wet season. One of such areas is Port Harcourt in the southern part of the country. The amount of solar energy received and the extent of energy losses drives a climatic system. Warm tropical ocean currents hardly affects Nigeria's temperature regime so also altitude does not alter the temperature regimes in Nigeria. Nigeria experiences consistent high temperatures all year round between 25-31°C (Ologunorisa, 2011). The extreme coastal areas recorded temperatures in the range of 30.0 – 32.0°C according to Nigeria Climate review 2010 (NIMET, 2010). Furthermore, the southern region recorded minimum temperatures ranging from 20.0 to 24.1°C. The first half of the year was found to be generally warmer with average monthly mean temperature departures ranging

between 1.0 – 1.6°C. February had the highest departure of 1.8°C followed by January (1.5°C).

Climate change is a change in the state of the climate that can be identified (eg. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period typically decades or longer” IPCC (2007). Climate fluctuations or climatic variability occurs on shorter temporal scale. The most crucial things about the concept of climate change is not only the time periods involved but also the degree of variability that the change is subjected to as well as the duration and impact of such variability on man and the ecosystem.

In the tropics, the lowest temperature during each day described as minimum temperature is experienced during the night while maximum temperatures are recorded during day time. In the Port Harcourt/Onne/Bonny axis and in Nigeria as a whole, the highest maximum temperatures are recorded in February, while the lowest maximum temperatures are recorded during the month of August. Temperatures were low in the study area during the field data gathering in August 2011 and ranged from 24.6 – 27.1oC with a difference of about 2.5oC during the rainy season, and from 24.2 – 27.1oC during the dry season (Table 4.2, Figure. 4.4). This is a reflection of climate change with a wide range of temperatures. Temperature is generally driven by the incident solar radiation which penetrates through the atmosphere. The difference in maximum temperatures between the two months of February and August remains at about 4oC.

The 22 year average monthly temperatures for the period 1983 – 2005 from NASA is shown in Figure 4.5a while that of the period 1993 – 2001 including sunshine hours from NIMET is shown in Figure 4.5b . The annual temperature pattern in the two figures is essentially the same as described in the preceding paragraph for Port Harcourt/Onne/Bonny axis and in Nigeria as a whole. The only difference between them is the daily temperature range which is about 4°C for the dry season and drops to a low of 2.2°C in the wet season as compared with the respective 11°C and 6°C for the NIMET data. During the field data gathering in August 2011, the temperature range was 2.5oC.

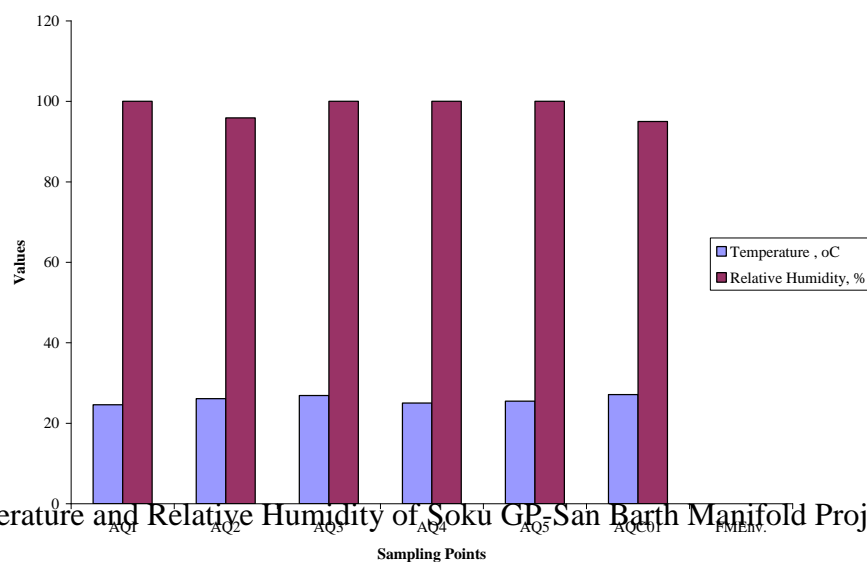
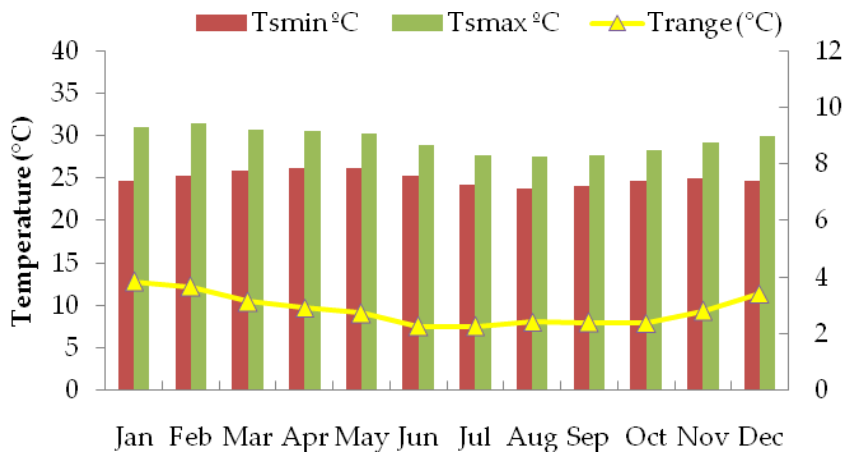


Figure 4.4: Temperature and Relative Humidity of Soku GP San Barth Manifold Project Area.



a

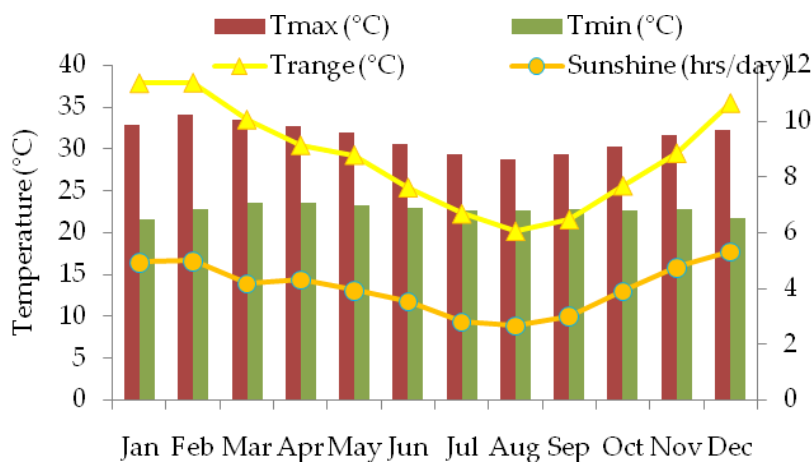


Figure 4.5: Monthly Average Minimum and Maximum Temperatures, Temperature Range and Sunshine Hours for Port Harcourt/Onne/Bonny Axis (a) 10m above the Earth (NASA) (b) Temperatures on the Earth's surface (NIMET)

4.4.2.4 Rainfall

Rinfall distribution both spatial and temporal is the single most important factor in differentiating seasons in the tropics. Rainfall occurrence and distribution in Nigeria are however dependent on the two air masses that prevail over the country. The Nigeria Climate Review 2010 noted that the southern part of the country experienced rainfall between 3000 – 4500mm. Some areas recorded higher than normal rainfall conditions and included some areas in the southwest and Ogoja, Calabar and Eket in the southeast. In 2010, the highest daily rainfalls of 199.5mm, 184.6mm and 183.8mm were recorded at Uyo (June), Benin (September) and Umuahia (June) respectively (NIMET, 2010).

Historical records show that the months of July, August and September have the highest precipitation while December, January and February records the lowest rainfall (Ologunorisa and Adejuwon, 2010). Table 4.3 shows the pattern of rainfall during the dry season (November - February) and wet season (March - October) which is typical of tropical rain forest covering Port Harcourt and Onne areas. The Table indicates the mean annual rainfall for Port Harcourt to be 2370.5mm and that of Onne to be 2438.4mm. Warri has the highest annual rainfall of 2907.8mm in the Niger Delta followed by Calabar (2903.8mm) and Onne



(2438.4mm). Rainfall was experienced almost every day during the field study carried out between 2nd and 8th August 2011 in the study area during the wet season.

Table 4.3: Summary of Rainfall Statistics for Selected Stations in the Niger Delta

S/N	Station	Mean Annual rainfall (mm)	Nov-Feb rainfall (mm) (% of Annual)	Mar - Oct rainfall (mm) (% of Annual)
1	Benin	2087.2	145.8 (7.05%)	1939.9 (92.95%)
2	Sapele	2391.5	167.5 (7.03%)	2223.4 (92.97%)
3	Warri	2907.8	228.7 (8.18%)	2578.0 (91.82%)
4	Port Harcourt	2370.5	237.9 (9.77%)	2138.9 (90.23%)
5	Onne	2438.4	222.4 (8.74%)	2225.3 (91.26%)
6	Opobo	3816.8	370.4 (9.44%)	3456.4 (90.56%)
7	Calabar	2903.8	304.1(10.75%)	2591.5 (89.25%)
8	Uyo	2142.2	142.1 (5.48%)	2007.7 (94.52%)

Source: Adapted from Ologunorisa and Adejuwon, 2010

There is a general decrease in rainfall in Nigeria, but the coastal area is experiencing slight increase. Apart from the general southward shift in rainfall patterns, the duration has also reduced from 80-360 (1941-1970) to 40-280 (1970-2002) rainy days per year (Odjugo, 2005). Table 4.4 shows the rainfall and rain days over 1993 – 2001 in Port Harcourt.

Table 4.4: Mean Monthly Rainfall and Number of Rainy Days in Port Harcourt (1993-2001).

Month	Fe		Ma		Ju		Au		Se		Oc		Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Rainfall (mm)	15.8	40.7	105.8	165.8	217.0	310.3	365.2	232.0	351.8	275.4	104.7	31.7	2216.2
Rainy days	2	4	8	10	14	19	22	19	21	19	8	3	149

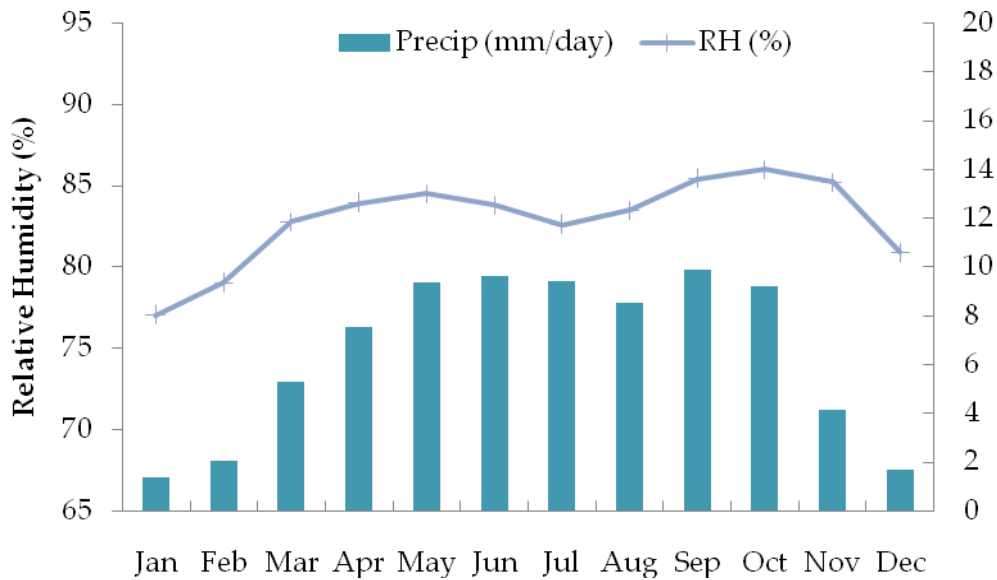
Source: NIMET, Oshodi

The 22 year average rainfall per day for the period 1983 – 2005 from NASA is shown in Figure 4.6a while that of the period 1993 – 2001 from NIMET is shown in Figure 4.4b. The annual daily average rainfall pattern also shows the normal bimodal distribution typical of the Niger Delta. As already pointed out, the maximum daily rainfall can increase to 200 mm/day but the average hardly exceeds 10 to 12 mm/day in the peak of the rainy season during June/July/September and is below 2 mm/day in the dry season.

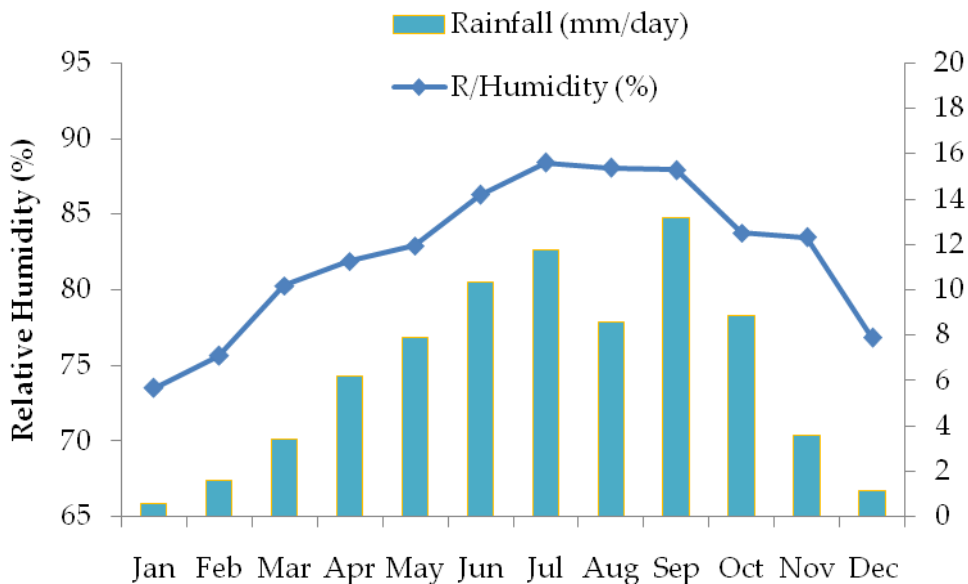
4.4.2.5 Relative Humidity

The composite relative humidity curves in Figure 4.6 (a and b) show that mean monthly relative humidity is consistently high in the eighties with no month experiencing values greater than 88% . As expected, mean monthly relative humidity values are slightly high for the wet season months (approximately March to November) with the highest values occurring within the months of July to August. This is when the influence of the moisture-laden South-westerlies is greatest. In the dry season relative humidity drops to the high seventies. During the wet season field data gathering (August 2011), the relative humidity values ranged from 95.0 - 100% during the rainy season and ranged from 58 to 63% during the dry season (Table 4.2; Figure 4.4) and give a reflection of the historical data obtained for the study area.

A 100% RH was recorded at the respective sampling stations when it was raining during sampling.



(a)



(b)

Figure 4.6: Daily Average Rainfall and Relative Humidity, for Port Harcourt/Onne/Bonny Axis (a) 10m Above the Earth (NASA) (b) Earth's Surface (NIMET)

4.4.3 Air Quality and Noise

Potential sources of air pollution that may impact negatively on the ambient air quality in the area include emissions from the pipeline operation activities. Others sources are boating activities, swamp biogenic activities and domestic fires. Most of the lands in this area are vegetated and less likely to induce wind generated dust from open fields. Expanse of some degraded mangrove forest arising from oil spillages was observed and oil sheens were occasionally seen on water surfaces. These incidences are capable of modifying the ambient air quality through the parameters chosen for observation. The major pollutants consisting of



carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), hydrogen sulfides (H₂S), volatile organic compounds (VOC) and suspended particulate matter (SPM) were investigated in this study. A summary of the data for ambient air quality measurements at the ROW and the surrounding area during the field data gathering is presented in Table 4.5. Table 4.6a is essentially a subset of the more complete USEPA NAAQS (Table 4.6b) and WHO guidelines (WHO, 2005). The ambient levels of the air quality parameters measured in the proposed project area are below the regulatory limits.

i) Carbon Monoxide (CO), and Carbon Dioxide (CO₂): Carbon Monoxide is a colourless, odourless gas emitted from combustion processes. In urban areas, the majority of CO emissions into ambient air come from mobile and some stationary sources. In the swamp, it is expected that biogenic and boating activities will also be contributory sources. Carbon Monoxide can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues (asphyxiation). At extremely high levels, CO can cause death. In the study area, all CO readings ranged from below detection limit of the analytical equipment (<dL) to 0.01 ppm, during the wet season and from below detectable limit to 0.02 ppm during the dry season data gathering; about the same as the control (<dL) and far less than the FMEnv limits of 1.0 ppm – 20.0 ppm. The concentrations of CO₂ ranged from 127.3ppm to 210.3ppm in the wet season and from 127.7ppm to 215.0 ppm in the dry season. The concentrations of CO₂ were below standard limit of 325ppm recommended by the Federal ministry of environment. Although carbon dioxide is not generally considered as a pollutant because the entire food chain by which man exists is based on it, high levels can result in green house effect.

ii) Oxides of Nitrogen (NO_x): Oxides of Nitrogen (NO_x) are the group formula for nitric oxide (NO) and nitrogen dioxide (NO₂). Nitrogen dioxide is the main toxic component in the air; it could be released directly from combustion points or arises as the oxidation product of nitric oxide which is a less harmful species. Nitrogen dioxide (NO₂) forms quickly as a result of emissions from cars, trucks, buses, power plants, and off-road equipment. In addition to contributing to the formation of ground-level ozone, and fine particle pollution, NO₂ is linked with a number of adverse effects on the respiratory system. All the sites sampled in the study area gave values less than detection limit, in both the wet and dry seasons respectively and far less than the FMEnv limits of 0.04 ppm – 0.06 ppm.

iii) Oxides of Sulphur: Oxides of Sulphur (SO_x) is the group formula for SO₂, SO₃ and SO₄²⁻ which usually occur as both primary and secondary air pollutants. Power plants, industry, volcanoes and the oceans emit these species as primary pollutants. In addition, biological decay processes and some industrial sources emit H₂S which is oxidized to form the secondary pollutant, SO₂. The combustion of fossil fuels containing sulphur yields SO₂ in direct proportion to the sulphur content of the fuel.

The primary threat of SO₂ to urban atmosphere may arise not from the SO₂ itself but from the changes it undergoes in the atmosphere such as the formation of sulphuric acid, H₂SO₄, a reaction which is catalysed by particulate matter; and the formation of sulphate aerosols. SO₂ can also be absorbed on small particles such as the salts of iron; manganese and vanadium present in the atmosphere and thus enter the alveoli of the lungs. All the sampled sites yielded SO_x results less than detection limit during the wet and dry seasons respectively. These were below the FMEnv limits of 0.01 ppm – 0.1 ppm.

iv) Volatile Organic Carbon (VOC): Volatile Organic Carbon is an aggregate parameter defining volatile hydrocarbon species. These are airborne and are usually composed of low



and intermediate molecular weight hydrocarbons. All the sampled sites of the ROW study area, gave values within the range of less than detection limit to $0.04 \mu\text{g}/\text{m}^3$ during the wet season. The dry season values of VOC ranged from below detectable limit to 0.06 ppm . These values are far less than the FMEnv limit of $160 \mu\text{g}/\text{m}^3$, indicating that the study area is not contaminated with VOCs or that its carrying capacity has not been exceeded.

vi) **Particulate Matter:** This is the term for a mixture of solid particles and liquid droplets found in the air. Suspended particulate matter values for the wet season ranged from less than detection limit to $0.330 \mu\text{g}/\text{m}^3$. The dry season values ranged from less than detection limit to 0.692 ppm . These values were less than the control which had SPM value of $0.331 \mu\text{g}/\text{m}^3$. Nevertheless these figures never exceeded the FMEnv limit of $250 \mu\text{g}/\text{m}^3$.

vi) **Noise:** Noise is an unwanted sound, considered as an environmental pollutant, a waste product generated in conjunction with various anthropogenic activities. Noise is any sound, independent of loudness, that can produce an undesirable physiological or psychological effect in an individual and that may interfere with the social end, such as communication, work, rest, recreation and sleep of an individual or group.

The results obtained from the field data gathering show that except at the sampling points AQ2 and AQ3, the ambient noise level within the ROW were less than 60 dB(A) for both wet and dry seasons.. The noise level was also below the FMEnv limit of 90 dB(A) for eight hours continuous exposure (Table 4.5c). Sources of noise generation in the area were mainly boat movement and Human activities. Environmental impacts that may be associated with noise may not be due to oil exploration activities alone but also in combination with boat, human activities etc. The air and noise standard are shown in Tables 4.6a-4.6c.

Table 4.5: Air Quality Characteristics for Soku Gas Plant Pipeline Project EIA

Parameters	Wet Season						Dry Season*						FMEnv Limits
	AQ 1	AQ 2	AQ3	AQ 4 Ekul. II	AQ 5 Luckyland.	AQC 01 Control,	1	2	3	4	5	Control,	
VOC (µg/m ³)	0.01	0.02	0.04	<dL	<dL	<dL	0.02	0.03	0.06	<dL	<dL	<dL	160
CO (ppm)	0.01	0.01	0.02	<dL	<dL	<dL	0.01	0.01	0.02	<dL	<dL	<dL	1.0 – 20.0
CO ₂ (ppm)	129.0	195.1	127.3	210.3	143.0	115.2	147.0	188.0	127.7	191.4	215.0	119.1	325
SO _x (ppm)	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	0.01 - 0.1
NO _x (ppm)	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	0.04 – 0.06
H ₂ S (ppm)	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	<dL	NA
SP M (µg/m ³)	0.060	<0.010	0.327	0.330	0.016	0.331	0.060	<0.010	0.692	0.351	0.035	0.340	150
Noise level dB (A)	39.6	58.0	49.0	46.0	38.0	48.2	41.3	47.0	53.0	46.0	41.1	41.3	90 dB(A)

Key: <dL = Below detection limit, NO_x, SO_x, H₂S = 0.01ppm; NA = Not Available

*Sources: Environmental Impact Assessment for Gbaran - Soku EGGS-11 Gas Development Project. Draft report (2006)
 Environmental Impact Assessment of Nembe Creek Trunkline Replacement Project. Final report (2006)



Table 4.6a: Nigerian Ambient Air Quality Standard

Pollutants	Time of Average	Limit
Particulates	Daily average of daily values 1 hour	250 µg/m ³ 600 µg/m ³
Sulphur oxides (Sulphur dioxide)	Daily average of hourly values 1 hour	0.01ppm (26 µg/m ³) 0.1ppm (260 µg/m ³)
Non-methane Hydrocarbon	Daily average of 3-hourly values	160 µg/m ³
Carbon monoxide	Daily average of hourly values 8-hourly average	10ppm (11.4 µg/m ³) 20ppm (22.8 µg/m ³)
Nitrogen oxides (Nitrogen dioxide)	Daily average of hourly values (range)	0.04ppm – 0.06ppm (75.0 µg/m ³ - 113 µg/m ³)
Photochemical oxidant	Hourly values	0.06ppm

Source: FEPA (1991)

Table 4.6b: National Ambient Air Quality Standards of USEPA & WHO

Pollutant	Primary Standards		Secondary Standards	
	Level	Averaging Time	Level	Averaging Time
Carbon Monoxide	9 ppm (10 mg/m ³)	8-hour	None	
	35 ppm (40 mg/m ³)	1-hour		
Lead	0.15 µg/m ³ (2)	Rolling 3-Month Average	Same as Primary	
	1.5 µg/m ³	Quarterly Average	Same as Primary	
Nitrogen Dioxide	0.053 ppm (100 µg/m ³)	Annual (Arithmetic Mean)	Same as Primary	
Particulate Matter (PM10)	150 µg/m ³	24-hour	Same as Primary	
Particulate Matter (PM2.5)	15.0 µg/m ³	Annual (Arithmetic Mean)	Same as Primary	
	35 µg/m ³	24-hour	Same as Primary	
Ozone	0.075 ppm (2008 std)	8-hour	Same as Primary	
	0.08 ppm (1997 std)	8-hour	Same as Primary	
	0.12 ppm	1-hour	Same as Primary	
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Mean)	0.5 ppm (1300 µg/m ³)	3-hour (1)
	0.14 ppm	24-hour (1)		

Source: EPA (1973)

Table 4.6c: Noise Exposure Limits for Nigeria

Duration per Day, Hour	Permissible Exposure Limit dB(A)
8	90
6	92
4	95
3	97



2	100
1.5	102
1	105
0.5	110
0.25 or less	115

Source : FEPA (1991)

4.4.4 Soil Studies

The soils found in the study area are mainly the mangrove forest soils, which in the USDA Soil Classification scheme is termed Histosol, but locally termed Chikoko. The soils are made up of decomposing plant tissues mixed with silt/sandy mineral matter and, in their natural state, saturated with water all year round by tidal inundation. These soils contain a thick network of mangrove roots and detritus in varying stages of decomposition. In general, the soils contain iron sulphides that, when drained and aerated, easily convert to sulphuric acid thereby acidifying the soil. The standard practice of coating pipelines is also a measure to forestall corrosion.

4.4.4.1 Soil Physical Properties

Soil Colour: In general, Histosols are dark green in colour and the soils of the study area had colours varied from white grey to dark grayish (2.5YR Hues), with the colour tending to darken with depth. In general, mottling, minute red coloured spots, are observable in the soil matrix, due to changes in the redox potential of iron (from Fe²⁺ to Fe³⁺) resulting from oxidation under fluctuating moisture conditions.

Soil Porosity: The results of soil porosity testing are shown in Table 4.7a and b. The porosity of the soils in the study area ranged from 44 to 80% at the surface (mean 68.5%) soil level and 40 to 74% (mean of 56.72 %) at the subsurface soil level during the wet season. The dry season porosity values ranged from 42.00 to 83.00 % (mean 69.59%) at the surface soil level, and from 42 to 76 % (mean (58.81) at the sub surface soil level during the dry season. The porosity of the soils collected from control site was higher than soils collected along the pipeline ROW.

Soil Bulk Density: The bulk density of the soils along the pipeline ROW (Table 4.7) ranged from 0.98 to 1.17g/cm³ at the surface soil level and 1.03 to 1.19 g/cm³ at the subsurface soil level during the rainy season. The dry season bulk density values of the soil ranged from 0.95 to 1.14 g/cm³ at the surface soil level, and from 1.00 to 1.16 g/cm³ at the subsurface soil level. This is no more different than the values obtained from the control point soil (mean: 1.01 and 1.15 g/cm³ at for surface and subsurface levels respectively).

Available Water Holding Capacity (AWHC): Available water holding capacity of the pipeline ROW soils ranged from 20.00 to 56.00 (31.45) at the surface soil level and 26.00 to 60.00 % (43.18) at the subsurface soil level respectively during the wet season. The dry season Water Holding Capacity 24.00 to 56.00 % at the surface soil level and from 29.00 65.00% at the sub surface soil level. Mean AWHC at both depths was moderately higher than 20 % obtained in the control surface soil. The higher AWHC observed is attributed to the texture type which has average clay content (mainly silty clay).

Permeability: The permeability of the soil of the pipeline ROW ranged from 0.09 to 0.40 cm/s (mean 0.19 cm/s) and 0.07 to 0.32 cm/s (0.14 cm/S) at the surface and subsurface soil levels respectively during the rainy season. The dry season permeability values ranged from

0.25 to 0.62 cm/s at the surface soil level and from 0.09 to 0.35 cm/s at the subsurface soil level.

4.4.4.2 Soil Chemical Properties

Exchangeable Cations: Exchangeable calcium content of the soil of the pipeline ROW surface soils ranged from 30.90 to 226.00mg/kg at the surface soil level, and from 22.11 to 211.72 mg/kg at the sub surface soil level during the wet season. The dry season values of the calcium content of the soil ranged from 32.12 to 239.0 mg/kg at the surface soil level, and from 27.13 to 218.44 mg/kg at the subsurface soil level. Potassium content ranged from 10.55 to 338.00mg/kg at the surface soil level and from 7.88 to 226.55 at the subsurface soil level during the wet season. The dry season values of Potassium ranged from 9.44 to 331.0 mg/kg at the surface soil level and from 6.36 to 214.0 mg/kg at the sub surface soil level while the subsurface content of Potassium ranged from 6.36 to 214.0 mg/kg at the sub surface soil level. Sodium concentration ranged from 313.52 to 499.24 mg/kg at the surface soil level and from 118.67 to 328.00 mg/kg at the sub surface level during the wet season. The dry season values of sodium ranged from 338.61 to 519.0 at the surface soil level, and from 121.80 to 335.0 mg/kg at the sub surface soil level.

The exchangeable cation of the soil of the project area is dominated by sodium (Fig.4.7)

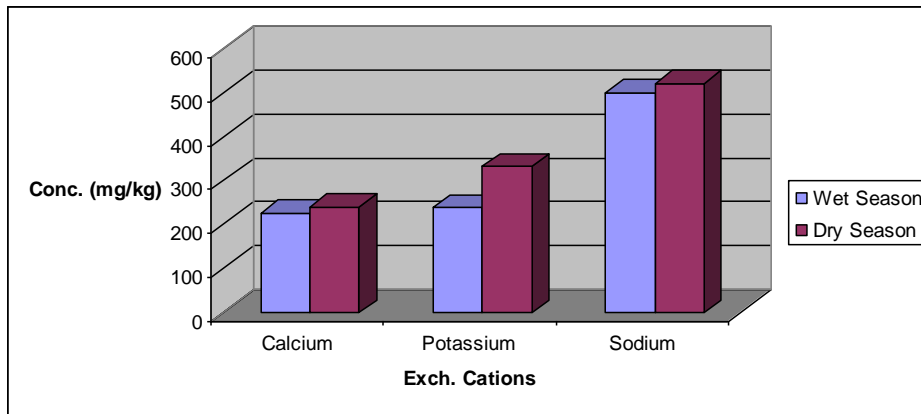


Figure 4.7: Exchangeable Cations Concentration of the Study Area

Ammonium content ranged from 5.75 to 52.20mg/kg (mean= 27.03 mg/kg) at the surface and 8.40 to 57.90mg/kg at the subsurface soil levels respectively during the wet season. The dry season values of ammonium content of the soil ranged from 5.61 to 50.0 mg/kg at the surface soil level and from 8.36 to 55.20 mg/kg at the subsurface soil level. . The concentration was highest in the control soils and this is attributed to favourable soil water contents expressed in the available water holding capacity and porosity, relative to the pipeline ROW soils.

Anions: Chloride (salinity) ranged from 66.05 to 2477.07mg/kg (mean = 1074.33 mg/kg) in the surface and 87.17 to 1604.00mg/kg at the subsurface soil level during the wet season. The dry season concentration ranged from 68.00 to 2483.11 at the surface soil level and from 89.22 to 1618.00 at the subsurface soil level. The values were higher than that obtained at the control sampling point. Nitrite content ranged from 0.14 to 0.86 and 0.12 to 0.27 at both surface and subsurface depths respectively during the wet season. The dry season concentration ranged from 0.13 to 0.81 at the surface soil level and from 0.11 to 0.23 mg/kg at the subsurface soil level.

Nitrate concentration ranged from 1.44 to 130.11mg/kg and from 0.58 to 151.02 mg/kg respectively at the surface and subsurface soil levels during the wet season. The dry season



concentration of Nitrate ranged from 1.46 to 133.0 mg/kg at the surface soil level, and from 0.62 to 154.11 mg/kg at the subsurface soil level. Nitrate and nitrite contents of the soils from the ROW were slightly lower compared to the control soils. This is an indication that net nitrification process is higher in the control soils relative to the pipeline ROW soils.

Sulphate concentration ranged from 14.20 to 302.08mg/kg and from 10.22 to 290.00mg/kg at the surface and subsurface soil levels respectively during the wet season. The dry season concentration ranged from 14.00 to 312.0 mg/kg at the surface soil level and from 10.00 to 60.12 mg/kg at the subsurface soil level. The strongly acidic reaction reported for the ROW soils are attributable to the higher sulphate contents. Sulphate with ground water results in the production of sulphurous acid and HCl that may dissociate to yield H⁺.

The phosphate concentration of the soil ranged from 12.50 to 42.66 mg/kg at the surface soil level, and from 12.06 to 61.74 mg/kg at the subsurface soil level. The dry season phosphate concentration ranged from 12.46 to 39.20 mg/kg at the surface soil level and from 9.00 to 57.81 mg/kg at the subsurface soil level. Phosphate availability and solubilisation are more in the control soil compared to the pipeline ROW soils. At extremely acidic and alkaline level, phosphate availability and solubilisation are at minimum.

Heavy Metals: The concentration of Cadmium ranged from 0.36 to 6.77 mg/kg at the surface soil level, and from 0.12 to 7.12 mg/kg at the subsurface soil level during the wet season. The dry season concentration of Cadmium ranged from 0.33 to 6.50 mg /kg at the surface soil level and from 0.12 to 7.00 mg/kg at the subsurface soil level

The concentration of Iron ranged from 866.4 to 926.5 mg/kg at the surface soil level, and from 426.8 to 231.4 mg/kg at the subsurface soil level during the wet season. The dry season concentration of Iron ranged from 862.4 to 926.0 mg /kg at the surface soil level and from 424.5 to 2210 mg/kg at the subsurface soil level. The mean Iron concentration at the control point was 1827 mg/kg at the surface soil level and 1449 mg/kg at the subsurface soil level. Adefemi et al (2007) reported the occurrence of Fe in high concentrations in Nigeria soils.

The concentration of Chromium ranged from 0.65 to 5.21 mg/kg at the surface soil level, and from 0.89 to 2.66 mg/kg at the subsurface soil level during the wet season. The dry season concentration of Chromium ranged from 0.64 to 5.21 mg /kg at the surface soil level and from 0.88 to 2.64 mg/kg at the subsurface soil level

The concentration of Zinc ranged from 18.31 to 79.51 mg/kg at the surface soil level, and from 17.66 to 40.98 mg/kg at the subsurface soil level during the wet season. The dry season concentration of Zinc ranged from 18.20 to 78.44 mg /kg at the surface soil level and from 16.59 to 40.12 mg/kg at the subsurface soil level. The Zn concentrations in all the soils are generally below the critical limit of 250 mg/kg and are within the tolerable limit.

The concentration of Nickel ranged from 3.76 to 12.2 mg/kg at the surface soil level, and from 1.33 to 10.96 mg/kg at the subsurface soil level during the wet season. The dry season concentration of Nickel ranged from 3.74 to 12.3 mg /kg at the surface soil level and from 1.34 to 11.10 mg/kg at the subsurface soil level.

The concentration of Vanadium in the soil of the study area is below the detectable limit (0.01 mg/kg) of the analytical equipment.

The concentration of Lead ranged from 2.37 to 7.96 mg/kg at the surface soil level, and from 1.27 to 12.31 mg/kg at the subsurface soil level during the wet season. The dry season concentration of Lead ranged from 2.38 to 7.98 mg /kg at the surface soil level and from 1.28



to 12.34 mg/kg at the subsurface soil level. Generally, lead content of both soils was low and below the critical soil content of 100.00 mg/kg and are therefore within tolerable limits.

The total organic carbon (TOC) concentration of the study area soils ranged from 0.22 to 0.51 % at the surface soil level, and from 0.01 to 0.09 % at the subsurface soil level during the wet season. Dry season concentration ranged from 0.20 to 0.48 % at the surface soil level and from 0.01 to 0.09 % at the subsurface soil level. Lower percentages of mean of total organic carbon were observed in the control point soils; 0.29 % at the surface soil level and 0.02% at the subsurface soil level.

Total Petroleum Hydrocarbon (TPH) content of the soil of the area ranged from 0.20 to 0.44 mg/kg at the surface soil level and below detectable limit at the subsurface soil level during the wet season. The dry season concentration ranged from 0.20 to 0.45 mg/kg at the surface soil level and below detectable limit at the subsurface soil level. These values indicate very low concentration of petroleum hydrocarbon in the soil of the study area.

Microbial Properties of Soils: During the wet season, the Total Heterotrophic Fungi (THF) count ranged from 2.60 to 4.60 x 10⁵ cfu/g at the surface soil level and from 3.0 to 3.10 x 10⁵ cfu/g at the subsurface soil level respectively. The predominant fungal isolates were Mucor, Candida, Aspergillus, Cladosporium and Penicillium. Some of the Candida and Penicillium spp isolated were hydrocarbon utilizers. The total heterotrophic bacteria in the soils ranged from 2.90 to 6.80 x 10⁵ (cfu/g) at the surface soil level and from 2.40 to 4.90 x 10⁵ (cfu/g) at the sub surface soil level. The bacteria population was dominated by Bacillus, Klebsiella, Staphylococcus, Flavobacterium, Escherichia, Pseudomonas and Serratia. The hydrocarbon utilizing bacteria included Pseudomonas and Bacillus also as the dominant species. The dry season Total Heterotrophic Fungi (THF) count ranged from 2.52 to 4.12 x 10⁵ cfu/g at the surface soil level and from 2.80 to 3.10 x 10⁵ cfu/g at the subsurface soil level respectively. The predominant fungal isolates were Mucor, Candida, Aspergillus, Cladosporium and Penicillium. Some of the Candida and Penicillium spp isolated were hydrocarbon utilizers. The total heterotrophic bacteria in the soils ranged from 2.30 to 6.60 x 10⁵ (cfu/g) at the surface soil level and from 2.38 to 4.84 x 10⁵ (cfu/g) at the sub surface soil level. The bacteria population was also dominated by Bacillus, Klebsiella, Staphylococcus, Flavobacterium, Escherichia, Pseudomonas and Serratia. The hydrocarbon utilizing bacteria included Pseudomonas and Bacillus also as the dominant species. Kigbara (2008) earlier reported critical mean value of 4.30 x 10⁴ cfu/g after screening seven different soils in Rivers state. However, in Rivers State Onifade and Abubakar (2007) reported a range of 3.00 x 10⁶ to 2.9 x 10⁷ cfu/g that was higher than that obtained from the RoW and control soils.

Table 4.7a: Wet Season Soil Physico-chemical Properties of Project Area

Parameters	Range in soils (0-15cm)	Mean 0-15cm	Range in soils (15-30cm)	Mean 15-30cm	Control Mean 0-15cm	Control Mean 15-30cm	Critical level in soil	DPR Target value (mg/kg)	DPR Intervention value (mg/kg)
Electrical conductivity, $\mu\text{S}/\text{cm}$	699.00-12490	6742.90	624.2-12880	6797.03	5622	5720			
Cation Exchange Capacity, mg/kg	0.45-3.064	1.60	0.43-3.10	1.44	1.028	0.885			
Exchangeable acidity, mg/kg	0.16-0.648	0.36	0.09-0.41	0.26	0.617	0.552			
Bulk density, cm^3/g	0.98-1.17	1.05	1.03-1.19	1.10	1.01	1.15	1.25a		
Porosity, %	44.00-80.00	68.54	40.00-74.00	56.72	80.0	64.0			
Available water holding, %	20.00-56.00	31.45	26.00-60.00	43.18	20.0	36.0			
Permeability, cm/s	0.09-0.40	0.19	0.07-0.32	0.14	0.19	0.12			
Phosphate, mg/kg	12.50-42.66	29.24	12.00-61.74	35.04	54.62	42.33			
Sulphate, mg/kg	114.20-1302.08	148.57	110.22-1290.00	156.13	204.66	308.57			
Calcium, mg/kg	30.90-226	109.70	22.11-211.72	88.72	54.20	51.30	761.52 b		
Sodium, mg/kg	313.52-499.24	359.53	118.67-328.00	279.17	327	322.91	50.00b		
Nitrate, mg/kg	1.44-130.11	45.54	0.58-151.02	27.51	59.62	34.68			
Ammonium, mg/kg	5.75-52.2	27.03	8.40-57.90	28.01	82.43	76.69			
Nitrite, mg/kg	0.14-0.86	0.47	0.12-0.27	0.18	0.55	0.28			
Potassium, mg/kg	10.55-338	130.35	7.88-226.55	102.58	95.33	26.00	98.84 b		
Salinity as chloride, mg/kg	66.05-2477.07	1074.33	87.17-1604.00	822.42	750.06	263.03			
Carbonate, mg/kg	14.70-127.5	65.64	17.31-152.14	83.39	211.91	308.57			
Total Organic Carbon), %	0.22-0.51	0.34	0.01-0.09	0.03	0.29	0.02	1.00 b		
Total Hydrocarbon Content, mg/kg	0.64-2.09	1.06	0.04-1.11	0.59	<0.01	<0.01		1	40.00
TPH, mg/kg	0.2-0.44	0.16	<0.001	<0.001	<0.001	<0.001	50.00	50.00	5000
Vanadium, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10.80 d		

Nickel, mg/kg	3.76-12.2	9.18	1.33-10.96	8.32	6.04	5.16	50.00 c		
Lead, mg/kg	2.37-7.96	5.11	1.27-12.31	5.01	5.62	2.64	100 c	85	530
Chromium, mg/kg	0.65-5.21	2.54	0.89-2.66	1.72	4.93	6.75	50.00 c	100	380
Zinc, mg/kg	18.31-79.51	36.73	17.66-40.98	27.91	66.49	61.84	250.00 c	140	720
Cadmium, mg/kg	0.36-6.77	2.63	0.12-7.12	2.86	0.83	0.97	5.00 c	0.80	12
Iron, mg/kg	866.492654	1392.23	426.8-2314	1115.33	1827	1449	200.00 c		
Manganese, mg/kg	5.22-180.67	72.29	15.60-178.61	67.90	95.64	108.62			
Total Heterotrophic Bacteria Count, x10 ⁵ Cfu/g	2.90-6.80	4.97	2.40-4.90	3.48	3.9	2.4			
Total Heterotrophic Fungi Count x10 ⁵ Cfu/g	2.60-4.60	3.51	3.0-3.10	1.45	3.3	2.0			

a = Foth (1975), b = Agboola and Ayodele, (1987), c = Lacatusu (2000), d = WHO (1983), and e = Department of Petroleum Resources (2002)

Table 4.7b: Dry Season Soil Physico-chemical Properties of Project Area

Parameters	Range in soils (0-15cm)	Mean 0-15cm	Range in soils (15-30cm)	Mean 15-30cm	Control Mean 0-15cm	Control Mean 15-30cm	Critical level in soil	DPR Target value (mg/kg)	DPR Intervention value (mg/kg)
Electrical conductivity, μ S/cm	683.00-12400	6911.10	618.0-12614	668.0	5436	5618			
Cation Exchange Capacity, mg/kg	0.48-3.212	1.64	0.46-3.13	1.47	1.212	0.960			
Exchangeable acidity, mg/kg	0.18-0.652	0.39	0.11-0.43	0.29	0.621	0.560			
Bulk density, cm ³ /g	0.95-1.14	1.00	1.00-1.16	1.07	0.99	1.13	1.22a		
Porosity, %	42.00-83.00	69.5495	42.00-76.00	58.81	81.5	66.0			
Water Holding Capacity, %	24.00-56.00	33.55	29.00-65.00	47.10	24.0	39.8			
Permeability, cm/s	0.25-0.62	0.23	0.09-0.35	0.17	0.22	0.15			
Phosphate, mg/kg	12.46-39.20	25.90	9.00-57.81	33.11	51.38	40.22			

Sulphate, mg/kg	114.00-1312.0	143.16	110.00-1160	152.11	201.20	302.11			
Calcium, mg/kg	32.12-239	112.41	27.13-218.44	91.55	57.30	53.10	764.58 b		
Sodium, mg/kg	338.61-519.0	362.61	121.80-335.00	284.11	336	329.44	50.00b		
Nitrate, mg/kg	1.46-133.0	47.59	0.62-154.11	28.44	61.10	36.20			
Ammonium, mg/kg	5.61-50.0	26.10	8.36-55.20	26.50	79.22	74.51			
Nitrite, mg/kg	0.13-0.81	0.38	0.11-0.23	0.16	0.53	0.26			
Potassium, mg/kg	9.44-331	129.24	6.36-214.0	100.37	92.41	24.98	98.84 b		
Salinity as chloride, mg/kg	68.00-2483.11	1216.38	89.22-1618.00	826.52	754.00	265.00			
Carbonate, mg/kg	11.44-11.90	63.00	16.11-143.10	80.28	204.42	304.22			
Total Organic Carbon), %	0.20-0.48	0.29	0.01-0.09	0.02	0.27	0.02	1.00 b		
Total Hydrocarbon Content, mg/kg	0.65-2.15	1.10	0.04-1.12	0.59	<0.01	<0.01		1	40.00
TPH, mg/kg	0.2-0.45	0.17	<0.001	<0.001	<0.001	<0.001	50.00	50.00	5000
Vanadium, mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	10.80 d		
Nickel, mg/kg	3.74-12.3	9.17	1.34-11.10	8.34	6.08	5.17	50.00 c		
Lead, mg/kg	2.38-7.98	5.18	1.28-12.34	5.04	5.64	2.66	100 c	85	530
Chromium, mg/kg	0.64-5.21	2.53	0.88-2.64	1.71	4.92	6.73	50.00 c	100	380
Zinc, mg/kg	18.20-78.44	35.98	16.59-40.12	27.12	66.31	61.24	250.00 c	140	720
Cadmium, mg/kg	0.33-6.50	2.23	0.12-7.00	2.84	0.80	0.94	5.00 c	0.80	12
Iron, mg/kg	862.4-926.0	1365.10	424.5-2210	1100.25	1819	1436	200.00 c		
Manganese, mg/kg	4.93-160.35	69.25	14.94-162.14	64.49	91.38	102.56			
Total Heterotrophic Bacteria Count, x105Cfu/g	2.30-6.60	4.91	2.38-4.84	3.35	3.6	2.2			
Total Heterotrophic Fungi Count x105Cfu/g	2.52-4.12	3.44	2.80-3.10	1.42	3.2	2.0			

a = Foth (1975), b = Agboola and Ayodele, (1987), c = Lacatusu (2000), d = WHO (1983), and e = Department of Petroleum Resources (2002)



*Sources: Environmental Impact Assessment for Gbaran - Soku EGGS-11 Gas Development Project. Draft report (2006)
Environmental Impact Assessment of Nembe Creek Trunkline Replacement Project. Final report (2006)

4.4.5 Vegetation and Biological Diversity of the Study Area

The General Ecology of the Study Area: The proposed pipeline project is located in the predominantly mangrove ecosystem of the Niger Delta. The mangrove of the Niger Delta is said to be the third largest expanse of mangrove forest, which is characterised by saline tidal waters and highly adapted plant species. The mangrove renders ecological services that include the stabilization of the swamp system (by trapping of silt) and provision of valuable habitats for the spawning and survival of organisms. Also, patches of freshwater vegetation can be found on levee crest, which are elevated areas, found in Soku area. The baseline vegetation characteristics along existing pipeline routes are distinctly different from the undisturbed areas. This is due to the clearance of trees (mostly mangrove) to create the pipeline right-of-way (ROW). There are no seasonal changes in the vegetation types and they are predominantly perennial and evergreen.

Vegetation Characteristics: A total of 33 plant species were encountered in the study area as shown in Table 4.8. The predominant type of vegetation seen along the pipeline route is the mangrove plants and their associates that constitute about 99% of the species found.

However, freshwater plants were seen colonizing old dredge dumps and on levee crest due to lack of regular inundation by the brackish waters. The mangrove vegetation is found mainly where brackish water prevails (Plate 4.3) within muddydeltaic deposits, while the freshwater vegetation (Plate 4.4) are influenced by rainfall as the areas where they are found is not inundated by saline tidal waters.



Plate 4.3: Mangrove Vegetation in the Study Area

Mangrove Species: The plant with the highest frequency of occurrence is the dwarf red mangrove (*Rhizophora mangle*), which are found interspersed beyond the edges of creeks, where the he tall red mangrove (*Rhizophora racemosa*) are found. Also found in the study area are white mangrove (*Avecinnia africana*), which are occasionally seen on in the midst of the dwarf red mangrove. The mangroves are adapted to the brackish water environment, by possessing pneumatophores (breathing roots) and prop/stilt roots which are covered with lenticels. These lenticels serve as passages for gaseous exchange; oxygen and carbon dioxide are channeled through these organs. The superficial roots are however sensitive. The trees can easily die if the ventilating organs (lenticels) are covered. The dense network of stilt roots and branches of the *Rhizophora* spp make accessibility extremely difficult.



Plate 4.4: Freshwater Vegetation in the Study Area

In terms of density, the red mangroves occur in the form of seedlings, shrubs and trees with a density of about 390/ha in the control areas outside existing pipeline ROW (Table 4.9), as compared to only about 20/ha at sampling sites are within the existing ROW (particularly between Krikakiri and Soku Gas Plant). The canopy height ranges between 2 and 4m for the dwarf red mangrove, and 15-20m for the tall red mangrove. The mangrove plants are generally harvested for firewood by the locals (Plate 4.5).



Plate 4.5: Harvested Fuel wood

Non-mangrove Species/Mangrove Associates: The non-mangrove species found in the study area include demanding *Acrostichum aureum* (mangrove fern) and *Paspalum vaginatum* (mangrove grass), often found underneath the mangrove canopies. Others include mangrove associates, which were seen in discrete patches mainly along the banks of the artificially-created well slots and they include *Machaerium lunatus* and *Dalbergia ecastaphyllum* (leguminous plants that help to enrich the mangrove soils with biologically-fixed nitrogen). Also found are epiphytic species such as *Platyserium* sp, *Bulbophyllum oreonastes* and the moss *Ocoblepharum* sp, seen in abundance on the mangrove tree trunks, as well as *Nypa fruticans*, seen in impacted areas.

Freshwater Vegetation: Although the project area is found within the brackish-water mangrove ecosystem, there exist small patches of freshwater areas on levee crests, where human settlements also exist. Within the pipeline route, the freshwater vegetation was seen

around the Soku axis (Plate 4.6). The species found include naturally occurring plants such as *Mariscus ligularis*, *Paspalum pes-capre*, *Ficus* sp., *Anthocleista vogellii* and *Alchornea cordifolia*. Others include raffia palms (*Raphia hookeri*), Abura (*Halea stipulosa*), baphia (*Baphia* sp) and cabbage tree (*Anthocleista vogellii*). In addition, agricultural crops such as plantain (*Musa paradisiacal*), oil palm (*Elaeis guineensis*), coconut (*Cocos nucifera*), sugar cane (*Saccharum officinalis*), mango (*Mangifera indica*), pawpaw (*Carica papaya*) were seen in the area (around Krikakiri area).



Plate 4.6: Freshwater Swamp Forest Close to Soku Gas Plant

Vegetation Characteristics in Impacted Areas: In general, the impacted areas were seen around Soku flowstion and Gas Plant areas (due to previous oil spills and fire), around dredge dumps and along the existing pipeline RoW. The vegetation at the impacted areas did not have any discernible structure since most of the plants had been destroyed following the oil spills and fire. Like in other areas, the impacted areas were also vegetated mostly by mangrove species (*Rhizophora* sp and *Avicennia africana*), *Acrostichum aureum* (mangrove fern), but with much higher density of *Nypa fructicans* (Nipa palm). However, plant densities were significantly lower in the impacted areas (20 stands/ha). In the past, an attempt had been made at regeneration of the mangrove plants in the impacted areas by planting seedlings of the red mangroves at a mean density of about 9 plants/m², as compared to about 4/m² in the unimpacted /control sites, resulting in higher density in the impacted areas (Plate 4.7).



Plate 4.7: Mangrove in the impacted area in Soku

Phytochemistry/Plant Tissue Chemical Analysis: The results of analysis of plant tissues (mature leaves) of the red mangrove (*Rhizophora* spp) from the various sampling stations within the Soku Gas Plant – San Barth Manifold pipelines ROW are shown in Table 4.8. The concentrations of copper, zinc and iron and heavy metals can be considered normal (Salisbury and Ross, 1985; Jain, 2007). Chloride concentrations ranged from 1.28 – 544.04 mg/kg as against the recommended adequate level of 100 mg/kg; copper (6.65- 16.41 mg/kg) as against 6mg/kg; zinc (8.09 – 47.25mg/kg) as against 20 mg/kg and iron (98.2–1083.0 mg/kg) as against 100 mg/kg. However, the concentrations of essential elements are below critical limits. For instance, nitrogen concentrations range from 5.29- 22.92 mg/kg as against the critical limit of 15,000mg/kg; phosphorus was 2.58–16.27mg/kg, as against 2,000mg/kg; while the range for sulphur was 0.28 –3.47mg/kg (compared to a limit of 1,000 mg/kg). Also, the concentrations of potassium (32.01 – 648.06mg/kg), magnesium (132.31-636.98 mg/kg) and manganese (0.99 – 24.62 mg/kg) were also low.

Table 4.8: Plant Elemental Composition (mg/kg) of Rhizophora spp

Parameters	Parameters in ionic form	VG 1 Control	VG1	VG.2	VG.3	VG.4	VG.6	VG.7	VG.8	VG.9	Adequate for higher plants Salisbury and Ross (1985); Jain (2007)
Nitrogen, mg/kg	NO ₃ ⁻ , NH ₄ ⁺	22.18	14.06	12.54	22.92	14.52	15.07	12.62	14.50	5.21	17.29
Chloride, mg/kg	Cl ⁻	2.12	6.49	2.55	2.40	6.99	544.04	112.18	90.19	54.62	1.28
Total Phosphorus, mg/kg		16.27	8.24	8.06	4.44	2.58	4.28	4.62	5.22	8.46	6.55
Sulphur, mg/kg	SO ₄ ²⁻	2.54	1.64	1.28	0.44	0.28	0.55	0.92	3.47	2.81	0.99
Potassium, mg/kg	K ⁺	434.00	365.05	648.06	480.10	618.20	32.01	651.21	254.70	444.43	638.32
Magnesium, mg/kg	Mg ²⁺	442.20	441.14	233.08	524.72	636.98	143.89	132.31	279.19	143.70	134.13
Iron, mg/kg	Fe ³⁺ , Fe ²⁺	149.91	116.78	776.75	98.20	240.85	115.88	1083	520.00	117.34	589.5
Manganese, mg/kg	Mn ²⁺	24.62	19.52	4.23	11.88	24.50	0.99	1.58	8.30	4.62	12.55
Zinc, mg/kg	Zn ²⁺	16.98	27.80	13.28	34.55	11.49	47.25	8.09	25.32	20.06	9.14
Copper, mg/kg	Cu ²⁺	14.82	15.57	6.65	16.41	6.98	15.61	8.12	6.76	15.82	9.26
Nickel, mg/kg	Ni ²⁺	7.14	8.81	12.76	14.42	12.88	10.97	12.87	10.22	13.49	12.73
Chromium, mg/kg	Cr ⁶⁺	1.05	0.21	0.21	1.97	1.86	1.54	4.05	1.53	1.42	1.37
Cadmium, mg/kg	Cd ²⁺	0.55	0.30	0.50	1.08	0.31	5.09	<0.005	6.51	4.13	0.31
Lead, mg/kg	Pb ²⁺	1.70	2.96	7.64	3.02	2.25	3.06	8.29	6.41	2.16	7.51

Plant Pathological Conditions: The commonest plant disease of the mangrove plants within the Soku Gas Plan – San Barth Manifold pipeline ROW study area was leaf spot (Plate 4.8) followed by sooty mildew. The red mangroves had very light and moderate infections of the leaf spot disease caused by *Cercospora* sp at both unimpacted/control and some impacted sites, but severe infection of leaves of *Rhizophora mangle* (dwarf red mangrove) at some crude oil spill impacted sites of the study area (particularly at VEG 2 mangrove swamp sampling location close to Soku Flowstation and Gas Plant). The tall red mangrove (*Rhizophora racemosa*) also had moderate infection of the sooty mildew disease at some impacted sites. The pathogens were however limited in their occurrence and did not pose any threat to the general healthy appearance of the entire vegetation in the study area. The disease symptoms, severity indices and causative organisms in vegetation of the study area are presented in Table 4.9:



Plate 4.8: Leaf Spot Disease of *Rhizophora* Mangle within the Study Area

Table 4.9: Disease Symptoms, Severity Indices and Causative Organisms in the Study Area

S/No	Plant species	Disease symptoms	Disease severity index		Identified causative agents
			Control Unimpacted Sites	Impacted Sites within ROW	
1	<i>Rhizophora racemosa</i> (Tall red mangrove)	Leaf Spots	1	2	<i>Cercospora</i> sp
2	<i>Rhizophora mangle</i> (Dwarf red mangrove)	Leaf Spots	2	3	<i>Cercospora</i> sp
3	<i>Rhizophora racemosa</i> (Tall red mangrove)	Sooty mildew	1	2	<i>Erysiphe</i> sp
4	<i>Alchornea cordifolia</i>	Leaf spots	2	-	<i>Cercospora</i> sp



	(Christmas bush)				
5	Elaeis guineensis (Oil palm)	Rust	1	-	Curvularia sp

Plants Density: The commonest plant species in the area are the red mangroves occurring in the form of seedlings, shrubs and trees with a density of about 390/ha at the unimpacted and control sites, and only about 20/ha at the impacted sites. Nypa palm and coconut trees were also common in the area (Table 4.10)

Table 4.10: Plant Density of Dominant Economic Plant Species in the Study Area

S/No	Scientific Name	Common Name	Population Density of Trees and Shrub in ROW study area	
			Control/Unimpacted Sites	Impacted Sites within ROW
1	Rhizophora racemosa	Tall red mangrove	110 ± 6	8 ± 2
2	Rhizophora mangle	Dwarf red mangrove	280 ± 10	12 ± 5
3	Nypa fruticans	Nypa palm	9 ± 5	2 ± 1
4	Avecinna africana	White Mangrove	10 ± 3	0
5	Alstonia boonei	Stoolwood	8 ± 2	-
6	Cocos nucifera	Coconut	3 ± 1	-
	Saplings			
	Rhizophora sp		4 ± 1	9 ± 3
	Avecimia spp		0	11 ± 4

4.4.6 Wildlife/Invertebrate Fauna

The terrestrial invertebrate fauna observed or collected from the Soku-San Barth ecosystems include arthropods e.g crustaceans (crabs). The crabs seen (Plate 4.9) were not only few in number but of small sizes. Few molluscs were recorded in the entire area of study. The common periwinkle was conspicuously absent due to the oil spill in the area.

The mangrove soil fauna was made up mainly of decapod crustaceans. They include small individuals of the marsh crab (*Sesarma huzardi*), and purple mangrove crab (*Goniopsis pelii*). Only few individuals, usually of small sizes, were seen in the area sampled. Population density of these crabs varied from 2 to 10 per m² in the San Barth area and 0 to 5 per m² in the Soku area. Very few live gastropod molluscs were observed throughout the entire area and during the period of study. Mangrove molluscs such as periwinkles (*Tympanotonus fuscatus*, *Littorina* sp.), the whelk (*Thais califera*, *T. haemastobium*), and the oyster (*Crassostrea gazar*) were not seen, neither on the mangrove plants nor in the mudflats. Oysters usually occur mostly attached to the roots of the red mangrove (*Rhizophora racemosa*) and other hard substrates near the river bank while gastropods occur in the mudflat or attached to the mangrove plants.

The common arthropods include ants (Hymenoptera), beetles (Coleoptera), grasshoppers (Orthoptera), termites (Isoptera), true bugs (Heteroptera), springtails and snowflies (Collembola), true flies (Diptera), butterflies (Lepidoptera), spiders (Araneae) and millipedes (Chilopoda). These organisms were also seen in low population on the mangrove plants.



The only conspicuous vertebrates in the entire Soku – San Barth area were birds (Plates 4.10 -4.13). Other vertebrates include a few species of reptiles and mammals. The reptiles observed in the communities (Ekulama I & II, Krikakri, and Lucky Town) and mangrove swamps include a few individuals of lizards, skinks and an unidentified species of snake near Ekulama II. The avifauna was represented by several species of egrets, ducks, herons, kingfishers, bulbuls, finches and birds of prey. Mammals recorded include a few species of rodents (Squirrels, rats) and monkeys (Mona monkey).

The birds found in the area are the ones associated with the mangrove. These include the heron, egrets, hammerkop, kingfishers, fish eagle, swallows, swifts, and other seed-eating birds such as finches, whydahs, bulbuls and weaver birds. A checklist of the birds found in the area is presented in Table 4.11.

A few reptiles were recorded and these include agamids and skinks. No mammal was physically observed in Soku area.

The paucity of wild life species in the project area especially at Soku axis is attributable to effect of oil spill that occurred in the area. The spill decimated the wild life and their habitats. There were no crabs, molluscs, periwinkles (*Tympanotonus fuscatus*, *Littorina* sp.), whelks (*Thais* sp.), and oysters which are common wild life features of the mangrove areas.

Table 4.11: Checklist of Birds Recorded from San Barth – Soku Study Areas.

Family/Common Names	Species
Phalacrocoracidae (Comorants & Darters)	African Darter, <i>Anhinga rufa</i>
Ardeidae (herons & Egrets)	Great White Egret, <i>Egretta alba</i> Little Egret, <i>Egretta garzetta</i> Goliath Heron, <i>Ardea cinerea</i> Black-headed heron, <i>Ardea melanocephala</i>
Scopidae (Hammerkop)	Hammerkop, <i>Scopus umbretta</i>
Anatidae (Ducks & Geese)	Hartlaub's Duck, <i>Pteronetta hartlaubii</i>
Acciptridae (Vultures, hawks, eagles, kites)	Harrier hawk, <i>Polyboides radiatus</i> Palm-nut vulture, <i>Gypohierax angolensis</i> West African Goshawk, <i>Accipiter taussenelii</i> African River eagle, <i>Haliaetus vocifer</i> Black Kite, <i>Milvus migrans</i> Sparrowhawk, <i>Accipiter melanoleucus</i>
Jacanidae (lily trotter)	Lilly Trotter, <i>Actophiliornis africana</i>
Columbidae (doves)	Red-eyed dove, <i>Streptopelia semitorquata</i> Laughing Dove, <i>Streptopelia senegalensis</i> Tambourine Dove, <i>Turtur tympanistria</i> Red-billed Dove, <i>Turtur afer</i>
Psittacidae (Parrots)	Grey Parrot, <i>Psittacus erithacus</i> Lovebird, <i>Agapornis pullaria</i>
Cuculidae (Coucals)	Senegal Coucal, <i>Centropus senegalensis</i>
Alcedinidae (kingfishers)	Pied Kingfisher, <i>Ceryle rudis</i> malachite kingfisher, <i>Alcedo cristata</i>

Apodidae (Swift)	Senegal kingfisher, <i>Halcyon senegalensis</i> White-rumped Swift, <i>Apus caffer</i> little African Swift, <i>A. affinis</i>
Meropidae (Bee-eaters)	Little Bee-eater, <i>Merops pusillus</i>
Bucerotidae (hornbills)	Black-and-white-tailed hornbill, <i>Tockus fasciatus</i>
Hirundinidae (swallows)	White-throated Blue Swallow, <i>Hirundo nigrita</i>
Motacillidae (wagtails)	Yellow-throated long-claw, <i>Macronyx croceus</i>
Covidae (Crow)	Pied Crow, <i>Corvus albus</i>
Pycnonotidae (Bulbuls)	common Bulbul, <i>Pycnonotus barbatus</i> little Green Bulbul, <i>Andropodus virens</i> Swamp Palm Bulbul, <i>Thescelocichla leucopleurus</i>
Turdidae (Thrushes)	West African Thrush, <i>Turdus pelios</i> Scrub Robin, <i>Cercotrichas leucosticta</i>
Muscicapidae (flycatchers)	Ussher's flycatcher, <i>Artomyias ussheri</i>
Nectariniidae (Sunbirds)	Collared Sunbird, <i>Anthreptes collaris</i> Olive Sunbird, <i>Nectarinia olivacea</i> Green-throated Sunbird, <i>N. rubescens</i>
Ploceidae (Weavers)	Village Weaver, <i>Ploceus cucullatus</i> Bush-sparrow, <i>Petronia dentata</i> Pin-tailed Whydah, <i>Vidua macroura</i>
Estrildidae (Estrildine Weavers)	Common waxbill, <i>Estrilda astrild</i>
Mammals	
Cercopithecidae	Mona Monkey, <i>Cercopithecus mona</i>
Sciuridae	Giant Squirrel, <i>Protexerus strangeri</i>
Muridae	Black Rat, <i>Rattus rattus</i>



Plate 4.9: Fiddler Crab Observed in Lucky Town



Plate 4.10: Hammerkop (*Scopus umbretta*) in the Study Area



Plate 4.11: Little Egret (*Egretta garzetta*) in the Study Area



Plate 4.12: Goliath Heron (*Ardea cinerea*) Observed in the Study Area



Plate 4.13: Grey Heron Observed in the Study Area

4.4.7 Aquatic Studies

4.4.7.1 Physico-Chemical Analysis Result of Surface Water in the Study Area

The physio-chemical characteristics of surface water samples collected from the aquatic systems along the Soku Gas Plant- San Barth Manifold Pipeline ROW are presented in Table 4.12 and Figs 4.8 to 4.10. Surface water was acidic with pH ranging from 5.5 to 6.7 during the wet season and from 5.7 to 6.9 during the dry season. . The acidic nature of surface waters in this survey is in tandem with literature report of similar surface waters in the Niger Delta (Egborge, 1994; Erondu et. al., 1999). However, the observed pH values measured were within permissible limit of 6.5- 8.5. Surface water temperature was between 24.7 to 24.90C during the wet season and from 24.3 to 26.70C during the dry season (Fig 4.8). The alkalinity level ranged from 15.99 to 27.99 mg/l in the wet season and from 16.13 to 29.00 mg/l in the dry season. The concentration of suspended solids varied from 20 to 60mg/l in the wet season and from 18.00 to 59.00 mg/l in the dry season (Fig 4.9). The surface water Biochemical oxygen demand (BOD) levels varied between 5.04 mg/l and 5.50 mg/l in the wet season and from 5.00 to 5.48 mg/l in the dry season. The Chemical Oxygen Demand, values varied from 6.0 to 7.6 mg/l in the wet season and from 6.00 to 6.95 mg/l in the dry season (Fig 4.10). The BOD levels recorded in this survey were relatively higher than that provided in literature (Ideriah et. al 2010) and this may be due to a high input of organic load from the riparian grounds into the aquatic environment. The surface water in the study area had BOD levels in excess of 5mg/l and according to a classification by Moore and Moore (1976), the water quality in the study area can be classified as “doubtful”.

Table 4.12: Physico-chemical Characteristics of Surface Waters along Soku Gas Plant-San Barth Manifold Pipeline Route

PARAMETERS	Wet Season					Dry Season*				
	SW 1	SW2	SW3	SW4	SW5	1	2	3	4	SW5
Physico-chemical										

Temp. 0C	24.8	24.7	24.7	24.9	24.8	24.3	24.3	26.7	26.7	25.9
pH	6.6	5.6	6.5	6.7	6.6	5.7	6.5	6.9	6.6	6.8
Total Suspended Solids (TSS), mg/l	20.00	60.00	40.00	20.00	50.00	18.00	59.00	39.00	19.00	48.00
Alkalinity, mg/l	21.99	19.99	15.99	27.99	25.99	22.03	20.15	16.13	29.00	27.25
Biochemical Oxygen Demand Demand (BOD), mg/l	5.50	5.04	5.28	5.41	5.47	5.48	5.00	5.22	5.37	5.45
Chemical Oxygen Demand DDeDemand (COD), mg/l	6.60	6.68	6.00	7.60	6.40	6.33	6.59	6.00	6.95	6.34
Hydrogen Sulphide, mg/l	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Hardness, mg/l	25.20	28.00	120.00	200.00	240.00	26.10	28.9202	120.00	200.00	240.00
Carbonate, mg/l	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Hydrocarbon Content (THC), mg/l	0.650	0.312	0.370	0.240	0.430	0.6532	0.310	0.370	0.241	0.434
Total Organic Carbon, (TOC), mg/l	6.42	6.90	5.48	7.89	6.42	6.39	6.90	5.46	7.76	6.42



Total Petroleum Hydrocarbon (TPH), mg/l	0.280	<0.001	<0.001	<0.001	0.020	0.283	<0.001	<0.0011	<0.001	0.020
Ammonium, mg/l	<0.010	0.011	0.020	<0.010	<0.010	<0.010	0.013	0.018	<0.010	<0.010
Nitrite ion, mg/l	0.050	0.081	0.009	0.004	0.017	0.052	0.083	0.009	0.006	0.018
Nitrate ion , mg/l	0.290	0.126	0.592	0.247	0.266	0.290	0.125	0.595	0.247	0.267
Phosphorus, mg/l	0.055	0.024	0.012	0.116	0.032	0.059	0.026	0.110	0.116	0.034
Sulphide ion, mg/l	0.920	0.520	1.612	2.404	0.861	0.924	0.520	1.614	2.406	0.863
Sulphate (SO ₄) ion , mg/l	6.652	8.340	46.321	52.526	69.471	6.651	8.340	46.317	52.531	69.392
Sulphite (SO ₃) ion , mg/l	<0.001	0.025	0.027	0.009	<0.001	<0.001	0.026	0.027	0.008	<0.001
Heavy Metals (mg/l)										
Cr	0.177	0.165	0.179	0.243	0.211	0.172	0.161	0.173	0.241	0.209
Cd	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cu	0.147	0.138	0.124	0.109	0.174	<0.005	<0.005	<0.005	<0.005	<0.005
Pb	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Fe	1.023	0.929	0.809	0.717	0.593	1.021	0.923	0.800	0.714	0.588
Ni	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
V	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	0.149	0.152	0.138	0.133	0.202	0.145	0.151	0.134	0.130	0.200
As	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mn	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Se	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ag	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

*Sources: Environmental Impact Assessment for Gbaran - Soku EGGS-11 Gas Development Project. Draft report (2006)

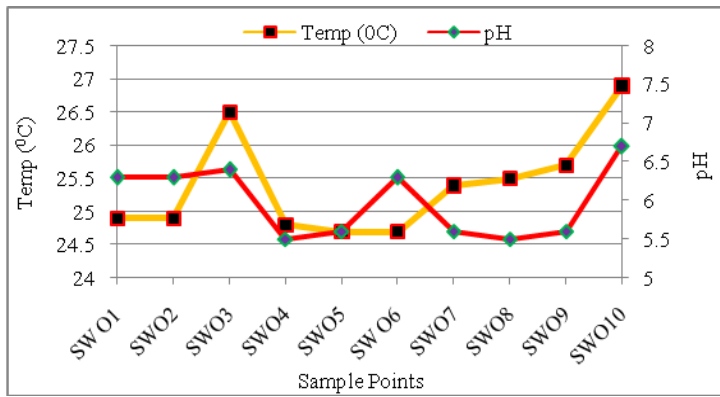


Figure 4.8: Spatial Variation in pH and Temperature (°C) in Surface Waters of the Project Area

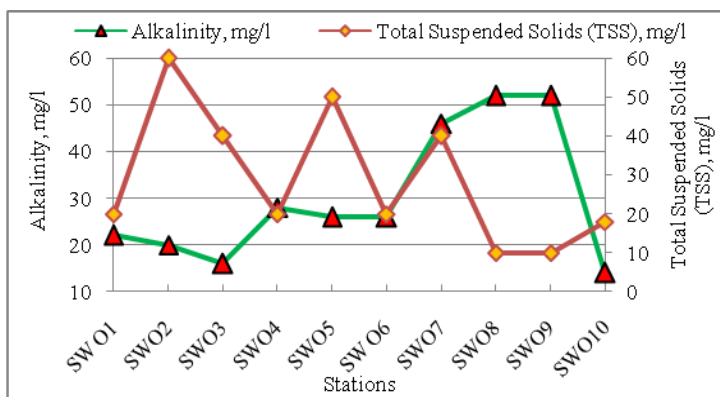


Figure 4.9: Spatial Variation in Total Alkalinity and Total Suspended Solids in Surface Waters of the Project Area

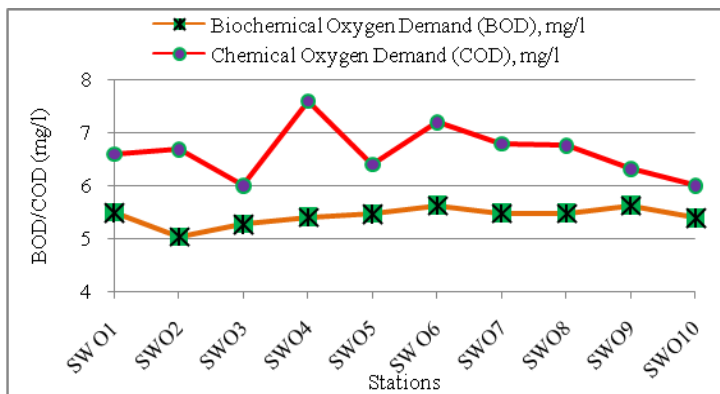


Figure 4.10: Spatial Variation in BOD and COD in Surface Waters Surface Waters of the Project Area

The total hardness of the surface water of the project area ranged from 25.20 mg/l to 240.00 mg/l in the wet season and from 26.10 to 240.0 mg/l in the dry season. The lowest concentration of 25.2mg/l and the highest concentration of 240.0mg/l (Fig 4.11), indicated a clear cut spatial variation.

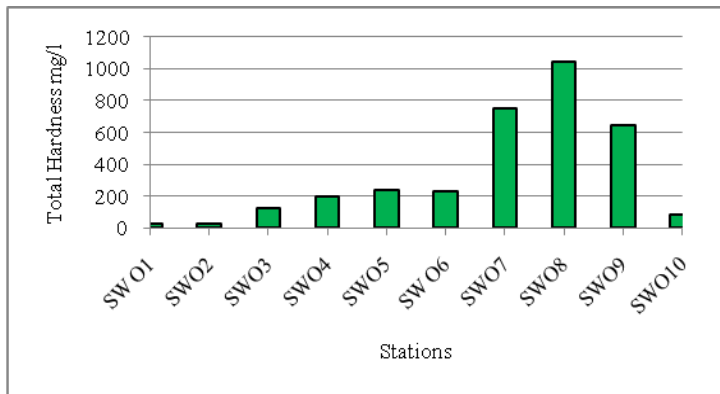


Figure 4.11: Spatial variation in Total Hardness in Surface Waters of the Project Area.

The Total Hydrocarbon Content (THC) and the Total Organic Carbon content (TOC) of the surface water of the study area were respectively low. They were also respectively recorded in all the sampling locations. The THC ranged from 0.240 to 0.650 mg/l in the wet season and from 0.241 to 0.653 in the dry season. These values are within permissible limits. The Total Organic Carbon (TOC) content varied from 5.48 to 7.89 mg/l in the wet season and from 5.46 to 7.76 mg/l in the dry season (Fig 4.12).

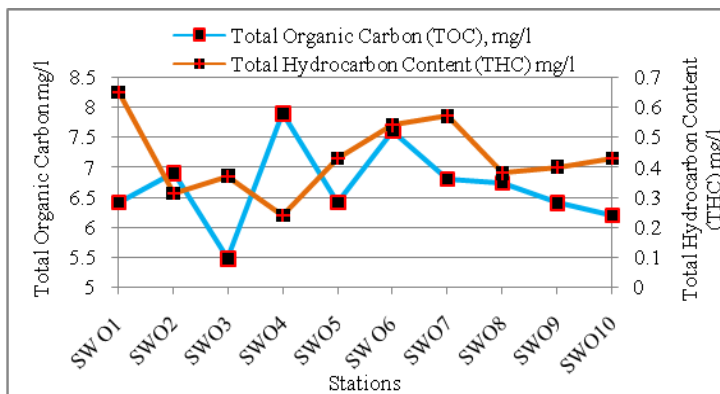


Figure 4.12: Spatial Variation in Total Organic Carbon and Total Hydrocarbon Content of Surface Waters in the Project Area.

The nutrient level in surface waters of the study area are presented in Figs 4.13 – 4.15. Nitrite concentration were generally low and ranged from 0.004 to 0.081mg/l during the wet season, and from 0.006 to 0.083 during the dry season. Nitrate concentrations ranged from 0.126 to 0.592 mg/l during the wet season and from 0.125 to 0.595 mg/l during the dry season (Fig 4.13) These values are higher than literature reports (Ideriah et al, 2010), suggesting that the study area is tending towards eutrophication. Against the backdrop of increased BOD levels it is clearer that the study area is suffering from some form of pollution.

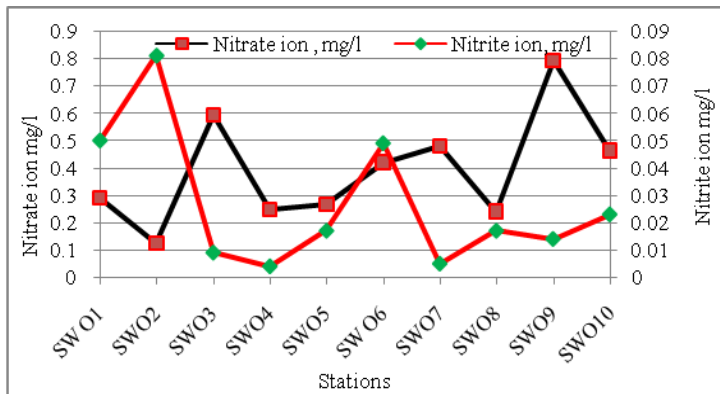


Figure 4.13: Spatial Variation in Nitrate ion and Nitrite ion of Surface Waters in the Project Area

The Phosphorous levels of the surface water varied from 0.012 to 0.055 mg/l during the wet season and from 0.026 to 0.116 during the dry season. These levels are similar to reports of phosphate in Luubara Creek (Deekae et. al. 2010). The phosphate levels in the study area were relatively low and conform to those reported for some other Nigerian rivers. This may be attributed to the rapid uptake of nutrients by primary producers (Ideriah et. al., 2010). Spatial variation in Phosphorus content of the soil of the surface area is shown in Figure 4.14.

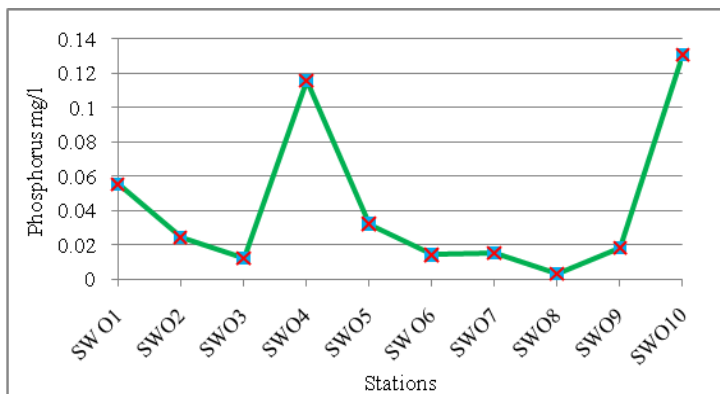


Figure 4.14: Spatial Variation in Phosphorus of Surface Waters in the Project Area

The Sulphate level of the surface water ranged from 6.65 to 69.47 mg/l in the wet season and from 6.651 to 69.392 during the dry season. The sulphite levels ranged from below the detectable limit of the analytical equipment (<0.002) to 2.404mg/l during the wet season and from 0.520 to 2.406 mg/l in the dry season for sulphides (Figure 4.15).

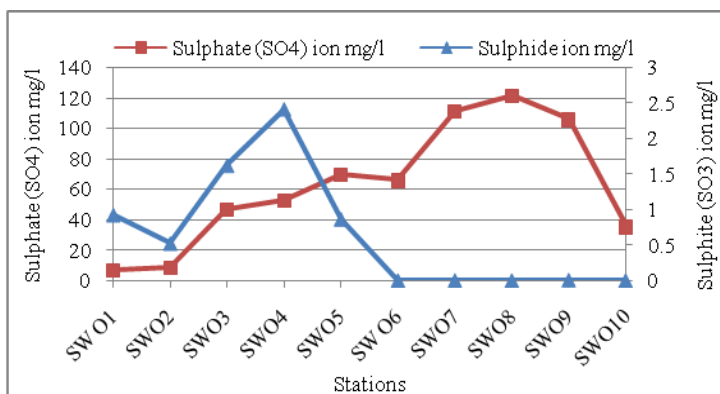


Figure 4.15: Spatial Variation in Sulphate and Sulphite of Surface Waters in the Project Area

Heavy Metals Characteristics: A summary of the heavy metals content of the surface water of the project area is presented in Table 4.13a and b and Figures 4.16 and 4.17. The result indicates that V, As, Hg, Mn, Se and Ag were below the detectable limit of the analytical equipment, while Cr, Cu, Fe and Zn concentrations varied. The concentrations of Cr ranged from 0.165 to 0.243 mg/l in the wet season and from 0.161 to 0.241 mg/l in the dry season.

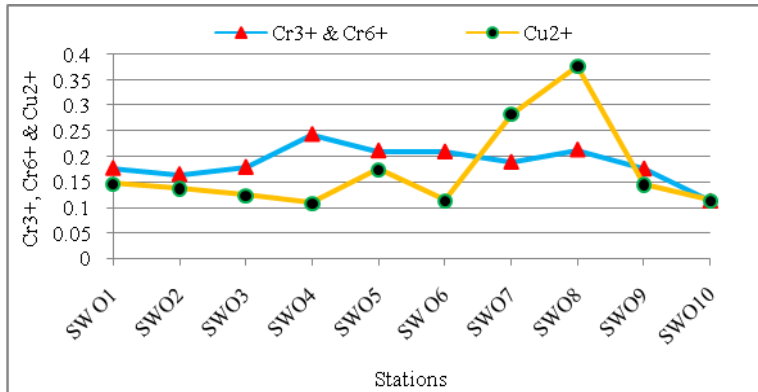


Figure 4.16: Spatial Variation in Cr³⁺, Cr⁶⁺ & Cu²⁺ of Surface Waters in the Project Area (August, 2011).

Iron (Fe) and Zn were also recorded in the surface waters along along Soku Gas Plant-San Barth Manifold Pipeline route. Zinc concentration ranged from 0.133 to 0.202 mg/l during the wet season and from 0.134 to 0.200 mg/l during the dry season. Iron (Fe) concentration ranged 0.593 to 1.023 mg/l in the wet season and from 0.588 to 1.021 mg/l in the dry season. (Fig. 4.17).

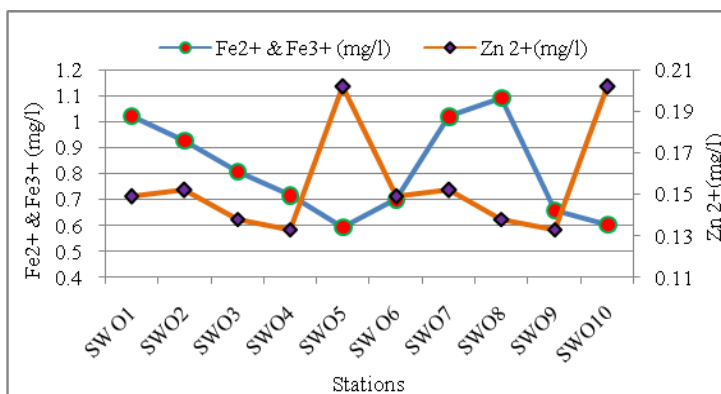


Figure 4.17: Spatial variation in Fe & Zn of Surface Waters in the Project Area

4.4.7.2: Aquatic Ecology

Phytoplankton: Phytoplanktons are the microscopic chlorophyll-a - containing plants found in aquatic ecosystems. In such ecosystems the phytoplanktons are the primary producers. A checklist of the phytoplankton in aquatic systems along Soku Gas Plant-San Barth Manifold Pipeline route is presented in Table 4.14a and b while Figure 4.18 shows the contributions of each of the major families of phytoplankton in the study area. Five major families of phytoplankton were recorded, namely; Baccillariophyceae, Dinophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae. This observation tallies with that made for similar

aquatic ecosystems in Nigeria (Nwankwo, 1997; Kadiri, 2002). Bacillariophyceae were the dominant family and constituted 43% of the total number of phytoplankton (Figure 4.18).

Table 4.14a: Diversity of Phytoplankton of the Project Area (Wet Season)

	SAMPLE STATIONS										Total	%Total
	1	2	3	4	5	6	7	8	9	10		
Bacillariophyceae												
<i>Amphiprora costata</i>	0	0	3	15	11	0	5	36	2	0	72	1.26
<i>Amphora ovalis</i>	0	16	0	0	7	0	0	0	42	0	65	1.14
<i>Bacillaria paradoxa</i>	0	10	0	9	21	31	0	0	9	16	96	1.68
<i>Biddulphia aurita</i>	0	0	28	0	4	5	20	4	4	2	67	1.17
<i>Coscinodiscus concinniformis</i>	0	0	0	5	0	0	27	11	0	0	43	0.75
<i>Coscinodiscus concinnus</i>	8	0	11	18	0	7	0	35	0	15	94	1.65
<i>Cosinodiscus lacustris</i>	21	6	6	12	0	0	24	0	0	22	91	1.59
<i>Cyclotella omta</i>	0	15	0	0	5	4	24	18	22	0	88	1.54
<i>Cyclotella operculata</i>	0	0	0	0	0	0	8	1	21	0	30	0.54
<i>Cymbella lata</i>	28	6	29	0	0	0	0	0	0	28	91	1.59
<i>Fragilaria intermedia</i>	38	35	0	25	48	2	5	5	0	3	161	2.82
<i>Gyrosigma</i>	0	0	9	0	6	23	8	13	0	34	93	1.63
<i>Gyrosigma acuminatum</i>	0	0	0	0	16	5	9	6	29	36	101	1.77
<i>Melosira granulata</i>	0	0	19	28	8	0	6	0	35	54	150	2.63
<i>Melosira distance</i>	0	0	0	15	36	8	0	13	0	17	89	1.56
<i>Melosira pusilla</i>	11	28	2	3	0	3	3	5	19	0	74	1.29
<i>Melosira varians</i>	5	0	0	0	0	38	10	9	7	0	69	1.21
<i>Navicula vividula</i>	47	12	10	6	18	5	27	0	8	55	188	3.29
<i>Nitzschia sigma</i>	0	0	0	0	0	0	38	0	0	67	105	1.84
<i>Pinnularia horealis</i>	0	0	0	0	0	0	15	28	43	35	121	2.12
<i>Stephanodiscus asroea</i>	0	35	26	9	36	25	0	48	55	0	234	4.11
<i>Synedra affinis</i>	17	12	0	0	6	5	0	20	20	5	85	1.49
<i>Synedra ulna</i>	45	18	18	5	5	0	9	0	0	41	141	2.47
<i>Tabellaria fenestrata</i>	0	0	3	0	0	35	7	27	0	8	80	1.41
Sub-Total	22	19	16	15	22	19	24	27	31	43	242	
	0	3	4	0	7	6	5	9	6	8	8	42.55
Chlorophyceae												
<i>Crusigenia truncata</i>	17	11	2	3	0	4	12	0	0	0	49	0.86
<i>Netrium intermedium</i>	1	0	0	17	29	0	25	3	18	29	122	2.14
<i>Spirotaenia cond</i>	5	15	19	5	8	5	6	0	0	19	82	1.44
<i>Closterium intermedium</i>	9	15	8	15	37	0	12	25	35	15	171	2.99
<i>Closterium pervulum</i>	7	0	0	8	0	79	0	0	0	7	101	1.77
<i>Clostridium gracile</i>	0	3	0	20	0	0	21	9	28	20	101	1.77
<i>Coelastrum reticulata</i>	3	8	12	26	17	8	0	0	0	0	74	1.29
<i>Crusigenia puadrata</i>	0	0	0	0	25	27	0	36	15	0	103	1.81
<i>Eudorina sp</i>	33	0	0	21	0	0	12	0	0	29	95	1.67
<i>Gonatozygon aculeatum</i>	0	0	7	0	0	0	0	0	27	0	34	0.59
<i>Netrium digitatus</i>	0	14	18	5	0	15	8	21	0	54	135	2.37
<i>S. quadricauda</i>	5	0	0	0	9	4	0	0	31	10	59	1.03
<i>Scenedesmus excelcia</i>	0	14	0	0	18	0	0	0	0	7	39	0.68



<i>Spirogyra</i> sp	0	0	3	6	0	0	0	3	55	0	67	1.18	
<i>Staurastrum seligerum</i>	4	0	0	14	0	15	32	15	36	0	116	2.04	
<i>Volvox aureus</i>	0	18	0	0	0	0	0	0	10	4	32	0.56	
<i>Volvox globator</i>	3	0	15	36	11	41	5	0	0	13	124	2.17	
Sub-Total	87	98	84	6	4	8	3	2	5	7	4	26.36	
Cyanophyceae													
<i>Anabaena affinis</i>	11	0	0		24	0	0	28	16	15	94	1.65	
<i>Anabaena arnoldii</i>	0	13	31	0	0	0	0	0	0	8	52	0.91	
<i>Anabaena spiroides</i>	29	3	3	20	0	0	0	0	0	31	86	1.51	
<i>Lynbya limnetica</i>	5	8	10	12	13	15	35	16	31	65	210	3.68	
<i>Merismopedia elegans</i>	0	9	0	9	0	35	38	16	0	0	107	1.88	
<i>Microcystis aeuroides</i>	0	0	0	3	11	0	7	0	0	0	21	0.37	
<i>Oscillatoria princeps</i>	7	5	20	11	0	0	17	9	2	0	71	1.24	
<i>Oscillatoria lacustris</i>	5	0	0	12	10	36	0	0	48	28	139	2.44	
<i>Pseudoanabaena</i>	35	11	36	0	14	12	38	11	36	3	196	3.44	
<i>Raphidiopsis mediteranea</i>	0	0	0	0	7	46		4	49	0	15	121	2.12
<i>Rivularia</i> sp.	21	0	9	0	5	9	28	8	45	3	128	2.24	
Sub-Total	11		10			15	16	13	17	16	122		
	3	49	9	67	84	3	7	7	8	8	5	21.48	
Xanthophyceae													
<i>Tribonema minus</i>	16	15	0	16	12	9	29	28	10	45	180	3.16	
<i>Tribonema viridis</i>	13	16	21	7	6	54	8	53	18	10	206	3.61	
Sub-Total	29	31	21	23	18	63	37	81	28	55	386	6.77	
Chrysophyceae													
<i>Dinobryon sertular</i>	9	36	31	12	9	11	27	0	5	21	161	2.82	
Total No. (x1000/l)	45	40	40	42	49	62	60	60	78	88	570		
No. of Species	8	7	9	8	2	1	9	9	2	9	4		
	29	28	27	33	32	32	36	32	32	38			

Table 4.14b: Diversity and Relative of Phytoplankton of the Project Area (Dry Season)*

	SAMPLE STATIONS										Total	%Total
	1	2	3	4	5	6	7	8	9	10		
Bacillariophyceae												
<i>Amphiprora costata</i>	0	0	2	11	9	0	4	28	1	0	54	1.33
<i>Amphora ovalis</i>	0	14	0	0	4	0	0	0	37	0	55	1.35
<i>Bacillaria paradoxa</i>	0	8	0	6	18	24	0	0	5	13	74	1.82
<i>Biddulphia aurita</i>	0	0	25	0	2	3	17	2	2	1	53	1.30
<i>Coscinodiscus concinniformis</i>	0	0	0	2	0	0	22	9	0	0	33	0.81
<i>Coscinodiscus concinnus</i>	5	0	7	13	0	4	0	29	0	11	69	1.70
<i>Cosinodiscus lacustris</i>	17	4	5	12	0	0	16	0	0	20	74	1.82
<i>Cyclotella omta</i>	0	11	0	0	3	3	21	18	16	0	72	1.77
<i>Cyclotella operculata</i>	0	0	0	0	0	0	4	1	17	0	22	0.54



Cymbella lata	23	4	24	0	0	0	0	0	0	23	74	1.82
Fragilaria intermedia	31	29	0	21	40	2	3	2	0	3	131	3.23
Gyrosigma	0	0	5	0	3	20	5	10	0	29	72	1.77
Gyrosigma acuminatum	0	0	0	0	10	5	5	4	29	30	83	2.04
Melosira granulata	0	0	13	20	5	0	3	0	21	44	106	2.61
Melosira distance	0	0	0	10	27	5	0	9	0	12	63	1.55
Melosira pusilla	8	31	2	3	0	3	3	5	14	0	69	1.70
Melosira varians	2	0	0	0	0	31	8	7	3	0	51	1.25
Navicula vividula	33	8	7	3	13	3	22	0	3	47	139	3.42
Nitzschia sigma	0	0	0	0	0	0	24	0	0	51	75	1.84
Pinnularia horealis	0	0	0	0	0	0	10	20	33	31	94	2.31
Stephanodiscus asroea	0	27	20	4	28	19	0	40	46	0	184	4.53
Synedra affinis	12	9	0	0	2	2	0	11	13	2	51	1.25
Synedra ulna	36	13	12	2	2	0	4	0	0	34	103	2.54
Tabellaria fenestrata	0	0	3	0	0	29	4	22	0	4	62	1.52
Sub-Total	167	158	125	107	166	153	175	217	240	355	1863	45.82
Chlorophyceae												
Crusigenia truncata	13	8	1	1	0	2	9	0	0	0	34	0.83
Netrium intermedium	1	0	0	11	22	0	23	3	12	0	72	1.77
Spirotaenia cond	5	11	13	1	3	5	3	0	0	12	53	1.30
Closterium intermedium	4	11	5	12	30	0	8	20	29	10	129	3.18
Closterium pervulum	3	0	0	3	0	54	0	0	0	3	63	1.55
Clostrium gracile	0	3	0	17	0	0	19	3	20	16	78	1.92
Coelastrum reticulata	3	3	8	20	12	5	0	0	0	0	51	1.25
Crusigenia puadrata	0	0	0	0	17	23	0	25	9	0	74	1.82
Eudorina sp	29	0	0	19	0	0	9	0	0	21	78	1.92
Gonatozygon aculeatum	0	0	3	0	0	0	0	0	21	0	24	0.59
Netrium digitatus	0	9	11	2	0	8	4	17	0	33	84	2.07
S. quadricauda	3	0	0	0	4	1	0	0	27	8	43	1.06
Scenedesmus excelcia	0	11	0	0	12	0	0	0	0	3	26	0.64
Spirogyra sp	0	0	1	3	0	0	0	3	44	0	51	1.25
Staurastrum seligerum	1	0	0	10	0	9	27	9	29	0	85	2.09
Volvox aureus	0	12	0	0	0	0	0	0	7	1	20	0.49
Volvox globator	3	0	9	23	9	33	3	0	0	8	88	2.17
Sub-Total	65	68	51	122	109	140	105	80	198	115	1053	25.9
Cyanophyceae												
Anabaena affinis	6	0	0		9	0	0	19	10	9	53	1.33
Anabaena arnoldii	0	9	11	0	0	0	0	0	0	3	23	0.56
Anabaena spiroides	17	1	1	12	0	0	0	0	0	23	44	1.08
Lynbya limnetica	2	4	4	5	12	7	24	9	27	41	135	3.29
Merismopedia elegans	0	3	0	4	0	13	23	7	0	0	50	1.23
Microcystis aeuroginosa	0	0	0	3	6	0	4	0	0	0	13	0.32
Oscilartoria princeps	3	2	15	8	0	0	11	4	2	0	45	1.10
Oscillatoria lacustris	1	0	0	7	6	29	0	0	32	19	94	2.31
Pseudoanabaena	26	7	27	0	9	5	22	7	24	1	128	3.15
Raphidiopsis mediteranea	0	0	0	0	3	33	2	28	0	11	77	1.89
Rivularia sp.	17	0	6	0	2	4	21	3	37	2	92	2.26
Sub-Total	72	26	64	39	47	91	107	77	132	109	754	18.52
Xanthophyceae												



Tribonema minus	10	9	0	10	9	5	21	19	7	34	124	3.05
Tribonema viridis	8	7	14	3	2	45	4	47	13	5	148	3.65
Sub-Total	28	16	14	13	11	50	25	66	20	39	272	
Chrysophyceae												
Dinobryon sertular	4	27	25	7	3	8	19	0	3	17	113	2.78
Total No. (x1000/l)	336	285	279	288	336	442	431	453	570	635	4055	
No. of Species	29	28	27	33	32	32	36	32	32	38		

*Sources: Environmental Impact Assessment for Gbaran - Soku EGG-11 Gas Development Project. Draft report (2006)

Environmental Impact Assessment of Nembe Creek Trunkline Replacement Project. Final report (2006)

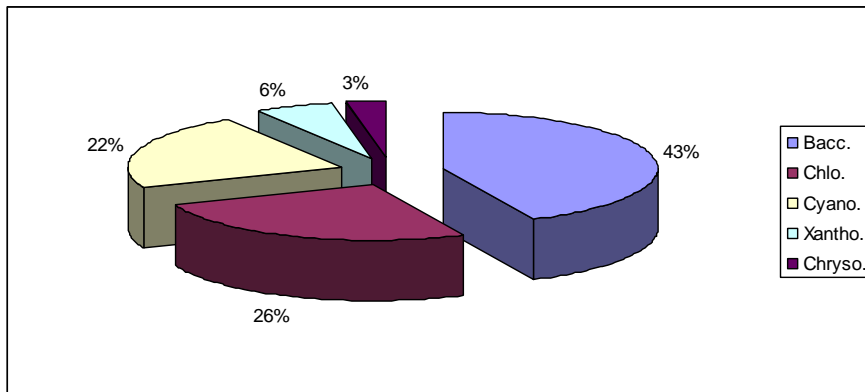


Figure 4.18: Relative Abundance of Major Families of Phytoplankton in the Project Area.

The Bacillariophyceae comprised 43 %. The second dominant group of phytoplankton was the Chlorophyceae, which contributed 26%, the Cyanophyceae made up 22% of the total number of phytoplankton. The Xanthophyceae made up 6% of the phytoplankton while the Chrysophyceae made up 3 % of the total phytoplankton count

The spatial variation in both the total phytoplankton count and the number of species of phytoplankton is presented in Figure 4.19. The number of phytoplankton in the various stations ranged between 407x10³ organisms per liter of water in Sample Point 2 (SW2) of brackish water to 889 x10³ organisms per liter (SW10). The number of species of phytoplankton ranged from 27 (SW3) to 38 (SW10).

These values were grossly lower than literature reports of phytoplankton abundance in the Niger Delta (Dahlin et. al., 1985; Ezekiel et.al., 2011).

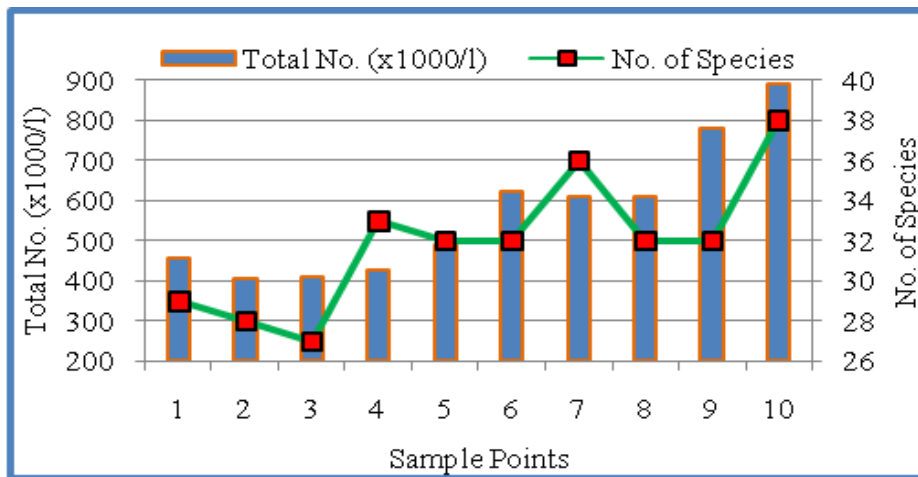


Figure 4.19: Spatial Variation in Total Phytoplankton Count and Number of Species of Phytoplankton in the Project Area

The linear relationship between the number of species of and total phytoplankton count is graphically presented in Fig 4.20. The co-efficient of co-relation (R) is 0.0.64 (R²=0.412) and shows that there is a linear relationship between both variables, thus an increase in the number of species of phytoplankton will likely result in an increase in the total phytoplankton count and vice versa.

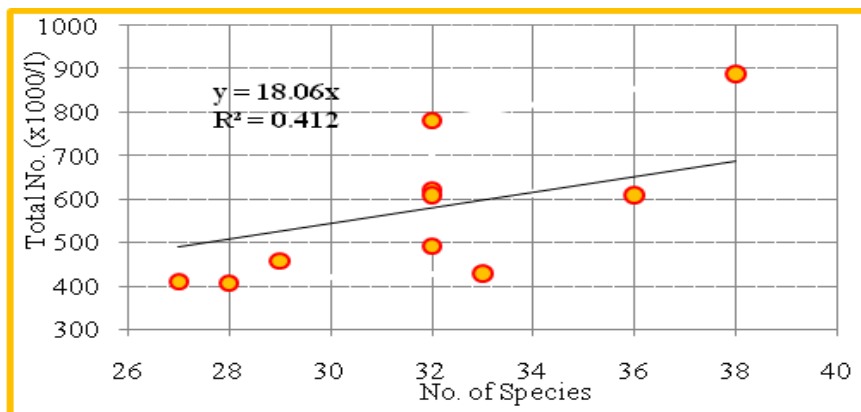


Figure 4.20: Linear Relationship between Total Phytoplankton Count and Number of Species of Phytolankton in the Project Area.

The diversity as shown by the Shannon-Wiener Index (Hs) was between 0 and 0.89 while Menhinick Index (D) was between 0 and 0.62. Margalef Index (d) values ranged from 0 to 2.33, Equitability was between 0 and 0.92 and Simpson's Dominance Index ranged between 0 and 1.00 (Table 4.15)

Table 4.15: Phytoplankton Community Composition Parameter of the Project Area

Bio-indices	Sample Points									
	1	2	3	4	5	6	7	8	9	10
Total species diversity (S)	29	28	27	33	32	32	36	32	32	38
Total abundance (N)	458	407	409	428	492	621	609	609	782	889
Log of Species diversity (Log S)	1.26	0.77	0.70	0.85	0.90	0.00	0.00	0.70	0.95	0.00



Log of abundance (Log N)	3.17	2.3	1.93	2.09	2.22	0.00	0.00	2.13	2.48	0.99
Shannon-Wiener Index (Hs)	0.89	0.72	0.64	0.65	0.74	0.00	0.00	0.57	0.82	0.10
Menhinick Index (D)	0.47	0.52	0.54	0.61	0.62	0.00	0.00	0.43	0.52	0.36
Margalef Index (d)	2.35	1.44	0.89	0.97	1.25	0.80	0.00	0.82	1.40	0.00
Equitability Index (j)	0.81	0.75	0.92	0.81	0.82	0.00	0.00	0.81	0.86	0.00
Simpson's Dominance Index (C)	0.20	0.25	0.26	0.25	0.23	0.00	0.00	0.36	0.19	0.89

Zooplankton: Zooplanktons are microscopic animals found mainly in the pelagic zone of water bodies where they depend on water currents and waves for motion. Zooplankton was sampled in ten (10) pre-determined sample points, in aquatic systems along Soku Gas Plant-San Barth Manifold Pipelines route. A checklist of the zooplankton species recorded in aquatic systems along Soku Gas Plant-San Barth Manifold Pipelines route is presented in Table 4.16a and b. The identified zooplankton fauna were categorized into protozoa, cladocera, decapod crustacean, rotifers, copepods, euphaisacea and larval/nymphal stages of insects. The percentage composition of each of these major zooplankton groups of the study area is presented in Fig 4.21. In both seasons, the copepods were the dominant zooplankton and contributed 33% of the zooplankton. Among copepods, Cyclops stenuis (6.36%), Mesocyclops (5.05%), and Thermocyclops (4.75%) are predominant. Cladocerans were the second dominant zooplankton with respect density and were represented by six (6) species amongst which were Moina cacrocapa (6.81%), Daphnia longippina (6.81%) and Alonella costata (5.97%).

Table 4.16a: Diversity and Relative Number of Zooplankton of the Project Area (Wet Season).

	SAMPLE STATIONS										Total	%Total
	1	2	3	4	5	6	7	8	9	10		
Protozoa												
Halteria sp	10	0	2	5	13	0	0	0	0	8	38	2.91
Spirostomum sp.	2	9	2	2	10	8	7	3	0	15	58	4.44
Tintinopsis senensis	5	5	4	0	2	18	7	7	27	0	75	5.74
Sub-Total Protozoa	17	14	8	7	25	26	14	10	27	23	171	13.09
Rotifers												
Brachionus calyciflorus	0	0	1	4	2	2	4	7	1	0	21	1.61
Brachionus falcatus	12	0	4	5	10	0	21	0	7	0	59	4.52
Sub-Total Rotifers	12	0	5	9	12	2	25	7	8	0	80	6.13
Cladocera												
Alonella costata	6	8	8	15	31	1	0	0	2	7	78	5.97
Bosmina fatalis	0	0	2	0	5	0	13	4	0	34	58	4.44
Ceriodaphnia	5	4	0	2	18	0	0	0	0	10	39	2.99
Daphnia carinata	0	2	0	13	0	0	3	0	8	12	38	2.91
Daphnia longippina	8	0	2	17	16	28	0	0	10	0	81	6.21
Moina cacrocapa	0	9	13	0	4	15	0	12	25	11	89	6.81
Sub-Total Cladocera	19	23	5	47	74	44	16	16	45	74	383	29.33



Copepods													
Acanthocyclops carinatus	0	0	1	2	1	28	0	6	4	0	42	3.22	
Acanthocyclops viridis	0	9	1	4	3	6	5	15	7	0	50	3.83	
Cyclops stenuis	4	3	0	0	45	11	11	7	2	0	83	6.36	
Mesocyclops	5	0	6	0	0	0	0	10	37	8	66	5.05	
Paracalanus	0	1	0	10	15	0	15	0	0	0	41	3.14	
Paracyclops afinis	2	0	0	0	0	0	0	30	0	0	32	2.45	
Paracyclops fimbriatus	0	5	0	9	0	7	2	12	0	12	47	3.59	
Thermocyclops	0	0	1	4	8	0	15	0	10	0	62	4.75	
Sub-Total Copepods	1	1	2	18	33	64	67	48	80	60	423	32.39	
Decapod Crustaceans													
Mysis sp.	4	8	4	0	12	0	0	19	12	0	69	5.28	
Euphaiacea													
Meganicliphanes norvegia	1	2	22	7	0	0	15	5	10	7	9	87	6.66
Larval													
Nauplius Larval	0	1	2	0	0	0	0	0	10	1	14	1.07	
Zoea	0	4	6	0	1	7	4	3	6	2	33	2.53	
Megalopa Larval	4	12	0	8	1	6	4	7	1	3	46	3.52	
Fish Larval	0	0	0	0	0	0	0	0	0	0	0	0	
Sub-Total Larval	4	17	8	8	2	13	8	10	17	6	93	7.12	
Total No. of zooplankton (100/l)	7	10	8	10	18	16	11	15	17	13	130		
No. of Species of zooplankton	9	2	9	4	9	7	6	2	6	2	6		
	1	3	1	7	14	17	14	14	15	17	13		

Table 4.16b: Diversity and Relative Number of Zooplankton of the Project Area (Dry Season).

	SAMPLE STATIONS										Total	%Total
	1	2	3	4	5	6	7	8	9	10		
Protozoa												
Halteria sp	8	0	2	3	8	0	0	0	0	4	25	6.32
Spirostomum sp.	2	4	2	1	6	3	4	3	0	9	34	8.60
Tintinopsis senensis	1	0	1	0	1	3	1	1	2	0	10	2.53
Sub-Total Protozoa	11	4	5	4	15	6	5	4	2	13	69	17.45
Rotifers												
Brachionus calyciflorus	0	0	1	2	2	2	1	3	0	0	11	2.78
Brachionus falcatus	4	0	1	2	2	0	9	0	2	0	20	5.06
Sub-Total Rotifers	4	0	2	4	4	2	10	3	2	0	31	7.84
Cladocera												
Alonella costata	2	3	2	4	3	1	0	0	2	2	19	4.81
Bosmina fatalis	0	0	2	0	2	0	3	1	0	5	13	3.29
Ceriodaphnia	2	1	0	2	3	0	0	0	0	2	10	2.53

<i>Daphnia carinata</i>	0	2	0	3	0	0	3	0	2	4	14	3.54
<i>Daphnia longipinna</i>	3	0	2	4	3	7	0	0	4	0	23	5.82
<i>Moina cacrocapa</i>	0	3	4	0	4	5	0	3	9	4	32	8.10
Sub-Total Cladocera	7	9	10	13	15	13	6	4	17	17	111	28.09
Copepods												
<i>Acanthocyclops carinetus</i>	0	0	1	2	1	4	0	2	1	0	11	2.78
<i>Acanthocyclops viridis</i>	0	2	1	1	3	3	2	3	2	0	17	4.30
<i>Cyclops stenuis</i>	2	1	0	0	6	3	3	2	2	0	19	4.81
Mesocyclops	1	0	1	0	0	0	0	2	8	3	15	3.79
Paracalanus	0	1	0	2	3	0	4	0	0	0	10	2.53
<i>Paracyclops afinis</i>	1	0	0	0	0	0	0	11	0	0	12	3.03
<i>Paracyclops fimbriatus</i>	0	3	0	3	0	2	0	2	0	4	14	3.54
Thermocyclops	0	0	3	2	0	6	6	0	2	0	19	4.81
Sub-Total Copepods	4	7	6	10	13	18	15	22	15	7	117	29.59
Decapod Crustaceans												
<i>Mysis sp.</i>	2	3	4	0	3	0	0	2	3	0	17	4.30
Euphaiacea												
<i>Meganicliphanes norvegia</i>	3	2	2	0	0	4	2	2	1	2	18	4.55
Larval												
Nauplius Larval	0	1	0	0	0	0	0	0	1	1	3	0.75
Zoea	0	1	2	0	1	3	2	3	2	1	15	3.79
Megalopa Larval	1	3	0	2	1	2	1	2	1	1	14	3.55
Fish Larval	0	0	0	0	0	0	0	0	0	0	0	0
Sub-Total Larval	1	5	2	2	2	5	3	5	4	3	67	16.93
Total No. of zooplankton (100/l)	32	30	41	33	52	48	41	42	44	42	395	
No. of Species of zooplankton	13	15	17	14	17	14	14	15	17	13		

*Sources: Environmental Impact Assessment for Gbaran - Soku EGG-11 Gas Development Project. Draft report (2006)
 Environmental Impact Assessment of Nembe Creek Trunkline Replacement Project. Final report (2006)

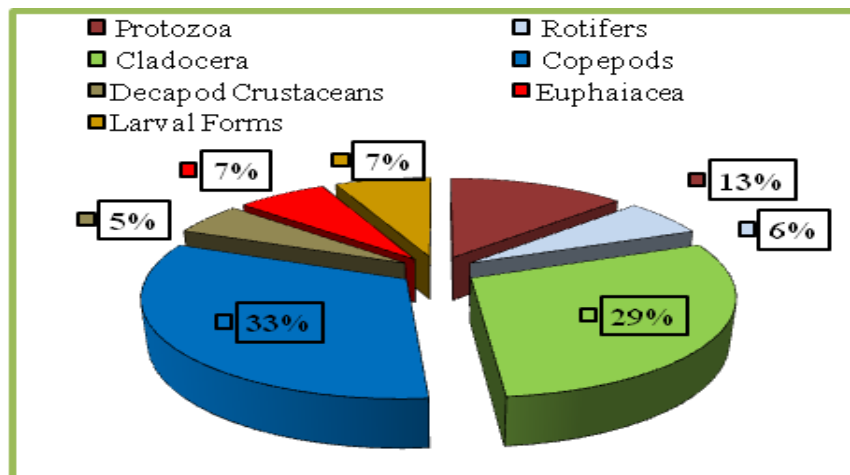


Figure 4.21: Relative Abundance of Major Families of Zooplankton in the Project Area.

The spatial variation in abundance and diversity of zooplankton in aquatic systems along Soku Gas Plant-San Barth Manifold Pipeline route is presented in Figure 4.22.

The highest zooplankton number of 189 x10² organisms/l was recorded in sample point 5 (SW5) while the lowest count of 79 x10² organisms/l was recorded in SW1. Similarly there were a maximum of 17 species of zooplankton in stations 3, 5 and 9 while 13 species were recorded in stations 1 and 10. These numbers were lower than literature reports in Minichindah stream (Davies et. al., 2009). Density and diversity of zooplankton are governed by a number of factors which include low dissolved oxygen and high biological oxygen demand levels (Davies et. al. (2009). In the study area, it was very common to see smears or films of crude oil on the water surface and this may account for the low density and diversity of zooplankton in the system.

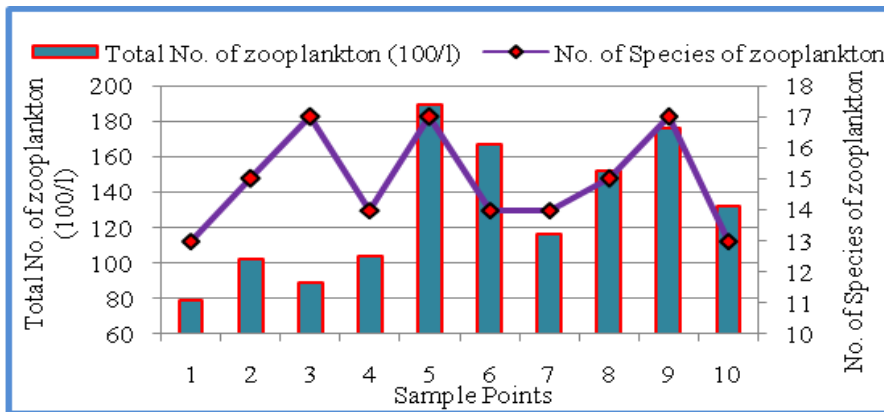


Figure 4.22: Spatial Variation in Total Zooplankton Count and Number of Species of Zooplankton in Aquatic Systems of the Project Area

Benthic Fauna: The benthic fauna are the bottom dwelling organisms. Majority of them are found living in or on the bottom sediment as infauna, while others live on the surface either attached to different types of substrates (sessile) or as mobile benthic inhabitants, these are known as epifauna. A checklist of the abundance and diversity of benthic fauna in the study area is presented in Table 4.17a and b. One hundred and seventy-two (172) organisms were encountered and these belong to five (5) major taxonomic groupings, namely polychaetes (37%), crustaceans (31%), insects (12%), bivalves (10%) and gastropods (10%) (Fig 4.23).

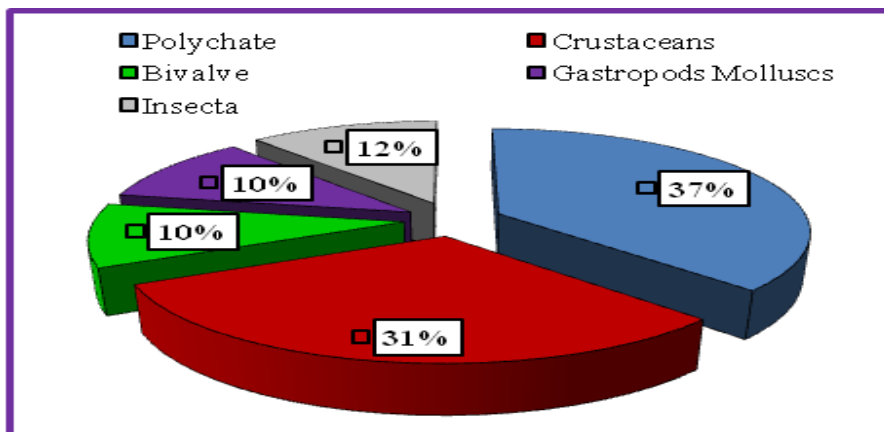


Figure 4.23: Relative Abundance of Major Families of Benthos in Aquatic Systems of the Project Area

The spatial variation in the total number of benthos in the study is presented graphically in Fig 4.24. Abundance of benthos fluctuated between 11 individuals per sq m (Sample point 5) and 25 individuals per sq m (Sample point 3). Similarly, number of species of benthos in the study area fluctuated between 10 (Stations 2 and 7) and 15 (stations 3 and 10).

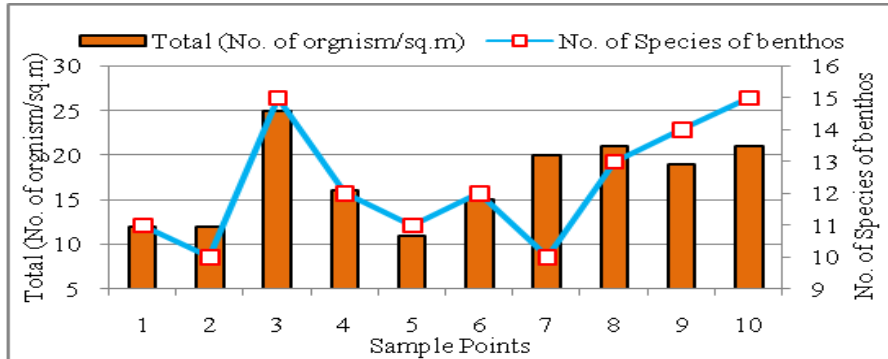


Figure 4.24: Spatial Variation in Total Benthos Count and Number of Species of Benthos in Aquatic Systems of the Project Area

The records of abundance and diversity of benthos in the study area was low when compared with literature reports of other rivers in Nigeria (Victor and Ogbeibu, 1985, Olomukoro and Ezemonye, 2007; and Emere and Nasiru 2008). The sediment in the study area was heavily covered with sheens of oily (crude petroleum) products and these may have accounted for the low level of habitation of the aquatic systems by benthic organisms. Dead and decaying organic matter increase the tendency of sediment to be anoxic, a condition generally unfavourable for habitation by benthic organisms (Victor and Onomivbori, 1996).

Table 4.17a: Relative Abundance of Benthos in Aquatic Systems in the Project Area (Wet Season)

	SAMPLE STATIONS										Total	%Total	
	1	2	3	4	5	6	7	8	9	10			
Polychate													
Arenicola marina	0	0	0	0	1	1	0	0	0	0	2	1.16	
Capitella capitata	0	0	1	2	0	0	1	0	0	1	5	2.91	
Eunice harassi	1	0	0	0	1	1	0	0	1	0	4	2.33	
Glycera capitata	0	0	1	1	1	1	1	0	0	0	5	2.91	
Glycera convoluta	1	0	0	0	0	0	0	0	0	0	1	0.58	
Marphysa sanguinea	0	0	0	1	0	0	0	0	1	1	3	1.74	
Nephtys hombergi	0	2	1	0	0	1	0	2	0	0	6	3.49	
Nereis diversicolor	0	1	0	1	1	0	0	3	0	2	8	4.65	
Nereis pelagica	0	0	1	0	0	0	0	0	1	0	2	1.16	
Nereis virens	0	0	0	1	1	2	1	1	0	0	6	3.49	
Nereis virens	0	0	2	0	0	0	0	2	0	1	5	2.91	
Notomastus tenuis	0	0	0	1	0	1	1	0	3	0	6	3.49	
Notomastus laterella	0	1	0	0	0	0	0	2	2	0	5	2.91	
Scolopsis uniramus	1	0	0	0	0	0	1	0	1	0	3	1.74	
Sternopsis scutata	1	0	0	0	0	0	0	0	1	1	3	1.74	
Sub-Total	4	4	6	7	5	7	5	10	10	6	64	37.21	

Crustaceans												
Alpheus monodi	1	1	0	3	0	2	0	0	0	1	8	4.65
Ballanus	2	0	2	0	0	0	0	1	1	0	6	3.49
Callianasa	0	1	2	0	0	0	0	0	0	1	4	2.33
Cliberanus cooci	1	0	0	1	1	1	1	0	0	0	5	2.91
Gammarus	0	0	3	0	0	0	0	0	0	1	4	2.33
Iphinoe tripanosa	0	0	0	1	0	0	0	0	2	2	5	2.91
Isodus sp	1	0	1	0	0	1	0	1	0	0	4	2.33
Jassa	0	0	1	0	1	0	0	0	1	0	3	1.74
Leplalpheus sp.	0	0	0	0	0	0	1	0	0	0	1	0.58
Metagrasmus	0	0	0	0	0	2	0	0	0	1	3	1.74
Nototropis swamidami	0	1	1	0	1	0	0	2	1	0	6	3.49
Tianid sp.	0	0	0	0	0	0	1	1	0	2	4	2.33
Sub-Total	5	3	10	5	3	6	3	5	5	8	53	30.83
Bivalve												
Tellin a nymphalis	0	0	0	2	0	0	0	2	0	0	4	2.33
Nucula	0	0	1	1	1	0	2	0	0	1	6	3.49
Stylaria	1	1	2	0	0	1	0	0	2	0	7	4.07
Sub-Total	1	1	3	3	1	1	2	2	2	1	17	9.89
Gastropods Molluscs												
Littorina sp	1	2	0	0	0	0	0	0	1	0	4	2.33
Neritina oweniana	0	0	1	1	0	0	1	0	0	3	6	3.49
Tellina nymphalis	0	0	0	0	1	1	0	1	1	1	5	2.91
Tympanotonus fuscatus	1	1	0	0	0	0	0	1	0	0	3	1.74
Sub-Total	2	3	1	1	1	1	1	2	2	4	18	10.47
Insecta												
Chironomus ablab iesmia	0	1	5	0	1	0	9	2	0	2	20	11.62
Total (No. of orgnism/sq.m)	12	12	25	16	11	15	20	21	19	21	172	

Table 4.17b: Relative Abundance of Benthos in Aquatic Systems along the Project Area (Dry Season).

	SAMPLE STATIONS										Total	%Total
	1	2	3	4	5	6	7	8	9	10		
Polychate												
Arenicola marina	0	0	0	0	1	1	0	0	1	0	3	2.22
Capitella capitata	0	0	1	1	0	0	1	0	0	1	4	2.96
Eunice harassi	1	0	0	0	1	0	0	0	1	0	3	2.22
Glycera capitata	0	0	1	1	0	1	1	0	0	0	4	2.96
Glycera convoluta	1	0	0	0	0	0	0	1	0	0	2	1.48
Marphysa sanguinea	0	0	0	1	0	0	0	0	1	1	3	2.22
Nephtys hombergi	0	1	1	0	0	1	0	1	0	0	4	2.96
Nereis diversicolor	0	1	0	1	1	0	0	2	0	1	6	4.44
Nereis pelagica	0	0	1	0	0	0	0	0	1	0	2	1.48
Nereis virens	0	0	0	1	1	0	1	1	0	0	4	2.96
Nereis virens	0	0	1	0	0	0	0	1	0	1	3	2.22



Notomastu s tenuis	0	0	0	0	0	1	1	0	2	0	4	2.96
Notomastus laterella	0	1	0	0	0	0	0	1	1	0	3	2.22
Scolopsis uniramus	1	0	0	0	0	0	1	0	0	0	2	1.48
Sternapsis scutata	1	0	0	0	0	0	0	0	1	1	3	2.22
Sub-Total	4	4	6	7	5	7	5	10	10	6	50	37.00
Crustaceans												
Alpheus monodi	1	1	0	1	0	2	0	0	0	1	6	4.44
Ballanus	1	0	1	0	0	0	0	1	1	0	4	2.96
Callianasa	0	1	1	0	0	0	0	0	0	1	3	2.22
Cliberanus cooci	1	0	0	1	1	1	0	0	0	0	4	2.96
Gammarus	0	0	2	0	0	0	0	0	0	1	3	2.22
Iphinoe tripanosa	0	0	0	1	0	0	0	0	1	1	3	2.22
Isodus sp	1	0	0	0	0	1	0	1	0	0	3	2.22
Jassa	0	0	1	0	1	0	0	0	1	0	3	2.22
Leplalpheus sp.	0	0	0	0	0	0	1	0	0	0	1	0.74
Metagrasmus	0	0	0	0	0	1	0	0	0	1	2	1.48
Nototropis swamidami	0	1	1	0	1	0	0	1	1	0	5	3.70
Tianid sp.	0	0	0	0	0	0	1	1	0	1	3	2.22
Sub-Total	5	3	10	5	3	6	3	5	5	8	40	29.6
Bivalve												
Tellin a nymphalis	0	0	0	2	0	0	0	2	0	0	3	2.22
Nucula	0	0	1	1	1	0	1	0	0	1	5	3.70
Stylaria	1	1	1	0	0	1	0	0	1	0	5	3.70
Sub-Total	1	1	3	3	1	1	2	2	2	1	13	9.62
Gastropods Molluscs												
Littorina sp	1	1	0	0	0	0	0	0	1	0	3	2.22
Neritina oweniana	0	0	1	1	0	0	1	0	0	1	4	2.96
Tellina nymphalis	0	0	0	0	1	1	0	1	1	1	5	3.70
Tympanotonus fuscatus	1	1	0	0	0	0	0	1	0	0	3	2.22
Sub-Total	2	1	1	1	1	1	1	2	2	4	15	
Insecta												
Chironomus ablab iesmia	0	1	4	0	1	0	7	2	0	2	17	11.1
Total (No. of orgnism/sq.m)	12	12	25	16	11	15	20	21	19	21	135	

*Sources: Environmental Impact Assessment for Gbaran - Soku EGGS-11 Gas Development Project. Draft report (2006)

Environmental Impact Assessment of Nembe Creek Trunkline Replacement Project. Final report (2006)



Aquatic Microbiology: The heterotrophic bacteria count ranged from 3.30 to 3.80 x 10⁵ cfu/ml during the wet season and from 3.10 to 3.77 x 10⁵ cfu/ml during the dry season . The bacteria population was dominated by Bacillus, Klebsiella, Staphylococcus, Flavobacterium, Escherichia, Pseudomonas and Serratia. The hydrocarbon utilizing bacteria included Pseudomonas and Bacillus also as the dominant species. The heterotrophic fungal count varied from 1.90 to 3.0 x10⁵ cfu/ml during the wet season and from 1.88 to 3.10 x10⁵ cfu/ml during the dry season. The predominant fungal isolates were Mucor, Candida, Aspergillus, Cladosporium and Penicillium. Some of the Candida and Penicillium spp isolated were hydrocarbon utilizers. Thus the fungal population is slightly lower than the bacterial population. The microbial populations indicate that the study area has experienced some form of hydrocarbon contamination.

Sediment: The physico-chemistry and microbiological characteristics of the sediments of the study area for the wet season are presented in Table 4.18. The pH values ranged from 4.26 to 5.96 during the wet season and from 4.35 to 6.10 during the dry season. The electrical conductivity values ranged from 377.0 to 4409 µS/cm during the wet season and from 366.2 to 4270 µS/cm in the dry season. The cations were dominated by calcium (37.02 to 1704mg/kg in the wet season, and 39.14 to1719 mg/kg in the dry season), Potassium (146.1 to 1031.0mg/kg in the wet season, and from 1420 to 1029.4 mg/kg in the dry season) and Sodium (60.60 to 397mg/kg in the wet season, and 61 to 399 mg/kg in the dry season). The heavy metal concentrations (Ni, Pb, Cr, Zn) were below their respective DPR target levels while Cd (1.76 to 22.90mg/kg in the wet season and 1.75 to 21.83 mg/kg in the dry season) recorded values higher than the DPR target level of 0.3mg/kg and intervention level of 10mg/kg. The organic carbon concentration (0.01 to 0.25 % in the wet season, and 0.10 to 0.22 % in the dry season) and total hydrocarbon content (0.06 to 0.77mg/kg in the wet season, and 0.06 to 0.79 mg/kg in the dry season) were comparable to the concentration in the soils of the study area. The microbial loads of the sediments were low with bacterial population count of 4.3 to 6.6 x 10⁴ cfu/g and fungal population count of 3.8 to 5.7 x 10⁴ cfu/g in the wet season, and 3.7 to 6.2 x 10⁴ cfu/g and fungal population count of 3.4 to 5.2 x 10⁴ cfu/g in the dry season.

Table 4.18 Physico-chemistry and Microbiology of Sediments from Soku – San Barth study area

Parameters	Wet Season		Dry Season		DPR (2002) Limits	
	MIN	MAX	MIN	MAX	Target	Intervention
pH	4.26	5.96	4.35	6.10		
Electrical conductivity, µS/cm	377.0	4409	366.2	4270		
Cations						
Phosphate, mg/kg	20.46	44.94	19.11	37.18		
Calcium, mg/kg	37.02	1704	39.14	1719		
Sodium, mg/kg	60.60	397	61.00	399		
Nitrate, mg/kg	0.89	107.75	0.74	103.0		
Ammonium, mg/kg	7.40	56.30	6.92	56.49		
Nitrite, mg/kg	<0.001	<0.001	<0.001	<0.001		
Potassium, mg/kg	146.1	1031.0	142.0	1029.4		

Salinity as chloride, mg/kg	29.88	303.70	30.11	305.8		
Organics						
Organic Matter (Organic carbon), %	0.01	0.25	0.1	0.22		
Total Hydrocarbon Content, mg/kg	0.06	0.77	0.06	0.79	50	5000
Heavy metals						
Vanadium, mg/kg	<0.001	<0.001	<0.001	<0.001		
Nickel, mg/kg	7.60	16.63	7.63	17.10	35	210
Lead, mg/kg	3.29	11.86	3.31	11.53	85	530
Chromium, mg/kg	8.97	22.72	8.83	21.50	100	380
Zinc, mg/kg	5.79	34.52	5.39	21.48	140	720
Cadmium, mg/kg	1.79	22.90	1.75	21.83	0.3	10
Iron, mg/kg	79.73	2209	80.13	2213	-	-
Manganese, mg/kg	10.53	50.74	10.49	50.13		
Microbiology						
Bacteria Count, x10 ⁴ Cfu/ml	4.3	6.6	3.7	6.2		
Fungi Count, x10 ⁴ Cfu/ml	3.8	5.7	3.4	5.2		

4.4.8 Fish and Fisheries

Fishing activities in the study area was very scanty as few fishers were noticed in the study area. There were no commercial fishers, artisan fishers or small scale fishers dominate the fishery of the area. They operate in dug-out wooden canoes which may or may not be motorized. Fishing gears were largely made of manually operated long setlines, circling nets and seine nets of different mesh sizes varying from ½”, 1”, 1½”, 2”, 2½ to 3”. The gears measure 6-12m in length and 2-4 meters in width. Usually the nets are set and allowed to stay for up to one hour before they are removed with the catch. When the net is set and before it is removed another net is also set. Catch rates are seasonally dependent and varied between 15-120 kg/day in the wet season. Income from fishing activities in the area is on the average about ₦30,000 per month.

The fish species identified in the landings of some fishers and some fish mongers in the local market in Soku are presented in the Tables 4.19a and b below.

Table 419a: List of Shellfish of the Project Area.

SHELLFISHES			
Family	Scientific Name	Common Name	Occurrence
Portunidae	<i>Callinectes anonicola</i>	Swimming crab	X
	<i>C. marginatus</i>		X
Penaedae	<i>Penaes notialis</i>		X
	<i>P. kerrathurus</i>		
Palaemonidae	<i>Nematopalaemon hostatus</i>	White shrimp	X
Ocypodida	<i>Ocypoda africana</i>	Ghost crab	X
Potamidae	<i>Tympanotonus fuscatus</i>	Periwinkle	X
	<i>Pachymelania aurita</i>		X

Table 4 19b: List of Fin Fish of the Project Area.

FINFISHES			Occurrence
Family	Scientific name	Common name	
			X
	<i>Lutjanus gorensis</i>	Gorean snapper	X
Polynemidae	<i>Gaeloides decadactylus</i>	Smaller African threadfin	-
	<i>Pentanemus quinquarius</i>	Royal threadfin	X
	<i>Polydactylus quadrifilis</i>	Giant African threadfin	X
Pomadasyidae = Haemulidae	<i>Brachydeuterus auritus</i>	Bigeye grunt	X
	<i>Parapristipoma octolineatum</i>	African striped grunt	-
	<i>Pomadasys jubelini</i>	Sompat grunt	-
Rajidae	<i>Raja miraletus</i>	Skates	X
Dasyatidae	<i>Dasyatis pastinaca</i>	Stingray	-
Sciaenidae	<i>Pseudolithus</i> (F.) <i>elongatus</i>	Bobo croaker	X
	<i>Pseudolithus</i> (Pinnacorvina) <i>epipercus</i>	Guinea croaker	X
	<i>Pseudolithus senegalensis</i>	Cassava croaker	X
	<i>Pseudolithus</i> (P.) <i>typus</i>	Longneck croaker	X
	<i>Pteroscion peli</i>	Boe drum	-
Ariidae	<i>Arius heudeloti</i>	Sea catfish	X
Bagridae	<i>Chrisichthys nigrodigitatus</i>	Brackishwater catfish	X
Carangidae	<i>Caranx</i> spp.	Jacks	-
	<i>Trachurus trachurus</i>	Atlantic horse mackerel	X
	<i>T. teraia</i>		X
	<i>Chloroscombrus chrysurus</i>	Atlantic bumper	
	<i>Vomer septinis</i>	Moon fish	X
Clupeidae	<i>Ethmalosa fimbriata</i>	Bonga shad	X
	<i>Ilisha Africana</i>	West African Ilisha	X
	<i>Sardinella maderensis</i>	Short bord sardine	X
Cynoglossidae	<i>Cynoglossus browni</i>	Nigerian tongue sole	X
	<i>Cynoglossus canarensis</i>	Canary tongue	-
	<i>Cynoglossus monodi</i>	Guinea tonguesole	-
	<i>Cynoglossus senegalensis</i>	Senegalese tonguesole	X
Serranidae	<i>Epinephelus aeneus</i>	White grouper	X
	<i>Epinephelus alexandrinus</i>	Golden grouper	X
	<i>Epinephelus caninus</i>	Dogtooth grouper	X
	<i>Epinephelus guaza</i> (= <i>E. gigas</i>)	Dusky grouper	X
Sparidae	Boops boops	Bogue seabrer	X
	<i>Dentex angolensis</i>	Angola seabream	X



	Pagellus bellottii (= P. coupei)	Red pandora	-
	Sparus pagrus pagrus	Common seabream	-
Monodactylidae	Psette sebae		
Scombridae	Scomberimus japonicus	Mackerels	X
	Scomberimus scomberimus		X
Mugilidae	Mugil falcipinnis	Mulletts	X
	M. cephalus	Mulletts	X
	grandisquamis	Mulletts	-

A total of 51 species of fish belonging to 21 families of finfishes and shellfishes were recorded in the study area. Similarly Ekeke et. al. (2008) had recorded 51 species of fin and shellfishes in the study area. Chindah and Osuamkpe (2008) recorded 57 species in 25 families in the fish assemblage of the lower Bonny River.

4.4.9 Hydrogeology

The proposed project area lies solely in the mangrove swamp forest of the Niger Delta. The topography is generally characterized by creeks and rivers notably the Segoo Creek, Rivers Santa Barbara and San Bartholomew. These main rivers are interconnected by creeks and sometimes man-made slots. Geologically, the site is lying in the southern border of the modern Niger Delta. It is underlain by the lowermost chronostratigraphic unit of the Niger Delta – the Akata Formation. The Akata formation is characterized by uniform open marine prodeltaic dark-grey shale with lenses of sandstone and siltstone. The shale contains plant remains and some mica especially in the upper part of the formation. The project area is not susceptible to soil shift and desertification.

The river systems in the project site forms the tributaries through which the Niger River empties into the Atlantic Ocean. The Islands are mainly sandy ridges. Precipitation is by rainfall which exceeds 260 cm annually. The aquifer system is usually phreatic and water table is usually close to the surface.

Six ground water monitoring boreholes (Plate 4.14) were drilled in the area using the manual rotatry method. This manual method of monitoring boreholes drilling enables access from the superficial layer down to the water-bearing litholog (aquifer) without usage of any drilling chemicals. The section from the borehole litho logs at San Barth axis shows four distinct strata (Figure 4.25). The strata are continuous but vary in thickness. The entire stratum of Clayey Sand body in the area is phreatic.



Plate 4.14: One of the Groundwater Monitoring Boreholes Drilled in the Study Area.

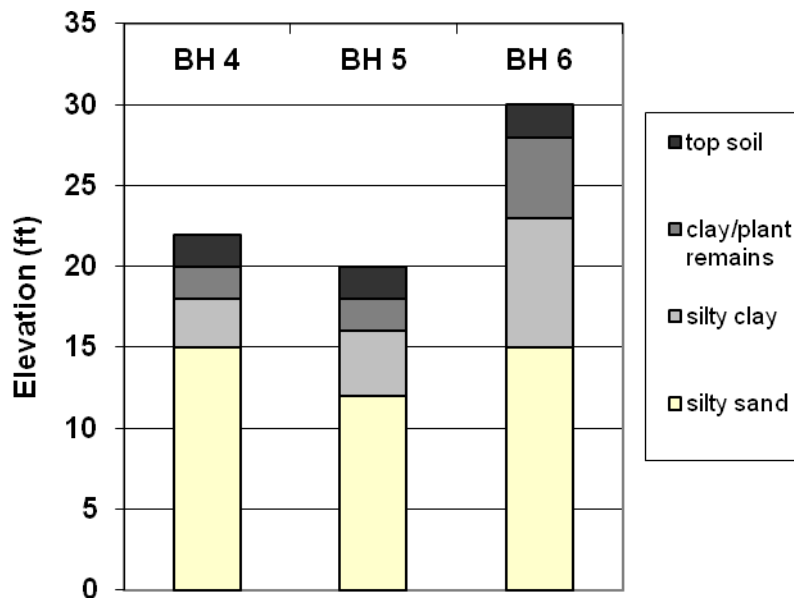


Figure: 4.25: Lithologs of the Boreholes at San Barth Axis.

Similar lithotype was encountered at Soku axis. However, the litho type is predominantly three – top soil, silt – clay admixture and very fine sand (Figure 4.26).

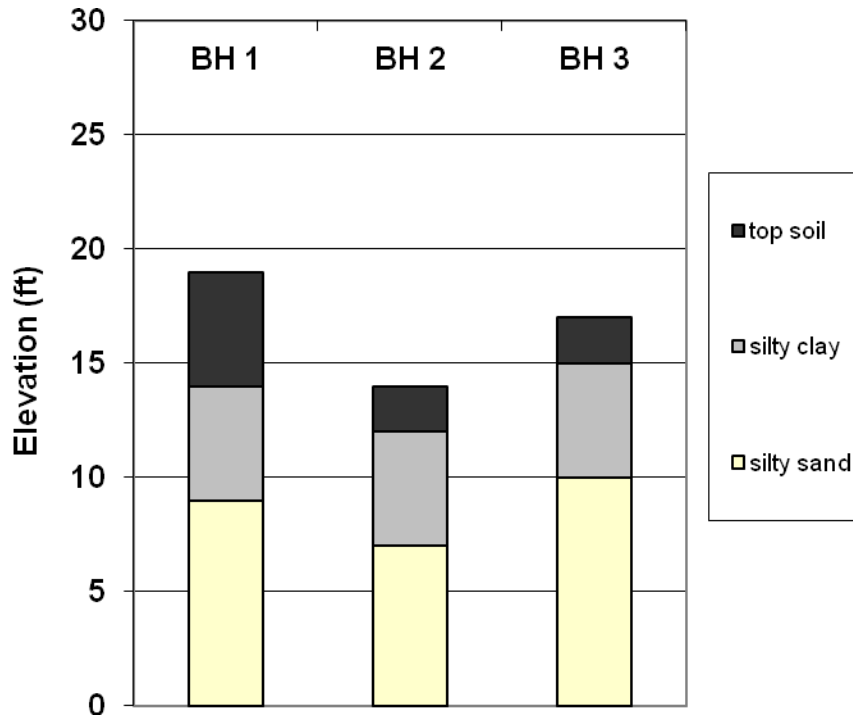


Figure 4.26: Lithologs of the Boreholes at Soku Axis.

The project area groundwater flow has been affected mostly by topographic factors. All six monitoring wells show shallow static water levels, with values ranging from 0 m around BH 3 and 4 to 4.6 m in BH 6 (Table 4.20). They are highly prolific.

Available information on subsurface lithology and depth to static water levels were combined with results from samples analyzed. As the formation is essentially phreatic, it is possible to generate a section of the piezometric surface by combining the hydro geologic data with elevation values derived. A section of the study area was marked to establish the groundwater flow direction – the area delineated by BH4, 5 and 6.

Table 4.20: Elevation Corrections of the Borehole Points in Soku – San Barth area

BH Num	1	2	3	4	5	6
Elevation(m)	7.315	5.182	6.096	6.62	5.962	9.144
Depth to SWL (m)	0.3048	0.3000	0	0	0.52	4.57
Corr. Elev. (m)	7.01	4.88	6.10	6.62	5.44	4.57

After elevation corrections as shown in Table 4.20, the groundwater flow was established to be in the South South direction (Fig. 4.27).

The vertical change in groundwater elevation over horizontal distance in the direction of groundwater flow shows a gentle slope. The transverse section taken in the direction of groundwater flow illustrates this vividly (Fig. 4.27).

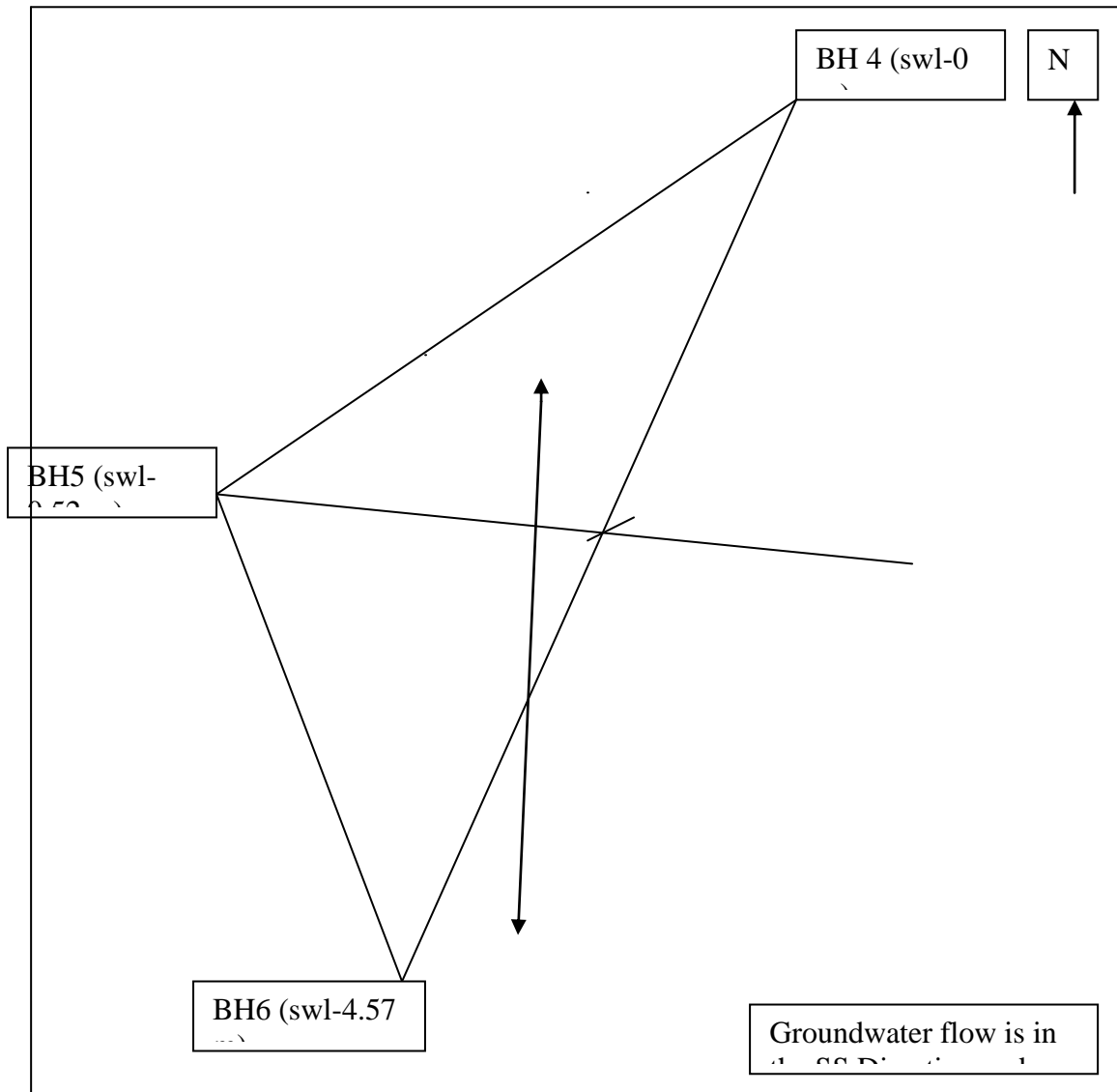


Figure: 4.27: The Groundwater Flow Direction at Soku – San Barth Study Area

The lithologs revealed that the study area has near surface clay, sand admixture underlain by a sandy stratum. This layer of loose, unconsolidated sand occupies the intermediate horizon which forms the underlying fresh water aquifer. This sand sequence constituting the major aquifer in the study area is recharged by precipitation and therefore sensitive to contamination from the overburden. The overlying clayey sand stratum is believed to be extensive, although the lateral extent could not be determined at this stage of the study.

The groundwater flow path is dominantly southerly, but subject to tidal influence. However, as a transport medium, the lithology in the study area will favour radial spreading of contaminants at near surface due to the presence of clay and fine sands in the upper 3 m stratum throughout the length of profile defined by the study.

Groundwater: The groundwater quality of the project area is presented in Table 4.21a and b. The pH values ranged from 4.8 to 6.2 in wet dry season and from 4.9 to 6.2 in the dry season. These values indicate that the ground waters are acidic in reaction. The electrical conductivity of the ground water ranged from 299 to 26400 μ S/cm in the wet season and from 294.0 to 24900 μ S/cm in the dry season. The total dissolved solid values ranged from 143.9 to 15540mg/l in the wet season and from 138.4 to 15531 mg/l in the dry season. The salinity levels thus ranged from 0.1‰ to 16.1‰. during the wet season, and from 0.1 to 9.0 % in the dry season. The heavy metal concentrations for Cr, Pb, Ni, Zn, and Cu were low while the concentrations of Cd, V, As, Hg, Mn Se and Ag were below the detection limits (0.01) of the analytical equipment. The slightly high concentration levels of Fe (0.928 to 25.64mg/l in the wet season, and 0.322 to 19.35 mg/l in the dry season) compared to DPR target level of 0.3mg/kg is due to the geochemistry of the Niger Delta ecosystem. No faecal coliforms were recorded in the groundwater.

Table 4.21: Physico-Chemical and Microbiological Characteristics of Groundwater from Soku – San Barth Study Area (Wet Season)

PARAMETERS	BH1	BH2	BH3	BH4	BH5	BH6
pH	6.2	6.1	6.1	5.4	4.8	5.3
Temperature, oC	24.7	24.7	28.6	26.0	26.3	25.5
Conductivity, μ S/cm	299.0	596.0	498.0	15960	26400	23400
TDS, mg/l	143.9	289.0	241.0	9000	15540	13620
Turbidity (NTU)	8.43	5.84	11.61	5.57	5.67	4.26
DO, mg/l	6.26	6.41	4.95	4.65	4.82	4.19
Salinity, %	0.1	0.3	0.2	9.3	16.1	14.1
Total Suspended Solids (TSS), mg/l	20.00	10.00	10.00	20.00	20.00	10.00
Alkalinity, mg/l	31.99	65.99	23.99	39.99	93.99	37.99
Biochemical Oxygen Demand (BOD5), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chemical Oxygen Demand (COD), mg/l	0.16	0.20	0.60	0.80	2.00	2.00
Hydrogen Sulphide, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Hardness, mg/l	40.00	80.00	40.00	1200	3320	2440
Carbonate, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Hydrocarbon Content (THC), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Organic Carbon, (TOC), mg/l	0.15	0.18	0.68	0.84	2.16	2.12
Total Petroleum Hydrocarbon (TPH), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ammonium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite ion, mg/l	0.020	0.032	0.012	0.004	0.017	0.048
Nitrate ion, mg/l	0.120	0.182	0.498	0.247	0.266	0.344
Phosphorus, mg/l	0.113	<0.020	0.021	<0.010	0.011	<0.02
Sulphide ion, mg/l	0.082	0.041	0.017	0.029	0.034	0.048
Sulphate (SO ₄) ion, mg/l	2.40	5.09	2.60	25.60	67.89	75.94
Sulphite (SO ₃) ion, mg/l	0.160	0.400	<0.02	0.150	0.140	0.180
Heavy metals (mg/l)						
Cr ³⁺ & Cr ⁶⁺	0.002	0.002	0.006	<0.001	0.092	0.004

Cd ²⁺	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cu ²⁺	0.833	0.476	0.648	0.811	0.285	0.028
Pb ²⁺	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Fe ²⁺ & Fe ³⁺	28.37	8.94	25.64	14.93	1.050	0.928
Ni ²⁺	0.009	0.007	0.012	<0.002	0.013	0.014
V ²⁺	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn ²⁺	0.927	0.886	1.056	1.123	0.476	0.444
As ²⁺	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hg ²⁺	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mn ²⁺	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Se ²⁺	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ag ⁺	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Microbiology						
Feacal Coliform, MPN/100ml	Nil	Nil	Nil	Nil	Nil	Nil

* Detectable Limit of Analytical Equipment is 0.01mg/l

Table 4.21b: Physico-Chemical and Microbiological Characteristics of Groundwater from Soku – San Barth Study Area (Dry Season)*

PARAMETERS	BH1	BH2	BH3	BH4	BH5	BH6
pH	6.2	6.2	6.1	5.6	4.9	5.4
Temperature, oC	25.1	25.1	27.4	26.0	26.3	25.4
Conductivity, μ S/cm	294.0	593.0	498.0	13890	24900	23350
TDS, mg/l	138.4	281.0	235.0	8923	15531	13591
Turbidity (NTU)	8.11	5.34	11.10	5.32	5.21	4.13
DO, mg/l	6.29	6.50	4.99	4.72	4.87	4.23
Salinity, ‰	0.1	0.1	0.2	4.1	6.4	9.0
Total Suspended Solids (TSS), mg/l	11.00	9.21	10.00	13.21	14.00	10.00
Alkalinity, mg/l	6.43	31.18	13.49	21.23	43.47	22.16
Biochemical Oxygen Demand (BOD ₅), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chemical Oxygen Demand (COD), mg/l	0.13	0.10	0.31	0.45	1.87	1.78
Hydrogen Sulphide, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Hardness, mg/l	32.00	47.15	29.14	1143	1935	1975
Carbonate, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Hydrocarbon Content (THC), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Organic Carbon, (TOC), mg/l	0.10	0.11	0.22	0.17	0.59	1.20
Total Petroleum Hydrocarbon (TPH), mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ammonium, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite ion, mg/l	0.015	0.022	0.010	0.004	0.010	0.032
Nitrate ion, mg/l	0.100	0.111	0.322	0.135	0.115	0.210
Phosphorus, mg/l	0.100	<0.002	0.015	0.010	0.010	<0.002
Sulphide ion, mg/l	0.074	0.021	0.012	0.015	0.011	0.022
Sulphate (SO ₄) ion, mg/l	1.85	4.00	2.13	13.26	44.10	47.88



Sulphite (SO ₃) ion , mg/l	0.130	0.328	<0.02	0.110	0.120	0.172
Heavy metals (mg/l)						
Cr ³⁺ & Cr ⁶⁺	0.001	0.001	0.003	<0.001	0.031	0.002
Cd ²⁺	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cu ²⁺	0.322	0.211	0.397	0.500	0.128	0.010
Pb ²⁺	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Fe ²⁺ & Fe ³⁺	18.41	6.35	19.35	9.71	1.000	0.322
Ni ²⁺	0.003	0.002	0.010	<0.002	0.010	0.011
V ²⁺	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn ²⁺	0.613	0.527	1.000	1.000	0.1136	0.135
As ²⁺	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hg ²⁺	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mn ²⁺	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Se ²⁺	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ag ⁺	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Microbiology						
Feacal Coliform, MPN/100ml	Nil	Nil	Nil	Nil	Nil	Nil

* Detectable Limit of Analytical Equipment is 0.01mg/l

*Sources: Environmental Impact Assessment for Gbaran - Soku EGGS-11 Gas Development Project. Draft report (2006)

4.5 Socio-Economic Baseline

4.5.1 Population and Socio-Demographic Characteristics

4.5.1.1 Population Size, Growth and Distribution

Demographic data from the provisional result of 2006 Population Census showed that majority of the communities to host the proposed project are in Akuku-Toru LGA of Rivers State with one community (Oluasari) in Nembe LGA of Bayelsa State (Federal Government of Nigeria Official Gazette, 2007).

The 1991 population census has the population of the bigger and permanent communities as follows: Kula (13,018 made up of 6,559 males and 6,459 females) and Soku (2,801 made up of 1,327 males and 1,474 females). These are the most densely populated with an average of 197 persons per square kilometer in the study area. There are the fishing and trading ports of Pinaro with less than 100 persons and are tagged sparsely inhabited. Many of the settlements, including Kula, Soku and the proximate Elem Sangama have continuously witnessed increased oil and gas activities, and consequently have attracted higher number of persons despite their remote locations. The moderately populated communities have the following 1991 census figures: Elem Sangama (784, made up of 523 males and 261 females); Opukiri (1,107, made up of 584 males and 523 females); Opropokiri (688, made up of 357 males and 331 females). The area is presently characterized with illegal oil bunkering and as such the settlements in and around the project area are presently harbouring many people. The most distant and remote communities and some fishing settlements which had witnessed inter-communal conflicts and militant activities have on the other hand had reversed and decreased population in recent times.

Household Size: The size of families differed from community to community. The size of families is also influenced by cultural attitude of the people, economy of the community, and

educational status/awareness of individuals in the community amongst other factors. The household size distribution is shown in Table 4.22.

Table 4.22. Distribution of Households in Soku-San Barth Communities by Size.

Household Size	Number of Households	Percentage (%)
1 - 3	5	16.67
4 - 6	10	33.33
7 - 9	10	33.33
10 and above	5	16.67
Total	30	100.00

The average household size in the Soku - St. Bartholomew communities was 6.70. This value compares well with a size of 6 estimated for Communities in Niger Delta (NDDC, 2006). In 1991, the average household size in Akuku-Toru LGA was 5.6. A total of 3,919,364 households were enumerated during the preparation of the Niger Delta Regional Development Master Plan with an average household size of 7.46, but with more than 70.0% of them having an average of 8 inmates. Large households were found prevalent in the rural areas (NDDC 2006). The average household size in the region however comes down to between six and seven persons with variations among the individual communities. This result is consistent with earlier studies (Ojile, 2009, 2006).

Several reasons account for the large household sizes in the study area in particular and the Niger Delta region in general. First is the recognition of marriage as a basic cultural institution for procreation in the communities. Marriage is a socio-cultural norm that is highly recognized in the area and persons that marry do so sometimes at a relatively early age. Second is the fact that most males married more than one wife in the area, with some of them keeping and maintaining several concubines. This suggests freedom and permission to high amorous (sexual) promiscuity among both sexes giving rise to high number of fertile intercourse amongst the people.

Marital Status: More than one half (58.0%) of the respondents were married, while approximately 19 percent are single (Figure 4.28). Freetown community has over two-thirds of its inhabitants as single parents. Each married male had an average of one wife. About 23 percent of the respondents were either divorced/separated from their spouses or widowed (Figure 4.29).

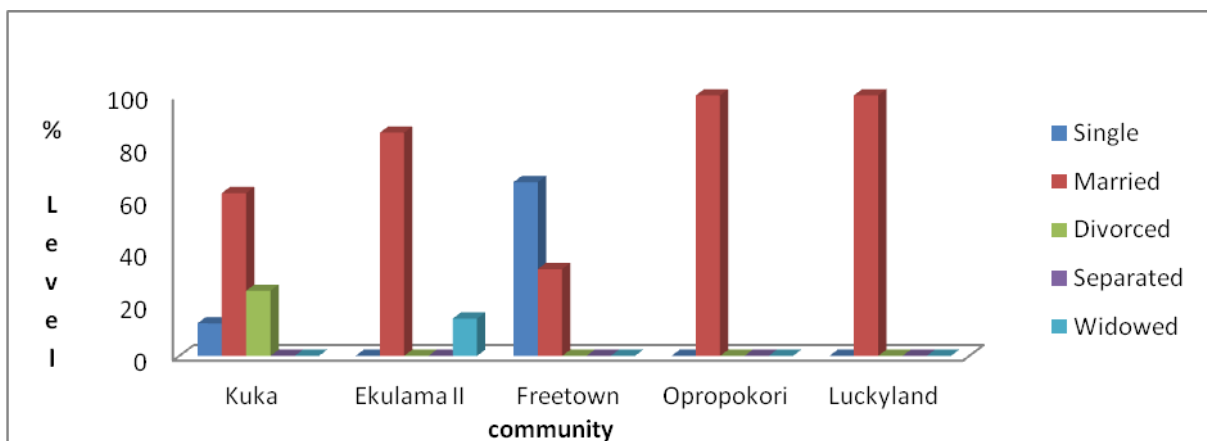


Figure 4.28: Distribution of Respondents by Marital Status

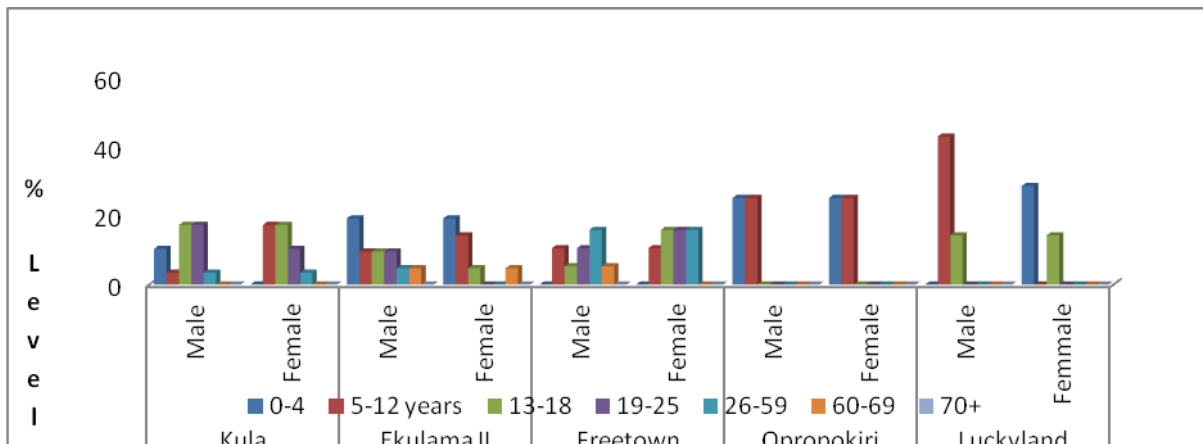


Figure 4.29: Age & Sex Structure of Households

Age/Sex Population Structure: The structure of the households in proposed project settlements/communities is that of patriarchal leadership. Men traditionally are the head of households. The women support the men especially in raising the children and in carrying out other household administrative matters. There are three different types of male-headed households namely; the English tradition (one husband and one spouse), African polygamous tradition (one man many wives), and single male (young male with no spouse, including widowers and older males that have never been married). Traditionally, the male is responsible for all the major decisions in a household.

The male and female populations in Kula, Ekulama II, freeman, Oropokori, and Luckyland communities respectively revealed that persons aged below 25 years were more in number than older people. This is an overwhelming preponderance of the younger ones in the population. Approximately 81 percent of all household members were aged below 18 years as opposed to less than a fifth (19.0%) that is 19 years and above (Figure 4.30). Previous studies (Ojile, 2009, SPDC, 2002) showed that children are proportionately more while the aged (>70 years) are few.

The overall implication of the age profile is that the population is young and growing. It suggests a high dependency ratio that places heavy economic burden on the adult working fraction of the population. It also indicates a low average life expectancy in the communities that would host the proposed field development projects. This suggestion is line with UNDP report, 2006, justifying the need to provide more training opportunities for people in the area, including vocational education and educational facilities to accommodate and empower this young population in this proposed project communities.

Figure 4.5.3 shows that the age distribution of the respondents indicating that most of those surveyed are adults of at least 20 years old; almost a quarter (24.2%) of all respondents were aged 20-29 years, while another group (19.3%) were in the 30-39 years age bracket. Those aged 40-59 years however, constituted over one half (51.3%) of the respondents. Amongst the older persons in the population, barely 5.2 percent were aged 60 years and above (Figure 4.30). The spread across the various age brackets indicated a wide spectrum of representation of opinion during the survey.

A reflection of Nigerian human male dominance was seen in the communities from where these data were gathered. The males were dominant (61.6 percent on the average), except for Freetown where there were as much males as there were females. (Figure 4.31).

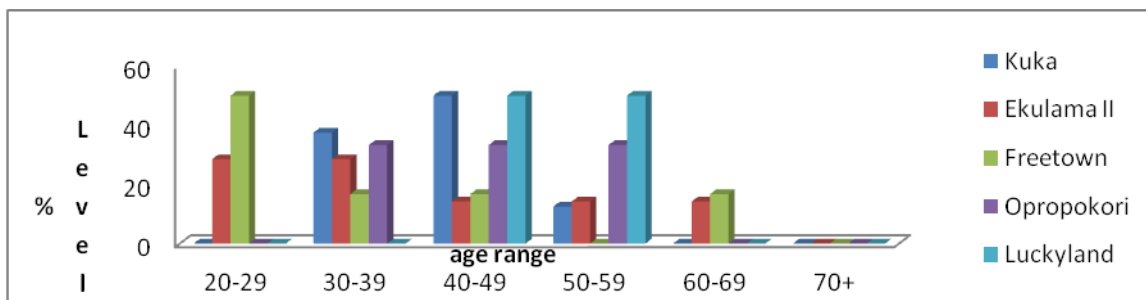


Figure 4.30: Distribution of Respondents by Age

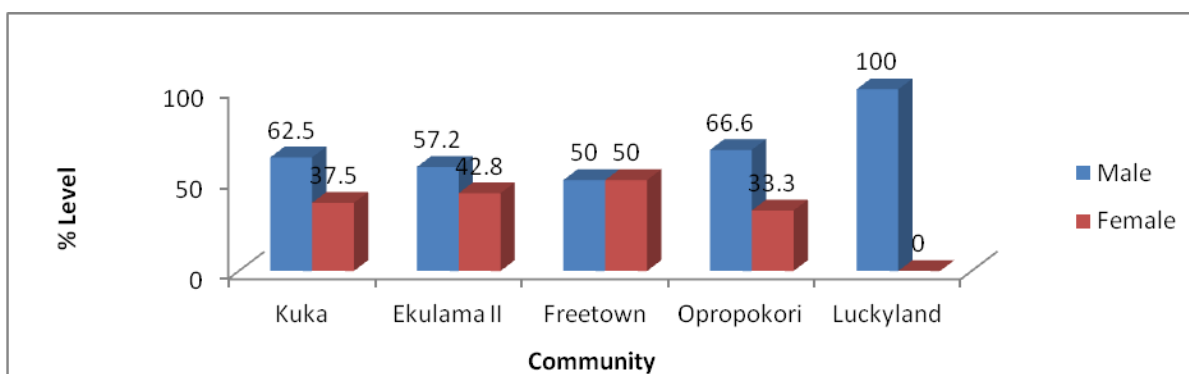


Figure 4.31 Distribution of Respondents by Gender in the Communities

Sex distribution of the population in the project environment reveals an overall sex ratio of 1:1. According to the 2006 census, in Akuku-toru LGA (AKULGA), the males slightly outnumbered the females, consistent with the overall Rivers State sex structure of 52.3 percent males and 47.7 percent females and a sex ratio of 1:1 (FGN Official Gazette, 2007). For every 100 females therefore, there are to be found almost 110 males. However, the survey carried out in the course of the Niger Delta development Master Plan process shows that there are more males (54.0%) than females (46.0%) in the Region.

Educational characteristics: Approximately 95 percent of the total population of the proposed project area has some form of education, with more than half of the people (51.9%) in Kula, Ekulama II, Freetown, and Opropokori having attempted/completed the post primary (secondary) education (Figure 4.32). About 21.1 percent and 6.2 percent on average also had the primary and tertiary education respectively. Approximately 16 percent of the inhabitants possess vocational/technical education, qualifying beneficiaries for some employment. Some of them have acquired some skills in the oil and gas industrial sector. Approximately 5 percent of the inhabitants have no formal education (NFE) (Figure 4.32).

Figure 4.5.6 indicated respondent’s spouses’ levels of educational attainment. The figure shared much in common with the level of education attained by the respondents in figure 4.5.5. The modal educational attainment of respondents’ spouses was the post-primary (46.3%), followed by primary education (29.4%) and then tertiary educational attainment (15.3%). Approximately 6.5 percent have no formal education while those with vocational/technical skills accounted for 2.4% of the spouses (Figure 4.33).

The literary level (those who can read and write) in the project area can be described as being sufficiently high judging by the level of educational attainment (formal training), exposure, knowledge and understanding of issues discussed during the Focus Group Discussions.

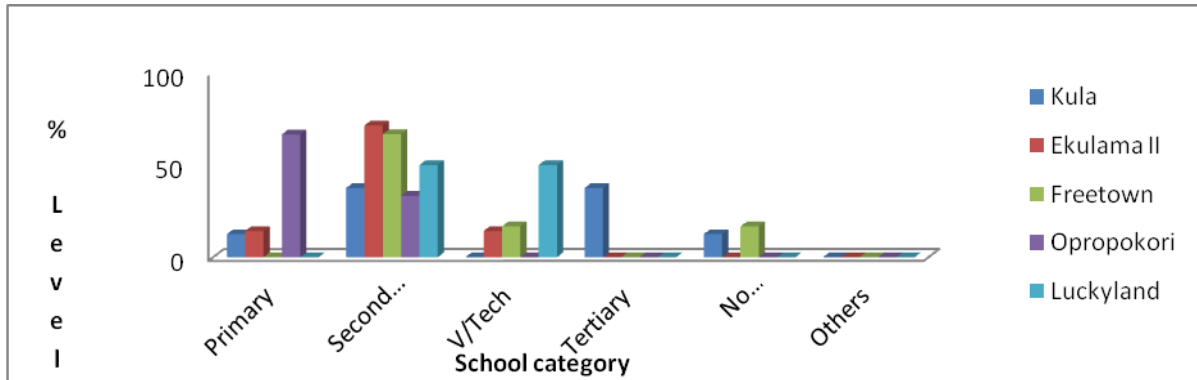


Figure 4.32: Distribution of Respondents by Levels of Education

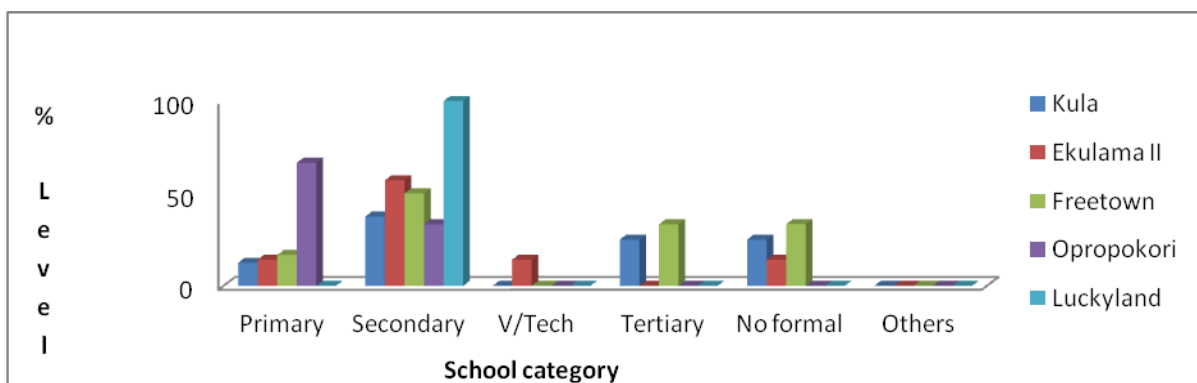


Figure 4.33: Distribution of Respondent's Spouses by Levels of Education

Literacy and educational attainment of household members also indicated that about 51.8% of the boys and 48.2% of the girls are presently attending various schools within and outside the study area (Figure 4.34). Approximately 33 percent and 41.0% of the children of school age in the households are currently attending primary and secondary schools. Similarly, about 21.7% of the children are attending post secondary school (tertiary). However, the levels of vocational training and skills and technical education of respondents' children in the area was very insignificant (4.3%) (Figure 4.34).

Statistical estimates have put the proportion of children attending primary school in the Niger Delta region at 80 per cent (which compares favourably with the estimated national average of 54 per cent) (UNDP 2006). The adult literacy level of the population is 78.7%. The educational attainment at Primary and Secondary levels has however, been reported to suffer from low teacher-pupil ratio of 1:42 compared with the national average of 1:36. The low teacher-pupil ratio reduces the ability to control classes and impart knowledge. Table 4.23 reveals the position of the Niger Delta States and Rivers State in particular.

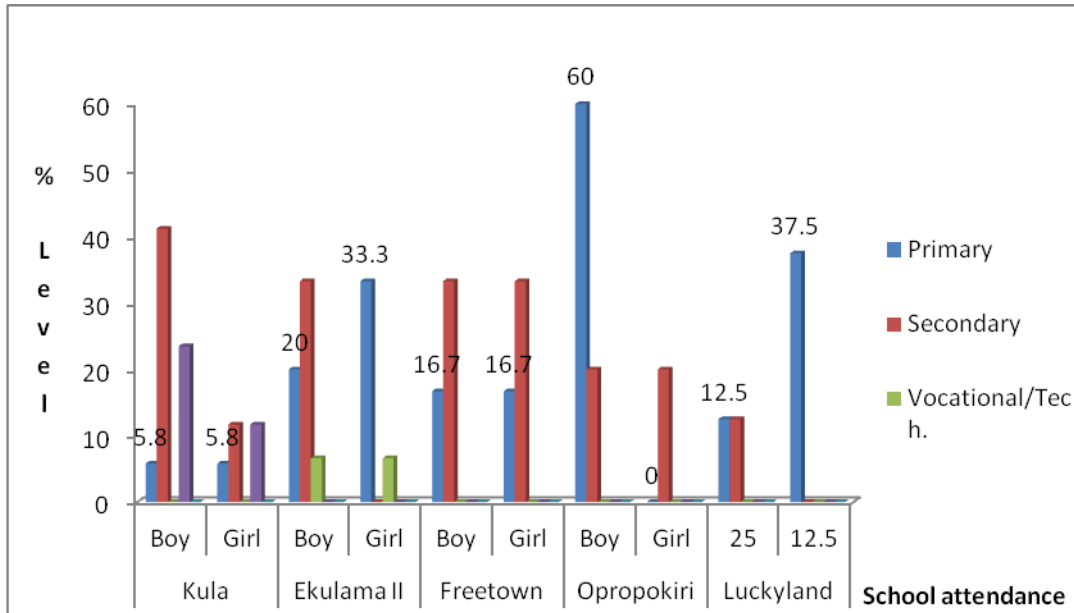


Figure 4.34: Distribution of Respondent's Children's Levels of Educational attainment.

Table 4.23: Levels of Educational Attainment in the Niger Delta States

STATE	Adult Literacy(%)	Attainment of Primary School (%)	Attainment of Secondary school (%)	Attainment of Post secondary education (%)	No. of jobs in Sector 2000 (teachers)
Abia	84.1	39.6	43.6	16.8	9276
Akwa Ibom	76.3	54.4	44.4	8.3	13,683
Bayelsa	78.7	38.8	49.3	11.9	3,515
Cross River	82.2	44.6	42.8	12.6	11,425
Delta	77.4	37.9	43.6	18.5	15,720
Edo	69.7	49.3	38.8	11.9	10,959
Imo	79.3	46.1	42.7	11.2	14,145
Ondo	78.8	45.0	44.2	10.8	12,342
Rivers	79.9	33.4	49.5	17.1	4,011
The region	78.7	43.3	43.2	13.5	95076

Source: Niger Delta Regional Development Master Plan (NDDC 2006)

4.5.2 Livelihood Structures and Local Economy

4.5.2.1 Occupation, Employment and Income Generating Activities in Project Area

In relatively big and permanent communities (Soku, Elem Sangama, and Kula), the inhabitants have well developed trading culture, a service sector and harvest of natural resources from water bodies. Thus, the economic geography of the communities, to a great extent, is characterized with interaction with neighbours and people of other culture in trade, anchored on local resource exploitation.

The settlements/communities predominantly engage in fishing. The proposed project is not expected to disrupt artisanal fishing activities in the area. Other significant economic activities include trading, logging (lumbering), and civil service. Farming is not a prime occupation because of limited arable lands and livestock are hardly reared, except in Kula, and Opropokiri with mixed mangrove and pockets of freshwater forest lands where crops like cassava, yam, cocoyam, plantain, okra, pepper, and vegetables are grown at subsistence levels. Figure 4.35 shows occupational distribution of the inhabitants of Kula, European Quarter (Ekulama II), Freetown, Opropokiri, Newtown and Luckyland. The distribution shows that on the average, about 57.8 percent are into fishing, 15.3% are into trading while approximately 7.0% are civil servants. Those involved in business/contracting constitutes about 4.1% with the remaining 16.1% living as students/apprentices and unemployed.

Previous studies (Ojile, 2009, 2006, SPDC, 2002) have reported about 29.0% of people engaged in the fishery occupation in Soku and a quarter (25.0%) in formal employments as civil servants (teachers and Local Government employees) at Abonnema and Port Harcourt.

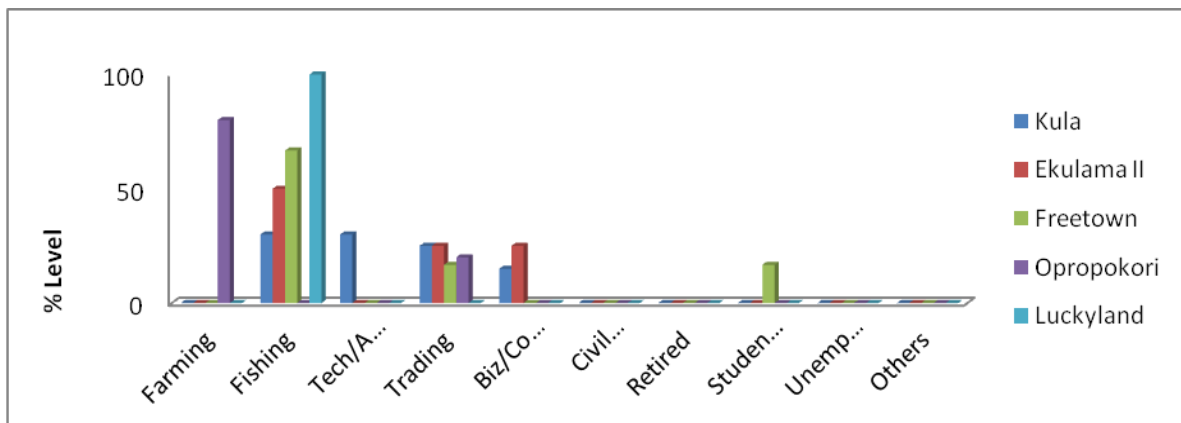


Figure 4.35: Distribution of Respondents by their Occupation

The male folks are more involved in the fishing occupation while the women take to collecting resources like pelagic organisms (periwinkles and oysters) and firewood from swamp forest for sale. The women set hooks and nets on and along the creeks to catch stray fishes and periwinkles. The fishing gear in common use includes various forms of nets, hooks and traps (Plate 4.15 and Plate 4.16). Lumbering is also an economic activity in Soku area (Plate 4.17)



Plate 4.15: Fishing Instruments/Gears (Hooks) commonly used in the Soku Area



Plate 4.16: Other Fishing Gears used in Soku



Plate 4.17: Sawn Timber in Soku Environment being transported to Port Harcourt for Sale

The number of persons involved in fisheries is more in the smaller fishing and/or trading ports than in the mainland permanent communities of Soku, Kula and Opropokori. The type of fishing carried out in the fishing is artisanal and on a small-scale usually in shallow waters. There are some of the fisher folks who fish in deep waters of Sombreiro, St. Bartholomew, Santa Barbara, St. Nicholas, Brass Rivers and the Atlantic Ocean engine powered boats. Migrant inhabitants of these settlements engage in diversified income-generating activities including logging, trading, and transportation by boats, harvesting of forest products, and fishing. Locally made canoes are used for fishing (Plate 4.18).



Plate 4.18: Fishing boats at Luckyland (left) and Newtown (right).

Respondents complained of serious occupational re-orientation that have involved abandonment of the traditional occupations of fishing and farming for livelihoods in the recent past. Fishing and agriculture have suffered some environmental and social challenges following oil mining activities and neglect of their restoration by successive governments. Presently many youths and other able-bodied men and women get their livelihood from illicit activities of oil bunkering, hostage-taking of oil workers and sabotage of oil pipelines. Others endlessly seek for rent on land from crude oil corporate companies in the area.

Product Trading: Though the livelihood system in the project area appears predominantly subsistent, some artisanal fisheries are geared towards earning some incomes and excess produce from the farming carried out taken to the markets (Plate 4.19) for sale to earn incomes. The trading system in the area is such that each of the community has a market day, which holds on regular intervals of every four-day, or every seven-day. To add-value for the caught fishes, they are processed by sorting to sizes, and smoking to preserve the fishes. The fish is staked on fish cards/racks made of wood. Making of fish cards is another craft that give income to many people in Kula community.

From Soku to Kula, and in all of the fishing settlements/camps, durable trading shades are not readily available. With trading structures or not, many people in the communities have known the market days. Trading takes place either in the community's village squares or open market squares. Cargo boats are used by inhabitants of Soku, Elem Sangama, Kula, and the fishing ports to take their fisheries and agricultural produce to the markets in Abonnema, Abua, Ndele and Port Harcourt paying transport fares of between N500 and N1,000 with travel time taking between 45 minutes to 10 hours.



Plate 4.19: A Markets at Soku community.

Social Reward System: Community service and exemplary behaviour by inhabitants of the communities are rewarded by social clubs and the community leaderships with chieftaincy titles. Religious groups, traditional groups, cults, community based organizations and thrift clubs provide strong social networks that unite members through a common set of shared values.

Income Distribution and Levels: Income is an important variable that influences socio-economic status of individuals and its distribution pattern has the potential of influencing other demographic variables. However, personal income levels of self-employed rural households is always difficult to assess because many local people do not keep records and are therefore uncertain of the gross or net amount actually earned from self-endeavors. Household members are engaged in several income-generating activities and their respective contributions to the overall household income most times are difficult to calculate. The consequence is that presented incomes of rural households are often less reliable.

As mentioned already, fishing and fisheries activities are the economic mainstay of the inhabitants of these communities. In addition, petty trading, lumbering/logging, the civil service, and private business/contracting, are other significant income-generating activities in the project area.

For the Soku-San Barth Pipeline study, income estimation was a difficult exercise. Five of the six sampled communities could not provide valid and reliable information of income.

However, information from a previous socioeconomic survey of communities in the area with the estimation of incomes of the population a few years ago (Ojile, 2009), was used to fill this gap. The income levels estimated showed that about a quarter (25.0%) of households in Soku earned N10,001–N15,000 in a month, while almost two fifth (18.8%) of the population earned above N50,000 in a month. Residents, who are into business and contracting however, earned better incomes that averaged, N200, 000.00 in a year. However, the frequency of getting such businesses was unpredictable.

A quarter (25.0%) of the respondents covered in this survey at Kula reported earning incomes within the range of N15,000 to N20,000; N25,00 to N35,000; and N45,000 to N50,000 in a month respectively. Discussions with fisher folks revealed that on a good day, each fisherman



makes income of between N5, 000.00 and N10, 000.00 daily. This income range being not quite regular was estimated to be about N20, 000 to N30, 000 monthly. The price of fish varies with the season of catch and quantity of fish caught, other pelagic resources have more predictable unit prices. A 25Kg bag of periwinkles (Esam) is bought for between N1, 000.00 and N1, 200.00 and then sold for between N1, 500.00 and N1, 600.00, in distant markets. These are taken to the distant markets by boats. Hiring a boat carrying about 46 bags of Periwinkle attracts a charge of N7, 000.00 to and from the market. Studies across the Niger Delta communities (UNDP, 2006, NDDC, 2006) have confirmed that except for those employed in oil and gas related activities, income of majority of the people in the coastal communities are generally low and highly variable.

4.5.2.2 Household Expenditure and Consumption

A review of ranking in order of concern on issues for household expenditure indicates that food was listed by 75.0% of heads of households as the most important spending priority, with entertainment ranked the least by (3.0%) in priority in the communities. Spending on Education was ranked the second most important household expenditure item 56.0% of the respondents. Many parents spend much in getting their children educated outside their immediate environment.

Surprisingly, healthcare (5.0%), energy (5.0%), and transportation (5.0%) were rated low in their expenditure priority lists. It was difficult to estimate accurately how much individual households spent on these priority items per month due to reluctance of respondents to provide accurate record on these non-durable consumer items.

On durable consumer items, many households especially the fishing settlements had few residential properties. In the three bigger permanent communities of Soku, Elem Sangama and Kula a good proportion of the people had some household properties/assets and accessories, like Television sets, electric fans, radios and Global System of Mobile telephones (GSMs). With limited access to electricity supply in their homes, only very few persons in the fishing/trading settlements generated their power from energy generating sets for the purposes of watching their television sets, powering their transistor radios and lighting their rooms.

The most utilized source of domestic energy is the wood-fuel, used mainly for the cooking of meals. The mere absence of electrical energy makes use of fuel-wood energy inevitable in almost all the households. Households source their firewood from the surrounding mangrove forest. People prefer to use red mangrove to using white mangrove in cooking meals and smoking fishes. A canoe full of red mangrove firewood costs between N10, 000.00 and N20, 000.00. Available Statistics show that across the Niger Delta region, on average, only 34 per cent of people use electrical lighting; 61 per cent use kerosene or a lantern. Less popular sources of lighting are gas (1.2 per cent on average), a generator (1.5 per cent), batteries (0.2 per cent), candles (0.6 per cent), firewood (1.8 per cent) and others (1.2 per cent) (NBS/FOS 2005).

4.5.3 Natural resource acquisition, ownership and management

4.5.3.1 Land Tenure, Use and Management

Land Ownership/Access and Tenure System: Nigeria is blessed with vast area of land resource. Nigerians share land for social, economic and development purposes. The manner in which this resource (land) is acquired, owned, used, and transferred to successors is referred to as land tenure (NEST 1991, Igbozurike 1978). Land has to be acquired through



anyone of six principal methods of acquisition, namely, inheritance, purchase, lease, pledge, exchange, and gift before ownership and access rights can be exercised over it.

Land in Nigeria falls under four broad ownership classes, regardless of who the law says holds the land in trust for whom. They are individually-owned, family-owned, communally-owned, and government-owned land. By providence, in and around the proposed project impacted communities and settlements, availability of land resource is very limited because of overwhelming influence of hydrology; myriads of rivers, creeks and creek lets that fan-across the terrain, leaving very limited solid land space used for either habitation, road construction, social development or cultivation purposes. Consequently, the available small land surface is held in very high regard by the inhabitants. The regard is heightened by individuals, families and communities owning lands intended to be used for oil wells and facilities. Two forms of land-ownership are common in the project area: family and communal land ownership. The reward for use of land is the rent payable to the rightful owner. By historical antecedents, the permanent large communities own lands that fall within their territory just as the smaller fishing ports/camps and settlements own lands in their immediate vicinities. Settlers and some migrant individuals doing business in the area owe allegiance to the communities that own the lands and “pay nominal fees or rent” to the land-owning community or compound as the case may be.

Historically, lands in the Soku, Elem Sangama, and Kula communities are owned by the founding families in each of the communities and the authority is vested in the hands of the eldest man in the families. However, there are some portions of the lands that are communally owned. Thus, ownership of land are passed down from one generation to another succeeding it and members of the families acquire their portions of land through inheritance. The bulk of the land made available to government and corporations (oil companies) for major public projects/utilities (schools, hospitals/clinics) come out of communally owned spaces. So do most of the plots utilized by each of the communities for setting up their Civic Centers/town halls, markets, schools, places of religious worship.

In communities with arable lands, following population increases land is used for cropping and left to fallow for between 2 to 5 years to allow it regain nutrients and fertility naturally. The fallow years have reduced from seven years to this on account of increasing pressure on land. Virgin land is cleared for cassava, yam, plantain, maize, melon and vegetables in the dry season and used for mixed cropping system. Cumulatively, land take by oil and gas pipelines, flowlines, oil wells and processing facilities can be substantial and impinge on both cultivable land and fisheries ground.

Common Uses of natural resources (Communal Forest and Swamp Resources): Forests and swamps provide households in the Project area with important livelihood resources. Non-timber products are used for food, as poles for building or for making fish traps and for herbal medical treatment. The forest areas serve as important sources of soft and hard wood and provide income for those engaged in the logging trade. The forests also provide habitat for wildlife readily hunted and sold for income by hunters. The animals caught include bush rats and grass-cutters for consumption and sales, monkeys and snakes for medicine. Mangrove swamps provide a rich source of shellfish and snails. Generally communal land and natural resources ownership most times overlap and it is difficult to determine precisely the boundaries of each settlement’s communal land.



There is similarity in the ownership of land and exploitation of natural non-timber resources as there are minimal or no restrictions to people. For examples, natural resources are communally owned in Soku and there are no restrictions to members of the community. Migrants however, pay some amount of money as rents to the community. The rents paid to the sand-filled areas go mainly to the chiefs and families.

In Elem Sangama land is communally owned and members are allotted portions for building their family houses. Natural resources are open for use by members of the community. In Kula kingdom, land resource is equally owned by the community. All members of the community are free to use resources found within the communal lands.. There are no restrictions while visitors are asked to pay a token.

In Freetown and European Quarter, natural resources are owned by community. Members are free to use; there are no restrictions for any resources but visitors/strangers are charged a fee of N1, 000.00 before use. In Luckyland, land ownership is communal. The use of natural resources is free to the community members while non-indigenes are usually permitted after payment of a certain amount of money.

Responses to question on any identifiable restrictions on fishing in the area yielded no meaningful result except that it became clear that restrictions are both self-imposed (lack of necessary equipment, including, gears and accessories to withstand fishing in the deep sea, fear of strong waves and respect for identified deities in the respective domains) and those having to do with ‘exclusive zones’ where there are SPDC’s Flowstations and pipelines/flowlines right-of-ways (ROWs), house boats. Fishing is forbidden within and around these facilities. The heavy security around these facilities instill enough fears into any one who dares to violate these ‘restrictions’.

4.5.4 Social Infrastructures and Services

The level of functional infrastructure and amenities available to a community has direct implications on the quality of life in the community, and therefore the willingness of people to live and remain there. It also influences other socio-cultural and economic variables in the area. The field study showed that the population in the bigger and permanent communities of Soku, Elem-Sangama, and Kula has more basic infrastructures and amenities, many of which have been provided by the oil and gas companies (SPDC and her partners). They have done this as part of their Corporate Social Responsibility (CSR) in compliance to best industry practice and to strengthen the Global Memorandum of Understanding (GMOU) they signed with the communities.

Some infrastructural projects have been started and left uncompleted and un-maintained, leading to their deterioration and non-functionality. The number, quality and capacity of some of the projects where maintained may be inadequate for the population on ground. Most of the smaller fishing settlements/ports lack the most basic infrastructures. For instance in Luckyland and Newtown are hardly any infrastructures.

4.5.4.1 Educational Facilities

Unlike most of the smaller settlements, Soku, Elem Sangama, and Kula have a number of public and privately-owned primary and post primary schools that provide education to the children and wards of the inhabitants of the communities (Table 4.24). These schools relatively have capacities and structures that can be adjudged adequate for their pupils/students and teachers in 2008/2008 academic session. Soku community has a primary

school called Holy Trinity State School, with 217 pupil enrollment and 12 teachers including the headmaster (HM). This on the average gave a teacher-pupil ratio of 1:18. The community supported this school by paying salaries of three of her teachers. During the period of this survey however, school enrollment has fallen to 137 pupils, with 6 teaching and 1 non-teaching staff in the school in the 2010/2011 academic session (Rivers State UBE Board, 2011). Against the physical setting and enrollment statistic, the available infrastructures are adequate. The school operates from one 6-classroom block and another block used for the nursery section. An 8-room block, that once served as a residential quarter for the teachers has been demolished reconstructed under the GMoU agreement (Plate 4.20). The school's infrastructures have been greatly enhanced by the Nigerian Liquefied Natural Gas (NLNG) who few years back refurbished the buildings. However, the headmaster (HM), Chief Pius Fenibo, stressed that the school needs a hall (to serve as a general assembly) and teaching aids and instructional materials for sciences.

The fishing settlements/ports on their part however are poorly endowed with educational institutions. For example, there are no public primary or post primary schools in Newtown, Luckyland, Pinaro, Kongomaboko and Apiboko.



Plate 4.20: A 6-Classroom Block Community Primary School, Soku.

The Community Secondary School (Plate 4.21), Soku, founded in the year 2000 initially operated from the former UBE school premises but now have additional structures including a multipurpose hall shared by two arms. This hall was originally designed as a hostel for students and was built by Wilbross as Community Assisted (CA) project. The hall has a toilet and bathroom facilities. NISSCO an oil servicing company has built a 10-room accommodation for the teachers (Plate 4.22). This block is now effectively housing members of the National Youth Service Corps (NYSC) members posted to the school.



Plate 4.21: The UBE 6-Classroom Community Comprehensive Secondary School, Soku,



Plate 4.22: Blocks of 10 Single Rooms for The Teachers At The CSS Soku

Elem Sangama Community has Nursery, Primary and Secondary schools, all highly enhanced with infrastructures from the SPDC (Plate 4.23). This school as at 2010/2011 session enrolled seventy-one (71) pupils and used the services of 6 teachers for instructions. The Community Junior Secondary School (CJSS), Elem Sangama had 87 students enrolled last session and engaged the services of 9 teaching and 2 non-teaching staff (RSUBEB, 2011).



Plate 4.23: Primary and post primary schools infrastructures at Elem Sangam

Kula has seven (7) primary schools, 5 of which are located in the satellite villages. There are primary (Plate 4.24) and nursery schools in the town and only 1 public post primary educational institution. Like the other mainland communities, facilities and infrastructures are comparable to those in urban centers. One of the schools, SS, Kula had the second highest enrollments after Abonnema, (the council headquarters of the AKULGA) with 308 pupils, 13 teachers and 1 non-teaching staff. The UBE driven Community Junior Secondary (CJSS) had 127 students, 9 teaching staff and 5 non-teaching staff.

There are no primary and secondary schools at Luckyland, Newtown, and the other 10 fishing and trading settlements. Inhabitants of these settlements take their children for enrollment in schools.



Plate 4.24: Primary and Post Primary School Structures at Kula

4.5.4.2 Electricity and Power Supply

All of the communities to be impacted by this project are located in rural coastal areas and do not have access to electricity. They are remotely located and are not connected to the national grid of the Power Holding Company of Nigeria (PHCN). The presence of electricity supply in the mainland communities is therefore dependent on the benevolence of oil and gas companies, especially where the communities are host to their operations. Communities of Soku, Elem Sangama, and Kula have received donations of giant generators by SPDC, Chevron, Texaco and Niger Delta Development Commission (NDDC) over the years. Although these donations usually come with both the fuelling and servicing costs, the maintenance and sustenance of the projects have continued to be controversial. As at the time of study, the communities confirmed the availability of electricity at scheduled periods, mainly from 6PM-6/8AM or 6 PM -12 midnight or 2AM for the simple reason of conserving diesel supplied by SPDC. The upsurge in militancy was also cited as a clog in the wheel of progress to regular supply of fuel for the generators. There is no electricity in any of the fishing settlements. Newtown and Freetown, which once had a giant generator (courtesy of Odili's government in 2007) lost use of it when they had community crisis that had them burnt down.

4.5.4.3 Transportation (Bridges, Jetties, Embankment) and Communication Facilities

Due to the physical conditions imposed by nature on the project area, the development of roads is naturally retarded. Surrounded by water, the project area is therefore, accessible only through water. Transportation into the area is through hand-dug canoes (by residents in the villages/fishing camps particularly and for inter/intra community movement) and the popular fibre or outboard engine boats usually fitted with various grade of HP engines. Thus, all of the communities in the project area can be accessed from Port Harcourt by travelling first on land from Port Harcourt off the East-West Road through Degema-Abonnema, before embarking on a 25 minutes to 1.5 hours marine journey to the nearest (Soku) and to the farthest community (Kula). The cost of transportation ranges from N250.00 - N500.00 from Port Harcourt to Abonnema –Soku and from N1, 500 - N3, 000 to Kula. The fishing ports/settlements can be accessed by boat.



Although good landing jetties are as important to marine transport as parks and bus stops for land transport, there are functional concrete landing jetties only at the permanent bigger communities while none exist in the fishing settlements. The one available at Soku has since the time of the militancy been converted to a sentry for the military that keeps the peace and maintains security in the area. There are however, makeshift wooden and dangerous jetties at the waterfront for incoming boats in Soku and other fishing settlements. Soku, Elem Sangama and Kula as well as the fishing settlements contend with coastal flooding and erosion but only Elem Sangama and Kula have embankments while that for Soku initiated by the NDDC in 2006 is yet to be completed.

4.5.4.4 Potable Water Supply and Sanitation Facilities

Data from the Federal Office of Statistics, (now the National Bureau of Statistics), reveals that water in many of Niger Delta states comes from unsafe supply facilities, including rivers, lakes or ponds, unprotected wells and boreholes. The Bureau classifies available sources of potable water for household consumption as: pipe borne, untreated pipe, borehole, protected well, unprotected well, river/lake/pond, vendor trucks and other categories. More than any other amenity, water facilities can be found in all but the fishing settlements but paradoxically, not many of the facility can be found functional at any one time. Soku community has been provided water facilities (Plate 4.25) (two boreholes and a mono-pump), and yet there was scarcity of potable water for drinking as at the time of visit. The newly constructed water scheme with a treatment plant had its water tank collapsed under its weight. The second borehole cannot be used because there is no electricity to run its engine. In the alternative, the resident population source their domestic water from the mono-pump provided earlier. This water is not potable because it has a fouling odour. Another source of water used for domestic purposes here was of course harvested rainwater. The quality and/or portability of the water from both sources were highly questionable. Ultimately, hand-dug wells remain the most reliable though not necessarily safe source of domestic water for the population.

Elem Sangama has two gigantic water facilities provided by SPDC and the NDDC, one of which is still functional (Plate 4.26), while Kula has three (3) Water facilities, one provided by SPDC (not functional, and needs treatment to make water potable), the other provided by State Government and another provided by Local Government Council. Traditional hand-dug wells are more reliable sources of water for community members.

Newtown was the only fishing community found with some water from a borehole while the others travel long distances to nearest oil facility (Ekulama flow station) to obtain drinking water. Some inhabitants make do with water from ponds suspected to be contaminated (Plate 4.27).



Plate 4.25: One of two water schemes in Soku community



Plate 4.26: Water Borehole Facilities at Elem Sangama.

Across the project communities, proper sanitation and hygiene is also not observed. Human faeces (excrement) are discharged into the rivers and creeks through pier toilets (Plates 4.28) while some of the modern houses have private conveniences/sewage systems which are connected to the river/creek for disposal. Solid wastes from homes are also easily deposited at the banks of the river/creeks, which in addition to being un-aesthetic is conducive for vector-borne infestations/diseases (Plate 4.29). About 96.0% of the population defecates through the pier toilet system as against only 4.0% that have private conveniences. Similarly, an overwhelming majority (92.0%) of the resident population of Soku disposed of their solid waste at the banks of the creek.



Plate 4.27: Streams/ponds as source of water in the fishing communities



Plate 4.28: Pier toilets as main sewage system in project communities



Plate 4.29: Refuse dump at the banks of the river at Soku and Kula communities.

4.5.4.5 Housing Type, Pattern and Quality

The housing pattern, type and structure within the study area reflect the coastal rural setting. Old traditional houses are aligned with modern bungalows and duplexes. Plates 4.30- 4.31 show traditional and modern houses found in the project area. The old traditional houses are built in rooms, with modal walling made of molded cement blocks or bricks and roofing materials made of corrugated iron sheets (zinc). A good number of them is also constructed with wooden/plank and thatch materials especially in the fishing settlements. The modern houses are built in flats with modal walling made of molded cement blocks or bricks and roofing materials made of long span corrugated Aluminum sheets.

The resident population of the project communities own and live in their personal houses/dwellings. In all, majority of the housing stock are of good quality housing especially the stock at the mainland permanent communities of Soku, Elem Sangama, and Kula. Going by the quality of houses in these communities, the inhabitants could be described as wealthy. Two to four storey buildings of gigantic sizes constructed of molded blocks and concrete pillars, and covered with corrugated iron sheets (zinc and Aluminum) roofs exist in Soku and Kula communities each. A few years back, a satellite image analysis augmented by field enumeration of the SPDC's Eastern rich Gas Gathering project EIA study found that there were 343 buildings in Soku, 269 of the housing stock had bricks for walling, 18 had aluminum roofs and 17 made were made of planks (SPDC, 2002). About 80.0% of the houses also had aluminum as roofing materials while the remaining had thatch roofs.

There has been significant improvement in housing types and their quality in the communities. About 40.0% of the respondents at Kula own and live in houses constructed of molded blocks and has corrugated zinc for roofing. About 20% live in houses made of sticks/bamboo with thatch roofing. Twenty percent (20%) of the respondents also live in houses made wood/planks with zinc roofing, while another 20% live in houses made of zinc walling and zinc roofing (bacha type of houses)

Over one half (57.1%) of respondents live in houses constructed of ephemeral materials, i.e. wood/planks with thatch roofing (Plate 4.32). Approximately 14.0% each also live in houses made of concrete/block with zinc roofing, zinc walling and zinc roofing and sticks/bamboo with zinc roofing. The housing stock at Freetown and the other fishing settlements is dominated by those constructed of wood/plank with zinc and thatched roofing. Most of the stock can be rated deficient because they require major repairs to make them conducive. Most of these houses operate on multi-tenements and have shared facilities (particularly the kitchen) located outside the main buildings.



Plate 4.30 Houses along the waterfront in study communities



Plate 4.31 Modern housing type in Soku community



Plate 4.32: Housing type in the fishing/trading settlements.

4.5.4.6 Healthcare Facilities

Health care facilities and services are more limiting in the project communities than the other social infrastructures. They were only available in Soku, Elem Sangama, and Kula at limited levels of functionality. There are Cottage/Comprehensive Hospitals and Health Canters at Soku (Plate 4.33), Elem Sangama, and Kula with peculiar problems. The Comprehensive Health Centre (CHC) at Elem Sangama has six (6) staff but no resident doctor. The CHC is supported by the Community Trust (CT). Kula has a comprehensive health centre but it lacks drugs, medical personnel and accommodation for staff.



Plate 4.33: The Soku Cottage hospital under lock and key during the field study

4.5.4.7 Financial Organizations/institutions

There are many informal financial organizations in the project area. The local population use traditional banking (thrift clubs) to raise capital to finance the purchase of fishing gear and household goods. There are a number of unregistered social groups, trade associations and cooperative societies in the communities. The groups are mainly thrift and credit clubs focusing on fishing, fish and net trading businesses.

The thrift clubs within the settlements and communities help members to save money and disburse loans to requesting individuals. The small loans are paid back within an agreed time at 5.0% interest rate. Failure to pay on time attracts a fine of an additional one percent. Defaulters to loan repayments are uncommon. Rotational savings club, exist where money is saved into a fund every month and members take turn to benefit from for the fund. Loans are used to make purchases for livelihoods or luxury items such as a television set or power generating set.

There are no formal banking institutions in the area and the local economy is sustained by traditional practices and thrift.



Table 4.24: Summary of Infrastructures and Social Amenities Available in Project-Affected Communities

Settlement/ Community	Education	Electricity/Power Sources	Transportation/Jetty/ Bridges/Embankment/ Communication	Potable Water and Sanitation	Health Care Facilities	Housing Type/Pattern/ Quality and Others
Soku	<p>Has a primary school (Holy Trinity School), established in 1939, has 217 pupils enrolled (152 in primary section and 65 in nursery), 9 teachers + 2 community employed teachers</p> <p>Does not have enough desks and seats for pupils; 6 tables and 6 chairs brought in by SPDC through GMoU</p> <p>Teachers quarters completed</p> <p>Has a secondary school (CSS), with enough infrastructures</p> <p>Children have access to scholarships and skills' acquisition</p> <p>Library built by Government</p>	<p>Community energised with generators (2 nos. but only one functional), fuelling and maintenance by SPDC.</p> <p>Limited access to power supply; community electrified only at night</p>	<p>Community accessible through water from Abonnema; Concrete jetty occupied by JTF Team, so use dangerous wooden jetties;</p> <p>Concretized internal road network with drainages (GMoU).</p> <p>Riverbank embankment initiated by NDDC stalled</p> <p>Population has access to GSM telecommunications</p>	<p>Access to potable water supplies limited; two boreholes and mono-pump available but population uses water from hand-dug wells</p>	<p>Cottage hospital built by SPDC with 4 nurses and a visiting doctor</p>	<p>Mixture of old and modern housing of good quality. Modern Town with accessories</p> <p>Market stalls for daily marketing activities</p>
Elem Sangama	<p>Has one public nursery and primary school with modern structures courtesy of SPDC</p>	<p>Functional electricity through a generator</p>	<p>Concrete walkways (internal roads) courtesy of SPDC (GMoU), (need</p>	<p>Functional water supply through borehole by SPDC</p>	<p>Comprehensive Health Centre, with 6 staff but no resident</p>	<p>Mixture of modern, good quality housing and</p>



Settlement/ Community	Education	Electricity/Power Sources	Transportation/Jetty/ Bridges/Embankment/ Communication	Potable Water and Sanitation	Health Care Facilities	Housing Type/Pattern/ Quality and Others
	Has also secondary school with modern structures Scholarships and skills training programmes available to children	(150KVA) donated by SPDC	extension and drainages). Has a concrete landing jetty built by defunct DFFRI and refurbished by GMoU Population has access to modern GSM telephony.		doctor, but supported by Community Trust (CT)	old housing of corrugated zinc walls and thatch roofing. HRH Palace by Rivers State Government, guest houses by NESCO company (1998) open market stall Modern Town Hall with accessories
Kula	2 public nursery and primary schools in main community built by SPDC and Community and 5 in satellite settlements/villages; 3 privately-owned primary and nursery schools Teachers quarters by SPDC	Community has access to limited energy/electricity supply via a generator (2 nos.) with diesel from and maintenance by SPDC Electricity comes on 6pm-8am on	Very distant from land and close to the Atlantic Ocean, community accessible through water transport Has two landing jetties (iron steel jetty by DFFRI-abandoned) Population has access	3 Water facilities; 1 by SPDC (not functional, need treatment to make water potable); 1 by State Govt. and 1 by LG Council	Has a comprehensive health centre; no resident doctor, few nurses, lacks drugs, accommodation and medical personnel	Mixture of old and modern housing; very good quality housing alongside old housing made of wood, zinc and thatch



Settlement/ Community	Education	Electricity/Power Sources	Transportation/Jetty/ Bridges/Embankment/ Communication	Potable Water and Sanitation	Health Care Facilities	Housing Type/Pattern/ Quality and Others
	1 public secondary school	weekends and 14 hours on non-working days	to modern GSM telephony			
Luckyland, Opuonongi and Kalaonongi	No primary and secondary schools; children and wards go to school at parent community (Kula)	No access to electricity	Accessible through water, no landing concrete jetty	No potable water supplies, fetches from Ekulama Flowstation Once had access to SPDC-solar powered water facility but pirates have stolen solar panel	No health facility	Housing of temporary structures; wood and thatches.
Newtown, Opropokiri and Ababoko	Before crises in Jan. 2007, had primary and nursery school but yet to be restored; children go to school now at Kula	Once had access to electricity during Governor Odili's time via generator, but burnt during crisis	Accessible through water transport, no landing jetty, has access to GSM telephony	Have limited access to potable water; both Govt. and SPDC have provided boreholes (SPDC's yet uncompleted) Get water from Ekulama F/S, 15-20 minutes away but 3 hours by hand-pulling	No health centre	Temporary housing structures
Freetown and European Quarter	Nil	Once had access to electricity but no longer functioning.	Nil	Has a non-functional water borehole-provided by SPDC, (domestic water	Nil	Housing type and quality of temporary structures-



Settlement/ Community	Education	Electricity/Power Sources	Transportation/Jetty/ Bridges/Embankment/ Communication	Potable Water and Sanitation	Health Care Facilities	Housing Type/Pattern/ Quality and Others
				obtained from open well shared with pigs)		thatches and reeds
Apiboko and Kongomaboko	Nil	Nil	Nil	Water borehole facility provided by Kongomaboko community with funding from SPDC.	Nil	Poor housing quality; mixture of houses made of thatches and planks/wood
Pinaro	Nil	Nil	Nil	Nil	Nil	Houses are of thatches and reed and planks



4.5.5 Historical Perspective of the Communities and Cultural Properties

4.5.5.1 Settlement/community, History, and Ethnicity/tribe

Soku community was founded by a woman from Iboderema family who handed it to her husband named Nango (the Royal family). The community originated from the old settlement (Ariama). Nine (9) families make up the community namely; Ariamie, Idiom, Seda, Indewari, Emor, Egenaro, Paka, Fenibo and Simpele families. Simpele and Nango are the two Royal families of the community who produce the Chief or Paramount Ruler for the community.

Previous socioeconomic surveys of the Soku area (Ojile, 2009, 2006) which had more of the Chiefs and elders in FGD however, affirmed that Soku's establishment can be traced down to the 15th century. Nine (9) family heads (Chiefs) agreed and came together from disparate locations to establish the present day Soku. The Compound heads include Nangwuo (royal family), Simpele, Idiom, Sene, Imoh, Enyi, Ngeripakaibia, Fenibo and Ndewari. Another version of the community history has it that it was founded in line with the decision of the then Chiefs of its five clans to stay together and form a formidable presence against external aggression and the slave traders. The sister clans including Opiomo, Bokiama, Iriama, Doki and Amanama have since continued to stay together till date. They are scattered around the Soku oilfield presently and still recognize Soku main town as their traditional headquarters.

Historically, Soku is one of the few most permanent settlements in the area. However, it has given birth to several satellite or constituent villages under its jurisdiction. They include Russia camp (Ekilama), Bushbar, Abakadikiama, Poboro, Opukiri, Oguguama, Kpasipiriama, Piriama, Akpuokoloama, Arikaniama, Doma, Abakiri, Ekulama 1 field, Kalaponjama, Dadumo camp, Soku 2 (Boggy village) Ekineama 1, located at back of gas plant and Kirikakiri camp. Soku and her satellite settlements belong to the Kalabari clan, an Ijaw tribe, under the local jurisdiction of Akoku Toru Local Government Council Area of Rivers State.

Soku and other proximate human habitations situate adjacent to freshwater swamps and on elevated banks of the creeks and rivers because of the difficult terrain. Soku is an island community with linear and dense population. Land is very much in short supply in the Soku project area. A satellite image analysis showed that the community occupies an area of 57 hectares with about 343 houses as at 2000 (SPDC, 2002). Houses are therefore very compact with paved and concretized walkways/thoroughfares (Plate 4.34) which makes movement much easier than otherwise as the land are prone to flooding during heavy downpours. Present day developments are taking place on sand-filled land.

Elem Sangama is an Ijaw community that speaks Kalabari and shares boundaries with Soku, Oluasiri and Okanami communities. It is also the boundary town between Rivers and Bayelsa states. It originated from the old spring (Oru Sangama). Oral tradition revealed that Elem Sangama was founded by 'Oba' who came from Iselema (Itsekiri) and first settled at Oru-Sangama (let juju live with us) under the leadership of the Amanayanabo of Kalabari Kingdom (King Amakiri I) who was then settled at Elem Kalabari. The settlement and inhabitants lived in their abode between the 17th and 18th century and have remained part and parcel and one of the 33 settlements and towns that make up the Kalabari Kingdom. But in and about 1907, a conflagration that engulfed the community forced further migration to a hitherto fishing port under the leadership of Ogboma, the Amanayabo of Kalabari but had to leave again in 1929 because the place unknown to them was a cemetery and inhabitants were greatly terrified. The people came and settled on the present abode finally in 1930. Then



came the Nigerian Civil war also devastated the settlement, as the people ran for their lives and became refugees for a year before resettling in 1968 up to present date. Coming together to rebuild the place necessitated reverting to the name Elem (old) Sangama. There are five (5) main compounds headed by a compound head and these compounds are Dabibi, Kulo Igoniko, Erisi, Tunboye Tameya and Gogo compounds. Like the Soku main town, it Elem-Sangama is a much smaller island community, and situates about 2.5km South West of the present day Soku Gas Plant. Restricted by land, the settlement pattern is dense though linear, along the main river. As a beneficiary of oil and gas development, its streets are also paved and tiled, although the inner core remains a reminder of its old former self (Plate 4.35).

Kula community, located close to the Atlantic Ocean and also very distant from land and its LGA headquarters (Abonnema) has an old settlement history, dating back to the 13th century AD. Fourteen (14) independent settlements make up the Kula community, some having migrated from Warri, Ijaw, Itsekiri and Engenni. However, Kula belongs to the Kalabari ethnic group. Four major compounds however, make up the community, namely Ibani Polo, Ogono, Igbeberidia and Agame and each compound has the fourteen families represented in them as major compounds. Kula is more like an island; it is bounded by the Atlantic Ocean in the south, to the west by River Awon-Toru and to the east across to the west of the Sombreiro River, to the north by Soku, Idama and Abonnema.

Luckyland, Opuonongi and Kalaonongi communities are satellite communities/settlements under the Kula kingdom, inhabited by the Ijaws, Andonis, Nembe, Ibibios, Okirika and Kabaris. The settlements are all fishing and trading ports established in the 1960s according to the community leaders, and are all located along the shoreline of major rivers/water-bodies. Newtown, Opropokiri and Ababoko communities are also satellite settlements of kula kingdom, occupied mainly by visitors from Ijawland (Bayelsa State), Ibibios, Andoni, Nembe, Ogbia and Kalabari areas. The housing pattern is clustered and buildings are characteristically temporal, built of thatched materials (Plates 4.36 – Plates 4.38).

Freetown and European Quarter (also called Ekulama II) are like other temporary and recent settlements within the area founded by madam Hoha from Nembe in Bayelsa State some years ago. The area also belongs to Kula kingdom and inhabitants are ‘visitors from Nembe, Ijawland, Kalabari, Andoni, Ogbia, Ibibio, Hausa and Yorubalands respectively. The settlement history of Apiboko and Kongomaboko communities is the same. Both communities are Kula satellite communities and founded by a woman from Bayelsa State.

Pinaro settlement is also one of the satellite villages under the Kula kingdom, and therefore, pays ‘royalty’ on monthly or yearly basis to the Kula landlords. This settlement was founded by Erebiye from Koluama in Bayelsa State some 5-20 years ago. It is inhabited by people from diverse ethnicities: Kalabiri, Ijaw, Nembe, Okirika, Hausa, Ogoni and Andoni.

Kirikakiri settlement/community is about one of the youngest or recently established settlements in the study area, having been founded by Selema Harry from Kula Town only a decade ago.



Plate 4.34 Paved and Concretized walkways/streets in Soku Community



Plate 4.35: Paved walkways in Elem Sangama



Plate 4.36: View of Opuonongi Community.



Plate 4.37: Luckyland Fishing Port



Plate 4.38: New Town Fishing and trading Port

4.5.5.2 Religion, Customs, Belief Systems and Heritage

The religion, custom, believe system and heritage of communities can have influence on a proposed project in an area. The customs of a community for instance can favourable predispose the community to further socio economic development.

Despite the remote location of the project communities, inhabitants are adherents of the Christian religion. In six communities/settlements of Kula, Ekulama II, Freetown, Opropokiri, Newtown and Luckyland Christianity is the dominant religion of the inhabitants of these settlements. The Christian Missionary Service (CMS) or the Anglican Communion (Anglican Church), the Baptist and several Pentecostal churches like the Assemblies of God church, Greater Evangelism Crusade, the Redeem Christian Church, Jehovah's Witnesses Organisation abound in the mainland bigger communities.



Elders and leaders of the Elem Sangama community also confirmed that though Christianity is the widely professed religion of majority of the inhabitants, the traditional African religion (ATR) remains the most potent to the indigenes of their community. Historical antecedents and livelihood systems necessarily confer on them the culture and traditions akin to their Kalabari kith and kin. Therefore, although churches of different denominations exist, ancestral groves and shrines also co-exist especially along the water-courses.

Within the settlements and trading ports the presence of Churches is not easily obvious (worshipping facilities/structures are generally lacking) as is the case in the mainland and more permanent settlements of Soku, Elem Sangama, and Kula. Christianity however remains the predominant religion in these settlements. The ‘White garment’ churches like the Brotherhood of the Cross and Star (OOO), Cherubim and Seraphim have stronger presence in the area. Notwithstanding, the people’s attachment to their traditions is evidenced by the presence of sacred groves and shrines located especially at their waterfronts.

Festivals, Calendars, cultural Groups, and Marriage Types

The Kalabaris have rich and well established cultural and traditional institutions. Inhabitants of each community and settlement are easily discernable by their folklore and songs. Amongst the Soku people for example, the community’s highest cultural society is the Sekiapu Cult which has several cultural masquerades depicting different features of the animal kingdom and the mermaids of the sea. Apart from the ‘Sekiapu’ cult which held the community together in the past and still very much revered as a social group, several other socio-cultural groups exist within each of the community, reflecting the Kalabari culture generally. There are the men and women age-grades, social clubs, that play cultural music and dances during festivals, (especially at wake keeps and burial ceremonies) in well attired costumes (Plate 4.39). In Soku, women dressed in traditional wears, come out in celebrations between April and May every year. The significance of the festival is to usher in peace, protection and to appeal to the goddess for good harvest. It is at the completion of the festival that new yams are eaten in the community.

For the inhabitants of Freetown and European Quarters (Ekulama II), the Amatemeso festival is usually marked from November every year for peace, unity and protection from the goddess. The Pinaro festival is celebrated from 28th December annually to appease the goddess of the land. Luckyland, Opuonongi and Kalaonongi also have a number of festivals that are celebrated; Ibiamabo and Seyeihogofie between the months of June – August yearly, one for the cleansing of the land while the latter is observed in December for the goddess of the land. Two festivals are marked annually in Apiboko and Kongomaboko beginning from November 15th; the Kongoma Oru and Apiboko-Erebo. The significance of these festivals is to appease the goddess and for bumper harvests. Like every other place, the Christmas (Xmas) and Easter festivals by Christian are carried out along with cultural displays which usually set the communities agog.

In spite of the rich traditional culture of the Kalabari, early Christian Missionary entry through the Baptist Church lends the various constituent communities a strong Christian outlook. So, along with the entrenched traditional institutions are the various denominational churches which are well represented. This medley of traditional and religious institutions has no trace of confrontation or conflict amongst the Kalabaris’.



Plate 4.39: A cultural procession typical of Soku.

Womanhood and marriage are also two respected cultures of the Kalabari people and by extension its constituent communities and settlements. All through the life of the Kalabari woman, she is surrounded with several rites of passage; first at birth, she is wrapped in real India (injiri); just before puberty, the girl enters another stage of her life signaled by the ceremony of ikuta-de (bead decking); next is the ceremony of pakiri (tying of half cloth) which occurs around teenage years. Konju Fina (covering the buttocks) is the ceremony which marks the next stage and entails tying of important traditional attires like sinini bite, egene bite, loco bite just above the knees, which precedes the bite sira-ma stage (full length clothing). It is worthy to note that in each of the stages, the girl is confined to the fattening room, to be fully catered for by her family without her participation in household chores, expectedly for her to feed fat and get very robust. Undergoing these rites traditionally projects the girl as getting ripe for marriage; so suitors can start making advances. Originally, these rites helped to maintain the chastity, pride and status of the Kalabari girl.

From the foregoing, it is obvious that the marriage custom of payment of bride price on nubile and marriageable girls is widely practiced in the project communities. In fact, marriages are regarded as another very significant rite of passage in the life of a Kalabari woman. There are three types of marriages, recognized, respected and practiced in the area.



The first is the Olo sime and Ari ibara-emi (concubinage), the second is the Iru sama/Igwa sime and the third is Iya sime. Olo sime is the simplest and cheapest of the marriage types, because no money whatsoever is paid as pride price. Under this marriage type, to all public knowledge, a man and woman are in a relationship, live separately or co-habit but without any strings attached, one or many children could be borne out of this relationship but have more attachment to the maternal home and even could bear the maternal family's name. The ari- ibara emi is just a step away. Here the man presents some drinks and token money to the woman's family as the only ceremonial difference. Mutual and continuous co-habitation is guaranteed and the children are still not eligible to inherit the man's property except when he specifically directs such to his family at his death. In Iya sime or Iru sama, a reasonable normal bridal payments are made but still short of full acceptance. In this case, the man has more authority over the children than in Olo sime and Ari ibara-emi, but custom does not yet recognize them as full members of the father's family entitled to all rights and obligations. This is only achieved either through the iya sime under Kalabari custom or the solemnization of the marriage in the church or registry. Thus, iya sime is the highest form of Kalabari traditional marriage and confers a great honour on the wife.

Value System, Taboos and Social Norms

Every society is guided by some value systems which attempt to regulate or guide the way of living, otherwise there could be anarchy with disastrous results. The inhabitants of the study environment with cultural allegiance to the Kalabari ethnic group have its value system, taboos and social norms as well. The python is a totem; for the Kula people, its killing is forbidden. The killing/eating of snakes and Agbalakoko (Eagle) s a taboo in Freetown and European Quarter, just as the killing and eating of dogs, python and alligator are forbidden in Pinaro. For the inhabitants of Apiboko and Kongomaboko no one is allowed to kill and/or eat python, eagle, dog and duck fowl. The culture forbids fighting no matter the circumstance.

Sacred Forests/scenic Areas

In spite of the overwhelming presence and influence of Christianity in the study area, the practice of the traditional African religion still has a hold on the people. In fact, older members of the permanent bigger communities are quick to remind one that the communities are essentially 'traditional'. Traditional worship takes place in both community and numerous family shrines that exist in the study area. Cultural and traditional practices are either conducted at the individual level with the nuclear family or at the community level.

There are shrines in all the communities and such shrines are regarded as the abode of the gods. In fact, the beliefs of the people as it relate to their establishment on the land very much relies on the deities/gods. Some of the sacred/forbidden sites that were mentioned in Soku included the cemetery, the 'Amatemeso' shrine and the ancestral homes (juju houses). Field visit established that traditional places of worships are cultural heritage centres. The Soku community's shrine located within the town square is now well protected from the elements with new fences/abodes and entire environment paved and tiled. Other sacred shrines/forests, located along the Soku creek are Alabo Dokiyo, Dumuaye, Igabanoru, Eje Shrine, Egenaro and Iluma .

The people of Elem Sangama are mostly Christians now with a few practicing the traditional African religion. In Kirikakiri, some sacred sites/shrines exist namely; Bele shrine, Oru shrine and Ikowari shrine, all of which are located outside the community. The Elegba forest was mentioned at Newtown, Opoprokiri and Ababoko communities. At the Luckyland,



Opuonongi and Kalaonongi settlements/communities, reverential sacred forests include Elebu, Sayanga gofie and Monoba.

4.5.6 Local Governance, Social and Community Structure

4.5.6.1 Traditional Administration /Power Structure

The traditional structure of a small community living in a single settlement and the structure of a big community belonging to a entity spread out over several hamlets are the same. The men of a community are subdivided into the youth (young men able to work) and the elders, the latter being committed persons who have actively contributed to the development of the community and have to be recommended by other elders or the chiefs/traditional ruler. The women of a community are organized in the same way. Correspondingly there is the group of young, married women of working age and the group of the “elder women”. The “elders” (women and men) have a high status in the community because of their experience and often they make the final decisions regarding important activities at the community level. However, for over a decade now, several youth groups and movements have usurped this position due to the perceived inaction of the elders against perceived exploitation.

No description of the political life of the people of the coast communities in the Niger Delta today is intelligible without an analysis of the social structure known as the ‘house’ system. ‘Each city-state comprised a number of ‘houses’, with each house more or less a trading association of freemen and slaves under a head of chief. There are usually four social classes in a ‘house’-the chief, the sub-chiefs, the freemen, and slaves. The division into classes was not rigid as a dynamic and successful slave could rise to become the head of a ‘house’. Technically the heads of ‘houses’ formed a sort of advisory council over which the king presides in the city-state. Inter-house rivalry was a constant menace to stability, and if there was a weak king, civil war invariably threatens.

At the ethnic level, the Kalabari Sekobiri is the General Assembly which constitutionally consists of the Amanyanabo of Kalabari, the Kalabari Council of Chiefs and the male citizens. This assembly is the ancient constitutional institution of the people, a constitution that is unwritten, but very well embedded in ancient traditions, customs, rights and privileges and cherished by the people. The monarchy, represented by the Amanyanabo is constitutionally the fountain of justice, head of both the executive and judicial systems and patron of the highest cultural cult or society, the Kalabari Ekine-Ogbo. The monarchy is largely ceremonial, since time and modernization have tempered with some of the duties performed in times past. In other words, powers of the Amanyanabo are greatly limited and circumscribed by modern state or national governments. But he still attends and presides over the proceedings of the Sekobiri.

There are also hierarchies of chiefs in the traditional institutions of the Kalabari governing structures. Firstly, there is the Amanyanabo, who can be termed the Natural Ruler of the nation. He is followed by the Amadapu (Amadabo) as heads of the respective towns, then the paramount chiefs of the House chieftaincy stools, which are hereditary titles and may consist of more than one chieftaincy stool under them. The day-to-day administration of Kalabari communities is however, vested on government-recognized community development committees (CDCs). Both the CDC and the youth group have the community’s mandate to interact with government agencies and private organizations like the oil companies operating within their domain. The women groups ably led by vibrant women leaders are in charge of feminine affairs and contribute their quota to the community’s development. All of the organs work in concert for the harmonious and smooth governance of the respective constituent



Kalabari villages/towns/communities. Decisions concerning the community are reached with a consensus at the Amanyanabo's palace with chiefs, CDC, women and youth representatives in attendance.

The proposed pipelines project which starts at the Soku Gas Plant will cut across settlements/communities that are subsumed under the Akuku-Toru Local Government Area (AKULGA) in Rivers State and Oluasiri in Bayelsa State. Soku, Elem Sangama and Kula are bigger permanent communities while the remaining 13 settlements can better be described as 'temporary permanent fishing and trading settlements/communities' or villages that are further subsumed under the bigger communities. The permanent bigger communities either singly or in combination with a few other settlements make up a political ward or thus represented by Councilors at the local government council areas, which is the third tier of governance, closest to the grassroots.

The traditional power structure in the project communities consists of three, four and in some five tiers of authority (Figure 4.36 and Table 4.25). For example, in the Soku Community, the structure consists of His Royal Highness (HRH)-in-council, the Council of Chiefs and Elders, the Community Development Committee (CDC), Men Forum, Soku Welfare Forum, Women Forum and Soku Students' Association.

The governing structure in Elem Sangama is as with Soku. The paramount ruler is the head of the community. He is assisted by his council of chiefs and elders followed by the CDC, Oil and Gas committee, and youth and women groups respectively. The Kula community has His Royal Majesty (HRM), a King at the top of the hierarchy, followed by the Kula Council of Chiefs, the 4 compound heads, and CDC, youth and women groups. The compound heads are responsible for the day-to-day affairs of the community while the youth and women groups assist with affairs appertaining to their responsibility.

At the apex of traditional governance in the bigger communities is the Amanayabo, who as the paramount chief and ruler, is ably supported by a Council of Chiefs/Elders. This council constitutes the highest decision making body and performs traditional duties, of the community. The chiefs of the founding families/compounds that constitute the council of chiefs have life-long tenure and are usually succeeded by their sons when they die (Monarchy). The day-to-day administration of the communities however, is vested on the Community Development Committee (CDC), and the youth body, which are the government-recognized bodies but subject to the chiefs' council. The CDC and youth body have elected chairman, secretary and other officers. These are elected with a view to equal representation from the families and/or compounds that make up the community. These organs have the community mandate to interact with the government and oil companies operating within their domain. The CDC specifically oversees developmental matters while the functions of the youth association/group include sanitation, labour and security affairs or others as may be delegated. As taskforces, their tenure ranges from 2-4 years before another set of officers are elected.

Other organizations also exist, including those representing the interests of fishers (registered fishing cooperatives) and social clubs for men, women and youth respectively. The Jamakiri social club, Soku Awo Beleemo Ogbo, Ogbo SABO and Akinama social club are some well-known social organizations in Soku. Others are Isumto Ogbo, Lucky social dance club in Newtown, Opropokiri and Ababoko Communities. There are also social clubs such as Sekiyapu, Masquerade and women clubs in Freetown and European Quarter. In recent times,

the putting into effect the Global Memorandum of Understanding (GMOU) by the oil and gas multinational companies have brought organs for implementation, e.g. Oil and Gas Committees.

Before now, the women’s role in community administration and development was not recognized. Things have since changed; the women’s forum or group is the umbrella organization of the women in charge of feminine affairs and do also contribute their quota to community development. The elders’ council where it exists is another level of local administration. In Soku community, it is basically an advisory body which assists the chiefs’ council and is constituted of persons in the age bracket of 45 years and above.

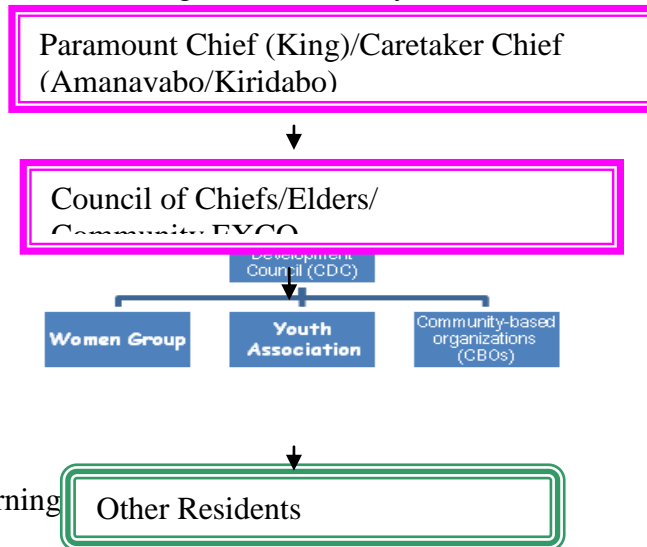


Figure 4.36: Traditional Governing

The power structure and traditional administration of the communities/settlements in the ‘less permanent fishing and trading ports are also similar. Their origins are traceable to a permanent bigger Kalabari Community and/or Kingdom and so, an indigent son or a representative of the landlord family/compound or entire community owning the land is appointed by the Council of Chiefs and placed as caretaker (Kiridabo or Kiriyanabo) of the port and all affairs are overseen by him. In addition to the appointed ‘Village Head’, an 8-10 member executive committee (EXCO) whose composition and approval is again subject to the scrutiny of the chief / landlord family/compound and Council of Chiefs at home is constituted, headed by a chairman. The youth and women groups are also organized into respective associations/groups to take charge of roles appertaining to gender/age, but more often than not, women’s voice are hardly heard nor their roles clearly defined.



Table 4.25: Traditional Governance and Community Structure in Soku, GP-San Barth Manifold Pipelines Communities

Community	Community and Traditional Power Structures
Soku	<p>Established since the 15th Century, Community is made up of 9 families, namely Nangwuo (royal family), Simpele, Idiom, Sene, Imoh, Enyi, Ngeripakaibia, Fenibo and Ndewari. Soku also has several satellite villages. At apex of traditional governance is the Amanayabo, as paramount chief and ruler, assisted by a Council of Chiefs made up of Chiefs from the 9 constituent founding families.</p> <p>Day-to-day administration vested in hands of the CDC, with elected chairman and other committee officials. The youth association is in charge of sanitation, labour and security of community. Tenure of office for both CDC and Youth leaders is 2 years and are re-electable for 2 or more years if services are satisfactory.</p> <p>Several social groups, age-grade and club appertaining to different social and economic needs are on ground in the community.</p>
Elem Sangama	<p>Community's history traced to between 17th and 18th Centuries, one of 33 towns and settlements that make up the Kalabari Kingdom, formerly settled at lem Kalabari, moved to Oru Sangama before finally settled at Elem Sangama.</p> <p>Traditional administration structured into hierarchies; the Chiefs and Elders Council, CDC, Youth group, women forum. Recognized individuals as opinion leaders co-opted into structure of leadership.</p> <p>The day-to-day administration of the community is however, vested in the hands of the CDC and Youth group headed by a chairman and president respectively other other elected officers with a 2-year tenure in office.</p> <p>Chiefs Gogo-Frank Thomas, S.Y. Dokubo-Tuboietimiye (as host), Orusah-Gooddey Sam Dinikpa, Elder Felix Dokubo (Opinion Leader) and Comrade Dakorinama (youth president) participated in community interview and focus group discussion (FGD).</p>
Kula	<p>Apparently the oldest settlement in the project area, founded way back since the 13th Century, Kula community is made up of 14 independent settlements.</p> <p>Community's power structure has the Amanayabo and his Council of Chiefs at the apex of leadership, the CDC, Compound leaders, Elders, Women and Youth group and several other social organizations.</p> <p>There are 4 major compounds in Kula, namely Ibani Polo (compound), Ogono, Igbeberidia and Agame with the 14 founding families represented in the 4 compounds respectively and some compounds also having sub-compounds.</p> <p>CDC made up of 8 members; two each from the 4 compounds, EXCO has 2-year tenure is headed by Owanate Lilly and assisted by Diepiriye Brown.</p> <p>Youth group, vibrant and strong but as at time of study having problems (4,000 strong member 8 years ago, making up about 60% of community's population).</p> <p>Women group very active in Kula; Secretary of CDC is a woman (Daffe Iyerikeimua).</p>
Luckyland, Opuonongi	<p>Small fishing ports; Luckyland was founded since the 1960s (according to village head) under Kula Kingdom with founder unknown is inhabited</p>



and Kalaonongi	<p>largely by fishers although population is mix-Kalabari, Ijaw, Calabar, Abua people, Ogoni, Ibibios, Annang, Hausa and Ibo; Some into fishing; Some into timber logging and, Some are itinerant traders.</p> <p>Settlement headed by a village head (Kiridabo), appointed by Kula Council of Chiefs to oversee the land; an 8-10 member Community EXCO headed by a chairman, secretary and other officials, including the youth members.</p> <p>Women’s vice is low, not formed into any group</p>
Newtown, Opropokiri and Ababoko	<p>The communities are satellite settlements of Kula kingdom, occupied mainly by visitors from Ijaw, Ibibios, Andoni, Nembe, Ogbia and Kalabari.</p> <p>The communities are answerable to Kula kingdom and are headed by Kiriyanabo. The Kiriyanabo are assisted by elders and some youth within the settlements to maintain law and order.</p> <p>Newtown settlement also established on same bank of river as Luckyland as a fishing port (trading, logging and transportation business also rife in area) in the 60s, has Kiridabo (village head) at apex of leadership.</p> <p>A 14-member EXCO with a chairman, secretary and other officials handles the day-to-day affairs of settlement; a Newtown youth group and a over 200 strong women forum headed by Mrs. Waibim David (woman leader/chairperson).</p> <p>Thanks to Pokubo (Adviser to Community), Oputoye Igbiki (community chairman), Tubojogoba Dokubo were all on hand during the field visit.</p>
Pinaro	<p>Founded by Erebiye from Koluama in Bayelsa state some 5 to 20 years ago, settlement is inhabited by population from Kalabiri, Ijaw, Nembe, Okirika, and Hausa, Ogoni and Andoni.</p> <p>One of the satellite communities from Kula Kingdom, inhabitants pays royalty on monthly or yearly basis.</p> <p>Community is headed by the Kiridabo who is assisted by an advisory committee.</p>
Apiboko and Kongomaboko	<p>Both communities are Kula satellite communities, founded by non-natives from Bayelsa.</p> <p>Ethnic composition of population is heterogeneous; settlement inhabited by visitors mainly from Ibibio, Andoni, Ogoni, Ijaw and Nembe.</p> <p>The heads of the communities are the Kiridabos, assisted by his council, women and youth groups in each of the communities.</p>
Freetown and European Quarter	<p>Founded by Madam Hoha from Nembe in Bayelsa state some years ago in an area that belongs to Kula kingdom; inhabitants are from Nembe, Ijaw, Kalabari, Andoni, Ogbia, Ibibio, Hausa and Yoruba.</p> <p>Governance is same as other fishing settlements; European quarter’s presently overseen by a caretaker.</p>
Kirikakiri	<p>Settlement founded by Selema Harry from Kula Town about a decade (past 10 years).</p> <p>The community is headed by the Kiriyanabo and the appointment is for life except he resigns and is assisted by the youth and women groups.</p>

4.5.6.2 Conflicts and Conflict Resolution in Project Communities

Conflicts and contentious issues are resolved in the various project communities by dialogue among the traditional head (Amanayabo), the Council of Chiefs, the Community Development Committees, Youth and Women groups. The rungs of power are many as revealed by the illustrated administrative structures starting from the family heads, compound



chiefs, through the various organs that terminate at the feet of the Amanayabo. In the event that a community member running fowl of the law, the issue is handled from the lower organ—the youth or women group and the deviant is punished according to the gravity of the offence. Smaller crimes could lead to monetary fines, according to the nature and gravity of the offence. Serious cases therefore involve meting out serious punishment, including being handed over to the police.

Several external conflicts were reported to have occurred between and amongst inhabitants of the project communities. In all of the cases, the source of the conflicts revolved around the issue of who owns a portion of land that bears an oil well or other oil and gas facility. The land ownership conflicts precipitate into crisis, some of which had been violent, and result in loss of lives and properties. Inter-communal skirmishes were reported between Kula and Soku and between Kula and Idama Ekulama. Government had to intervene and all issues involved have as at date been resolved.

4.5.7 People's Perception, Fears and Expectations of the Project

The response of the inhabitants of the project communities indicated that the resident population is not opposed to the proposed pipeline project. The inhabitants seem to have gotten used to several of such oil and gas projects and some actually expressed the expectation that the project could bring some socioeconomic benefits.

The general disposition to the proposed Project is predicated on various reasons but basically on the premise of the expected positive benefits.

These positive expectations include:

The project creating more employment opportunities for people in the area. The employment of the youth in cutting the mangrove vegetation, digging the trenches for the pipes, and keeping surveillance over the pipeline to avert unauthorized breaking of pipes;

The project helping to boost the economy of the communities as those who will execute the various activities will have to be provided with foods, toiletries, and accommodation at some commercial charges;

Ultimately, the project implementation shall accelerate the rate of development in the project communities through community development infrastructures as will be contained in the GMoU agreements to be signed by SPDC with communities;

The pipeline ROW is expected to open up new canal in the mangrove swamp along which fishing can profitably be carried out later in the life of the project.

Income of land owners and families whose lands will be used for the laying of the pipelines will be enhanced by the project. This will be empowerment to them in their various fields of endeavour and attract better living standards.

More scholarships expected to be granted to sons and daughters of families in the communities and settlements by SPDC;

The left over sand should be used to sand-fill the swamps for building and construction of concrete walkways.

There were fears also expressed concerning the project implementation, all of which are summarized in Table 4.26.

Table 4.26: Benefits from Oil and Gas Production in Project Communities and Further Expectations

Community	Priority Needs/Demands/Expectation	Fears
Soku	Happy with project; long expected. Needs manpower development so that youth can work with company when project starts Educational empowerment through the granting of more scholarships; manpower needs of proposed project should be recruited from the project-affected communities. Sand filling of the area, Women empowerment, Payment of allowances to the aged and Provision of employment etc.	Degenerative effects on the aquatic ecosystem Reduction in number of endangered species, Reduction of life expectancy of the inhabitants, High possibility of spills and Pollution Non compliance of SPDC to community demands.
Elem Sangama	Sand-filling of the community, provision of 150 housing units, network of concrete walkway up to 1000kms, Job employment for men and women of the community, Means of communication facility and skill acquisition for women (animal husbandry and fish farming).	Expectations will not be implemented; there will be rancour when people and company are not transparent.
Kula	Provision of social amenities, employment creation, skill acquisition and increased business activities.	Sea piracy, water pollution, land degradation and pipeline vandalization.
Kirikakiri	Shoreline protection/embankment Employment opportunities for the youth and provision of social amenities etc. Needs assistance with writing desks and chairs for pupils and students of both schools, as well as teachers Needs fast-tracking of water facility reconstruction. Needs also transportation and communication facilities and services; cargo boats and GSM telephony facilities Employment for community members also needed and scholarships and skills acquisition.	Aquatic lives will be affected, Youth restiveness and teenage pregnancies are likely to occur amongst indigenous girls exposed to temptation of Oil workers.
Luckyland, Opuonongi and Kalaonongi	Sand-filling, construction of concrete walk ways, skill acquisition centre for the youth.	Sickness and communal problems.
Freetown and European Quarter	Employment, provision of infrastructure especially pilling of water-front, i.e. shoreline protection/embankment and potable water Payment of compensation.	Attack from unrepentant militants Water pollution from pipe laying test runs. Strange/alien diseases, sex trade and piracy.



Newtown, Opropokiri and Ababoko	Sand-filling and pilling, provision of social amenities, Women empowerment and surveillance services	More teenage pregnancies and prostitution, Water pollution and spread of diseases
Apiboko and Kongomaboko	Provision of social amenities, Payment of adequate compensation to victims of spills, Provision of soft loan to women and relief materials.	
Pinaro	Pay compensation, Provision of social amenities such as school, landing jetty, water and health centre.	Poor fishing harvest, Water pollution and spread of diseases.

4.6 Health Status

4.6.1 Socio-Demographic Characteristics

In terms of their socio-demographic characteristics, the project communities were classified into the major towns and their satellite settlements.

The major towns are the renowned ‘traditional’ communities in the project area that have long been listed by the National Population Commission (NPC). The communities, which are fairly well-built up in terms of social infrastructure, include Soku, Elem Sangama, Kula and the Oluasiri communities. Most of the indigenes live and work outside the communities and only return, so the regular residents during the working days of the week (de facto population) are predominantly the elderly, some fisher-folks and their households, and the indigenes that work in the oil facilities in the area.

The satellite settlements are essentially the habited ‘fishing ports’ belonging to the parent main towns of the project area. These include Krikakiri, Kala-onogi, Opu-onogi, Ababoko, Opukiri, Freetown, European Quarters, Newtown, Luckyland, Kongomaboko, Apiboko, Pinaro and Opropokiri. Most of these satellite communities belong to the Kula community. They are basically fishing settlements with few homesteads that serve as the operational bases for occupational fisher-folks from the major communities, and itinerant fisher-folks that have migrated from Andoni, Ijaw areas of Rivers State, and Ibibios from Akwa Ibom State. Some of the satellite communities like Freetown and Luckyland that are close to major oil facilities, also host young women and traders that derive their livelihood from their proximity to the oil facilities.

All the project communities are “riverine” (swamp) communities, because they are mostly accessed by water (Plate 4.40) and their indigenous populations are predominantly fisher-folks.

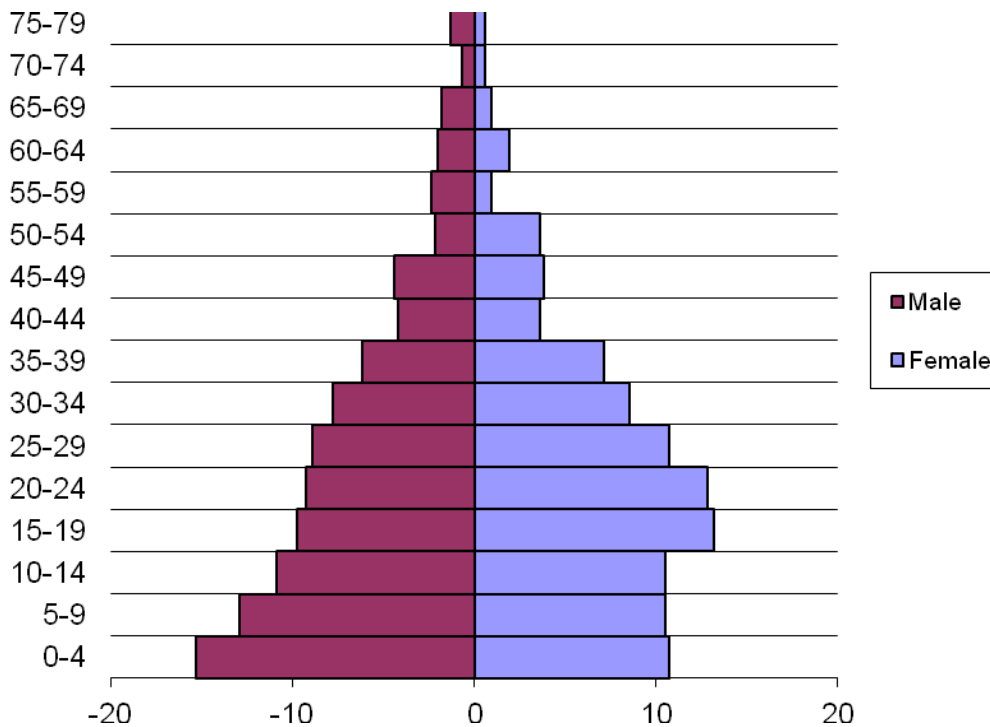


Plate 4.40 Canoes for Water Transport at Kongomaboko

Figure 4.37 illustrates a population Age-Sex Structure obtained in a previous HIA study of Shell’s GPHSL communities that are contiguous to the Soku-San Barth project area (ENVHRA, 2004); the pyramidal shape with a broad (large) base of a growing young population, is typical of communities in a developing country.

Fishing was the commonest occupation among household heads in the area, according to the GPHSL HIA Report (ENVHRA, 2004) - Table 4.27. Most of the household heads (82.1%) were or had been married, while polygamy rate was 9.7% (95% CI=6.0-14.8). Virtually all the household heads (99.0%) in the study area were Christians by religion, and about two-thirds (64.2%, 95% CI=57.2-70.8) were of the indigenous ethnic group. The average (median) number of persons per household was 5, which compares well with the National mean Household Size of 4.9 and 5.2 for Rivers State (inclusive of Bayelsa State) reported in the 1991 National Population Commission census reports¹.

Regarding education, the 2008 National Demographic and Health Survey (NDHS) reported that the South South zone had the lowest percentage of persons who had never been to school, 8% among males and 15% among females (NPC and ICF Macro, 2009)².



Population Pyramid (Age-Sex Structure) of Study Population (n=919)

Source: Environmental and Human Health Research Association [ENVHRA] (2004). Health Impact Assessment of Greater Port Harcourt Swampland MTR Project: Draft Report. Shell Petroleum Development Company, Port Harcourt, Nigeria.

¹Figure 4.37: National Population Commission. 1998. Population Census and Post Enumeration Survey 1991. Abuja: National Population Commission.

² National Population Commission (NPC) [Nigeria] and ICF Macro. 2009. Nigeria Demographic and Health Survey 2008. Abuja, Nigeria: National Population Commission and ICF Macro.

Table 4.27: Distribution of Marital Status and Occupation amongst Household Heads

	n	%	95% CI
Marital Status (n=195)			
Monogamous	124	63.6	56.4%-70.3%
Polygamous	19	9.7	6.0%-14.8%
Live with partner	2	1.0	0.1%- 3.7%
Separated	1	0.5	0.0%- 2.8%
Divorced	6	3.1	1.1%- 6.6%
Single	33	16.9	11.9%-22.9%
Widowed	10	5.1	2.5%- 9.2%
Occupation (n=206)			
Farming	3	1.5	0.3%- 4.2%
Trading	29	14.1	9.6%-19.6%
Fishing	90	43.7	36.8%-50.8%
Civil Service	17	8.3	4.9%-12.9%
Company employee	24	11.7	7.6%-16.8%
Contractor/Business	3	1.5	0.3%- 4.2%
Pensioner	2	1.0	0.1%- 3.5%
Unemployed	14	6.8	3.8%-11.1%
Artisan	10	4.9	2.4%- 8.7%
Retiree	14	6.8	3.8%-11.1%

Source: Environmental and Human Health Research Association [ENVHRA] (2004). Health Impact Assessment of Greater Port Harcourt Swampline MTR Project: Draft Report. Shell Petroleum Development Company, Port Harcourt, Nigeria.

4.6.2 Morbidity and Mortality Pattern

The prevalence of three commonest causes of ill health among children under-five years of age in the project area is instructive i.e. fever, diarrhoea and Acute Respiratory Infections (ARIs). The 2008 NDHS indicated that fever due to malaria remains an important consideration. As shown in Table 4.28, up to one-fifth of under-five children recorded a febrile illness in the two weeks preceding the survey. It is noted that this prevalence was higher than the national median of 15.9%.

Though the prevalences of diarrhoea and ARIs (mainly due to pneumonia) were less in the region than the National figures, they were no less significant as causes of ill health among children.

Table 4.28: Morbidity Pattern among Children in Project Area

	Proportion of children under age five who had a fever in the two weeks preceding the survey	Proportion of children under age five who had diarrhoea in the two weeks preceding the survey	Proportion of children under age five who had ARI in the two weeks preceding the survey
Rivers State	20.6%	3.8%	n.a.

Bayelsa State	18.1%	3.2%	n.a.
South South Zone	20.6%	3.8%	3.5%
National	15.9%	10.1%	2.8%

Source: NPC and ICF Macro, 2009

Analysis of the Weekly Epidemiology Report for the period of the field study in August 2011 that is published by the Federal Ministry of Health on epidemic prone diseases showed that Cholera and Cerebro-Spinal Meningitis were rare in Bayelsa and Rivers State (FMoH, 2011).³ However, the cumulative number of measles cases in the two States totaled about 220, though there were no fatalities recorded.

4.6.3 Nutritional Status and Immunization

The prevalence of malnutrition among under-five children is one of the indicators for the Millennium Development Goal 1. Indices commonly used to assess nutritional status at community level include Height-for-Age (stunting), Weight-for-Height (wasting) and Weight-for-Age (under-nutrition); stunting indicates chronic malnutrition, while the latter two indices reflect recent or acute malnutrition occurring in under-five children.

The levels of these indices in children in the project area were reported to be lower than the South South and National averages (Table 4.29). Notwithstanding, the levels displayed are dismal in particular for stunting, which is a reflection of long-standing poor diet and low socio-economic status, and also points deplorable environmental conditions in the communities (Ruel and Menon, 2003).

Table 4.29: Anthropometric Measurement of Under-Five Children in the Communities

	Proportion of children under age five with Height-for-Age below -2 SD of reference value (Stunting)	Proportion of children under age five having Weight-for-Height below -2 SD of reference value (Wasting)	Proportion of children under age five with Weight-for-Age below -2 SD of reference value (Under-nutrition)	Proportion of children aged 12-23 months who had received DPT3 vaccination
Rivers State	28.9%	4.8%	10.6%	51.8%
Bayelsa State	28.7%	7.4%	8.0%	27.6%
South South Zone	31.1%	7.5%	12.8%	54.2%
National	40.6%	13.9%	23.1%	35.4%

Source: NPC and ICF Macro, 2009

Anecdotal information gathered during the fieldwork indicate that the local staples were cassava, yam and plantain, which were often complemented with fish and shell foods, the major agricultural produce of the people. Several respondents, especially in Luckyland, pointed to a

³ Federal Ministry of Health [Nigeria] (2011). Weekly Epidemiology Report. WER-Nigeria, August, 2011; Vol. 1: No. 21.



worsening food security situation, due to frequent oil spills that have reduced the fish and periwinkle yields in the area.

4.6.4 Access to Safe Drinking Water

The source of drinking water is an indicator of whether it is suitable for drinking. Sources that are likely to provide water suitable for drinking are identified as improved sources (NPC and ICF Macro, 2009); they include, piped source within the dwelling or plot, public tap, tube well or borehole, and protected well or spring. Access to improved sources in the project area appears to be higher than the national average (Table 4.30), however disaggregated data suggests that ‘riverine’ communities have poorer access as shown by the difference in the figures for Rivers and Bayelsa States.

Information obtained from the field during Group Interviews supported this; while boreholes were common among respondents in the major towns, most of the respondents from the satellite settlements reported that they relied on rain water (Plate 4.41) and hand-dug wells.

Table 4.30: Access to Improved Drinking Water Sources and Sanitation Facilities

	Proportion of Households having improved drinking water sources	Proportion of Households having improved, not shared sanitation facilities
Rivers State	69.3%	19.6%
Bayelsa State	26.6%	6.1%
South South Zone	58.8%	22.3%
National	55.9%	27.0%

Source: NPC and ICF Macro, 2009



Plate 4.41: Rainwater Collection at Kula Community

Most of the water facilities in the communities were provided by the government and its agencies like the Niger Delta Development Commission (NDDC), but this included the protected hand-dug well constructed during the colonial and immediate post-colonial periods, and the hand-pumped well provided by several ad-hoc government water supply programmes. The water facilities provided by the oil companies were either provided as part of their social responsibility to the communities, or as part of the remediation for an oil spill.

All the public water facilities provided by the government and its agencies were noted not to have any plan for their maintenance (Plates 4.42); while those provided by the oil companies, especially SPDC had electric generators to facilitate their operation, and Management Committees for their maintenance. The Management Committees for the water facilities in the satellite communities were however found not to be as efficient as those in the major communities, which partly explain the non-functionality of the water facilities in the satellite communities.



Plate 4.42: A Non-functional Water Facility at Freetown

Lack of ready access to water may limit the quantity of suitable drinking water that is available to a household, even if the water is obtained from an improved source (NPC and ICF Macro,

2009). Water that must be fetched from a source that is not immediately accessible to the household may be contaminated during transport or storage (NPC and ICF Macro, 2009). It was reported that residents in the satellite fishing settlements, which have less social amenities, occasionally resort to “traveling” to the nearest Oil Company Facility (e.g. a Logistics Base) to fetch water for drinking.

From the analysis of the water samples taken from the underground water sources for the Bio-physical Studies, the quality was found to be largely within acceptable limits. Although the quality might be good, it does not guarantee that the water at the point of use would also be as good. This is because most households in the communities did not have the water piped to their houses, but instead collect and store the water at home. Good quality water collected from the vending tap and other water collection points can easily become grossly contaminated, in course of their transportation and storage at home (NPC and ICF Macro, 2009; Clasen et al, 2005).

It was noticed during the field study that members of the communities often used discarded drums of drilling chemicals as water storage containers (Plate 4.43). These drums have the potential of contaminating the water with the drilling chemical, especially when not properly washed. The health implications of this should be addressed with proper health education, especially as SPDC can easily be blamed for any health effects that arise from the use of the drums.



Plate 4.43: Discarded Drilling Chemical Drums for Water Storage at Apiboko

4.6.5 Access to Sanitation Facility

Sanitation facility was defined as a private excreta disposal facility that is either a toilet or a latrine, but not an overhung toilet, or a flush toilet without septic tanks that channels its effluents directly into the river (Billig et al, 1999). A household is classified as having an improved toilet if the toilet is used only by members of one household (i.e., it is not shared with other households) and if the facility used by the household separates the waste from human contact (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, 2004).

According to the 2008 NDHS Report, the proportion of households with access to improved toilet facility was 6.1%, 19.6% and 22.7% in Bayelsa State, Rivers State and South South zone

respectively (Table 4.:30). Although the latter two figures were close to the National average of 27.0%, the geographical shift can also be observed as noted for access to improved water sources. Social infrastructure has been noted to be sparse in the Niger Delta especially in the remote, often riverine areas similar to the project area (UNDP, 2006).

Direct Observation during fieldwork revealed that the jetty-type (over-hung) toilets were common in the project communities (Plate 4.44), and more in the fishing settlements than in the major towns. Responses from the group interviews also indicated that access to a proper toilet facility was better in the major communities.

Jetty-type or over-hung toilets grossly contaminate surface water, and are not technically considered a proper toilet facility. It was also observed that some households in the major communities practiced the channeling of sullage from water-flush toilets into the surface water bodies because of the problem posed by the high ground water level in the communities. This also constitutes is a major hazard to the health of members of the communities, as this contaminate the receiving water body with raw faeces, and has been linked to several excreta-related diseases including diarrhea, typhoid and schistosomiasis (WEEL, 1998).



Plate 4.44: A Toilet in Newtown Community

4.6.6 Waste Management

The wastes generated in the communities were observed to be mainly refuse and other domestic wastes. These wastes were often dumped close to residential accommodation, or at the bank of the river, where they sometimes served for land reclamation and/or shoreline protection. Leachates from the wastes can however become a source of contamination of water bodies (Plate 4.45).



Plate 4.45: Open Dumping of Refuse in the River at Kongomaboko

4.6.7 Housing Characteristics

From Direct Observation, the preponderant form of building materials in the major communities (such as Elem Sangama and Kula) was cement block walls and corrugated iron roofing sheets (Plates 4.46 and 4.47). This contrasted with the housing conditions observed in the satellite fishing settlements (such as Pinaro), which were mainly mud walls with thatch roofs, or mud walls with corrugated iron roofs (Plate 4.48).

It is noteworthy to report that it was observed that houses were mostly built in the popular traditional architecture, and often with small windows or without any. Feedback from members of the communities revealed that the practice was to reduce the biting nuisance of mosquitoes, which was described as very rampant due to the closeness of the communities to riverbanks and the mangrove swamp.

The 2008 NDHS Report showed that not many households in the project area own insecticide-treated mosquito nets (ITNs) or reported that household members sleep under them, as shown in Table 4.31. Though the figures for the South South zone were higher than National averages, a few other surveys have commented on the impact of net ownership and utilization in the communities in the Niger Delta (Ordinioha, 2007; Tobin-West and Alex-Hart, 2011).^{4 5}



Plate 4.46: Built-Up Housing Structures at Elem Sangama



Plate 4.47: Housing Structure at Kula Community



Plate 4.48: A Thatch House at Pinaro, a Fishing Settlement

Tablr 4.31: Ownership and Use of Mosquito Nets in Project Area

	households with at least 1 Insecticide-Treated Net (ITN)	Under-five children who slept under an ITN	Pregnant women aged 15-49 years who slept under an ITN
Rivers State	3.4%	9.6%	9.2%
Bayelsa State	2.4%	8.1%	10.0%
South South Zone	10.3%	9.4%	7.2%
National	8.0%	5.5%	4.8%

Source: NPC and ICF Macro, 2009

4.6.8 Air Quality

The results of the outdoor air quality measurement from the Bio-Physical Studies are presented in Table 4.5. The results were basically within FMEnv levels. Industrial activities are commonly the source of pollution of out-door air quality, while in-door air quality is usually compromised by domestic or related activities (Plate 4.49). The use of firewood and other bio-mass fuel as domestic fuel is a major cause of indoor air pollution, with wide-ranging health implications (WHO, 2003). Firewood is a common source of fuel for domestic use in the Niger Delta (Plate 4.50). An average of 73% of households in Niger Delta communities use firewood as their primary energy source (UNDP, 2006).



Plate 4.49: Fish drying in Kala-onogi



Plate 4.50: Firewood in Opu-onogi Waterside

4.6.9 Knowledge of HIV/AIDS and Sexual Behaviour

According to the 2008 NDHS Report, men and women of reproductive age in Rivers and Bayelsa States recorded proportions higher than the National median for those with multiple sex partners within a year (Table 4.32).

Despite this, the proportion of men with comprehensive knowledge of HIV/AIDS within the region is relatively low at 37.0% for South South, even though higher at 42.8% for Rivers State and 76.2% for Bayelsa State when compared to the National figure of 44.9%.

Table 4.32: Sexual Behaviour and HIV/AIDS Knowledge in Project Area

	Proportion of women aged 15-49 with comprehensive knowledge of HIV/AIDS	Proportion of men aged 15-49 with comprehensive knowledge of HIV/AIDS	Proportion of women aged 15-49 who had 2+ sex partners in past 12 months	Proportion of men aged 15-49 who had 2+ sex partners in past 12 months
Rivers State	17.1%	42.8%	3.1%	20.6%
Bayelsa State	41.7%	76.2%	2.7%	22.1%
South South Zone	26.0%	37.0%	2.2%	18.4%
National	23.4%	44.9%	1.0%	9.9%

Source: NPC and ICF Macro, 2009

Risky sexual behaviour is a determinant of transmission of sexually transmitted infections, including HIV/AIDS. Anecdotal information from the project communities suggested that it is perceived that a man is culturally permitted to engage in extra-marital affairs while fidelity in marriage was for women. Some of the project communities, especially the satellite communities like Freetown and Luckyland that are close to oil and gas facilities, have a history of accommodating Commercial Sex Workers (CSWs), when there is a major project. The 2007 Integrated Biological and Behavioural Surveillance Survey (IBBSS) identified sex workers as the sub-population most affected by HIV/AIDS in Nigeria (FMoH, 2007).

Project-induced influx of migrant population including working class population and “camp followers” is usually associated with an increase in the prevalence of HIV/AIDS and other STIs in the area (Kravitz et al., 1995)6.

4.6.10 Health Care Infrastructure

4.6.10.1 Soku Cottage Hospital

Soku and its neighbouring communities are served by the Soku Cottage hospital, located within the prescribed 30-minutes travel time from each of the catchment communities. The cottage hospital was built by SPDC, but handed over to the Akuku-Toru local government council for management. As at the time of field study, the health facility had the full complement of equipment expected for a comprehensive health center (Asuzu and Ogundeji 2007). They also had community health workers, nurses and other health workers that regularly run clinics in the facility.

The health facility offered mainly maternal and child health services like childhood immunization, ante-natal care, and maternity services; and also had the capacity to treat minor injuries and endemic diseases. However, the pharmacy lacked most of the essential drugs, and did not have a proper drug revolving fund.

However, the cottage hospital was grossly under-utilized (Plate 4.51), not helped by the fact that it was open for at most two weeks in a month, and never had a round the clock service. The poor utilization and truancy were however blamed on the crisis in the area, but can be improved through the greater input of members of the community in the running of the cottage hospital (Das Gupta et al, 2004).



Plate 4.51 Empty Ward in Soku Cottage Hospital

4.6.10.2 Elem Sangama Comprehensive Health Center

Elem Sangama and its neighbouring communities are served by the Elem Sangama Comprehensive Health Center, located within the prescribed 30-minutes travel time from each of the catchment communities. The comprehensive health center was built by SPDC, but handed over to the Akuku-Toru local government council for management. As at the time of field study,

the health facility had the full complement of human and material resources expected for a comprehensive health center (Asuzu and Ogundeji, 2007). It offered mainly maternal and child health services like childhood immunization, ante-natal care, and maternity services; and also had the capacity to treat minor injuries and endemic diseases. The health center also offered a monthly consultancy by a medical doctor, made possible by the community's health committee. However, the pharmacy lacked most of the essential drugs, and did not have a proper drug revolving fund.

Like the Soku cottage hospital, the Elem Sangama comprehensive health center was grossly under-utilized, and was open for a few hours, on specific days (Plate 4.52). Records obtained from the health center showed that an average of 0.77 out-patients was seen in the health facility in the first half of 2008. This is less than the 1.44 average for primary health care centers in the south-south region, according to the 2006 records of the National Primary Health Care Development Agency. This poor utilization is in spite of the staff residential quarters being built close to the health center. The staff of the health center blamed the poor utilization on the past crisis in the area, but can be improved through the greater input of members of the community in the running of the cottage hospital.



Plate 4.52: Elem Sangama Comprehensive Health Center Under Lock

4.6.10.3 Kula Primary Health Care Centre

Kula and its neighbouring communities including the satellite communities of the project area are served by the Kula Primary Health Care center, located within the prescribed 30-minutes travel time from each of the catchment communities (Plate 4.53). The Kula health center had a staff strength of ten (10) comprising: one (1) Community Health Officer, seven (7) Community Health Extension Workers, one (1) laboratory technician; and one (1) medical records staff. This is up to the required number for a primary health center in Nigeria (Asuzu and Ogundeji, 2007).



Plate 4.53: Kula Primary Health Care

Most of the medical equipment donated to the health center by SPDC were non-functional; but the staff were committed in ensuring that basic services were provided, and were ready to put in extra duty shifts. This perhaps explains the high level of utilization of the facility, as a daily average of three patients was treated in the facility, in the second quarter of 2011, largely thanks to the new Community Health Officer in the health center. This is higher than the 1.44 average for PHC Centers in the South South zone in the 2006 records of the National Primary Health Care Development Agency (NPHCDA).

The Rivers State government is however, constructing a new model primary health care center in the community (Plate 4.54).



Plate 4.54: New Health Center Under Construction in Kula Community

Health services in the satellite communities would improve significantly with the proper functioning of the Kula health center. This can be achieved with the posting of more staff to the health center, and the greater involvement of members of the Kula community in the running of the health center. The importance of a functional Community Health (Development) Committee in the management of primary health care facilities is recognized worldwide, and explains why it



was made a key recommendation in the revised national policy on health (Asuzu and Ogundeji, 2007). The input of members of the Kula community in the running of the Kula health center would not only ensure that the Drug Revolving Fund is made to serve the needs of the people and the facility, but also ensure that the health workers posted to the health center remain in their duty post, which has been a big problem in similar communities in Rivers and Bayelsa States.

4.6.10.4 Abonnema General Hospital

Abonnema General Hospital (GH) is the nearest secondary health care facility in to project communities. It is situated at Abonnema, the Akuku-Toru LGA headquarters, which is within 50 minutes by speedboat ride away from the proposed project area. Abonnema GH has the manpower and facilities expected of a secondary health care facility; with the capacity to attend to out-patient and in-patient care, surgery, and accident and emergency care.

However, the utilization of the facility was noted to be below expectation, due to a variety of reasons, amongst which was staff truancy.

4.6.10.5 Tertiary Health Care

Members of the project communities are also within reach of tertiary health care services provided at the University of Port Harcourt Teaching Hospital (UPTH), and the Braithwaite Memorial Specialist Hospital (BMH), Port Harcourt. These tertiary health care facilities have at least one thousand in-patient beds, and provide services in almost all specialties of medicine, including emergency care, orthopedics, medical and surgical care, and at a cost that is affordable to a large proportion of the citizenry. The hospitals have received seriously facility upgrade in recent years, such that they are capable of delivering world standard health care. Though it would take beyond the recommended 20-minute distance, but tertiary health services are ideally referral level of care.

4.6.10.6 Medical Emergency Evacuation System

None of the health care facilities in the communities had a boat ambulance, and were not served by the Rivers State Emergency Medical Service. Individuals make their own private arrangement in convening their sick and wounded for appropriate treatment. It would cost as much as seventeen thousand Naira (₦17, 000.00) to charter a boat, to convey a critically sick patient, from most of the communities to Port Harcourt.

4.6.10.7 Alternative Health Care

As displayed in Plates 4.55 - 4.57, self-medication and patronage of Patent Medicine Vendors (PMVs) and traditional medicine practitioners (especially Traditional Birth Attendants and Bone-setters) were observed in the project communities, especially in the satellite fishing settlements that lacked a health facility within the community.



Plate 4.55: Herbal Medicine Displayed for Sale in Luckyland



Plate 4.56: Stock of Medicines of an Itinerary Medicine Vendor in Opropokiri



Plate 4.57: A Young Boy with Wrist Dislocation Managed by a Bonesetter in Apiboko

4.7 Consultation

4.7.1 Introduction

The consultation process for the EIA was undertaken at an early stage of the project and helped to develop the scope of issues addressed on the proposed project activities. This consultation was accorded high priority as to capture and address issues and concerns of stakeholders and any other legislative issues. The consultation with the identified stakeholders for the Soku Gas Plant - San Barth Manifold Pipeline project was designed to be a continuous process throughout the development and operation of the facilities.

A scoping workshop was held in Port Harcourt and served as the first interactive session organized by the proponent of this project -the SPDC, with various stakeholders and communities involved in the project. The project communities are listed in the Socio-economics



and Health sections of this report (Table 4. 1). The project communities are from the Akuku-Toru LGA of Rivers State and Oluasiri in Nembe LGA of Bayelsa State.

4.7.2 Objectives

The objectives of the consultation for the Soku Gas Plant - San Barth Manifold Pipeline Project are as follows:

- Sustaining consultation with stakeholders via people’s parliament with explanation on key issues associated with the project and their effects on the people;
- Maintaining effective communication between SPDC and the project communities;
- Assuring full commitment to implement mutually accepted and sustainable community development Projects;
- Facilitating communication and understanding between the various stakeholders and SPDC (the project proponent) ;
- Gaining support and buy-in from all relevant stakeholders;
- Obtaining the initial consent to conduct scoping workshop;
- Complying with mandatory statutory requirements;
- Identifying issues relevant to the project which are likely to cause impacts;
- Avoiding conflict with the primary stakeholders by addressing issues promptly;
- Ensuring that any apprehension and disenchantment about the project with respect to environmental impacts are given the required attention by sensitizing, and mobilizing the project communities to express their concerns vis-a-vis the potential impacts of the project;
- Providing a link between the communities and SPDC in order to obtain early notification of any changes in the environment as a result of the project;
- Understanding stakeholders’ views of the project with respect to the present environmental conditions in the area and any changes thereof in the future;
- Assessing the participation of the project communities in maintaining and sustaining the beneficial impact of the project;
- Maintaining continuous interaction with the project communities to obtain early warning information on the physical, chemical, biological, health, and social components of the environment to resolve detrimental consequences during the construction and operational phases of the project;
- Identifying legacy issues associated with previous activities in the locations prior to their abandonment.

4.7.3 Identification and Involvement of Key Stakeholders

Experience has shown that certain potentially contentious issues get to the public domain only when appropriate consultation process is maintained from the conceptual stage of any project. The SPDC has engaged in the consultation process with all the relevant parties, to ensure that all the issues of concern are sorted out and rationalized prior to construction and operation of the proposed project.

4.7.3.1 The Primary Stakeholders

These are the members of the 17 project communities in the Local Government Areas (Table 4.2.1) of Rivers and Bayelsa States. They also include the NGO’s and CBO’s concerned with environmental and human right issues and other concerned Nigerians.



4.7.3.2 The Regulators

The identified regulators are:

The Federal Ministry of Environment (FMEnv), Abuja

Department of Petroleum Resources (DPR)

The Rivers State Ministry of Environment

Bayelsa State Ministry of Environment

The above regulators were notified by letters of the project proponent's intention to carry out the Soku Gas Plant – San Barth Manifold Pipeline Project. They were by the same letter invited to participate in the scoping workshop that held on 11th August 2010 at Presidential Hotel Port Harcourt, Rivers State.

4.7.4 Scoping Workshop

During the workshop, the following activities were undertaken:

Stakeholder Analysis, aimed at identifying those present, their status and interest and those absent;

Syndicate Group Work, during which participants carried out the following tasks:

Identifying potential impacts of the proposed pipeline project;

Identifying environmental components that can be potentially impacted

Suggesting the project proponents information to assist in predicting and evaluating the potential impacts of the proposed project;

Ranking the impacts in order of importance to them;

Suggesting mitigation measures acceptable to them to assist eliminate or reduce the potential impacts.

Each syndicate group carried out these tasks with respect to issues associated with the project intention and design; and biophysical, social and health environment.

Technical Review Session, which involved the review of the inventory of identified issues, later in the day, by a team of SPDC representatives, EIA consultants, and FMEnv/regulators that facilitated the syndicate groups. This was to assess the identified issues and sensitivities, eliminate repetitions and categorize the biophysical, social and health issues for the Terms of Reference (ToR).

Among the issues identified were the potential impacts of the project on the socio-economic activities of the project communities, the resultant change in the quality of life of the project communities, the potential impact of obstructions, noise and vibration resulting from pipe laying activities on human inhabitants, wildlife; the impact of exhaust emissions (smoke), radiation, and operational wastes on the quality of life of third parties; the likely issues that will cause agitation and accidents amongst members of the project communities, and issues of creating employment.

Further consultation was carried out immediately before and during the fieldwork in the various project communities.



4.7.5 Community Concerns

In general, interactions with the communities were positive and there was widespread appreciation of the process of consultation undertaken by the project proponents. The project communities were delighted with the proposed project and their requests are summarized as follows:

Creation of opportunities for employment/jobs for members of their communities during the lifetime of the project;

Involvement of the communities in the EIA study and report preparation;

Commitment in implementation of appropriate mitigation measures;

Settlement of legacy issues.

In response, the SPDC advised communities to reenact areas of concerns relating to the provision of infrastructure during survey especially in forum of Participatory Rural Appraisals or FGDs to ensure greater attention by SPDC. In addition, the SPDC reiterated that:

All complaints/issues raised outside the context of the project shall be sent to appropriate authorities;

Terms of Reference (ToR)/scope of work from the workshop will form the basis of the EIA study;

Consultation will be continuous and all areas of concern as well as mitigation measures shall be implemented.

4.7.6 Future Consultations

The SPDC will continue to consult with all relevant parties throughout the execution of this project. Significant comments from communities/individuals consulted would be given due attention until the contract closes out for the proposed Soku Gas Plant – San Barth Manifold Pipelines Project.



CHAPTER FIVE

ASSOCIATED POTENTIAL ENVIRONMENTAL IMPACTS

5.1 Introduction

There are a number of approaches for the prediction and evaluation of impacts. The ISO 14001 method is simple to apply and provides a high level of detail and also relies on limited data, unlike the other methods that require the availability of large historical data. The ISO 14001 method, therefore, is selected for the identification and evaluation of impacts for the proposed Soku GP-San Barth Manifold Pipeline Project.

5.2 Impact Identification and Evaluation

In line with general guidelines for an Environmental Impact Assessment (EIA) process, the following were the basic steps adopted for identification and evaluation of impacts:

Impact identification

Impact qualification

Impact rating

Impact description

5.2.1 Impact Identification

The aim of impact identification is to account for the entire potential and associated bio-physical, social and health impacts making sure that both significant and insignificant impacts are accounted for. The anticipated impacts were determined based on the interaction between project activities and environmental sensitivities. The identified potential impacts during the different phases of the project are listed in Table 5.1.

Table 5.1: Identified Project Impacts in Soku GP-San Barth Manifold Pipeline Project

Impacts	Project Phases			
	Pre-Construction	Construction	Operation & Maintenance	Decommissioning /Abandonment
Acceleration of erosion	√	√		
Alteration of natural drainage pattern	√	√		
Alteration of river bed bathymetry and hydrodynamic pattern		√		
Alteration of soil profile		√		
Availability of fuel wood	√			
Blockage of waterways		√		√
Burns/ injuries from welding sparks		√		√
Change in local topography of the area		√		
Contamination of surface water/ soil and sediment	√	√	√	√
Damage to archaeological artifacts		√		
Destruction of aquatic habitat	√	√		√
Destruction of assets and properties from oil spill/fire.			√	√
Destruction of vegetation	√			
Disruption of fisheries activities	√	√		√
Encroachment on culturally sensitive sites	√			
Exposure of workers to wildlife attack	√	√	√	√
Visual Impairment from high intensity welding flash		√		√
Radiation burns from radioactive emissions		√		
Habitat fragmentation	√			
Impact on fisheries from pipeline breach and oil spillage			√	√
Impairment of air quality	√	√	√	√
Improved health status/quality of life	√	√	√	√
Incidence arising from accidental contact with power cables and other underground infrastructure		√		√
Increased morbidity/mortality	√	√	√	√
Injuries and deaths	√	√	√	√
Increase in employment, service and income opportunity	√	√	√	√

Impacts	Project Phases			
	Pre-Construction	Construction	Operation & Maintenance	Decommissioning /Abandonment
Increase in social vices	√	√		√
Increase in surface water turbidity	√	√		√
Injuries/fatality of workforce	√	√	√	√
Legacy issues	√			
Loss of employment/ income				√
Loss of wildlife habitat	√			
Mental stress and illness	√			√
Noise and vibration	√	√		√
Noise and vibration from heavy machinery		√		√
Opportunity for hunting	√			
Pirates/ armed bandit attacks and kidnappings	√	√	√	√
Protein-Energy Malnutrition	√	√		
Reduction of access to land and its resources	√			
Sexually transmitted infections including HIV/AIDS	√	√		
Third party agitations	√	√	√	√
Waste generation	√	√	√	√
Water traffic accidents	√	√	√	√



5.2.2 Impact Qualification

The identified impacts of the project were qualified based on the following four criteria:

Positive or Negative

Short-term or long-term

Reversible or Irreversible

Direct or indirect

Negative impacts are those that impact negatively on the biophysical, health, and social environments, while positive impacts are those which enhance the quality of the environment. For this study, short term means a period of time less than 3 months while any period greater than three months is considered long term. By reversible/irreversible, is meant whether the environment can either revert to previous conditions or remain permanent when the activity causing the impact is terminated.

The outcome of the qualification of the identified impacts is shown in Tables 5.7a-5.7e.

5.2.3 Impact Rating

This stage involves evaluation of the impact to determine whether or not it is significant. The quantification scale of 0, 1, 3 and 5 was used. This is a modification of the arbitrary scale proposed by Vesilind, et al. (1994). The ratings are as described below and are adapted from The International Organization for Standardization ISO 14001– Environmental Management System Approach. The criteria and weighting scale used in evaluating significance are as follows:

Legal/regulatory requirements (L)

Risk factor (R)

Frequency of occurrence of impact (F)

Importance of impact on an affected environmental components (I), and

Public perception/interest (P).

5.2.3.1 Legal /Regulatory Requirements (L)

This asks the question ‘is there a legal/regulatory requirement or a permit required?’ The scoring is as follows:

0= There is no legal/regulatory requirement

3= There is legal/regulatory requirement

5= There is a legal/regulatory requirement and permit required

The legal/regulatory requirements were identified based on national laws/guidelines/standards (FMENV and DPR) relating to the project activity.

5.2.3.2 Risk (R)

This uses a matrix based on the interaction of the probability of occurrence of the impact (Table 5.2) against consequences (Table 5.3). The matrix (Figure 6.1) is referred to as the Risk Assessment Matrix (RAM). Five probability categories are interacted against four groups of consequences. The resultant outcomes are given scores with colour-coding. High-risk categories are red; intermediate risks, yellow and low risks, green as follows:

1=Low risk (green)

3=Intermediate risk (yellow)
5=High risk (red)

Table 5.2: Probability of Occurrence

Probability Category	Definition
A	Possibility of Repeated Incidents
B	Possibility of Isolated Incidents
C	Possibility of Occurring Sometime
D	Not Likely to Occur
E	Practically Impossible

Table 5.3: Consequence Categories

Consequence Category	Considerations			
	Safety / Health	Public Disruption	Environmental Aspects	Financial Implications
I	Fatalities / Serious Impact on Public	Large Community	Major/Extended Duration/Full Scale Response	High
II	Serious Injury to Personnel / Limited Impact on Public	Small Community	Serious / Significant Resource Commitment	Medium
III	Medical Treatment for Personnel / No Impact on Public	Minor	Moderate / Limited Response of Short Duration	Low
IV	Minor Impact on Personnel	Minimal to None	Minor / Little or No Response Needed	None

	A	B	C	D	E
I					
II					
III					
IV					

Figure 5.1: Risk Assessment Matrix

5.2.3.3 Frequency of Impact (F)

Frequency of impact refers to the number of occurrence of impact. The frequency of impact was determined using historical records of occurrence of impacts, and consultation with experts and local communities. The criteria for rating the frequency of impacts are outlined in Table 5.4.

Table 5.4: Frequency Rating and Criteria

Frequency	Rating	Criteria
High	5	Very likely to happen throughout the project lifespan
Medium	3	Likely to happen \geq 5 years
Low	1	Rare, not likely to happen within project lifespan

5.2.3.4 Importance of Affected Environmental Component and Impact (I)

The importance of the affected environmental components was determined through consultation and consensus of opinions. This was also further facilitated by information on experiences on the impacts of already existing facilities in the proposed project area. The rating of the importance of impacts is shown in Table 5.5.

Table 5.5: Importance Criteria

Importance	Rating	Criteria
High	5	Highly undesirable outcome (e.g., impairment of endangered, protected habitat, species) Detrimental, extended animal behavioural change (breeding, spawning, moulting) Major reduction or disruption in value, function or service of impacted valued ecosystem resource Impact during environmentally sensitive period Continuous non-compliance with existing statutes
Medium	3	Negative outcome Measurable reduction or disruption in value, function or service of impacted resource Potential for non-compliance
Low	1	Imperceptible outcome Insignificant alteration in value, function or service of impacted resource Within compliance, no controls required

5.2.3.5 Public Perception (P)

The consensus of opinions among the project stakeholders was used to determine the public perception on the potential impacts and the following criteria were applied (Table 5.6):

Table 5.6: Public Perception Criteria

Public Perception	Rating	Criteria
High	5	Elevated incremental risk to human health, acute and/or chronic Possibility of life endangerment for residents, abutting communities Major reduction in social, cultural, economic value Continuous non-compliance with statute Any major public concern among population in study area
Medium	3	Limited incremental risk to human health, acute and/or chronic Unlikely life endangerment for residents, abutting communities Some reduction in social, cultural, economic value Possibility of adverse perception among population Potential for non-compliance
Low	1	No risk to human health, acute and/or chronic No possibility of life endangerment for residents, associated communities Minor reduction in social, cultural, economic values Unlikely adverse perception among population

The combination of the five impact rating weights forms the basis for judging the level of significance of each impact. A matrix displaying the combination based on the ISO 14001 tool is shown in Figure 5.2.

Impact value	Cut off values	Impact Rating
L+R+F+I+P	≥15	High
F + I	>6	
P	= 5	
L+R+F+I+P	≥8 but <15	Medium
L+R+F+I+P	<8	Low
Positive		Positive

Figure 5.2: Impact Value and Rating Colour Code

The final ratings of the identified impacts are presented in Tables 5.7a-5.7e. In this report, medium and high significant negative impacts were judged to require mitigation, and all positive impacts required enhancement.

Table 5.7a: Impact Assessment (Pre-Construction Phase)

Project Activity	Description of Impact	Impact Qualification								Impact Quantification							
		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	Impact Rating
Land acquisition	Reduction of access to land and its resources		√	√			√	√		3	5	3	3	5	19	6	H
	Encroachment on culturally sensitive sites		√	√			√		√	3	3	3	5	5	19	8	H
	Third party agitations		√		√		√	√		3	5	5	5	5	23	10	H
	Legacy issues		√		√		√	√		3	5	5	5	5	23	10	H
	Opportunity for income generation	√			√	√		√		-	-	-	-	-	-	-	P
	Improved health status/quality of life	√			√	√		√		-	-	-	-	-	-	-	P
Mobilization (transport) to site (equipment & personnel)	Water traffic accidents		√	√		√	√	√	√	3	5	3	5	5	21	8	H
	Pirates/ armed bandit attacks/ kidnappings		√	√			√	√		3	3	3	5	5	16	8	H
	Contamination of surface water from release of petroleum products		√	√		√		√		3	1	1	1	1	7	2	L
	Disruption of fisheries activities		√	√		√		√		3	3	1	3	3	10	4	M
	Increase in surface water turbidity		√	√		√		√		3	1	1	1	1	7	2	L
	Noise/ vibration		√	√		√		√		3	1	1	1	1	7	2	L
	Impairment of air quality		√	√		√		√		3	1	1	1	1	7	2	L
	Third party agitation		√		√	√		√		3	5	5	5	5	20	10	H
	Injuries/trauma and deaths		√	√			√		√	3	3	5	5	3	19	10	H
	Improved health status/quality of life	√			√	√		√		-	-	-	-	-	-	-	P
Increase in morbidity		√		√	√		√		3	3	3	3	3	15	6	M	

Project Activity	Description of Impact	Impact Qualification								Impact Quantification							
		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	Impact Rating
	Increase in mortality		√		√		√		√	3	3	3	5	3	17	8	H
	Protein-Energy Malnutrition		√		√	√		√		3	1	3	3	1	12	5	L
	STIs including HIV/AIDS		√		√	√		√		3	5	3	3	3	17	6	H
Site Preparation (vegetation clearing)	Destruction of vegetation		√	√		√		√		0	3	3	3	3	13	6	M
	Exposure of workers to wildlife attack		√	√		√		√		3	5	1	3	3	15	4	H
	Loss of wildlife habitat		√	√			√		√	0	3	5	3	1	12	8	H
	Increase in erosion of the cleared area		√	√			√		√	0	3	3	3	3	12	6	M
	Increase in access for hunting	√	√	√			√		√	0	1	3	1	1	6	4	L
	Waste generation		√	√		√		√		3	3	5	5	5	21	10	H
	Availability of fuel wood	√		√		√		√		-	-	-	-	-	-	-	P
	Injuries/fatality of workforce		√	√		√	√	√	√	3	5	3	5	5	21	8	H
	Noise/vibration		√	√		√		√		3	1	3	3	1	11	6	M
	Habitat fragmentation		√	√			√		√	0	1	3	3	1	8	6	M
	Increase in Social vices		√	√			√	√	√	3	3	3	3	5	17	6	H
	Opportunities for employment	√		√		√		√		-	-	-	-	-	-	-	P
	Improved health status/quality of life	√			√	√		√		-	-	-	-	-	-	-	P
	Increase in morbidity		√		√	√		√		3	3	3	3	3	15	6	M
	Increase in mortality		√		√		√		√	3	3	3	5	3	17	8	H
Protein-Energy Malnutrition		√		√	√		√		3	1	3	3	1	12	5	L	
STIs including HIV/AIDS		√		√	√		√		3	5	3	3	3	17	6	H	

Table 5.7b: Impact Assessment (Construction Phase)

Project Activity	Description of Impact	Impact Qualification							Impact Quantification								
		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	Impact Rating
Excavation of pipeline route	Employment and income generating opportunity	√		√		√		√		-	-	-	-	-	-	-	P
	Third party agitation		√	√		√		√		3	3	3	3	5	17	6	H
	Damage to archeological artifacts		√	√			√		√	3	1	1	3	3	11	4	M
	Change in local topography of the area		√	√		√		√		3	1	3	3	1	8	6	M
	Flooding		√	√			√		√	0	3	3	5	5	14	8	H
	Increase in surface water turbidity		√	√		√		√		3	1	3	5	5	17	8	H
	Alteration of natural drainage pattern		√	√		√		√		0	1	3	1	1	6	4	L
	Acceleration of erosion		√	√			√	√		0	1	3	3	3	10	6	M
	Noise and vibration from heavy machinery		√	√		√		√		3	3	3	5	5	19	8	H
	Alteration of soil profile		√	√			√		√	0	3	3	5	5	14	8	H
	Soil acidification from dredgespoil deposition		√	√			√		√	0	3	3	5	5	14	8	H
	Reduction in air quality		√	√		√		√		3	3	3	3	1	13	6	M
	Incidence arising from accidental contact with power cables and other underground		√	√		√		√		0	3	1	3	1	8	4	M

Project Activity	Description of Impact	Impact Qualification							Impact Quantification								
		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	Impact Rating
	infrastructure																
	Disruption of fisheries activities		√	√			√	√		0	1	3	5	5	14	8	H
	Alteration of river bed bathymetry and hydrodynamic pattern		√	√			√	√		0	1	3	1	1	6	4	L
	Destruction of aquatic habitat		√	√		√		√		3	1	3	5	5	17	8	H
	Noise and vibrations from heavy machinery		√	√		√		√		3	3	3	3	3	15	6	M
	Injuries/trauma and deaths		√	√			√		√	3	3	5	5	3	19	10	H
	Improved health status/quality of life	√			√	√		√		-	-	-	-	-	-	-	P
	Protein-Energy Malnutrition		√		√	√		√		3	1	3	3	1	12	5	L
	STIs including HIV/AIDS		√		√	√		√		3	5	3	3	3	17	6	H
Pipeline welding/stringing	Visual impairment from high intensity welding flash		√	√		√		√		0	3	3	3	3	12	6	M
	Burns/ injuries from welding sparks		√	√		√		√	√	3	3	3	3	3	15	6	M
	Noise/vibration nuisance		√	√		√		√		3	1	3	1	3	11	4	L
NDT of Welds	Radiation burns from radioactive emissions		√	√			√		√	3	5	3	5	3	19	8	H
	Noise and vibrations		√	√		√		√		3	1	1	1	1	7	2	L

Project Activity	Description of Impact	Impact Qualification							Impact Quantification								
		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	Impact Rating
Pipeline laying	Blockage of waterways		√	√		√		√		3	3	3	1	3	13	4	M
	Injuries from work-related accidents		√	√		√		√	√	3	3	3	3	3	15	6	H
Backfilling	Increase in surface water turbidity		√	√		√		√		3	3	3	5	5	19	8	H
	Disruption of fisheries activities		√	√		√		√		0	1	3	5	5	14	8	H
	Impairment of air quality		√	√		√		√		3	3	3	3	1	13	6	M
	Noise/vibration nuisance from machinery		√	√		√		√		3	3	3	5	5	19	8	H
	Alteration of soil profile/river bathymetry		√	√			√		√	0	1	1	3	1	6	4	L
	Injuries/trauma and deaths		√	√			√		√	3	3	5	5	3	19	10	H
	Improved health status/quality of life	√			√	√		√		-	-	-	-	-	-	-	P
STIs including HIV/AIDS		√		√	√		√		3	5	3	3	3	17	6	H	
Cathodic protection	Contamination of soil and water from rust		√	√		√		√		0	1	1	1	1	4	2	L
Pressure testing of pipeline	Contamination of surface water/soil by leakage of spent test water from leakage.		√	√		√		√		0	1	1	3	1	6	4	L
	Injuries/trauma and deaths		√	√			√		√	0	3	5	5	3	16	10	H
Piling for	Noise/vibration		√	√		√		√		3	3	1	1	3	14	2	M

Project Activity	Description of Impact	Impact Qualification							Impact Quantification								
		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	Impact Rating
construction of manifold	Hearing impairment from noise		√	√		√		√		3	3	1	3	3	16	2	H
Pipeline commissioning	Contamination/pollution of surface water and soil		√	√		√		√		1	1	1	1	1	5	2	L
	Fire/blow-outs from process upsets		√	√		√		√		1	1	3	5	3	13	8	H
	Injuries/trauma and deaths		√	√			√		√	1	1	3	5	3	13	8	H

Table 5.7c: Impact Assessment (Demobilization Phase)

Project Activity	Description of Impact	Impact Qualification	Impact Quantification
------------------	-----------------------	----------------------	-----------------------

		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	Impact Rating
Demobilization (workers camp, equipment and personnel from site)	Water traffic accidents		√	√		√		√	√	3	3	3	5	5	19	8	H
	Pirates/ armed bandit attacks/ kidnappings		√	√		√			√	0	5	5	5	5	20	10	H
	Impairment of air quality		√	√		√		√		3	1	1	1	1	7	2	L
	Third party agitation		√	√		√		√		0	3	3	3	5	14	6	H
	Loss of employment/ income		√	√		√		√		3	1	5	5	5	19	10	H
	Mental stress and illness		√	√		√		√		3	1	5	5	5	19	10	H
	Protein-Energy Malnutrition		√		√	√		√		3	1	3	3	1	12	5	L
	Injuries/trauma and deaths		√	√			√		√	3	3	5	5	3	19	10	H
	Disruption of fishery activities		√	√		√		√		3	3	1	3	3	10	4	M
	Contamination of surface water from release of petroleum products		√	√		√		√		3	1	1	1	1	7	2	L

Table 5.7d: Impact Assessment (Operations and Maintenance Phase)

Project Activity	Description of Impact	Impact Qualification								Impact Quantification							
		Positive	Negative	Direct	Indirect	Short term	Long term	Reversible	Irreversible	L	R	F	I	P	Total	F+I	Impact Rating
Pipeline operations	Destruction of assets and properties from oil spill/ fire		√	√			√	√		0	5	5	5	5	20	10	H
	Impact on fisheries from pipeline breach and oil spillage		√	√			√	√		0	3	3	5	5	16	8	H
Inspection and Refurbishment of facilities	Increase in access to hunting and fuel wood	√		√		√		√		-	-	-	-	-	-	-	P
	Employment and income generating opportunity	√		√		√		√		-	-	-	-	-	-	-	P
	Improved health status/quality of life	√			√	√		√		-	-	-	-	-	-	-	P
	Injuries/trauma and deaths		√	√			√		√	0	3	5	5	3	16	10	H
Surveillance	Employment and income generating opportunity	√		√		√		√		-	-	-	-	-	-	-	P
	Improved health status/quality of life	√			√	√		√		-	-	-	-	-	-	-	P
	Injuries/trauma and deaths		√	√			√		√	0	3	5	5	3	16	10	H
	Shift from traditional occupations to other activities		√		√		√	√		0	3	3	3	3	12	6	M
	Third party agitation		√	√		√		√		0	3	3	3	5	14	6	H

Table 5.7e: Impact Assessment (Decommissioning Phase)

Project Activity	Description of Impact	Impact Qualification		
		Positive	Negative	Direct
Dismantling and Site Clean-Up	Increase in surface water turbidity		√	√
	Disruption of fisheries activities		√	√
	Impairment of air quality		√	√
	Noise and vibration		√	√
	Contamination/ pollution of water, soil and sediment		√	√
	Employment and income generating opportunity	√		√
	Third party agitation		√	√
	Improved health status/quality of life	√		
	Increase in access to hunting and fuel wood	√		√
	Loss of employment/ income for laid-off workers and contractors		√	√
	Injuries/trauma and deaths		√	√
	Mental stress and illness		√	√
	Population pressure on social infrastructure including housing, water, sanitation and health facilities		√	√
	Increase in morbidity		√	
	STIs including HIV/AIDS		√	
	Injuries/trauma and deaths		√	√
Harzadous Waste generation		√	√	
Rehabilitation of site	Employment and income generating opportunity	√		√
	Improved health status/quality of life	√		
	Restoration of aesthetic value of the environment	√		√

Project Activity	Description of Impact	Impact Qualification		
		Positive	Negative	Direct
	Injuries/trauma and deaths		√	√



5.3 Description of Impacts

In the course of the entire project, about 40 skilled and 80 unskilled locals shall be employed. The high and medium negative impacts for the project are described below:

5.3.1 Pre-Construction Phase

5.3.1.1 Land Acquisition

The potential impacts of the land in-take are:

Reduction of access to land and its resources

Soku Gas Plant –San Barth Manifold and Soku Flowstation- Soku Gas Plant pipelines require land-take of 26.5km by 0.03km of land for the RoW all of which will be in the mangrove swamp area. These 80 hectares of land once acquired by the project proponents will become

Encroachment on culturally sensitive sites

In the Soku-San Barth project community areas like most riverine areas, some culturally sensitive sites such as shrines and burial grounds are located in the mangrove forest and along the water courses. The 26.5km long pipeline has a high potential of encroaching on these culturally sensitive sites. The potential impact was rated negative and high.

Third party agitations

There is usually community agitations over compensations paid for acquired land in the Niger Delta. The execution of this project is unlikely to be different. This was rated as negative and high impact.

Legacy issues

Unfulfilled promises to project communities are a common source of conflict between project communities and project proponent especially during project execution. This impact was described as negative, direct, long-term, and reversible and was rated as high impact. SPDC have had footprints in the area over the years and if there are any unfulfilled agreements resulting from these previous projects these could impact on the relationship between SPDC and the project communities in this project. This is a potential negative high impact.

Opportunity for income generation

Monetary compensation shall be paid for very land acquired for this project. This is an opportunity for communities to enhance their income. This is a windfall income and there are chances that the money will be used for other income generating ventures.

Improved health status/quality of life

Proceeds from the land take would constitute an increase in household income for the landowners, which would result to an improvement in the quality of life and health status of members of those households. This impact was considered positive.

5.3.1.2 Mobilization to Site

Water traffic accidents.

Mobilization of equipment and personnel to site will involve the use of water crafts. The route that will be used for the mobilization will be from Nestoil Jetty in Abuloma through the New Calabar River, the Sombrero River into the Saint Bartholomew River. These routes are also used



by the locals for intra-community transport. They are however, mostly used by companies because of the large size of boat required to ply these relatively large rivers. There still remains the possibility of traffic accidents involving SPDC boats alone or SPDC and third party boats during mobilization.

Pirates/ armed bandit attacks/ kidnappings

Attacks by pirates and armed bandits and kidnappings are among the major security concerns in the Niger Delta especially in the coastal communities. This often happens along the waterways and could occur during the mobilization in this project. This was described as negative and was rated as high impact.

Contamination of surface water from release of petroleum products

Mobilization of equipment and personnel to site will involve the use of water crafts which could release refined products especially diesel and lube oil into the river. This would result in toxins entering the food chain, air pollution (from evaporation), and a decrease in the oxygen content of the water, which would negatively affect the surrounding aquatic life as seen before by Wachs et al., (1992) and Johnson (1998).

Disruption of fisheries activities

Fisheries activities could be disrupted during the mobilization of personnel, materials and equipment to project site. Fisheries activities that could be disrupted include trap setting, destruction of fishing gears, disturbance of water causing the migration of fish, thereby affecting the fish catch per effort. All of the seventeen project communities except Oluasiri are located along the mobilization route and engage in one form of fishing or the other. The fishing activities of the communities along the New Calabar River and Sombrero River may also be affected.

Increase in turbidity

The movement of boats through water can also cause disturbance to the bed of the water body, either through direct contact or through the effect of turbulence created by the vessel's passage. This disturbance is most evident in the form of the stirring up of fine sediments from the bottom of the water body which decreases water clarity in the water column. Such 'turbidity' can cause potential problems for both aquatic flora, which depend on light transmission through the water column for growth, and fauna which feed on the submerged vegetation. It can also smother and suffocate benthic communities. The waters in the mobilization travel route are sufficiently deep such that only thing that will cause a change in the turbidity of the waters will be the turbulence created by the passage of the boats.

Community agitation

Mobilization is the first physical contact of the project personnel and the communities and this usually witnesses the first community agitation. This is common during project executions in the Niger Delta and is a potential impact of the proposed pipeline project.

Injuries and deaths

These could result from traffic-related accidents due to the increase in vehicular movements, and also work-related accidents. This impact was rated high.

Improved health status and quality of life

The general well being of community members could improve as an indirect result of the increased household income from the various economic opportunities and employment brought about by the project. This is a positive impact.

Increase in morbidity

The prevalence of some diseases could increase as a result of pressure on available health services, housing and sanitation facilities due to population influx. Water-washed (water-impounded) diseases could result from shortage of potable water sources; water-borne diseases from faecal contamination of water sources due to inadequate sanitation facilities; and respiratory and skin disorders from over-crowding and poorly ventilated housing. This impact was rated medium.

Increase in mortality

Deaths could increase from the inability of health facilities to meet the increase in service demand from the population influx and from the rising prevalence of illnesses. This impact was rated high.

Sexually transmitted infections including HIV/AIDS

This could result from increase in social vices and risky sexual behaviour due to the improvement in the local economy and/or due to the influx of migrant population or so-called “camp followers”. This impact was rated high.

5.3.1.3 Site Preparation (Vegetation Clearing)

Destruction of vegetation

About 4 hectares of mangrove vegetation along the proposed pipeline RoW will be destroyed during project execution. Because the pipeline trench will not be completely backfilled, this area of the mangrove will not regenerate and will be lost at least through the lifetime of the pipeline. This clearing together with the clearing for the other pipeline projects going on the area will have a negative cumulative effect on the mangrove vegetation of the area.

Exposure of workers to wildlife attack

Forests such as found in the project area could provide habitat for dangerous animals like snakes, scorpions, bees and soldier ants. Snakes were cited in Ekulama I and II, Krikakiri and Luckytown during the baseline study. Field workers engaged in vegetation clearing could be exposed to attack by these animals. These attacks could result in injuries, poisoning or even death.

Loss of wildlife habitat

Many types of ecosystems are not represented in protected areas such as national parks and nature reserves in the country and continued unplanned vegetation clearance further diminishes the possibility of biodiversity preservation. Site clearing will lead to loss of species diversity and abundance, including soil organisms, fungi, invertebrates, bacteria etc. It will also lead to loss of food sources, fauna habitat, breeding grounds and nesting sites. The plant with the highest frequency of occurrence in the project area is dwarf red mangrove (*Rhizophora mangle*). The tall red mangrove (*Rhizophora racemosa*) is confined to the edges of creeks and rivers whereas the



white mangrove (*Avecinnia africana*) is seen occasionally on the muddy deposits. Species such as *Acrostichum aureum* (mangrove fern) and *Paspalum vaginatum* (mangrove grass) occurred between the mangrove canopies. The mangrove associates are *Machaerium lunatus* and *Dalbergia ecastaphyllum* which are leguminous plants that help to enrich the mangrove soils with nitrogen through biological nitrogen fixation. Typical epiphytic species found on the mangrove tree trunks include *Platyserium* sp, *Bulbophyllum oreonastes* and the moss *Ocoblepharum* sp. The mangrove ecosystem is home to rich biodiversity. Mangrove forests and the salt marshes connected to them provide food and a home for fish, shellfish, molluscs, wildfowl and an enormous variety of crabs.

Increase in erosion of the cleared area

When the vegetation is cleared, and the top soil is exposed washed into rivers when it rains, and then out to sea. This destroys the ability for the land to regenerate because it has lost its topsoil. De-stumping of vegetation especially in an area having a rainfall regime of over 3000mm annually could lead to soil erosion. The Chikoko soil in the area is however very resistant to erosion and the impact will be moderate.

Increase in access for hunting

The cleared pipeline RoW may be used by the local people for hunting. Hunting is not a major occupation in the area but some people may use the increased access to hunt monkeys. Ordinarily, this could have been regarded as a positive impact, but it could also lead to uncontrolled exploitation, which could threaten biodiversity.

Waste generation

Solid wastes particularly wood/vegetation wastes and spoils would be generated during site preparation. Wood could be used as fuel wood by the community members, but there are other vegetal wastes consisting of shrubs, leaves, grasses that may not be used as fire wood. Other wastes that will be generated will include food waste and sewage from the houseboat. These other wastes beside fuel wood have to be managed.

Availability of fuel wood

Families in project area spend between ten to twenty thousand Naira on a canoe load of red mangrove sticks which is the preferred fuel wood. Those who chose to cut the mangrove trees by themselves find it tedious job. One of the positive impacts of site preparation is the availability of free wood for fuel wood.

Injuries/fatality of workforce

Site clearing is typically done using both heavy and light equipment such as dredgers, swamp buggies, bulldozers etc. In the process of the clearing there could be injuries and possibly fatality among the workforce.

Noise and vibration

Noise and vibration arising from the use heavy machinery for clearing the vegetation would usually produce some noise above the noise threshold of a rural community like the communities in the project area. The smallest perceptible change in sound level for a person with normal hearing sensitivity is approximately 3 dBA. A change of at least 5 dBA would be noticeable and



would likely evoke a community reaction. A 10-dBA increase is subjectively heard as a doubling in loudness and would most certainly cause a community response (Air Services Australia, 2002). The range of noise produced by the type of earth moving equipment usually used for vegetation clearing ranges from 96-103dbA. This is an increase of more than 48dbA from the average 48dbA baseline noise value of the project area. Given the topography, existing structured and climatic conditions of the project area, the noise level is expected to however decrease by more than 36 dbA at a distance of 1km from the source point. The degree to which noise can impact the human environment ranges from levels that interfere with speech and sleep (annoyance and nuisance) to levels that cause adverse health effects (hearing loss and psychological effects).

Ground-borne vibration levels rarely affect human health. High levels of ground-borne vibration may damage some of the fragile buildings or interfere with equipment that is highly sensitive to ground-borne vibration. The site clearing activity is not expected to be carried out as close the houses as could cause damage.

Habitat fragmentation

The linear nature of this project will fragment wildlife habitats, which affects species migration patterns. This will result in a decrease in the amount of resources and shelter areas available to wild species and therefore leads to a general reduction in the number of individuals that can be hosted. Sedentary species, with specialized in habitat requirement show an important decline. Also the degree of isolation of habitat patches might depend on the migration capacity of each species living within them. The impact will be pronounce because the area had earlier been fragmented by the NCTL Trunk line and the GPHSL.

Increase in Social vices

The increase in population arising from project execution could lead to social vices like violence, alcoholism, attraction of commercial sex workers (CSW), substance abuse, teenage pregnancies etc. This could lead to increase in sexually transmissible diseases (HIV/AIDS, syphilis, etc).

Opportunities for Employment

The site clearing will be done using both skilled and unskilled labour. Due to SPDC local content policy, this could create opportunity for employment, contracting and increase in income for the communities.

Improved health status and quality of life

The general well being of community members would improve as an indirect result of the increased household income from the various economic opportunities and employment brought about by the project. This is a positive impact.

Injuries and deaths

These would result from work-related accidents and exposure of workers/community members to injurious plants or displaced dangerous wildlife. This impact was rated high.

Increase in morbidity



The prevalence of selected diseases would increase as a result of pressure on available health services, housing and sanitation facilities due to population influx. Water-washed (water-impounded) diseases could result from shortage of potable water sources; water-borne diseases from faecal contamination of water sources due to inadequate sanitation facilities; and respiratory and skin disorders from over-crowding and poorly ventilated housing. This impact was rated medium.

Sexually transmitted infections including HIV/AIDS

This could result from increase in social vices and risky sexual behaviour due to the improvement in the local economy and/or due to the influx of migrant population or so-called “camp followers”. This impact was rated high.

Increase in mortality

Deaths could increase from the inability of health facilities to meet the increase in service demand from the population influx and from the rising prevalence of illnesses. This impact was rated high.

5.3.2 Construction Phase

5.3.2.1 Recruitment of Labour

The labour required for the project could be sourced locally, nationally or internationally. There could be other migrant workers who will come to look for opportunities for employment thereby increasing the overall population of the project area. The potential impacts from these are:

Increase in Employment, Services and Income

The project could offer employment for the indigenes at various stages. This could improve the income of the those employed in particular and the average earning of the community in general.

Pressure on existing infrastructure, health, recreational, housing

Pressure on existing infrastructure such as healthcare, housing, recreational and other social amenities could arise due to migrant job seeker and camp followers to project locations.

Increase in Social vices

The increase in population arising from influx of migrant workers and camp followers could lead to social vices like violence, alcoholism, attraction of commercial sex workers (CSW), substance abuse, teenage pregnancies etc. This could lead to increase in sexually transmissible diseases (HIV/AIDS, syphilis, etc).

Third Party Agitation

Labour issues are always a source of friction between companies and project communities. Agitation could be either due to requests for a certain percentage of labour force that could not be met or sharing the employment opportunities in the community. The impact was described as direct, negative, short term, local and reversible. It was rated medium.

5.3.2.2 Excavation of Pipeline Route



The trenching/ excavation would be done on land and water using land excavators and Barge-mounted Bucket dredger. These could have the following impacts:

Damage to archeological artifacts

Archeological chance-finds could occur during pipeline route excavation. The impact was described as direct, negative, long-term, local, reversible and rated medium.

Change in topography of the area

The dredge spoil from the trenching will be dumped along the trench and this could alter the local topography of the area, thus affecting the hydrology of the area, which could affect wetland functions and productivity. The impact was described as direct, negative, short-term, local, reversible and rated medium.

Increase in turbidity of surface water

Trenching by bucket dredger could cause the loosening of the sediments in the water bringing a huge amount of materials into suspension. The suspended materials could thus increase the turbidity of the water over a stretch of the river. The increased turbidity can cause potential problems for both aquatic flora, which depend on light transmission through the water column for growth, and fauna which feed on the submerged vegetation. It can also smother and suffocate benthic communities. The impact was described as direct, negative, short-term, local, reversible and rated high.

Acceleration of erosion

Excavation destroys the soil structure and loosens the compacted soil and therefore enhances erosion. A total of 297,000m³ will be leftover after back fill and this quantity of soil will be highly susceptible to erosion. Erosion could also increase as a result of change in local soil topography. Hence, the impact was described as negative, direct, long-term, and reversible and was rated as medium impact.

Destruction of fauna habitat.

Excavation destroys the habitat of earth-living fauna especially the burrowing animals. While some may escape deeper into the forest, the sedentary species could be destroyed when their habitat is destroyed. Hence, the impact was described as negative, direct, short-term, and reversible and was rated as medium impact.

Noise and vibration from heavy machinery

Noise and vibration arising from the use of heavy equipment for site excavation such as dredgers, swamp buggies, bulldozers etc could affect the workers, project communities and scarce wildlife. The smallest perceptible change in sound level for a person with normal hearing sensitivity is approximately 3 dBA. A change of at least 5 dBA would be noticeable and would likely evoke a community reaction. A 10-dBA increase is subjectively heard as a doubling in loudness and would most certainly cause a community response (Air Services Australia, 2002). The range of noise produced by the type of earth moving equipment usually used for vegetation clearing ranges from 96-103dbA. This is an increase of more than 48dbA from the average 48dbA baseline noise value of the project area. Given the topography, existing structured and climatic conditions of the project area, the noise level is expected to however decrease by more than 36 dbA at a distance of 1km from the source point. The degree to which noise can impact



the human environment ranges from levels that interfere with speech and sleep (annoyance and nuisance) to levels that cause adverse health effects (hearing loss and psychological effects).

Ground-borne vibration levels rarely affect human health. High levels of ground-borne vibration may damage some of the fragile buildings or interfere with equipment that is highly sensitive to ground-borne vibration. The site clearing activity is not expected to be carried out as close the houses as could cause damage. The impact was described as negative, direct, short-term, and reversible and was rated as high impact.

Alteration of soil profile (acidification)

Excavation and backfilling could result in the alteration of soil profile thus negatively affecting soil microbes and fauna. The impact was described as negative, direct, long-term, and irreversible and was rated as medium impact.

Soil Acidification from Dredgespoil Deposition

Excavation and backfilling could result in soil acidification from dredgespoil deposition, thus negatively affecting soil microbes and fauna. The impact was described as negative, direct, long-term, and irreversible and was rated as high impact.

Flooding

The excavation of the pipeline Right of Way could result in a new water channel This could cause flooding in the area. The impact was described as negative, direct, long-term, and irreversible and was rated as high impact.

Reduction in air quality

Reduction in air quality could arise from the emission of pollutant gases from construction equipment during excavation activities. The impact was described as negative, direct, short-term, and reversible and was rated as medium impact.

Incidents arising from accidental contact with power cables and other underground infrastructure Excavation equipment could make some accidental contact with power cables and other underground infrastructure. Such cables or other infrastructures could be destroyed or the contact may cause cause electric shock in the case of electrical cable or spills in the case of oil or gas pipeline. The impact was described as negative, direct, short-term, and reversible and was rated as medium impact.

Improved health status and quality of life

The general well being of community members would improve as an indirect result of the increased household income from the various economic opportunities and employment brought about by the project. This is a positive impact.

Injuries and deaths

These would result from traffic-related accidents, work-related accidents and exposure of workers/community members to injurious plants or displaced dangerous wildlife. This impact was rated high.



Sexually transmitted infections including HIV/AIDS

This could result from increase in social vices and risky sexual behaviour due to the improvement in the local economy and/or due to the influx of migrant population or so-called “camp followers”. This impact was rated high.

5.3.2.3 Pipeline Welding/Filing and Stringing

The welding and stringing of the pipes at site could lead to the following impacts:

Visual impairment from high intensity welding flash

Welding generates high intensity welding flash. This flash could affect the eyes giving rise to arc eye. The impact was described as direct, negative, short term, local, reversible and rated medium.

Burns from Welding Sparks

The sparks generated during welding activities could result in injuries to the body. The impact was described as direct, negative, short term, reversible and rated medium.

Noise nuisance from plant and machinery

Noise and vibration arising from filing of welding joint could affect the workers and scarce wildlife. The impact was described as negative, direct, short-term, and reversible and was rated as medium impact.

5.3.2.4 NDT of Welds

Radiation burns and sickness from exposure to radioactive emissions

The integrity of the welded pipeline joints will be checked visually and by radiography. Radioactive materials emitted during radiography could affect the health of the worker especially in the long run with a possibility of genetic mutations. The impact was described as direct, negative, long term, irreversible and rated medium.

5.3.2.5 Pipeline Laying

The lowering of the pipeline into the excavated ditch could have the following impact:

Blockage of waterways and possibility of maritime accidents

The whole length of the pipeline would be welded on land and then pulled into the excavated area as one piece. This activity could temporarily lead to blockage of the waterways to other users. The impact was described as direct, negative, short term, and reversible. It was rated medium.

Injuries and deaths

These would result from traffic-related accidents, work-related accidents and exposure of workers/community members to injurious plants or displaced dangerous wildlife. This impact was rated high.

5.3.2.6 Backfilling

The potential impacts of this activity are:

Increase in turbidity



The backfilling of excavated area in the water using the dredged spoil materials could increase the turbidity of the river. The impact was described as direct, negative, short term, reversible and was rated high.

Disruption of fisheries activities

Fisheries activities could be disrupted during backfilling especially at the water crossings. Fisheries activities that could be disrupted include trap setting, destruction of fishing gears, disturbance of water causing the migration of fish, thereby affecting the fish catch per effort. This was therefore described as negative, direct, long-term, and reversible and was rated as medium impact.

Impairment of air quality

Reduction in air quality could arise as a result of the continued operation of heavy duty construction equipment from backfilling activities. The impact was described as negative, direct, short-term, and reversible and was rated as medium impact.

Noise and vibration

Noise arising from the use of heavy equipment for backfilling such as dredgers, swamp buggies, bulldozers etc could affect the workers, project communities and scare wildlife. The impact was described as negative, direct, short-term, and reversible and was rated as high impact.

Alteration of soil profile/river bathymetry

Backfilling could result in the alteration of soil profile and river bathymetry, thus negatively affecting flora and fauna. The impact was described as negative, direct, long-term, and irreversible and was rated as medium impact.

Injuries and deaths

These would result from traffic-related accidents, work-related accidents and exposure of workers/community members to injurious plants or displaced dangerous wildlife. This impact was rated high.

Improved health status and quality of life

The general well being of community members would improve as an indirect result of the increased household income from the various economic opportunities and employment brought about by the project. This is a positive impact.

Sexually transmitted infections including HIV/AIDS

This could result from increase in social vices and risky sexual behaviour due to the improvement in the local economy and/or due to the influx of migrant population or so-called “camp followers”. This impact was rated high.

5.3.2.7 Hydrotesting

Contamination of surface water/ soil by spent test water from leakage



Contamination of surface water/soil from leakage of spent pressure testing water could contaminate the environment. This was therefore described as negative, direct, short-term, and reversible and was rated as medium impact.

Injuries and deaths

These would result from work-related accidents due to incidents such as blowouts caused by process upsets during the systems testing. This impact was rated high.

5.3.2.8 Piling for Construction of Manifold

Hearing impairment from noise

This activity could result in vibration and increase in ambient noise, which could impair the hearing and health of workers and community members. This impact was rated as high.

5.3.2.9 Pipeline Commissioning

Contamination/ pollution of surface water / land

Contamination of surface water/soil by oil during pipeline commissioning could contaminate the environment. This was therefore described as negative, direct, short-term, and reversible and was rated as medium impact.

Fire/blow-outs from process up-sets

Incidents and accidents could occur from process up-sets during the commissioning of the facilities, and could lead to fires and destruction of assets. This impact rated high.

Injuries and deaths

These would result from work-related accidents due to incidents such as blowouts caused by process upsets during commissioning. This impact was rated high.

5.3.3 Demobilization Phase

Water traffic accidents

Mobilization of equipment and personnel to site will involve the use of water crafts. The route that will be used for the mobilization will be from Nestoil Jetty in Abuloma through the New Calabar River, the Sombrero River into the Saint Bartholomew River. These routes are also used by the locals for intra-community transport. They are however, mostly used by companies because of the large size of boat required to ply these relatively large rivers. There still remains the possibility of traffic accidents involving SPDC boats alone or SPDC and third party boats during mobilization.

Pirates/ armed bandit attacks/ kidnappings

Attacks by pirates and armed bandits and kidnappings are among the major security concerns in the Niger Delta especially in the coastal communities. This often happens along the waterways and could occur during the mobilization in this project. This was described as negative and was rated as high impact.

Contamination of surface water from release of petroleum products



Mobilization of equipment and personnel to site will involve the use of water crafts which could release refined products especially diesel and lube oil into the river. This would result in toxins entering the food chain, air pollution (from evaporation), and a decrease in the oxygen content of the water, which would negatively affect the surrounding aquatic life as seen before by Wachs et al., (1992) and Johnson (1998).

Disruption of fisheries activities

Fisheries activities could be disrupted during the mobilization of personnel, materials and equipment to project site. Fisheries activities that could be disrupted include trap setting, destruction of fishing gears, disturbance of water causing the migration of fish, thereby affecting the fish catch per effort. All of the seventeen project communities except Oluasiri are located along the mobilization route and engage in one form of fishing or the other. The fishing activities of the communities along the New Calabar River and Sombrero River may also be affected.

Increase in turbidity

The movement of boats through water can also cause disturbance to the bed of the water body, either through direct contact or through the effect of turbulence created by the vessel's passage. This disturbance is most evident in the form of the stirring up of fine sediments from the bottom of the water body which decreases water clarity in the water column. High turbidity can cause potential problems for both aquatic flora, which depend on light transmission through the water column for growth, and fauna which feed on the submerged vegetation. It can also smother and suffocate benthic communities. The waters in the mobilization travel route are sufficiently deep such that only thing that will cause a change in the turbidity of the waters will be the turbulence created by the passage of the boats.

Mental stress and illness

The loss of employment and contract opportunities of members of the community and the resultant decrease in household income could result in psychological trauma. This impact was rated high.

Injuries and deaths

These could result from traffic-related accidents due to the increase in vehicular movements, and also work-related accidents. This impact was rated high.

5.3.4 Operations and Maintenance Phase

The potential impacts of this phase are:

5.3.4.1 Pipeline Operations

Contamination of water, sediments and soil from oil spill

Breakdown in the oil pipeline integrity due to either mechanical failure or sabotage could lead to spillage. The spilled oil could contaminate the soil, sediments or water bodies. The impact was described as direct, negative, long term, and reversible. It was rated high.

Direct fisheries impacts from pipeline breach and oil spillage

Direct impacts of fisheries arising from pipeline breach and oil spillage could affect fisheries and fishing activities. This impact evaluated and described as negative, direct, long-term and reversible and was rated as high.

Destruction of Assets and Properties from any Fire Incident

The oil spillage could be followed by fire incident leading to loss of assets and properties including that of third parties. The impact was described as direct, negative, long term, and irreversible. It was rated medium.

5.3.4.2 Inspection and Refurbishment of Facilities

Increase in access to hunting and fuel wood

Following the completion of the construction work, the pipeline RoW would constitute an additional route for members of the communities to access the surrounding environment for hunting and wood harvesting.

Employment and income generating opportunity

The chances are high that the pipeline inspection and maintenance could be contracted out or contracted to members of the project communities. This will offer employment to people. The impact was adjudged a positive impact.

Improved health status and quality of life

The general well being of community members could improve as an indirect result of the increased household income particularly for those employed in this phase of the project. This is a positive impact.

Injuries and deaths

These could result from work-related accidents due to incidents such as blowouts caused by process upsets during commissioning. This impact was rated high.

5.3.4.3 Surveillance

Employment and income generating opportunity

The chances are high that the pipeline surveillance could be contracted out or contracted to members of the project communities. This will offer employment to people. The impact was adjudged a positive impact.

Improved health status and quality of life

The general well being of community members could improve as an indirect result of the increased household income particularly for those employed in this phase of the project. This is a positive impact.

Injuries and deaths

These could result from work-related accidents and exposure of workers/community members to injurious plants or displaced dangerous wildlife. This impact was rated high.

Shift from traditional occupations to other activities



It is expected that members of the host communities could abandon their traditional farming and fishing occupations and search for contracts and manual labour jobs related to the project. This impact was rated medium.

Third party agitation

Issues on giving employment to members of the host communities are capable of generating disagreement among members. These disagreements could be many and destabilising. The impact was rated medium.

5.3.5 Decommissioning Phase

5.3.5.1 Dismantling and Site Clean Up

Decommissioning phase would be after 35 years when the entire pipeline design life would have expired. The potential impacts from this are:

Increase in surface water turbidity

Sediment disturbance during pipeline decommissioning could increase the turbidity of the water over a stretch of the river thereby impairing its quality and rendering it unsuitable as a source of household water. High turbidity can cause potential problems for both aquatic flora, which depend on light transmission through the water column for growth, and fauna which feed on the submerged vegetation. It can also smother and suffocate benthic communities. The waters in the mobilization travel route are sufficiently deep such that only thing that will cause a change in the turbidity of the waters will be the turbulence created by the passage of the boats. The impact was described as direct, negative, short-term, local, reversible and rated high.

Disruption of fisheries activities

Direct impacts of fisheries arising from pipeline decommissioning could affect fisheries and fishing activities. This impact evaluated and described as negative, direct, short-term reversible and was rated as high.

Impairment of air quality

Reduction in air quality could arise as a result of transportation demobilization activities, releases from purging of pipelines and leaks during pipeline retrieval. The impact was described as negative, direct, short-term, and reversible and was rated as medium impact.

Noise and vibration

Noise arising from the use of heavy equipment for demobilization, could affect the workers, project communities and scare wildlife. The impact was described as negative, direct, short-term, and reversible and was rated as high impact.

Contamination/ pollution of water, soil and sediment

Contamination of surface water, sediment and soil by oil during pipeline decommissioning could contaminate the environment. This was therefore described as negative, direct, short-term, and reversible and was rated as high impact.

Employment and income generating opportunities

There shall be loss of employment/income associated with decommissioning. On the other hand, decommissioning could bring opportunity for business and employment. There could be payoffs.



Business opportunities and employment could arise during removal and sales of recovered pipelines. Hence, the impact was described and rated as positive.

Improved health status and quality of life

The general well being of community members could improve as an indirect result of the increased household income particularly for those employed in this phase of the project. This is a positive impact.

Loss of job opportunity

The end of the project will bring about loss of job for the project workers. This will translate to loss in income and business opportunities.

Mental stress and illness

The loss of employment and contract opportunities of members of the community and resultant decrease in household income could result in psychological trauma. This impact was rated high.

Third Party Agitation

Third party agitation can arise from employment issues and loss of benefits within the pipeline project communities. This impact was described as negative, direct, short-term, and reversible and was rated high impact.

Increase in access to hunting and fuel wood

Following the completion of the construction work, the pipeline RoW would constitute an additional route for members of the communities to access the surrounding environment for hunting and wood harvesting.

Injuries and deaths

These could result from traffic-related accidents due to the increase in vehicular movements, and also work-related accidents. This impact was rated high.

Population pressure on social infrastructure including housing, water, sanitation and health facilities

Increased human presence in communities surrounding the project location give rise to pressures on available water, houses, footpaths, waste bins, and health centres. The impact was rated high.

Increase in morbidity

The prevalence of some diseases could increase as a result of pressure on available health services, housing and sanitation facilities due to population influx. Water-washed (water-impounded) diseases could result from shortage of potable water sources; water-borne diseases from faecal contamination of water sources due to inadequate sanitation facilities; and respiratory and skin disorders from over-crowding and poorly ventilated housing. This impact was rated high.

Sexually transmitted infections including HIV/AIDS



This could result from increase in social vices and risky sexual behaviour due to the improvement in the local economy and/or due to the influx of migrant population or so-called “camp followers”. This impact was rated high.

Hazardous Waste generation

Solid wastes particularly from facilities dismantling and site cleaning reagents will be generated. This impact was rated high.

Injuries and deaths

These would result from work-related accidents and exposure of workers/community members to injurious while dismantling the facilities. This impact was rated high.

5.3.5.2 Rehabilitation

Employment and income generating opportunity

Site rehabilitation could demand for employment of labour (both skilled and unskilled).

Payments for such labour are a good source of income to persons who might be employed. The impact was described as positive.

Improved health status and quality of life

The general well being of community members could improve as an indirect result of the increased household income particularly for those employed in this phase of the project. This is a positive impact.

Restoration of aesthetic value of the environment

Proper restoration of the environment through maintenance and management could improve the environment. The Impact is positive.

Injuries/trauma and deaths

Rehabilitating a site involves great work much of which is manual and the others involve travels. These travels under the heavy water traffic might occasionally be involved in a mishap. The impact was described as direct, negative, short/long term, local,





CHAPTER SIX

MITIGATION MEASURES

6.1 Introduction

The actions and measures that the proponent intend to take to reduce (or eliminate) negative impacts and promote positive bio-physical environmental, social and health impacts of the proposed Soku – San Barth Pipeline Project are presented in this chapter. In these mitigation measures, emphases are placed on those negative impacts rated as medium and high. These measures are aimed at reducing these impacts to As Low As Reasonably Practicable (ALARP). The residual impacts that could arise despite these mitigation measures were also noted. Impacts shall be mitigated through effective implementation of the Environmental Management Plan (EMP) articulated for this project.

The mitigation measures proposed are in keeping with the following:

Environmental laws in Nigeria, with emphasis on permissible limits for waste streams FMEnv (formerly FEPA, 1991)

Department of Petroleum Resources Guidelines and Standards

Rivers State Ministry of Environment Policies

Bayelsa State Ministry of Environment Policies

Best Available Technology for Sustainable Development

Social well being and

Concerns of stakeholders

6.2 Selected Control Measures

A summary of the mitigation measures is presented In Table 7.1a – 7.1d. These measures are recommended to ameliorate the potential high and medium impacts identified for the proposed project.

Table 6.1a: Impact Mitigation (Pre-Construction Phase)

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
Land acquisition	Reduction of access to land and its resources	H	SPDC shall ensure: thorough assessment of land requirements before additional land take; appropriate compensation is paid for any additional land take; provision of encourage adoption of alternative means of livelihood e.g. micro credit scheme	M
	Encroachment on culturally sensitive sites	H	SPDC shall as much as possible route pipeline away from culturally sensitive areas; In event of pipeline falling along the culturally sensitive site, SPDC shall assist the owners by paying for the relocation the site to new free place.	L
	Third party agitations	H	SPDC shall ensure: management of public expectations by engaging the communities regular/periodic dialogue sessions with the communities adoption of appropriate community entry strategies; commitment to transparent adherence to GMoU programmes and projects. improvement of company-media relation obtain the Freedom to Operate (FTO)	M
	Legacy issues	H	SPDC shall identify and settle all outstanding legacy issues within the project area	M

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
Mobilization (transport) to site (equipment & personnel)	Water traffic accidents	H	SPDC shall ensure: the creation of awareness amongst communities on the potential of increase in traffic on water and the need for extra cautions through public enlightenment. compliance with SPDC journey management policy for water transport. Use of certified boat drivers that all water borne crafts are pre-mobbed. that all personnel for water related operations shall have certificate of swimming proficiency the provision of First Aid facilities in all water borne crafts . the use of PPEs at sites. that daily pep talks are conduction during mobilization	L
	Pirates/ armed bandit attacks/ kidnappings	H	SPDC shall: make adequate security arrangements for the mobilization. ensure staff are sensitized on the peculiarity of the project environment	M
	Disruption of fisheries activities	M	SPDC shall: issue timely information to stakeholders particularly fisher folk on the nature and timing of activities that may interfere with fisheries operations. carry out the movement in phases to avoid prolonged interruption of fishing activities schedule project activities to minimize disruption of fisheries activities.	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Third party agitation	H	SPDC shall ensure: engagement of community leadership. management of public expectations by engaging NGOs and CBOs.. the adoption of appropriate community entry strategies. commitment to transparent adherence to GMOU programmes and projects. good company-media relation. ensure proper sensitization of community leadership structure.	M
	Injuries/trauma and deaths	H	SPDC shall ensure: strict adherence to safe speed limits that the mobilisation schedule shall be phased to minimize traffic flow, and restricted to day time. SPDC shall provide On-site/Referral health care (including MEDEVAC)	
	Increase in morbidity	M	SPDC shall ensure that project recruits a large proportion of the work force from the locality. SPDC shall ensure provision of proper accomodation, waste disposal, medical and recreational facilities within the campsite for workers.	L
	Increase in mortality	H	SPDC shall: provide On-site/Referral health care for workforce to reduce stress on existing facilities. facilitate the inauguration of Health Facility Management Committees for all the PHC Centres and Soku Cottage Hospital facilitate the establishment of Community Health Insurance Scheme in the communities	M

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
			facilitate the upgrade of health services in the communities through the existing GMoU structure	
	STIs including HIV/AIDS	H	SPDC shall ensure recruitment of a large proportion of the work force from the locality to reduce migrant population. SPDC shall carry out HIV/AIDS education campaign in line with the National Prevention Program. SPDC shall enforce strict Access control within workers camp sites.	M
Site Preparation (vegetation clearing)	Destruction of vegetation	M	SPDC shall ensure: minimum land clearing. re-planting of area outside the RoW	L
	Exposure of workers to wildlife attack	H	SPDC shall: provide and enforce usage of PPE by field workers. provide First aid/Anti venom and insect repellent on site. create awareness among site workers and nearby communities on the likelihood of exposure to wildlife/insect attack	L
	Loss of wildlife habitat	H	SPDC shall limit clearing activities as necessary. SPDC shall avoid game reserves	L
	Increase in erosion of the cleared area	M	SPDC shall re-vegetate cleared areas outside the RoW with erosion control plants SPDC shall limit de-stumping	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Waste generation	H	SPDC shall encourage community to use wood waste for building and firewood SPDC shall provide mobile toilets SPDC shall provide waste bins	L
	Injuries/fatality of workforce	H	SPDC shall: provide workers with appropriate PPEs ensure that daily toolbox meeting are conducted carry out Job Hazard Analysis where applicable provide First aid facilities at site ensure Medevac procedures are in place	L
	Noise/vibration	M	SPDC shall ensure: machines are turned off when not in use combustion engines are fitted with effective silencers. regular maintenance of machines and equipment. machinery covers and panels are closed and well fitted at all times equipments with low noise level are used appropriate PPEs are provided	L
	Habitat fragmentation	M	SPDC shall provide: Wildlife corridor Fauna crossing	L
	Increase in Social vices	H	SPDC shall ensure: intensive enlightenment campaign and health education for the abatement of abuse of drugs, alcohol and sexual promiscuity in the community and among workers.	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
			that contractor enforces the alcohol and drug policy for staff. regular medical check-up are conducted for project work force condoms are provided for workers.	
	Increase in morbidity	M	SPDC shall ensure that project recruits a large proportion of the work force from the locality. SPDC shall ensure provision of proper accomodation, waste disposal, medical and recreational facilities within the camp site for workers.	L
	Increase in mortality	H	SPDC shall provide On-site/Referral health care for workforce to reduce stress on existing facilities. SPDC shall facilitate the inauguration of Health Facility Management Commiittees for all the PHC Centres and Soku Cottage Hospital SPDC shall facilitate the establishment of Community Health Insurance Scheme in the communities SPDC shall facilitate the upgrade of health services in the communities through the existing GMoU structure	M
	STIs including HIV/AIDS	H	SPDC shall ensure recruitment of a large proportion of the work force from the locality to reduce migrant population. SPDC shall carry out HIV/AIDS education campaign in line with the National Prevention Program. SPDC shall enforce strict Access control within workers camp sites.	M

Table 6.1b: Impact Mitigation (Construction Phase)

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Third party agitation	H	SPDC shall ensure: management of public expectations by engaging NGOs and CBOs regular/periodic dialogue sessions with active NGOs and CBOs adoption of appropriate community entry strategies; commitment to transparent adherence to GMoU programmes and projects. improvement of company-media relation	M
Excavation, & Trenching of pipeline route ; and Dredging at River Crossings	Damage to archaeological artefacts	M	SPDC shall recover and preserve all archaeological chance finds	L
	Change in local topography of the area	M	SPDC shall restore the site topography SPDC shall spread the dredge spoil in a manner that will not alter the topography of the area.	L
	Increase in surface water turbidity	H	SPDC shall ensure the rapid completion of the decommissioning to minimize turbidity SPDC shall compensate all affected fisher folks SPDC shall supply potable water to the affected communities during river crossing	L
	Acceleration of erosion	M	SPDC shall ensure that trenches backfilled with spoils as soon as pipe is laid SPDC shall ensure timely re-vegetation of exposed areas	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Noise and vibration from heavy machinery	H	SPDC shall ensure: machines are turned off when not in use combustion engines are fitted with effective silencers. regular maintenance of machines and equipment. machinery covers and panels are closed and well fitted at all times appropriate PPEs are provided	L
	Injuries/trauma and deaths	H	SPDC shall carry out first aid training of workers including casual workers and locals. SPDC shall provide and enforce appropriate use of PPEs (e.g. life vests, hard hats, eye goggles) SPDC shall ensure that work area shall be cordoned off as restricted areas with ample warning signals SPDC shall ensure that health talks and awareness and job hazard analysis are carried out prior to work activities	L
	Alteration of soil profile	M	SPDC shall backfill the land trenches with the excavated soil in the reserved order of excavation	L
	Soil Acidification	H	SPDC shall analyze dredgespoil to confirm acidity and then treat soil	L
	Flooding	H	SPDC shall restrict activity to the pipeline ROW only SPDC shall ensure that natural drainage channels are as much as possible avoided.	
	Reduction in air quality	M	SPDC shall use only pre-mobbed equipment. SPDC shall ensure the use of scrubbers SPDC shall ensure that there is controlled use of all equipment and that equipment engines are turned off when not in use.	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Oil spill/gas explosion arising from accidental contact underground infrastructure	M	SPDC shall obtain/use authorized exaction permit SPDC shall provide all site plans of the underground infrastructures in the pipeline RoW SPDC shall ensure proper insulation of pipeline	L
	Disruption of fisheries activities	H	SPDC shall: issue timely information to stakeholders particularly fisher folk on the nature and timing of activities that may interfere with fisheries operations ensure proper signposting and mapping of any sub-sea structures to exclude trawling and avoid damage to fishing gear provide fishing gears and fingerlings affected fisher folk schedule project activities to minimize disruption of fisheries activities	L
	Noise and vibrations from heavy machinery	M	SPDC shall ensure strict adherence to Work Safety Acts and the use of PPEs by all workers, and work area shall be condoned off as restricted areas.	L
	STIs including HIV/AIDS	H	SPDC shall ensure recruitment of a large proportion of the work force from the locality to reduce migrant population. SPDC shall carry out HIV/AIDS education campaign in line with the National Prevention Program. SPDC shall enforce strict Access control within workers camp sites.	M
Pipeline welding/stringing	Visual impairment from high intensity welding flash	M	SPDC shall provide appropriate PPEs for all the welders SPDC shall engage certified and competent welders SPDC shall use certified welding equipment	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Burns from welding sparks	M	SPDC shall provide appropriate PPEs for all the welders SPDC shall provide First Aid facilities SPDC shall provide a site clinic	L
NDT	Exposure to radioactive emissions	H	SPDC shall ensure: that workers use appropriate radiation protection clothing .workers do not have high exposure time radiation monitors are provided to monitor radiation levels at site. warning signs are provided during radiation emitting activities. that radiation emitting activities are carried out in accordance with standard construction specifications	L
Pipeline laying	Blockage of waterways	M	SPDC shall minimize river crossing time SPDC shall proactively engage the community prior to the blockage	L
	Injuries from work-related accidents	M	SPDC shall carry out first aid training of workers including casual workers and locals. SPDC shall provide and enforce appropriate use of PPEs (e.g. life vests, hard hats, eye goggles) SPDC shall ensure that work area shall be cordoned off as restricted areas with ample warning signals SPDC shall ensure that health talks and awareness and job hazard analysis are carried out prior to work activities	L
Backfilling	Increase in surface water turbidity	H	SPDC shall ensure the rapid completion of the backfilling to minimize turbidity SPDC shall compensate all affected fisher folks SPDC shall supply potable water to the affected communities during crossings	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Disruption of fisheries activities	H	SPDC shall: issue timely information to stakeholders particularly fisher folk on the nature and timing of activities that may interfere with fisheries operations ensure proper signposting and mapping of any sub-sea structures to exclude trawling and avoid damage to fishing gear provide fishing gears and fingerlings to affected fisher folk schedule project activities to minimize disruption of fisheries activities	L
	Impairment of air quality	M	SPDC shall use only pre-mobbed equipment. SPDC shall ensure that d that equipment engines are turned off when not in use.	L
	Noise/vibration from machinery	H	SPDC shall ensure: machines are tuned off when not in use ensure combustion engines are fitted with effective silencers. ensure regular maintenance of machines. machinery covers and panels are closed and well fitted at all times equipment with low noise level are used	L
	Injuries/trauma and deaths	H	SPDC shall carry out first aid training of workers including casual workers and locals. SPDC shall provide and enforce appropriate use of PPEs (e.g. life vests, hard hats, eye goggles) SPDC shall ensure that work area shall be condoned off as restricted áreas with ample warning signals SPDC shall ensure that health talks and awareness and job hazard analysis are carried out prior to work activities	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	STIs including HIV/AIDS	H	SPDC shall ensure recruitment of a large proportion of the work force from the locality to reduce migrant population. SPDC shall carry out HIV/AIDS education campaign in line with the National Prevention Program. SPDC shall enforce strict Access control within workers camp sites.	M
Piling	Noise/vibration	M	SPDC shall use a high frequency vibratory hammer for piling. SPDC shall install and use temporary sound barrier wall that will screen the site from the residential properties during pile driving activities	L

Table 6.1c: Impact Mitigation (Demobilization Phase)

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
------------------	--------------------	---------------------------------	---------------------	--------------------------------



Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
Demobilization (workers camp, equipment and personnel from site)	Water traffic accidents	H	SPDC shall ensure: the creation of awareness amongst local communities on the potential of increase in traffic on water and the need for extra precautions through public enlightenment compliance with SPDC journey management policy for water transport Marine boat quarter master training for boat drivers that all water borne crafts are pre-mobbed and pre-mobilization/compliance certificate issued. that all personnel for water related operations shall have certificate of swimming proficiency the provision of First Aid facilities in all water borne crafts . the use of PPEs at sites. that daily pep talks are conduction during mobilization	L
	Pirates/ armed bandit attacks/ kidnappings	H	SPDC shall: make adequate security arrangements for the mobilization. ensure staff are sensitized on the peculiarity of the project environment	M
	Third party agitation	H	SPDC shall facilitate management of public expectations by engaging NGOs and CBOs; SPDC shall ensure commitment to transparent adherence to GMoU programmes and projects.	M
	Loss of employment/ income	H	SPDC shall encourage alternative income generation through skills acquisition programmes SPDC shall implement end- of- job pay	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Mental stress and illness	H	SPDC shall support entrepreneurial skill development and opportunities for community members to cushion the effect of reduction in economic/income generating activities.	L
	Injuries/trauma and deaths	H	SPDC shall ensure strict adherence to safe speed limits SPDC shall ensure that the mobilization schedule shall be phased to minimize traffic flow, and restricted to daytime. SPDC shall provide On-site/Referral health care (including MEDEVAC)	M
	Disruption of fishery activities	M	SPDC shall: issue timely information to stakeholders particularly fisher folk on the nature and timing of activities that may interfere with fisheries operations ensure proper signposting and mapping of any sub-sea structures to exclude trawling and avoid damage to fishing gear provide fishing gears and fingerlings to affected fisher folk schedule project activities to minimize disruption of fisheries activities	L

Table 6.1d: Impact Mitigation (Operations Phase)

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
Operation	Destruction of assets and properties from oil spill/ fire.	H	SPDC shall implement oil spill/contingency plan SPDC shall immediately isolate the source of spill SPDC shall compensate for the loss in property SPDC shall ensure proper insulation of pipeline	L
	Reduction in fisheries resources from pipeline breach and oil spillage	H	SPDC shall ensure proper signposting and mapping of any sub-sea structures to exclude trawling and avoid damage to fishing gear SPDC shall provide fishing gears and fingerlings to affected fisher folk	L
Inspection and Refurbishment of facilities	Injuries/trauma and deaths	H	SPDC shall ensure strict adherence to safe speed limits SPDC shall ensure that the mobilisation schedule shall be phased to minimize traffic flow, and restricted to day time. SPDC shall provide On-site/Referral health care (including MEDEVAC)	L
Facility Surveillance	Injuries/trauma and deaths	H	SPDC shall ensure strict adherence to safe speed limits SPDC shall ensure that the mobilisation schedule shall be phased to minimize traffic flow, and restricted to day time. SPDC shall provide On-site/Referral health care (including MEDEVAC)	L
	Shift from traditional occupations to other activities	M	SPDC shall be organize Pre-sensitisation campaigns in the communities. SPDC shall support value-adding SMEs that promote and sustain traditional occupations	L



Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Third party agitation	H	SPDC shall facilitate management of public expectations by engaging NGOs and CBOs; SPDC shall ensure commitment to transparent adherence to GMoU programmes and projects.	M

Table 6.1e: Impact Mitigation (Decommissioning Phase)

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
Dismantling and Site Clean-Up	Increase in surface water turbidity	H	SPDC shall ensure the rapid completion of the decommissioning to minimize turbidity SPDC shall compensate all affected fisher folks SPDC shall supply potable water to the affected communities during river crossing	L



Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Disruption of fisheries activities	H	SPDC shall: issue timely information to stakeholders particularly fisher folk on the nature and timing of activities that may interfere with fisheries operations provide fishing gears and fingerlings to affected fisher folks schedule project activities to minimize disruption of fisheries activities	L
	Reduction in air quality	M	SPDC shall use only pre-mobbed equipment. SPDC shall ensure that there is controlled use of all equipment and that equipment engines are turned off when not in use.	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Noise and vibration	H	SPDC shall ensure: machines are turned off when not in use combustion engines are fitted with effective silencers. regular maintenance of machines and equipment. machinery covers and panels are closed and well fitted at all times equipments with low noise level are used appropriate PPEs are provided	L
	Contamination/ pollution of water, soil and sediment	H	SPDC shall purge and flush all pipelines prior to decommissioning SPDC shall treat decommissioning effluents to regulatory limits before discharging into the environment	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	Third party agitation	H	SPDC shall facilitate management of public expectations by engaging NGOs and CBOs; SPDC shall ensure commitment to transparent adherence to GMoU programmes and projects.	M
	Loss of employment/ income	H	SPDC shall support entrepreneurial skill development and opportunities for community members to cushion the effect of reduction in economic/income generating activities.	L
	Injuries/trauma and deaths	H	SPDC shall carry out first aid training of workers including casual workers and locals. SPDC shall provide and enforce appropriate use of	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
			PPEs (e.g. life vests, hard hats, eye goggles) SPDC shall ensure that work area shall be cordoned off as restricted areas with ample warning signals SPDC shall ensure that health talks and awareness and job hazard analysis are carried out prior to work activities	
	Hazardous Waste Generation		SPDC shall manage all hazardous waste in line with its waste management procedure that is in line with regulatory standards.	
	Mental stress from loss of job	H	SPDC shall support entrepreneurial skill development and opportunities for community members	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
			to cushion the effect of reduction in economic/income generating activities.	
	Population pressure on social infrastructure and health facilities	H	SPDC shall ensure that project recruits a large proportion of the work force from the locality. SPDC shall ensure provision of proper accomodation, waste disposal, medical and recreational facilities within the camp site for workers.	L
	Increase in morbidity	H	SPDC shall ensure that project recruits a large proportion of the work force from the locality. SPDC shall ensure provision of proper accomodation, waste disposal, medical and recreational facilities within the camp site for workers.	M

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
	STIs including HIV/AIDS	H	<p>SPDC shall ensure recruitment of a large proportion of the work force from the locality to reduce migrant population. SPDC shall carry out HIV/AIDS education campaign in line with the National Prevention Program. SPDC shall enforce strict Access control within workers camp sites.</p>	M
Site Restoration	Injuries/trauma and deaths	H	<p>SPDC shall carry out first aid training of workers including casual workers and locals. SPDC shall provide and enforce appropriate use of PPEs (e.g. life vests, hard hats, eye goggles) SPDC shall ensure that work area shall</p>	L

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation
			be condoned off as restricted areas with ample warning signals SPDC shall ensure that health talks and awareness and job hazard analysis are carried out prior to work activities	

CHAPTER SEVEN

ENVIRONMENTAL MANAGEMENT PLAN

7.1 Introduction

SPDC recognizes that the development of an effective and integrated Environmental Management Plan (EMP) facilitates better achievement and demonstration of sound environmental performance. Moreover, environmental management is seen as the means of ensuring that the commitments specified in this EIA are properly managed and that unforeseen or unidentified impacts of the proposed project are detected and managed.

In line with SPDC HSE policy of good environmental practice, the EMP of the Soku-San Barth Pipeline Project has been designed in accordance with existing regulatory specifications.

7.2 Objectives of the EMP

The FMENV and DPR require an EMP as part of an EIA. The aim of the EMP is to ensure that the high and moderate negative rated environmental impacts in the EIA are effectively mitigated in the design, construction, operation and decommissioning phases of the Project. The EMP instills confidence in the host communities, the proponent of the project (SPDC), and the regulatory bodies that the identified impacts have been adequately mitigated.

The objectives of the EMP therefore are:

To ensure compliance with existing legislations on the protection of the environment and with SPDC HSE policy;

To achieve, enhance and demonstrate sound environmental performances;

To integrate environmental issues fully into the project implementation process;

To rationalize and streamline environmental activities to add value to the project in efficiency and effectiveness;

To achieve the highest level of environmental and socio-economic performance and response from employees and contractors alike throughout the life of the project;

To provide the standards for planning, operation, audit and review of environmental guidelines and principles;

To ensure that only environmentally sound procedures are employed during the project planning and execution phases of the project;

To present an effective monitoring plan, including parameters to be monitored, frequency of monitoring, and responsibilities of the impact monitor for the project.

In order to measure the achievement of the objectives, the Environmental Monitoring Programme has been integrated into the EMP (Tables 7.1a-7.1e).

Table 7.1a: Environmental Management Plan (Pre-Construction Phase)

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
Land acquisition	Reduction of access to land and its resources	H	SPDC shall ensure: thorough assessment of land requirements before additional land take; appropriate compensation is paid for any additional land take; provision of encourage adoption of alternative means of livelihood e.g. micro credit scheme	M	Site inspection report. Map of pipeline RoW. Post-construction RoW dimensions. Evidence of disbursement of compensation Evidence of provision of alternative means of livelihood.	Before, during and after construction.	Once before, during and after construction.	SPDC Project Manager.
	Encroachment on culturally sensitive sites	H	SPDC shall as much as possible route pipeline away from culturally sensitive areas; In event of pipeline falling along the culturally sensitive site, SPDC shall assist the owners by paying for the relocation the site to new free place.	L	Map of pipeline RoW; Site inspection report.	Before and during construction.	Once before and during construction.	SPDC Project Manager.
	Third party agitations	H	SPDC shall ensure: management of public expectations by	M	Records of public engagement sessions.			

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			engaging the communities regular/periodic dialogue sessions with the communities adoption of appropriate community entry strategies; commitment to transparent adherence to GMoU programmes and projects. improvement of company-media relation obtain the Freedom to Operate (FTO)		Records of minutes of meetings. Records of Third Party Grievances. Records of GMoU implementation status.	During land acquisition	Quarterly	SPDC Project Manager.
	Legacy issues	H	SPDC shall identify and settle all outstanding legacy issues within the project area	M	Records of legacy issues identified/resolved	Throughout the life span of the project.	Quarterly	SPDC Project Manager.
Mobilization (transport) to site (equipment & personnel)	Water traffic accidents	H	SPDC shall ensure: the creation of awareness amongst communities on the potential of increase in traffic on water and the need for extra cautions through public	L	Records of meetings/ awareness sessions; Journey management records; IVMS records;			

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			<p>enlightenment.</p> <p>compliance with SPDC journey management policy for water transport.</p> <p>Use of certified boat drivers</p> <p>that all water borne crafts are pre-mobbed.</p> <p>that all personnel for water related operations shall have certificate of swimming proficiency</p> <p>the provision of First Aid facilities in all water borne crafts .</p> <p>the use of PPEs at sites.</p> <p>that daily pep talks are conduction during mobilization</p>		<p>SPDC drivers permit/ DEP certificates</p> <p>First Aid box and contents;</p> <p>Maritime accident records;</p> <p>Minutes of tool box meetings;</p> <p>Site inspection report;</p> <p>Incident reports (injuries and fatalities).</p>	Before commencement of movement to site.	Once	SPDC Project Manager.
	Pirates/ armed bandit attacks/ kidnappings	H	<p>SPDC shall:</p> <p>make adequate security arrangements for the mobilization.</p> <p>ensure staff are sensitized on the peculiarity of the project environment</p>	M	<p>State/ company Security incident reports</p> <p>Evidence of approved security plans;</p> <p>Evidence of staff sensitization</p>	Before commencement of movement to site.	Once	SPDC Project Manager.

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
					sessions.			
	Disruption of fisheries activities	M	SPDC shall: issue timely information to stakeholders particularly fisher folk on the nature and timing of activities that may interfere with fisheries operations. carry out the movement in phases to avoid prolonged interruption of fishing activities schedule project activities to minimize disruption of fisheries activities.	L	Evidence of stakeholder engagement meetings (Minutes, Attendance lists, photographs etc; Evidence of project activities schedules; Site Inspection report.	During the mobilization of materials and personnel to site.	Daily	SPDC Project Manager
	Third party agitation	H	SPDC shall ensure: engagement of community leadership. management of public expectations by engaging NGOs and CBOs.. the adoption of appropriate community entry strategies.	M	Records of public engagement sessions Records of minutes of meetings Records of Third Party Grievances. Records of GMoU	Before commencement of movement to site	Once	SPDC Project Manager

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			commitment to transparent adherence to GMoU programmes and projects. good company-media relation. ensure proper sensitization of community leadership structure.		implementation status			
	Injuries/trauma and deaths	H	SPDC shall ensure strict adherence to safe speed limits SPDC shall ensure that the mobilisation schedule shall be phased to minimize traffic flow, and restricted to day time. SPDC shall provide On-site/Referral health care (including MEDEVAC)		Compliance monitoring report Journey Management Reports Facility Walk-Through Surveys Routine health service surveillance	Before start of project activity and periodically as stated under monitoring	Weekly Weekly Monthly Weekly	SPDC
	Increase in morbidity	M	SPDC shall ensure that project recruits a large proportion of the work force from the locality. SPDC shall ensure	L	Household Demographic & Health Survey (DHS) Routine health	Before start of project activity and	Quarterly Weekly	SPDC

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			provision of proper accomodation, waste disposal, medical and recreational facilities within the campsite for workers.		service surveillance	periodicall y as stated under monitoring		
	Increase in mortality	H	<p>SPDC shall provide On-site/Referral health care for workforce to reduce stress on existing facilities.</p> <p>SPDC shall facilitate the inauguration of Health Facility Management Committees for all the PHC Centres and Soku Cottage Hospital</p> <p>SPDC shall facilitate the establishment of Community Health Insurance Scheme in the communities</p> <p>SPDC shall facilitate the upgrade of health services in the communities through the existing GMoU structure</p>	M	<p>Compliance Monitoring Reports</p> <p>Activity Reports</p> <p>Facility Walk-Through Surveys</p> <p>Routine health service surveillance</p>	<p>Before start of project activity and periodicall y as stated under monitoring</p>	<p>Weekly</p> <p>Monthly</p> <p>Quarterly</p> <p>Weekly</p>	SPDC

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
	STIs including HIV/AIDS	H	<p>SPDC shall ensure recruitment of a large proportion of the work force from the locality to reduce migrant population.</p> <p>SPDC shall carry out HIV/AIDS education campaign in line with the National Prevention Program.</p> <p>SPDC shall enforce strict Access control within workers camp sites.</p>	M	<p>Compliance Monitoring Reports</p> <p>Activity Reports</p> <p>Reproductive Health Survey</p> <p>Routine health service surveillance records</p>	Before start of project activity and periodically as stated under monitoring	<p>Weekly</p> <p>Monthly</p> <p>Quarterly</p> <p>Weekly</p>	SPDC
Site Preparation (vegetation clearing)	Destruction of vegetation	M	SPDC shall ensure: minimum land clearing. re-planting of area outside the RoW	L	Records of RoW inspection. Records of re-planting of vegetation	Before and after site preparation	Weekly	SPDC Project Manager
	Exposure of workers to wildlife attack	H	<p>SPDC shall: provide and enforce usage of PPE by field workers.</p> <p>provide First aid/Anti venom and insect repellent on site.</p> <p>create awareness among site workers and nearby</p>	L	<p>Evidence of provision of PPE/first Aid facility</p> <p>Awareness campaign records</p>	During site preparation	Daily	SPDC Project Manager

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			communities on the likelihood of exposure to wildlife/insect attack					
	Loss of wildlife habitat	H	SPDC shall limit clearing activities as necessary. SPDC shall avoid game reserves	L	Records of RoW inspection	During site preparation	Daily	SPDC Project Manager.
	Increase in erosion of the cleared area	M	SPDC shall re-vegetate cleared areas outside the RoW with erosion control plants SPDC shall limit de-stumping	L	Records of RoW inspection. Records of re-planting of vegetation	During and after site preparation	Once	SPDC Project Manager
	Waste generation	H	SPDC shall encourage community to use wood waste for building and firewood SPDC shall provide mobile toilets SPDC shall provide waste bins	L	Evidence of waste management contract with third parties. Evidence of provision of mobile toilet and waste bins.	During site preparation	Monthly	SPDC Project Manager
	Injuries/fatality of workforce	H	SPDC shall: provide workers with appropriate PPEs ensure that daily toolbox meeting are conducted carry out Job Hazard	L	Records of issuance of PPE Records of toolbox meeting Evidence of approved JHA	During site preparation	Weekly	SPDC Project Manager

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			Analysis where applicable provide First aid facilities at site ensure Medevac procedures are in place		HSE incident records Safety training records			
	Noise/vibration	M	SPDC shall ensure: machines are turned off when not in use combustion engines are fitted with effective silencers. regular maintenance of machines and equipment. machinery covers and panels are closed and well fitted at all times equipments with low noise level are used appropriate PPEs are provided	L	Noise monitoring records Maintenance records Equipment pre-mob records	During site preparation	Monthly	SPDC Project Manager
	Habitat fragmentation	M	SPDC shall provide: Wildlife corridor Fauna crossing	L	Evidence of provision of wildlife corridor and fauna crossing.	After backfilling	Once	SPDC Project Manager.
	Increase in	H	SPDC shall ensure:	L	Enlightenment			

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
	Social vices		<p>intensive enlightenment campaign and health education for the abatement of abuse of drugs, alcohol and sexual promiscuity in the community and among workers.</p> <p>that contractor enforces the alcohol and drug policy for staff.</p> <p>regular medical check-up are conducted for project work force</p> <p>condoms are provided for workers.</p>		<p>campaign records.</p> <p>Records of alcohol/drug policy</p> <p>Evidence of issuance of condoms.</p> <p>Records of regular medical records.</p>	During site preparation	Monthly	SPDC Project Manager.
	Increase in morbidity	M	<p>SPDC shall ensure that project recruits a large proportion of the work force from the locality.</p> <p>SPDC shall ensure provision of proper accomodation, waste disposal, medical and recreational facilities within the camp site for workers.</p>	L	<p>Household Demographic & Health Survey (DHS)</p> <p>Routine health service surveillance</p>	Before start of project activity and periodically as stated under monitoring	Quarterly Weekly	SPDC

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
	Increase in mortality	H	<p>SPDC shall provide On-site/Referral health care for workforce to reduce stress on existing facilities.</p> <p>SPDC shall facilitate the inauguration of Health Facility Management Committees for all the PHC Centres and Soku Cottage Hospital</p> <p>SPDC shall facilitate the establishment of Community Health Insurance Scheme in the communities</p> <p>SPDC shall facilitate the upgrade of health services in the communities through the existing GMoU structure</p>	M	<p>Compliance Monitoring Reports</p> <p>Activity Reports</p> <p>Facility Walk-Through Surveys</p> <p>Routine health service surveillance</p>	Before start of project activity and periodically as stated under monitoring	<p>Weekly</p> <p>Monthly</p> <p>Quarterly</p> <p>Weekly</p>	SPDC
	STIs including HIV/AIDS	H	<p>SPDC shall ensure recruitment of a large proportion of the work force from the locality to reduce migrant population.</p> <p>SPDC shall carry out</p>	M	<p>Compliance Monitoring Reports</p> <p>Activity Reports</p> <p>Reproductive Health Survey</p> <p>Routine health</p>	Before start of project activity and periodically as stated	<p>Weekly</p> <p>Monthly</p> <p>Quarterly</p> <p>Weekly</p>	SPDC

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			HIV/AIDS education campaign in line with the National Prevention Program. SPDC shall enforce strict Access control within workers camp sites.		service surveillance records	under monitoring		

Table 7.1b: Environmental Management Plan (Construction Phase)

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
	Third party agitation	H	SPDC shall ensure: management of public expectations by engaging NGOs and CBOs regular/periodic dialogue sessions with active NGOs and CBOs adoption of appropriate community entry strategies; commitment to transparent adherence to GMoU programmes and projects. improvement of company-media relation	M	Records of Third Party Grievances Records of work stoppages at locations. Records of GMoU programmes implementation. Minutes of meetings	All through the construction phase	Monthly	SPDC Project Manager
Excavation of pipeline route	Damage to archaeological artefacts	M	SPDC shall recover and preserve all archaeological chance finds	L	Records of chance finds	All through the construction phase	Monthly	SPDC Project Manager
	Change in	M	SPDC shall restore	L	Site restoration			SPDC

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
	local topography of the area		the site topography SPDC shall spread the dredge spoil in a manner that will not alter the topography of the area.		records	After construction	Quarterly	Project Manager
	Increase in surface water turbidity	H	SPDC shall ensure the rapid completion of the decommissioning to minimize turbidity SPDC shall compensate all affected fisher folks SPDC shall supply potable water to the affected communities during river crossing	L	Physico- chemical parameters of surface water and sediment (pH, EC, Salinity, DO etc) Compensation disbursement records; Records of water supply	During excavation of pipeline trenches.	Once	SPDC Project Manager
	Acceleration of erosion	M	SPDC shall ensure that trenches backfilled with spoils as soon as pipe is laid SPDC shall ensure timely re-vegetation of exposed areas	L	Records of timing of backfilling Re-vegetation/ plant establishment records	After construction	Quarterly	SPDC Project Manager

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
	Noise and vibration from heavy machinery	H	SPDC shall ensure: machines are turned off when not in use combustion engines are fitted with effective silencers. regular maintenance of machines and equipment. machinery covers and panels are closed and well fitted at all times appropriate PPEs are provided	L	Noise monitoring records; Pipeline maintenance records; Equipment pre-mob records.	During construction.	Monthly	SPDC Project Manager.
	Injuries/trauma and deaths	H	SPDC shall carry out first aid training of workers including casual workers and locals. SPDC shall provide and enforce appropriate use of PPEs (e.g. life vests, hard hats, eye goggles) SPDC shall ensure	L	Compliance Monitoring Reports Site Inspection Reports Activity Reports Routine health service surveillance records	Before start of project activity and periodically as stated under monitoring	Weekly Weekly Monthly Weekly	SPDC

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			that work area shall be condoned off as restricted areas with ample warning signals SPDC shall ensure that health talks and awareness and job hazard analysis are carried out prior to work activities					
	Alteration of soil profile	M	SPDC shall backfill the land trenches with the excavated soil in the reserved order of excavation	L	Report of backfilling.	After backfilling.	Once	SPDC Project Manager.
	Reduction in air quality	M	SPDC shall use only pre-mobbed equipment. SPDC shall ensure that there is controlled use of all equipment and that equipment engines are turned off when not in use.	L	Air pollutants monitoring records; Equipment maintenance records Equipment pre-mob records.	During excavation activities	Monthly	SPDC Project Manager

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
	Oil spill/gas explosion arising from accidental contact underground infrastructure	M	SPDC shall obtain/use authorized exaction permit SPDC shall provide all site plans of the underground infrastructures in the pipeline RoW	L	Work permit Plan of underground structures in the pipeline route	Before excavation	Daily	SPDC Project Manager
	Disruption of fisheries activities	H	SPDC shall: issue timely information to stakeholders particularly fisher folk on the nature and timing of activities that may interfere with fisheries operations ensure proper signposting and mapping of any sub-sea structures to exclude trawling and avoid damage to fishing gear provide fishing gears and fingerlings	L	Evidence of stakeholders engagement meetings (Munities, Attendance lists, photographs etc.) Project schedule records	At each water crossing	Once	SPDC Project Manager

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			affected fisher folk schedule project activities to minimize disruption of fisheries activities					
	Noise and vibrations from heavy machinery	M	SPDC shall ensure strict adherence to Work Safety Acts and the use of PPEs by all workers, and work area shall be condoned off as restricted areas.	L	Site inspection report Compliance monitoring report Staff Audiometry	Before start of project activity and periodically as stated under monitoring	Weekly Weekly Monthly	SPDC
	STIs including HIV/AIDS	H	SPDC shall ensure recruitment of a large proportion of the work force from the locality to reduce migrant population. SPDC shall carry out HIV/AIDS education campaign in line with the National Prevention Program. SPDC shall enforce strict Access control	M	Compliance Monitoring Reports Activity Reports Reproductive Health Survey Routine health service surveillance records	Before start of project activity and periodically as stated under monitoring	Weekly Monthly Quarterly Weekly	SPDC

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			within workers camp sites.					
Pipeline welding/stringing	Visual impairment from high intensity welding flash	M	SPDC shall provide appropriate PPEs for all the welders SPDC shall engage certified and competent welders SPDC shall use certified welding equipment	L	Evidence of provision/ use of PPEs. Workers /equipment certifications Permit to work	Before the commencement of welding work	Once	SPDC Project Manager
	Burns from welding sparks	M	SPDC shall provide appropriate PPEs for all the welders SPDC shall provide First Aid facilities SPDC shall provide a site clinic	L	Evidence of provision/ use of PPEs Evidence of site clinic provision Medical incidents records	At the report of incidence	Once	SPDC Project Manager
NDT	Exposure to radioactive emissions	H	SPDC shall ensure: that workers use appropriate radiation protection clothing .workers do not have high exposure time radiation monitors are provided to monitor radiation	L	Evidence of provision/ use of PPEs Workers /equipment certifications Measurement of concentration levels of non methane, VOCs, Radiation	Before welding	Once	SPDC Project Manager

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			levels at site. warning signs are provided during radiation emitting activities. that radiation emitting activities are carried out in accordance with standard construction specifications		levels.			
Pipeline laying	Blockage of waterways	M	SPDC shall minimize river crossing time SPDC shall proactively engage the community prior to the blockage	L	Project schedule records Evidence of community engagement	Before laying pipes across water crossing	Once	SPDC Project Manager
	Injuries from work-related accidents	M	SPDC shall carry out first aid training of workers including casual workers and locals. SPDC shall provide and enforce appropriate use of PPEs (e.g. life vests,	L	Compliance Monitoring Reports Site Inspection Reports Activity Reports Routine health service surveillance records	Before start of project activity and periodically as stated under monitoring	Weekly Weekly Monthly Weekly	SPDC



Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			<p>hard hats, eye goggles)</p> <p>SPDC shall ensure that work area shall be condoned off as restricted areas with ample warning signals</p> <p>SPDC shall ensure that health talks and awareness and job hazard analysis are carried out prior to work activities</p>					
Backfilling	Increase in surface water turbidity	H	<p>SPDC shall ensure the rapid completion of the backfilling to minimize turbidity</p> <p>SPDC shall compensate all affected fisher folks</p> <p>SPDC shall supply potable water to the affected communities during crossings</p>	L	<p>Water Turbidity records.</p> <p>Compensation disbursement records</p>	Before, during and after backfilling	Daily Once	SPDC Project Manager

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
	Disruption of fisheries activities	H	SPDC shall: issue timely information to stakeholders particularly fisher folk on the nature and timing of activities that may interfere with fisheries operations ensure proper signposting and mapping of any sub-sea structures to exclude trawling and avoid damage to fishing gear provide fishing gears and fingerlings to affected fisher folk schedule project activities to minimize disruption of fisheries activities	L	Evidence of stakeholders' engagement meetings (minutes of meeting, attendance list, photographs etc.). Project schedule records	Before and after backfilling	Twice	SPDC Project Manager
	Impairment of air quality	M	SPDC shall use only pre-mobbed equipment.	L	Air pollutants monitoring records; Equipment	During backfilling of	Once Monthly	SPDC Project Manager



Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
		H	SPDC shall ensure that d that equipment engines are turned off when not in use.		maintenance records; equipment pre-mob records.	spoil		
	Noise/vibration from machinery	H	SPDC shall ensure: machines are tuned off when not in use ensure combustion engines are fitted with effective silencers. ensure regular maintenance of machines. machinery covers and panels are closed and well fitted at all times equipment with low noise level are used	L	Noise monitoring records; Equipment maintenance records; Equipment pre-mob records.	During backfilling of spoil	Once	SPDC Project Manager
	Injuries/trauma and deaths	H	SPDC shall carry out first aid training of workers including casual workers and locals. SPDC shall provide and enforce	L	Compliance Monitoring Reports Site Inspection Reports Activity Reports Routine health service surveillance	Before start of project activity and periodically as stated under monitoring	Weekly Weekly Monthly Weekly	SPDC

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			<p>appropriate use of PPEs (e.g. life vests, hard hats, eye goggles)</p> <p>SPDC shall ensure that work area shall be condoned off as restricted areas with ample warning signals</p> <p>SPDC shall ensure that health talks and awareness and job hazard analysis are carried out prior to work activities</p>		records			
	STIs including HIV/AIDS	H	<p>SPDC shall ensure recruitment of a large proportion of the work force from the locality to reduce migrant population.</p> <p>SPDC shall carry out HIV/AIDS education campaign in line with the National Prevention Program.</p>	M	<p>Compliance Monitoring Reports</p> <p>Activity Reports</p> <p>Reproductive Health Survey</p> <p>Routine health service surveillance records</p>	<p>Before start of project activity and periodically as stated under monitoring</p>	<p>Weekly</p> <p>Monthly</p> <p>Quarterly</p> <p>Weekly</p>	SPDC

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			SPDC shall enforce strict Access control within workers camp sites.					
Piling	Noise/vibration	M	SPDC shall use a high frequency vibratory hammer for piling. SPDC shall install and use temporary sound barrier wall that will screen the site from the residential properties during pile driving activities	L	Noise level records Record of frequency of hits of piling hammer Evidence of sound barrier	Before and during piling	Twice	SPDC Project Manager

Table 7.1c: Environmental Management Plan (Demobilization Phase)



Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
Demobilization (workers camp, equipment and personnel from site)	Water traffic accidents	H	<p>SPDC shall ensure: the creation of awareness amongst local communities on the potential of increase in traffic on water and the need for extra precautions through public enlightenment compliance with SPDC journey management policy for water transport Marine boat quarter master training for boat drivers that all water borne crafts are pre-mobbed and pre-mobilization/compliance certificate issued. that all personnel for water related operations shall have certificate of swimming proficiency the provision of First Aid facilities in all water</p>	L	<p>Records of awareness sessions Journey management records; IVMS records SPDC drivers permit/ DEP certificates First Aid box and contents Maritime accident records. Minutes of pep tool box meetings Site inspection report Incident reports (injuries and fatalities).</p>	Before and during movement out of site	Once Weekly	SPDC Project Manager

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			borne crafts . the use of PPEs at sites. that daily pep talks are conduction during mobilization					
	Pirates/ armed bandit attacks/ kidnappings	H	SPDC shall: make adequate security arrangements for the mobilization. ensure staff are sensitized on the peculiarity of the project environment	M	State/ company Security/Incident Reports Evidence of approved security plans Evidence of staff sensitization sessions	Before commencement of movement out of site	Once	SPDC Project Manager
	Third party agitation	H	SPDC shall facilitate management of public expectations by engaging NGOs and CBOs; SPDC shall ensure commitment to transparent adherence to GMoU programmes and projects.	M	Records of public engagement sessions Records of minutes of meetings Records of Third Party Grievances. Records of GMoU implementation status	Before commencement of movement out of site	Once	SPDC Project Manager
	Loss of employment/ income	H	SPDC shall encourage alternative income generation through	L	Record of provision of alternative means of income	End of project	Once	SPDC Project

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			skills acquisition programmes SPDC shall implement end- of- job pay		Record of end of project payoff.			Manager
	Mental stress and illness	H	SPDC shall support entrepreneurial skill development and opportunities for community members to cushion the effect of reduction in economic/income generating activities.	L	Compliance Monitoring Reports Activity Reports Routine health service surveillance records	Before start of project activity and periodically as stated under monitoring	Weekly Monthly Weekly	SPDC
	Injuries/trauma and deaths	H	SPDC shall ensure strict adherence to safe speed limits SPDC shall ensure that the mobilisation schedule shall be phased to minimize traffic flow, and restricted to daytime. SPDC shall provide On-site/Referral health care (including MEDEVAC)	M	Compliance monitoring report Journey Management Reports Facility Walk-Through Surveys Routine health service surveillance	Before start of project activity and periodically as stated under monitoring	Weekly Weekly Monthly Weekly	SPDC
	Disruption of fishery	M	SPDC shall: issue timely	L	Evidence of stakeholders'	Before and		SPDC



Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
	activities		information to stakeholders particularly fisher folk on the nature and timing of activities that may interfere with fisheries operations ensure proper signposting and mapping of any sub-sea structures to exclude trawling and avoid damage to fishing gear provide fishing gears and fingerlings to affected fisher folk schedule project activities to minimize disruption of fisheries activities		engagement meetings (minutes of meeting, attendance list, photographs etc.). Project schedule records	after backfilling	Twice	Project Manager

Table 7.1d: Environmental Management Plan (Operations Phase)

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
Operation	Destruction of assets and properties from oil spill/fire.	H	SPDC shall implement oil spill/contingency plan SPDC shall immediately isolate the source of spill SPDC shall compensate for the loss in property SPDC shall ensure proper pipeline insulation	L	Oil spill/contingency plans Compensation records RoW surveillance records Installation and use of tamper proof devices Detailed monitoring of Risk Analysis	Throughout the operational life of the pipeline	Quarterly	SPDC Project Manager
	Reduction in fisheries resources from pipeline breach and oil spillage	H	SPDC shall ensure proper signposting and mapping of any sub-sea structures to exclude trawling and avoid damage to fishing gear SPDC shall provide fishing gears and fingerlings to affected fisher folk	L	Evidence of stakeholders' engagement meetings (minutes, attendance lists, photographs etc). Project schedule records RoW surveillance records	Throughout the operational life of the pipeline	Quarterly	SPDC Project Manager

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
Inspection and Refurbishment of facilities	Injuries/trauma and deaths	H	SPDC shall ensure strict adherence to safe speed limits SPDC shall ensure that the mobilization schedule shall be phased to minimize traffic flow, and restricted to day time. SPDC shall provide On-site/Referral health care (including MEDEVAC)	L	Compliance monitoring report Journey Management Reports Facility Walk-Through Surveys Routine health service surveillance	Before start of project activity and periodically as stated under monitoring	Weekly Weekly Monthly Weekly	SPDC
Facility Surveillance	Injuries/trauma and deaths	H	SPDC shall ensure strict adherence to safe speed limits SPDC shall ensure that the mobilization schedule shall be phased to minimize traffic flow, and restricted to day time. SPDC shall provide On-site/Referral health care (including MEDEVAC)	L	Compliance monitoring report Journey Management Reports Facility Walk-Through Surveys Routine health service surveillance	Before start of project activity and periodically as stated under monitoring	Weekly Weekly Monthly Weekly	SPDC

Project Activity	Impact Description	Impact Rating before Mitigation	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
	Shift from traditional occupations to other activities	M	SPDC shall be organize Pre-sensitisation campaigns in the communities. SPDC shall support value-adding SMEs that promote and sustain traditional occupations	L	Compliance monitoring report Activity Reports	Before start of project activity and periodically as stated under monitoring	Monthly	SPDC
	Third party agitation	H	SPDC shall facilitate management of public expectations by engaging NGOs and CBOs; SPDC shall ensure commitment to transparent adherence to GMoU programmes and projects.	M	Records of public engagement sessions Records of minutes of meetings Records of Third Party Grievances. Records of GMoU implementation status	Before commencement of Surveillance	Once	SPDC Project Manager

Table 7.1e: Environmental Management Plan (Decommissioning Phase)



Project Activity	Impact Description	Impact Rating before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
Dismantling and Site Clean-Up	Increase in surface water turbidity	H	SPDC shall ensure the rapid completion of the decommissioning to minimize turbidity SPDC shall compensate all affected fisher folks SPDC shall supply potable water to the affected communities during river crossing	L	Physico-chemical parameters of surface water and sediment Compensation disbursement records; Records water supply records	Before decommissioning	Once	
	Disruption of fisheries activities	H	SPDC shall: issue timely information to	L	Evidence of stakeholders engagement Project schedule	At each water crossing	Once	SPDC Project Manager



Project Activity	Impact Description	Impact Rating before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			stakeholders particularly fisher folk on the nature and timing of activities that may interfere with fisheries operations provide fishing gears and fingerlings to affected fisher folks schedule project activities to minimize disruption of fisheries activities		records			
	Reduction in air quality	M	SPDC shall use only	L	Air pollutants	During	Mont	



Project Activity	Impact Description	Impact Rating before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
		H	pre-mobbed equipment. SPDC shall ensure that there is controlled use of all equipment and that equipment engines are turned off when not in use. SPDC shall ensure the use of scrubbers		monitoring records; Equipment maintenance records Equipment pre-mob records	excavation activities	Monthly	SPDC Project Manager
	Noise and vibration	H	SPDC shall ensure: machines are turned off when not in use combustion engines are fitted with	L	Noise monitoring records Maintenance records Equipment pre-mob records	During decommissioning	Monthly	SPDC Project Manager



Project Activity	Impact Description	Impact Rating before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			effective silencers. regular maintenance of machines and equipment. machinery covers and panels are closed and well fitted at all times equipments with low noise level are used appropriate PPEs are provided					
	Contamination/ pollution of water, soil and sediment	H	SPDC shall purge and flush all pipelines prior to decommissioning	L	Evidence of flushing the pipeline prior to decommissioning; Record of	During decommissioning	Once	SPDC Project Manager.



Project Activity	Impact Description	Impact Rating before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			SPDC shall treat decommissioning effluents to regulatory limits before discharging into the environment		effluent treatment ;			
	Third party agitation	H	SPDC shall facilitate management of public expectations by engaging NGOs and CBOs; SPDC shall ensure commitment to transparent adherence to GMoU	M	Records of public engagement sessions Records of minutes of meetings Records of Third Party Grievances. Records of GMoU implementation status	Before decommissioning	Once	SPDC Project Manager.



Project Activity	Impact Description	Impact Rating before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			programmes and projects.					
	Loss of employment/ income	H	SPDC shall support entrepreneurial skill development and opportunities for community members to cushion the effect of reduction in economic/income generating activities.	L	Household consumer budget.	Before start of project activity and periodically as stated under monitoring	Weekly	SPDC
	Injuries/trauma and deaths	H	SPDC shall carry out first aid training of workers including casual	L	Compliance Monitoring Reports Site Inspection Reports Activity	Before start of project activity and periodically as stated under monitoring	Weekly Weekly Monthly Weekly	SPDC



Project Activity	Impact Description	before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			<p>workers and locals. SPDC shall provide and enforce appropriate use of PPEs (e.g. life vests, hard hats, eye goggles) SPDC shall ensure that work area shall be condoned off as restricted areas with ample warning signals SPDC shall ensure that health talks and awareness and job</p>		<p>Reports Routine health service surveillance records</p>		<p>ly</p>	



Project Activity	Impact Description	Impact Rating before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			hazard analysis are carried out prior to work activities					
	Mental stress from loss of job	H	SPDC shall support entrepreneurial skill development and opportunities for community members to cushion the effect of reduction in economic/income generating activities.	L	Compliance Monitoring Reports Activity Reports Routine health service surveillance records	Before start of project activity and periodically as stated under monitoring	Weekly Monthly Weekly	SPDC
	Population pressure on social infrastructure and health facilities	H	SPDC shall ensure that project recruits a	L	Compliance Monitoring Reports Site	Before start of project activity and periodically	Weekly Weekly	SPDC

Project Activity	Impact Description	Impact Rating before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			large proportion of the work force from the locality. SPDC shall ensure provision of proper accomodation, waste disposal, medical and recreational facilities within the camp site for workers.		Inspection Reports Household Demographic & Health Survey (DHS)	y as stated under monitoring	Quarterly	
	Increase in morbidity	H	SPDC shall ensure that project recruits a large proportion of the work force from	M	Household Demographic & Health Survey (DHS) Routine health service	Before start of project activity and periodically as stated under monitoring	Quarterly Weekly	SPDC



Project Activity	Impact Description	Impact Rating before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			the locality. SPDC shall ensure provision of proper accommodation, waste disposal, medical and recreational facilities within the camp site for workers.		surveillance			
	STIs including HIV/AIDS	H	SPDC shall ensure recruitment of a large proportion of the work force from the locality to reduce migrant population. SPDC shall	M	Compliance Monitoring Reports Activity Reports Reproductive Health Survey Routine health service surveillance	Before start of project activity and periodically as stated under monitoring	Weekly Monthly Quarterly Weekly	SPDC

Project Activity	Impact Description	Impact Rating before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			carry out HIV/AIDS education campaign in line with the National Prevention Program. SPDC shall enforce strict Access control within workers camp sites.		records			
Site Restoration	Injuries/trauma and deaths	H	SPDC shall carry out first aid training of workers including casual workers and locals. SPDC shall provide and	L	Compliance Monitoring Reports Site Inspection Reports Activity Reports Routine health service	Before start of project activity and periodically as stated under monitoring	Weekly Weekly Monthly Weekly	SPDC

Project Activity	Impact Description	before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			enforce appropriate use of PPEs (e.g. life vests, hard hats, eye goggles) SPDC shall ensure that work area shall be condoned off as restricted areas with ample warning signals SPDC shall ensure that health talks and awareness and job hazard analysis are carried out prior to		surveillance records			



Project Activity	Impact Description	Impact Rating before	Mitigation Measures	Impact Rating after Mitigation	Parameters for Monitoring	Timing	Monitoring Frequency	Responsible Party
			work activities					



CHAPTER EIGHT

CONCLUSIONS

This Environmental Impact Assessment (EIA) report of the Soku GP-San Barth Manifold Pipeline Project has been prepared by adopting a multidisciplinary team approach in accordance with the regulatory requirements set down in DPR's Environmental Guidelines and Standards for Petroleum Industries in Nigeria (EGASPIN, 2002). The report was also prepared by employing the established requirements of other relevant statutory and international organizations. The EIA study involved a detailed literature search, field observations and measurements, field sampling and laboratory analyses, data analyses and correlations, and impact identification and evaluation.

The potential impacts of the project on the existing environment of the project area were identified and evaluated and the impact assessment was based on the interactions between the project activities and the environmental status and sensitivities of the various ecological components of the project, namely the biophysical, social, and health components.

The magnitude of the anticipated impacts of the project activities on air quality, water quality, soil, sediments, vegetation, fauna, fisheries, land use, waste management, as well as on socio-economic and health issues, were rated and mitigation measures proffered to reduce the magnitude of the identified adverse impacts to a level that is As Low As Reasonably Practicable (ALARP).

These mitigation measures were incorporated into the Environmental Management Plan (EMP), which was developed specifically for this project and which would ensure not only that procedures for managing the potential adverse impacts and associated impacts of the project on the environment are put in place but that they are also enforced throughout the life of the project. In addition to the foregoing, monitoring programme of the project has been recommended in order to ensure that all impact indicators for all the environmental components in every phase of the project are within statutory limits throughout the life of the project.

REFERENCES

Agboola, A.A and Ayodele, O. (1987) Soil test calibration for upland rice in southwestern Nigeria. *Fertilizer Research*. 14: 227 – 234.



- Air Services Australia (2002). Environmental Principles and Procedures for Minimising the impact of aircraft noise Environment Branch 19 August 1997, Revised 21 November 2002.
- Ajayi, S.O., & Osibanjo, O., (1981). Pollution studies on Nigerian waters. Water Quality of some Nigerian Rivers. Environ. Pollut. (Series B) 2: 87 – 95.
- Akobundu, I.O and Agyakwa, C.W. (1987). A Handbook of West African Weeds. International Institute of Tropical Agriculture, Ibandan. 521p.
- Akinkugbe OO (Ed) 1997. Non-communicable diseases in Nigeria: Series 4. Final report of a national survey. Federal Ministry of Health and Human Services. Lagos: 2 – 41.
- Akin-Oriola G. A. (2003): On the phytoplankton of Awba reservoir, Ibadan, Nigeria. Rev. Biol. Trop. 51(1): 99-106.
- Alasoadura, S.O and Fajola, A.O. (1970). Studies on the frog-eye disease of Tobacco (*Nicotiana tabacum*) in Nigeria. Mtcopath. Mycol. Appl.42:117-185.
- Angela Dale & Richard B. Davies (Eds.) (0.1995) Analysing Social and Political Change: A Case-book of Methods. Sage Publications, London.
- APHA (1997). Standard Methods for the examinations of water and wastewaters, 18th ed. Publishers: American Public Health Association; American Water Works Association and Water Pollution Control Federation.
- Araoye M.O (2003). Research methodology with statistics for health and social sciences. Ilorin. Nathandex Publishers. 1- 178
- Asuzu M.C, Ogundeji M.O (2007). Minimum standards for primary health care services nationwide in Nigeria. Report of a consultancy assignment for NPHCDA.
- Aseez, L. O., (1989). Review of the stratigraphy, sedimentation and structure of the Niger Delta . In Geology of Nigeria (Kogbe, C. A. Ed) Rockview Int. Ltd (Publ), Jos.pp 311-324.
- Atkins, D.H.F and David, S.L (1995): Spatial and temporal variation of rural Nitrogen dioxide concentrations Across the United Kingdom. Atmospheric Environment, vol. 29 No 2, pp 223-239.
- Baumbach, G., Vogt, V; Hem, K.R.G; Oluwole, A.F., Ogunsola, O.J., Olaniyi, H.B; and Akeredolu, F.A (1995): Air pollution in a large tropical city with a high traffic density-results of measurements in Lagos, Nigeria. The Science of the Total Environment. 169, 25-31
- Birely, M. H. (1995). The Health Impact Assessment of development projects, HMSO London
- Boorman, J. (1970) West African Butterflies and Moths. Longman Group, 79pp.



- Brown, D.S. (1980). Freshwater snails of Africa and their medical importance. Taylor & Francis Ltd, London. 487pp.
- Belcher, H and Swale, E (1977): A beginner's guide to freshwater algae. Institute of terrestrial Ecology. Natural Environment Research Council. Her Majesty's stationary Office, London. Pp49.
- Bellinger, E.G. 1992. A key to common algae: Freshwater, estuarine and some coastal species. The Institute of Water and Environment Management, London, UK.
- Central Bank of Nigeria (CBN) (1990). Annual Report and Statement of Accounts. Central Bank of Nigeria.
- Chindah AC, Braide SA, Amakiri J, Onokurhefe J (2007). Effect of crude oil on mangrove (*Rhizophora Mangle* L.) seedlings from the Niger Delta, Nigeria. *Revista UDO Agricola*; 7 (1): 181 – 194.
- Chowdhury, M.M.R.; Mondol M.R.K. and Sarker, C. (2007): Seasonal variation of plankton population of Borobila beel in Rangpur district Univ. j. zool. Rajshahi Univ. Vol. 26, pp. 49-54.
- Chiodo JD, Jones N, Billett EH, Harrison DJ (2002). Shape memory alloy actuators for active disassembly using 'smart' materials of consumer electronic products. *Material Design* 23: 471 – 478.)
- Clasen T, Roberts I, Rabie T, Schmidt W, Cairncross S (2005). Interventions to improve water quality for preventing infectious diarrhea. *The Cochrane Library*, Issue 4, 2005. Oxford: Update Software.
- Cruickshank, R, Duguid, J.O, Manion, R.P and Swan R.H.A. (1975). *Medical microbiology*. 12th Edition, Voll I Churchill, livinstone. London.
- Craig, D. 1990 *Social Impact Assessment: politically Oriented Approaches and Application*. *Environmental Impact Assessment Review*: (10): 37-52
- Davis, M.L and Masten, S.J (2009): *Principles of Environmental Engineering and Science*, pp. 523-521.
- Davies O.A., Abowei, J.F.N and Tawari, C.C. (2009): Phytoplankton Community of Elechi Creek, Niger Delta, Nigeria-A Nutrient-Polluted Tropical Creek. *American Journal of Applied Sciences* 6 (6): 1143-1152.
- Deekae, S. N., Abowei, J. F. N. and. Alfred-Ockiya, J. F. (2010): Seasonal Variation of Some Physical and Chemical Parameters of Luubara Creek, Ogoni Land, Niger Delta, Nigeria. *Research Journal of Environmental and Earth Sciences* 2(4): 208-215.
- Durrand, J-R and Leveque, C. (eds) (1990): *Flore et faune aquatiques de l' Afrique Sahelo-Soudanienne*. Editions de ORSTOM documentations Technique no. 44 Paris. 608pp.



Dussart, B. H. (1980): Copepods: In Durrand, J-R and Leveque, C. (eds) (1990): Flore et faune aquatiques de l' Afrique Sahelo-Soudanienne. Editions de ORSTOM documentations Technique no. 44 Paris. 608pp.

Das Gupta M, Gauri V, Khemani S (2004). Decentralised delivery of primary health services in Nigeria: Survey evidence from the States of Lagos and Kogi. Geneva. Development Research Group, The World Bank.

Deskosons (1992) A Social-Economic Impact Assessment of the Influx of 8000 Construction Workers into Bonny/Finima area. Port Harcourt: Deskosons Investment Nigeria Ltd for Kellogs Nigeria Incorporated

DPR (1991). Environmental Guidelines and Standards for the Petroleum Industry in Nigeria, Lagos.

DPR EGASPIN (2002). Environmental Guidelines and Standards for the Petroleum Industry in Nigeria, Lagos

Dricol (1987) Groundwater and wells, Johnson Division Public., St. Paul Minnesota 55112, 2nd Edition, pages 707-714.

Egborge, A. B. M. (2000). Wild life, In: Government, oil companies, the people and the Niger Delta Environment (4th Convocation Lecture of Delta State University, Abraka) BEN Miller Books Nigeria Ltd. Pp 55-61.

Egborge, A.B.M. (1990). Eutrophication of Nigeria's Lake Asejire Arch. Hydrobiol Beith Ergebn. Limno 33: 793-88021.

Ekeke, B. A.; Davies, A. O. and Alfred-Ockiya, J. F. (2008): Sand dredging impact on te fish catch in Bonny River estuary, Nigeria. Environmental Research Journal 2 (6): 299-305. ISSN: 1994-5396.

Emere, M. C. and Nasiru, C. E. (2007): Macroinvertebrates as indicators of the water quality of an urbanized stream, Kaduna, Nigeria. Journal of Fisheries International: 2 (2); 152-157.

Erondu, E.S. and Chindah, A.C. (1991): Physicochemical and phytoplankton changes in a tidal fresh water station of the New – Calaber River, South Eastern Nigeria. Environ, and Ecol., 3: 561 - 570.

Ezekiel, E. N, Ogamba, E. N and Abowei, J. F. N. (2011): The Distribution and Seasonality of Phytoplankton in Sombreiro River, Niger Delta, Nigeria. Asian Journal of Agricultural Sciences 3(3): 192-199.

Elgood, J.H., Heigham, J.B., Moore, A.M., Nason, A.M., Sharland, R.E. & Skinner, N.J. (1994) The birds of Nigeria. An annotated checklist. British Ornithologists' Union.305pp.



Environmental Impact Assessment (EIA) process, A manual for EIA execution in SPDC – Dec. 2000

Emua S.A. (1980). Leaf spot diseases of cultivated yams (*Dioscorea* species) in southwest Nigeria. Ph.D. Thesis. University of Ibadan. 155p.

Emua, S.A. and Fajola, A.O. (1982). Chemical control of two leaf spot disease of cluster yam (*Dioscorea dumetorum*) caused by *Didymosphaeria donacina*. *Plant Disease* 67:389-391.

Environmental and Human Health Research Association; Niger Delta Regional Survey; 2000.

Etikerentse, G. (1985). Nigerian petroleum laws. Macmillan Publishers, London.

E&P Forum/UNEP (1997): Environmental Management in oil and gas exploration and production. An overview of issues and management approaches, Oxford, UK.

Euroconsult (1996). Niger Delta Environmental Survey. Volume 1.

European Center for Health Policy (1999). Gothenburg Consensus Paper: Health Impact Assessment main concepts and suggested approach. World Health Organization Regional Office for Europe. Brussels.

Famine Early Warning System Network (2008). Nigeria Food Security Update, July 2008. USAID.

Falase, A.O.; Akinkugbe, O.O (2002); A Compendium of Clinical Medicine, Pg 288.

FAO (2002). FAO Fisheries Department, FISHERY COUNTRY PROFILE-Nigeria (English).

FAO/WHO/URN (1985), Energy and Protein requirements, Tech. Rep. Sir, NO724.

FAO (1981) FAO species identification sheets for fishery purposes, Eastern Central Atlantic. Vol VI. Fisher, W., Bianchi, G. & Scott, W.B. eds.

Fetter, C.W. (1994) Applied Hydrogeology Macmillan, New York.

FEPA, 1991. National Guidelines & Standards for environmental Pollution in Nigeria.

Federal Republic of Nigeria Official Gazette (2007) Legal Notice on Publication of the 2006 Census Report, No. 4, Vol. 94, Lagos-19th January, 2007.

Federal Republic of Nigeria Official Gazette (2007) Legal Notice on Publication of the details of the breakdown of the National and State Provisional Totals, 2006 Census, No. 24, Vol. 94, Lagos-15th May, 2007.



- Federal Office of Statistics (FOS) and Institute for Research and Development (IRD) (1992). Nigeria and Demographic and Health Survey, 1990. Lagos, Nigeria and Macro Systems, Columbia, Maryland, 243p.
- Federal Ministry of Health (1998): National policy on population for development, unity, progress and self-reliance: Department of population situation in Nigeria: pp04.
- Federal Ministry of Health (FMOH) [Nigeria]. 2001. Strategic Plan for Rolling Back Malaria in Nigeria 2001-2005. Abuja, Nigeria: Federal Ministry of Health.
- Federal Ministry of Health (Nigeria) (2004). 2003 National HIV/AIDS and Reproductive Health Survey. Federal Ministry of Health Abuja, Nigeria.
- Foth, H.D. (1975) Fundamentals of soil science. 7th edition. John Wiley and sons, Inc. 30: 347.
- Gasana JK (1997). Factors of ethnic conflict in Rwanda and instruments for a durable peace. In: Bachler G. (ed.) Federalism against ethnicity: Institutional, legal and democratic instruments to prevent violent minority conflicts. Verlag Rueger Chur/Zurich: 107 – 136.
- Gealing, C. 1978: Birds of Yankari Game Reserve. Bull. Nigeria Orn. Society 14, 82-83
- Glasson, J. (1992). An introduction to regional planning, 2nd edition, London: UCL Press.
- Haltenorth, T. & Diller, H. (1977) A field guide to the mammals of Africa including Madagascar. Collins, London, 400pp.
- Happold, D.C.D (1987). The mammals of Nigeria. Oxford University Press, Oxford. 402pp
- Hawthorne, W. (1990). Field Guide to the forest trees of Ghana. Natural Resources Institute, Overseas Development Administration Kent, United Kingdom. 276p
- Henri Roggeri (1995). Tropical Freshwater Wetlands A guide to Current Knowledge and Sustainable Management. Kluwer Academic Publishers. Dordrecht.
- Health Effects Institute (HEI) (1995). Particulate air pollution and daily mortality: replication and validation of selected studies. The Phase I report of the particle epidemiology evaluation project. Boston, MA.
- Hines, A .L, Ghosh,T .K, Loyalka, S .K and Warder, R.C (1993): Indoor Air quality & Control, PTR Prentice Hall, Englewood Cliff, N.J. pp. 21, 34.
- Hutchinson, J and Dalziel, J.M. (1963). Flora of West Tropical Africa. Crown Agents for Oversea Govenrments and Administrations, London. 544p
- Ideriah, T. J. K., Amachree O and Stanley, H. O. (2010): Assessment of water quality along Amadi Creek in Port Harcourt, Nigeria. Scientia Africana, Vol. 9 (No.1), pp 150-162



- Iltis, A. (1980): Les algues. In Durrand, J-R and Leveque, C. (eds) (1990): Flore et faune aquatiques de l' Afrique Sahelo-Soudanienne. Editions de ORSTOM documentations Technique no. 44 Paris. 720pp
- Imoobe, T.O.T. & Ogbeibu, A.E. (1996). Copepods of Jamieson River, Nigeria. *Tropical Freshwater Biology* 5, 55 – 65.
- IUCN (1993) Environmental Synopsis-NIGERIA
- Jackson, L. S.; G. P. Morris & Smith, P. (1989): Environmental Health, Butterworths, London. 961pp.
- Jean (1993) – General Pelletier, Children in the tropics, severe malnutrition: A global approach, – No 208 – 209.
- Junge, C.E. (1972): The cycle of atmospheric trace gases- natural and man made. *Quart. J. Roy meteorol. Soc.*, 98, 711-716
- John Glasson (1995).”Socio-economic impacts 1: overview and economic impacts”, in *Methods of Environmental Impact Assessment* (Peter Morris and Riki Therivel. Editors) UCL Press, England.
- John, S. (1998). A Look Back at the U.S. Department of Energy’s Aquatic Species Program— Biodiesel from Algae. U.S. Department of Energy’s Office of Fuels Development
- Kao, A. S (1994): Formation & Removal Reactions of Hazardous Air Pollutants. *Journal of the Air Pollution Control Association* 44 683-696.
- Kovat RS, Menne B, McMichael AJ, Corvalan C, Bertollini (2000). *Climate Change and Human Health: Impact and Adaptation*. WHO. Geneva. WHO/SDE/OEH/00.4.
- Koefoed, O., 1979. *Geosounding Principles*. Elsevier Publ. Co. Amsterdam.
- Keller, G.V and Frischnecht (1970) *Electrical Methods in Geophysical Prospecting*, 2nd edition. Pergamon Press, New York NY, 517pp.
- Kershaw K. A. (1973). *Quantitative and Dynamic Plant Ecology*. Edward Arnold Publishers Ltd. 271p.
- Keay, R.W.J., Onochie C.F.A., and Standfield D.P. 1964: *Nigerian Trees Vols I & II*. Federal Department of Forest Research, Ibadan, Nigeria. 334p & 495p respectively.
- Lacatușu, R; Lungu, M AND Teodorescu, S (2011). Heavy metals abundance in the soils of the pantelimon Branseti area: iron, Fe, Mn, Ni, Pb and Zn. *Present Environment and sustainable development*. Vol 5, No. 2
- Loke, M. H. (2001): 1-D Resistivity, IP, and SIP inversion and forward modeling Software.



Lucas A.O & Gilles H.M, (2003) Health Statistics: Information for health, Short Textbook of Public health Medicine for the tropics. 4th ed, Publishers Arnold

Lucas A.O, Gilles H.M (2003). Short textbook of public health medicine for the tropics. 4th edition. London. Book Power.

Marrow, D.E. (1984): Toxicological data on NO₂: An overview. J. Toxicological Environ. Health. 13, 205-227.

Moore W. J and Moore E. A (1976): Environmental Chemistry. Academic Press Inc. London. Cited in Odokuma, L.O. and Okpokwasili, G. C.: Seasonal influences of the New Calabar River, Nigeria: Environmental Monitoring and Assessment, (1996), 5, 1-14.

Murray CSL, Lopez (1997). Alternative projections of mortality and disability by cause 1990 – 2020:

National Population Commission (NPC) [Nigeria]. 1998. 1991 Population Census of the Federal Republic of Nigeria: Analytical Report at the National Level. Lagos, Nigeria: National Population Commission.

National Population Commission (NPC) [Nigeria]. 2000. Nigeria Demographic and Health Survey 1999.

National Population Commission (NPC) [Nigeria]. 2004. Nigeria Demographic and Health Survey 2003. ORC Macro, Calverton Maryland, USA.

National Population Commission (NPC) [Nigeria] and ORC Macro (2009). National Demographic and Health Survey 2008. Calverton, Maryland: National Population Commission and ORC Macro.

NDES (1997). Niger Delta Environmental Survey, Phase 1 Report, Vol. 1, Environmental and Socio-Economic Characteristics, submitted by Environmental Resources Managers Limited, Lagos.

Niger Delta Development Commission (NDDC) (2006), Niger Delta Regional Development Master Plan Final Report NDDC-FGN.

NPC (1991) National Population Commission. Census '91 Final Results, Rivers State.

NPC (1994) Census '91: National Summary. National Population Commission, Abuja.

National Population Commission (Nigeria). 2000: Nigeria Demographic and Health Survey 1999. Calverton, Maryland: National Population Commission and ORC/Macro.

NISER (2001). NISER Review of Nigerian Development, 2000: The State in Nigerian Development. Nigerian Institute of Social and Economic Research (NISER), Ibadan.



NEST (1991). Nigerian's Threatened Environment; A National Profile. Nigerian Environmental study/Action Team, Ibadan.

NPC (2002). Nigeria Population Census 1991 Analysis, Vol. II; Children, Adolescents and Youth. National Population Commission, Abuja.

NDES (1997) Niger Delta Environmental Survey Phase 1. Environmental and Socio-Economic Characteristics by Environmental Resources Managers Ltd.

NPC, 2003, National Population Commission: Nigerian Demographic and health Survey 2003

Nwauche CA, Akani CI (2006). An assessment of high risk sexual behavior and HIV transmission among migrant oil workers in the Niger delta area of Nigeria. *Niger J Clin Pract* 9: 48 – 51.

Obuoforibo A (2006). Health infrastructural development. Paper presented at Rivers State health summit. Port Harcourt. 2006.

Odum, E. P. (1971). *Fundamentals of Ecology*. 3rd ed. Saunders Company, Philadelphia, 574p.

Odu CT, I Baisari L, Fagde S.O. White SA and Nwadiaro C.S. (1986). Quantification and extent of degree of hydrocarbon pollution on the soils, mangrove vegetation, fauna and hydrobiological parameters. A technical report submitted to SPDC.

Ogbeibu, A.E and Egborge, A.B.M (1995). Hydrobiological studies of water bodies in the Okomu Forest Reserve (sanctuary) in Southern Nigeria. 1. Distribution and diversity of the invertebrate fauna. *Trop. Freshwat. Biol.* 4:1-27.

Ogbeibu, A.E and Victor, R (1989). The effects of road and bridge construction on the bank root macroinvertebrates of a southern Nigerian stream. *Environ. Pollut.* 56: 85-100.

Ogbeibu, A.E. & Anagboso, M.U. (2004). Baseline limnological investigation of the Utor River in Esan Southeast, Edo State, Southern Nigeria: 1. Physical and Chemical Hydrology. *Tropical Freshwater Biology* 12/13:45 - 62

Ogbeibu, A.E. & Omoigberale, M.O. (2005). Environmental Impacts of Oil Exploration and Production on the Rotifers of Osse River, southern Nigeria. *African Journal of Environmental Pollution & Health* 4(1): 72 – 80.

Ojile, Meshach Owho (2009). Socioeconomic Baseline Conditions/SIA Aspects (Draft Report) of the EIA for SPDC' Non-Associated Gas (NAG) Project, submitted to SEEMS Ltd, Lagos on behalf of SPDC. Pp. 58.

Ojile, M.O. and Okoye Chinyere (2006) Soku Foreshore Protection Project: Socioeconomic/SIA and Community Health/HIA Aspects, submitted to Harmonix Engineering and Environmental Services Ltd. on behalf of the NDDC. Pp31.



Ojile, M.O. (2000). Draft Report of the Socio-economic Baseline Conditions and SIA of the EIA of 3D Seismic Survey of OML 18 Prospect (Cawthorne Channel/Akaso Fields), submitted to Survicom Services Limited, Port Harcourt on behalf of the SPDC.

Ojile, M.O. (1999). Draft Report of the Socio-Economic Aspect of the Environmental Sensitivity Index Mapping (ESI) of Cawthorne Channel District, submitted to Prodec-Fugro Consultants Ltd., Port Harcourt, on behalf of SPDC East.

Okpidi. J. (1984). Soil chemical Analysis. *Soil Sc.* 105: 225-248

Okorodudu – Fubara, M. T. (1998). Law of environmental protection. Caltop Publications (Nig) Ltd, Ibadan, Nigeria, 938 pp.

Olomukoro, J. O. and Ezemonye, L. I. N. (2007): Assessment of the macro-invertebrate fauna of rivers in southern Nigeria. *African Zoology* 42(1):1-11

Ologunorisa T. E., (2011) In search of climate justice and equity, Inaugural lecture delivered at the Osun State University.

Ologunorisa, E. T. and Adejuwon, J. (2010): Rainfall pattern and Variability in the Niger Delta. *International Journal of Meteorology*, U.K. Vol 35, No 345, pp.22 – 30.

Oluwande, P.A (1977). Automobile traffic and air pollution in a developing country. *Int. J. Environ. Study*; 2,197-203

Omuemu VO, Okojie OH, Omuemu CE (2007). Awareness of high blood pressure status, treatment and control in a rural community in Edo State. *Nigerian Journal of Clinical Practice*; 10: 208 – 212.

Omoigberale, M.O. & Ogbeibu, A.E. (2005). Assessing the environmental impacts of oil exploration and production on the Osse River, southern Nigeria: 1. Heavy metals. *African Journal of Environmental Pollution & Health*, 4(1): 27 - 32

Omoigberale, M.O. & Ogbeibu, A.E. (2007). Assessing the environmental impacts of oil exploration and production on the water quality of Osse River, southern Nigeria. *Global Journal of Environmental Sciences* 6(1): 1 – 13

Oosting, H. J. (1956). The study of plant Communities. Introduction to plant Ecology. 2nd Edition. W.H.Freeman 7 Co. San Francisco. 440p

Ordinioha B, Adeosun A (2008). A survey of the community water supply of some communities in Rivers State, south-south Nigeria. *The Nigerian Health Journal*; 8: 39 – 42.

Ordinioha B, Owhonda G (2008). Clandestine abortion in Port Harcourt: Users' profile and motivation. *Nig J Med.* 17: 33 – 36.

Oremade, T. (1986). Petroleum operations in Nigeria. West African Book Publishers, Lagos. 69 pp.



Oshineye, A. (2000). The petroleum industry in Nigeria: an overview Modern Practice Journal of Finance and Investment Law. Vol. 4 (4), 325 – 344.

Pourriot, R. (1980): Rotifers. In Durrand, J-R and Leveque, C. (eds) (1990): Flore et faune aquatiques de l' Afrique Sahelo-Soudanienne. Editions de ORSTOM documentations Technique no. 44 Paris. 219-2328pp.

PORG (1983): The Third Report of the Photochemical Oxidants Review Group, AEA Technology, Harwell laboratory, Oxfordshire.

Pope, C.A; Dockery, D.W; Kanner, R.E, Villegas, G.M and Schwartz, J (1999): Oxygen Saturation, Pulse Rate and Particulate Air Pollution: A Daily Time – Series Panel Study. Am. J. Respiratory and Critical Care Medicine. 159 ; 365-372.

Prasad, A (1995): Air Pollution Control Technologies for Nitrogen Oxides. The National Environmental Journal May/June, 46-50.

Raunkiaer. C. (1934). The life form of plant and statistical Plant geography. Clarendo press, Oxford, p632.

Rahman, M.S. 1992. Water quality management in aquaculture. BRAC Prokashana, Dhaka, pp 83-84.

Raybaud, V., Tunin-Ley, A., Ritchie, M. E., and Dolan, J. R. (2008): Similar patterns of community organization characterize distinct groups of different trophic levels in the plankton of the NW Mediterranean Sea. Biogeosciences Discuss., 5, 4897–4917.

Rey, J. and Saint-Jean, L. (1980): Brachiopods. Durrand, J-R and Leveque, C. (eds) (1990): Flore et faune aquatiques de l' Afrique Sahelo-Soudanienne. Editions de ORSTOM documentations Technique no. 44. Paris. 608pp.

Reynolds, C.S. (1984): Phytoplankton periodicity: The interaction of form, function and environmental variability. Freshwater Biology, 14: 111–142.

Reijers T. J. A., Petters, S. W., Nwajide, C. S. (1996): The Niger Delta Basin. In Reijers, T. J. A., Selected Chapters on Geology Appendix A. NPDC Corporate Reprographic Services, Warri, Nigeria. ISBN: 978-2058-02-5 pp103-117.

Risk Assessment Matrix (1996): Health, Safety and Environment, Shell Health Safety and Environment Committee, Shell International BV. The Hague

Rubel, F and Kottek, M (2010): Meteorol. Z.19; 135-141.

Ruel M, Menon P (1995). Child care, nutrition and health in the central plateau of Haiti: The role of community, Household, and Caregiver Resources. Washington, DC. Food and Nutrition Technical Assistance (FANTA) project, Academy for Educational Development, 2003: 1 – 250.



- Serle, W., Morel, G.J. & Hartwig (1977) A field guide to the Birds of West Africa. Collins, London, 351pp.
- Short, K. C. and Stauble, A. J., 1967. Outline geology of the Niger Delta. AAPG Bull. vol. 51, pp 761-779.
- Sobolu, R. A., Fayemi, R.A., and Agboola, A. 1977. Application of soil and plant Analysis to nutrition of tomatoes in S.E. Nigeria. Act. Hort. 53: 235-249.
- SIEP (1996) Social Impact Assessment Guidelines, HSE Manual. Shell International Exploration and Production B.V. The Hague.
- SIEP (2000): Social Impact Assessment Guidelines, HSE Manual, Volume 3. Hazards and Effects Management Tools And Techniques, Shell International Exploration and Production B.V. The Hague.
- SPDC (2002). Environmental Impact Assessment of Eastern Gas (Rich Gas) Gathering System from Soku/Awoba- Bonny Project, Final Report. The Shell Petroleum Development Company of Nigeria Limited, August 2002.
- SPDC, East (1998) Environmental Impact Assessment of Akaso, Cawthorne Channel, Buguma Fields.
- Shell Petroleum Development Company Limited (2010) Map Showing Sampling Plan for the Soku Gas Plant – San Barth Manifold Pipeline EIA Project.
- Troade, J.P. and S. Garcia (eds), 1980. The fish resources of the Eastern Central Atlantic. Part 1. The resources of the Gulf of Guinea from Angola to Mauritania. FAO Fish.Tech.Pap., (186.1): 166 p. Issued also in French.
- Tucker M.E., 1981. Sedimentary Petrology. Blackwell Scientific Publications. ELBS, pp10-76
- U.M. Igbozurike (1978). “An Evaluation of the Impact of Land Fragmentation on Agricultural Productivity”, Resources and Development in Africa. Proceedings of the Regional Conference of the International Geographical Union (J.S. Oguntoyibo, M.O. Filani, and O. Areola, editor), Vol. 1, pp.95-100, Lagos.
- United Nations Development Programme (UNDP) (2006), Niger Delta Human Development Report 2006 UNDP, Nigeria, Abuja.
- United Nations Development Programme (2006). Niger Delta Human Development Report. Abuja, Nigeria. UNDP.
- United Nations Center for Human Settlement (UNCHS). Improving rural shelter in developing countries. Nairobi. UNCHS.
- USEPA, (1973). National Ambient Air Quality Standards (NAAQS)



Viets F.C and Lindsay W.L. (1984). Testing soils for Zn, Cu, Mn and Fe. In: Soil testing and plant analysis (Eds LM. Walsh and J.D. Bexton). Soil Sci. Soc. Am. Inc. Madison

Vollenweider, R. A. (1968): Scientific fundamentals of the eutrophication of lakes and flowing waters, with particular reference to nitrogen and phosphorous as factors in eutrophication. Paris. Rep. Organization for Economic Co-operation. 192pp.

Victor R. and Onomivbori O. (1996): The effects of urban perturbations on the benthic macroinvertebrates of a southern Nigerian stream. pp. 223–238. In Perspectives in Tropical Limnology. (F. Schiemer and K .T. Biland, ed.). Amsterdam, The Netherlands: SPB Academic Publishing.

Victor, R and Ogeibu, A. E. (1985): Macrobenthic invertebrates of a stream flowing through farmland in southern Nigeria. Environmental Pollution series A 39: 333-347.

Wachs, B., Wagner, H. and van Donkelaar, P. (1992). Two-stroke engine lubricant emission in a body of water subjected to intensive outboard motor operation. Science of the Total Environment. 116: 59-81

Ward, H.B. and Whipple, G.C. (1959): Freshwater Biology (ed.) Edmondson, W.T., editor. 2nd edition. John Wiley and Sons. U.S.A.

World Bank (1991) Environmental Assessment Source Book Vol.1-111. The Bank. Washington D.C. U.S.A

Wolf Charlic (2003): Resource Book on Social Impact Assessment. Social Impact Assessment Work organised by Environmental Assessment Department of SPDC, Nigeria. Held in Hotel Presidential Port Harcourt

Whiteman, A., 1982. Nigeria: Its petroleum geology, resources and potential. Graham and Trotman Publ., London.

WEEL (1998). Guideline manual for water supply and sanitation programmes. London. WEDC/DFID.

Wokoma FS, Alasia DD (2011). Blood pressure pattern in Barako: a rural community in Rivers State, Nigeria. The Nigerian Health Journal; 11: 8 – 13.

World Health Organization (2003). The World Health Report: 2002: Reducing risks, promoting healthy life. Geneva: World Health Organization.

Weber, K. J. and Daukuro, E., 1975. Petroleum geology of the Niger Delta. Proc. 9th World Petroleum Congress, Tokyo. Pp 209-229.



West, P.W and Gaeke, G.C. (1956): Fixation of sulphur dioxide as disulfitomercurate (ii) and subsequent colorimetric estimation. Anal. Chem., 28, No 12

WHO (1976): Selected methods of measuring Air Pollutants. WHO offset publication No 24E World Health Organisation.

WHO (World Health Organization). (1988) Vanadium. Environmental Health Criteria 81. Geneva.

World Health Organisation (1997): Health and Environment In: Sustainable Development- Five years after the earth summit.

Yalaju, Y. (2000). Joint operating agreements in Nigeria Petroleum Industry. Modern Practice Journal of Finance and Investment Law. MPJFIL Vol. 4(3), 147-157.

Zepeda, L. (2001) Agricultural Investment production Capacity and Productivity. In Zepeda. L (ed) Agricultural Investment and Productivity in Developing Countries. Rome: United Nations Food and Agricultural Organisation.

Zohdy, A., 1989. A new method for the automatic interpretation of Schlumberger and Wenner sounding curves. Geophysics. Vol. 54, no. 2, pp 245-253.

APPENDICES

Appendix 1

Laboratory Analytical Methods and Procedure for Water, Sediment, and Soil Analysis
Laboratory Analysis (carried out in Thermosteel Nigeria Limited laboratory, D1/D2 Gateway Estate, Warri)

The methods of analyses used in this study were those specified in EGASPIN (2002) and other internationally accepted analytical procedures. Also, in order to ensure the reliability and integrity of the data obtained, in-situ measurements of some surface and ground water properties were carried out in the field. Heavy metals were analysed using Atomic Absorption Spectrophotometer (AAS).

Details of analyses of the parameters studied are as follows:

- i. Phosphate: Phosphate was determined by the stannous chloride method (APHA, 1992). Phosphate in water reacts with ammonium molybdenum blue complex in the presence of stannous chloride. The intensity of colour was measured at 690 nm using a spectronic 20 spectrophotometer.
- ii. Sulphate: Sulphate was determined by the turbidimetric method (APHA, 1992). The sulphate was reacted with barium ion in the presence of sodium chloride-hydrochloric acid solution containing glycerol and ethyl alcohol. This resulted in the formation of colloidal barium sulphate, which was measured at 420 nm with a spectronic 20 spectrophotometer.



- iii. Total alkalinity: Total Alkalinity was determined by titrating water samples (100 ml) with 0.02 N sulphuric acid solution using methyl orange as indicator (APHA, 1992).
- iv. Ammonium nitrogen: This was determined by the phenol-hypochlorite method (APHA, 1992). Alkaline phenol and hypochlorite catalysed by sodium nitroprusside, reacted with ammonia to form indophenol blue complex. The intensity of the colour was measured at 630 nm using a spectronic 20 spectrophotometer.
- v. Suspended solids: This was measured by the gravimetric method (APHA, 1992). Water samples (200 ml) were filtered through pre-weighed 0.5µ membrane filters. The filters were then dried to constant weight in an oven.
- vi. Chloride: Chloride was measured titrimetrically (Argentometric Method) in slightly alkaline solution with silver nitrate (AgNO₃) solution in the presence of potassium chromate as indicator (APHA, 1992).
- vii. Oil: Oil in water was measured, after pre-extracting 100 ml sample with 10ml xylene, using a Horiba Oil Content Analyzer (OCMA-200, range 0-100 ppm).
- viii Heavy Metals: Heavy metals were analysed using Unicam Atomic Absorption Spectrophotometer Model 929.
- ix. Biochemical Oxygen Demand (BOD): The standard test involves seeding with river water, or effluent, and incubating at 20oC, for five days. The dissolved oxygen in the sample was determined before and after incubation.

Two sets of samples were collected; one set for immediate dissolved oxygen (DO) determination and the other for incubation for 5 days at 20oC. Prior to titration, each of the samples (250 ml) was fixed with 2 ml of Winkler I and II reagents. 2ml of concentrated H₂SO₄ was also added to aid liberation of iodine equivalent to the original DO content in the sample. The samples were then titrated with a standard solution of 0.025 M thiosulphate. The difference between initial and 5 day DO gave the BOD values in mg l⁻¹ of Oxygen.

Soil Mechanical and Physical Properties.

Particle size distribution was determined by the methods of Bougoueus as described by Day (1967) which involves dispersing the soil with sodium hexametaphosphate (CALGON), followed by saturation and hydration of particles with sodium hydroxide. Temperature readings as well as hydrometer readings to determine the water content were taken at specific intervals. Textural classes were then obtained from the texture analysis and expressed as % clay, % silt and % sand.

Soil Chemical Analyses

pH: This was measured in 1:1 soil to water suspension with a glass electrode pH meter. Similar measurement was also made in a 1:1 soil to 1.0 M KCl suspension. The pH meter used was bench CIBA Corning/Kent/EIL 7055 (1990) with a sensitivity of + 0.01.



- ii) Electrical Conductivity (EC): This was measured in the 1:1 soil to water suspension after the pH measurement using a bench/field Corning portable conductivity meter-(1990) with a sensitivity of + 0.5%, 0.2 μ Sat 5 mg/l ionic strength. The results were expressed in micro-siemens (μ S) per cm.
- iii) Organic Carbon: This was determined using ground soil sample by the chromic acid wet oxidation method of Walkley and Black (1973).
- iv) Total Nitrogen: Ground samples of the soil were digested by the modified Kjeldahl method using a BD20/40 Tecator block digester with concentrated H₂SO₄ and Selenium catalyst. The nitrogen content in the digest was determined on a bench Technicon-Auto-Analyser II.(1980/1985) with a sensitivity of 0.001 ppm.
- v) Nutrient/Fertility Analysis.
Available Phosphate: The available phosphate in the soil was extracted with Brain P1 solution (NH₄F 0.03N + HCl 0.02 N) and analysed using the ascorbic acid- molybdenum blue colour method of Murphy and Ritney (1972) on a bench Technicon-Auto-Analyser II (1980/1985) with a sensitivity of 0.001 ppm
- vi) NO₃⁻, NO₂⁻, and NH₄⁺ Nitrogen forms: The NO₃⁻, NO₂⁻, and NH₄⁺ nitrogen forms in the soils were determined by shaking 5.0g of representative soil sample with 50ml of 1.0 N K₂SO₄ and extracted, using Morgan's reagent. The NO₃-N forms were assayed using the Brucine method of Greweling and Peech (1964). Likewise, the NO₂-N and the NH₄⁺ N forms were assayed using the alpha naphthol method and the alkaline phenate method respectively. A bench Technicon-Auto Analyser II (1980/1988) with a sensitivity of 0.001 ppm was also used.
- vii) Sulphate (SO₄²⁻): The sulphate in the soil was extracted with a 500ml solution of potassium orthophosphate and the sulphate determined by BaCl₂. 2H₂O Gelatic turbidimetric method.
- viii) Exchangeable Cations (Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺): The exchangeable cations of the soil were extracted by equilibrating/shaking in neutral ammonium acetate. Calcium and magnesium ions concentrations were determined volumetrically by titration with EDTA while Na⁺ and K⁺ were determined by flame photometry using a digital bench Gallenkamp flame photometer (1990) with a sensitivity of 3 ppm.
- ix) Exchangeable Acidity (H⁺ and Al³⁺): Exchangeable H⁺ and Al³⁺ were determined by extraction with 1.0M KCl solution. The extract was first determined for exchangeable acidity (H⁺ + Al³⁺) by filtration with 0.05N HCl using phenolphthalein as indicator. Al³⁺ was only determined with 0.05N HCl after addition of 10 ml NaF solution (McLean, 1965).
- x) Effective Cation Exchange Capacity (ECEC): The effective cation exchange capacity (ECEC) was taken as summation of exchangeable bases (Ca²⁺, Mg²⁺, Na⁺, K⁺) and exchange acidity (Al³⁺ + H⁺) (Black et al., 1965).



xi) Heavy Metals Analyses: The heavy metals (Fe, Mn, Zn, Cu, Cr, Cd, Ni, V, Pb, Hg) were extracted using a mixture of equal volumes of analytical grade of a 1:10 soil to water ratio, shaken for 1h and followed by filtration. Fe, Mn, Zn, Cu, Cr, Cd, Ni, V, Pb and Hg were determined by Flame Atomic Absorption Spectrometer (AAS) using air-acetylene flame. Vanadium by AAS, but using nitrous oxide-acetylene flame. Hg was analysed by the flameless AAS using the cold vapour mode.

xii) Total Hydrocarbon Content: Five (5) grammes of the representative soil samples were weighed into 100ml volumetric flask. 10ml of xylene was added and mixed by swirling for 5 minutes and filtered through Whatman No 1. filter paper. The filtrate obtained was placed in the sample cell and measured in the UV spectrophotometer (Bench CECIL absorbance 303/393, sensitivity is + 0.01 ppm). The concentration of hydrocarbon was obtained from standard calibration curve and the results were reported in mg/kg.

xiii) Planktons: The phytoplankton species were identified using a Leitz Orthoplan Universal Wide-Field Research Microscope equipped with tracing and measuring devices. Enumeration of cells per m³ was computed using the following formula:

Number of cells/m³ = [N X 1000]/[Initial volume of water filtered]

where N = Cells counted per sample. That is;

$$\frac{\text{Counts x Fraction}}{\text{No. of fields counted}} \times \frac{1}{\text{Volume of Chamber}} \times \frac{100}{1}$$

Sorting and identification of the zooplankton were performed using a Wild-Lietz Stereo Zoom dissecting microscope and an Olympus Universal Vanox Research microscope with drawing attachment. Representative specimens were mounted in 100% glycerine after dissection of relevant taxonomic parts. Identifications were made to the lowest possible taxonomic level using relevant identification keys. Individuals of each identified taxon in each sample were enumerated using the counting chamber, and the zooplankton density expressed in numbers per m³ using the formula:

Number of individuals/m³ = [N X 1000]/[Initial volume of water filtered]

Where, N = total number of zooplanktons per sample.

Where Subsamples from the original 100ml concentrated samples were used, ‘N’ was first computed from the original sample before estimating the density.

xiv) Benthos: Benthic analysis was carried out using the Binocular Dissecting Microscope and the compound microscope for sorting, dissecting, slide preparation, identification and counting.

Faunal densities were computed in numbers per m² by multiplying the counts in the bank-root biotope by 4 and those of the bottom sediment by 44.4.

Indices of diversity and evenness were used to characterise the biotic communities. The following indices were used:

(1) Margalef’s index (d) of taxa richness where $d = \frac{S-1}{\ln N}$
 S = number of taxa, and N = total number of individuals/cell.

(2) Shannon-Wiener index (H) of general diversity: where $H = \frac{N \log N - \sum f_j \log f_j}{N}$



N = total number of individuals/cell and f_i = Number of individuals/cell in species 'i'.

(3) Evenness Index (E), where $E = H / H_{max}$; where $H_{max} = \log S$.

Evenness measures the degree of uniformity in the distribution or spread of individuals among the species (Odum 1971, Zar 1983).

xv) Microbiology: Soil microorganisms were estimated by the soil dilution plate method in which serial dilution of all the soil samples in sterile normal saline were plated on a surface agar medium. 10 g of each sample was aseptically added to 90ml of sterile normal saline and shaken vigorously to give a 10-fold dilution (10⁻¹). Transferring 1ml of the soil suspension to 9ml of the diluents, 10-fold serial dilutions were made. Up to 10⁻⁴ aliquots (0.1ml) of appropriate dilutions were then spread/plated in duplicate on surface nutrient agar (Oxoid cm 13), MacConkey agar (Oxoid cm 7) and Sabouraud dextrose agar (SDA). The nutrient agar and MacConkey agar plates were incubated at 37°C for 24 hours, while the Sabouraud agar plates were incubated at ambient temperature (28-30°C) for 3 - 7 days. Chloramphenicol was added to differentially isolate fungi. The plates with soil extract were incubated at 30°C for 96 hours for fungi species.

Population counts of hydrocarbon degrading bacteria and fungi were carried out using the methods of Mills et al., (1978). The prepared media were autoclaved at 121°C for 15 minutes. Each inoculated plate was inverted over sterile filter paper, which was moistened with Bonny light blend crude oil, placed in the lid of the Petri dish for 4 days. The resulting hydrocarbon biodegrading bacteria and fungi were recorded and their counts expressed as a percentage of the total heterotrophic bacteria or fungi.

Diseased plant/crop parts were aseptically collected using a sharp knife into sterilized polythene bags for further pathological studies in the laboratory. Photographs of the dominant vegetation types as well as other features of interest were taken. A total of 27 vegetation sampling sites were studied.

xvi) Plant Tissue Analysis: Mature leaves samples collected from the field were oven-dried at 70°C and milled to pass through a 2 mm mesh sieve. Sub-samples of these milled samples were then dry-ashed or wet-ashed (in some cases) and analysed to estimate their chemical composition.

Dry-ashing of plant materials was carried out by placing 1g of the finely ground plant material in silica dish and placed in a muffle furnace and burnt to ash at 550 °C for 4 hours. It was then cooled and the ash dissolved in 5 ml of 2N HNO₃, filtered into a 50 ml volumetric flask and diluted to volume with distilled water. Determinations of K, Ca, Mg, Mn, Fe, Zn, Cu, Cr, Pb, Ni, V, Cd and Hg were then carried out with a flame photometer, Auto Analyser, and Atomic Absorption Spectrophotometer. For the determination of phosphorous, the milled samples were also dry-ashed, only that the plant materials were treated with about 5ml of a 50% solution of hydrated magnesium nitrate (Mg (NO₃)₂ · 6H₂O) and heated at low temperature on a water bath until completely dried, before being burnt to ash in a muffle furnace at 550 °C for four hours, after which it was allowed to cool. Determination of nitrogen in plant samples was by using Kjeldahl's method with 0.5g of plant material.



xvii) Identification of Disease Pathogens: Diseased plant specimens were where necessary, washed with clean water before sterilization with 0.1% of HgCl₂ for one minute. Sterilized plant materials were then washed in sterile distilled water to remove traces of the sterilant. These were then cut into small bits (2 mm x 2 mm) and plated in nutrient medium following the methods of Wadel and Weber (1963) and Emua and Fajola (1982).

Three media were used in the isolation of pathogenic organisms, viz.: Yeast Extract Agar (YEA), Potato Dextrose Agar (PDA) as well as a decoction of the respective plant material. While the YEA and PDA were prepared following standard methods, the decoctions were each prepared as follows:

A 250g of plant material was chopped and boiled in 500 ml distilled water for one hour. This was allowed to cool and the supernatant carefully filtered through a laboratory test sieve (2 mm aperture). A 10g laboratory nutrient broth and 20g agar-agar were then added. This was then made up to one liter, mixed and dispensed at 200 ml into 250 ml conical flasks for sterilization. All media were sterilized in the autoclave at 1 kg/cm² for 15 minutes.

Specimens were inoculated into media plates and incubated at 25°C ± 1°C until adequate growth of organisms was obtained. Colonies so formed were examined under the microscope, counted and correctly identified using specific texts (Barneth and Hunter 1972, Street 1969).

Appendix 2

SOCIAL IMPACT ASSESSMENT (SIA) QUESTIONNAIRE FOR THE SOKU GAS PLANT-SANBARTH MANIFOLD PIPELINE PROJECT

Survey Questionnaire

Name of Community/Village: -----
 Name of Clan: -----
 LGA: -----
 Ethnicity / Language -----
 Name of Respondent: -----
 Post held in Community -----
 Respondent's code -----
 Date of Interview -----

01 Age of Respondent ----- 02 Period of Birth -----
 03 Respondent's Sex [] Male [] Female
 04 Respondent's Religion [] None [] Church
 [] African Traditional Religion
 05 Marital Status [] Single [] Married [] Divorced
 [] Re-married [] Widowed [] others specify
 06 If married, How [] introduction [] Bride price [] Church
 [] Court [] Yet to pay the bride price
 07 How old were you when you married? [] 12-16 [] 17-20 [] 21-24



25-29 30-35 over 36

08 What is the predominate type of marriage in this community? Suggest Proportion

09 Is your family Polygamous? Yes No

10 If yes, how many wives / mates do you have? 1 2-3 4-5 Above 5

11 How many children do you have? Specify sex and ages please

Sex of Children	0-5 yrs	6-10 yrs	11-15 yrs	16-20 yrs	21-24yrs	25+	Total
Females							
Males							

12 How many persons live with you in your house? Please specify relationship.

	Males	Female	Employed	Unemployed	Total
Children					
Relatives					
Other Assistants					

13 How old is your oldest / first child and youngest child

14 Can you Read Write. Please indicate yes or no within brackets.

15 Highest level of Education attained No formal Education Primary School

Secondary / TCII/GCE Diploma /NCE

Degree/ HND others, specify-----

16 Vocational Training / Skill Acquired

Tailoring Hair dressing Mat Making Pot making Baking Mechanic /Technician Mason Builder Blacksmith Trade Farming Traditional Birth Attendant (TBA) Fishing others, please specify

17 What is your major source of livelihood / occupation?

18 Please list other occupations specifying period(s)

19 Please list your sources of income and amount

Source of Income	Amount/Week	Amount/Month	Amount/Year

20 How many years have you been practicing your occupation? Years of experience 1-5 6 -10 11-15 16 – 20 21– 25 26 - 30 over 30 years

21 What type of house do you live in? one room Room and parlour Flat self contain others, specify

22 The accommodation is, rented family owned



- 23 If it is rented how much do you pay (monthly or yearly, please specify)
- 24 What is the rent in this community now? [] last two years []
- 25 In this community land is owned by [] the community [] individuals
- 26 How is land acquired in this community either for building a house or farming? [] By buying from those who have [] Through inheritance [] Others,. specify
- 27 Tick and indicate the importance of crops grown in this community. (Most important = 1)

Crops	Rank	Main reason for rank given	Income
Yam			
Plantain			
Oil Palm tree			
Rubber			
Pineapple			
Pepper			
Maize			
Melon			
Tomatoes			
Cassava			
Sweet Potatoes			
Vegetables			

27 How much do you spend on the following items?

	Weekly	Monthly	Quarterly	Yearly
House rent				
Meat/fish				
Garri				
Rice				
Beans				
Uniforms				
Books for children				
School fees specify				
Transportation				
Household items specify				
Health care				
Police case				

Awareness of Proposed Project

- 29 Are you aware of the proposed Trans Niger pipeline project? [] Yes [] No
- 30 If yes, what was your source of the information (Please specify)
- 31 Do you know some of the activities that would be involved in the project? [] Yes []No
- 32 If yes, please list the main activities that you know and likely effect on the community _____
- 33 What is your perception of this project in general? _____



34. Do you think that this project will impact on this community? Yes [] No []

35. If yes, please estimate the magnitude and direction of the impact on these (listed) social economic variables

Potential Impact	When expected	Good or Bad (Direction)	Who will suffer most?	Degree	Remark
Employment					
School drop out rates					
Income Generation					
Influx of People					
Water Pollution					
Reduced access to water front					
Fish catch					
Drugs					
Prostitution					
Unwanted pregnancies					
Teenage pregnancies					
Robbery					
Others					

36. Which of the following Amenities exist in this community? Please state source, condition and distance from community centre.

Facility / Benefit	Present	No.	Provided By	Year	Condition	Distance
Jetty						
Public Toilet						
Tarred roads						
Primary school						
Secondary school						
Health centre						
Town hall						
Employment						
Scholarship						
Skill acquisition centre						
Electricity						
Pipe borne water						
Training						
Market Stall built						
Micro credit						



Waste Management						
Recreational Facilities						
Embankment						
Shoreline Protection						
Educational Institution						
Bridges						
Others						

37. How in your opinion can the negative (bad) effect of the proposed project be minimized and remediated? _____

38. How best should the benefits of the proposed project be managed?

39. Please do you have any information for us? _____



APPENDIX 3

HEALTH IMPACT ASSESSMENT QUESTIONNAIRE FOR THE Soku Gas Plant-Sanbarth Manifold Pipeline Project

We are interested in studying the health impact of the proposed Soku Gas Plant-Sanbarth Manifold Pipeline Project on your community. This questionnaire is designed to enable us obtain relevant information. We need your assistance and cooperation in answering the questions asked below. Your answers will be treated as confidential.

SECTION 1: BASIC DATA

Name of community _____ **COMMUNITY**

Date of interview:

Name of Interviewer:

Name of Respondent: .._____

.

SECTION 2: HOUSEHOLD DETAILS

Line No.	Name of ALL Members of Household	RELATIONSHIP TO HEAD OF HOUSEHOLD	RESIDENCE	SEX	AGES	IF AGED 6 YEARS OR OLDER				
						EDUCATION		MAIN OCCUPATION	MARITAL STATUS	
	Please give me the names of the persons who live in your household, starting with the head of the household.	01= wife or husband 02= son or daughter 03= son or daughter-in-law 04= grandchild 05= parent 06= parent-in-law 07= brother or sister 08= other relative 09= not related 99= NK	Does (NAME) usually live here?	Is (NAME) male or female?	How old is (NAME)? IN YEARS	Has (NAME) ever been to school?	IF ATTENDED SCHOOL			01= farming 02= trading 03= fishing 04= civil servant 05= company worker 06= business / Contractor 07= student 08= apprentice 09= housewife only 10= pensioner only 11= artisan 12= Professional 13= Other
What is the highest level of school (NAME) attended?							Is (NAME) still in school?			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Head		HEAD	YES NO 1 2	M F 1 2		Yes No 1 2		YES NO 1 2		

02			1 2	1 2		1 2		1 2		
03			1 2	1 2		1 2		1 2		
04			1 2	1 2		1 2		1 2		
05			1 2	1 2		1 2		1 2		

SECTION 3: Environmental Health Data:

s/no	Questions and filters	Categories
	What is the main source of drinking water for members of your household	River/Stream Well Rain Water Public pipe-borne water Mono pump Piped into toilets and kitchen Borehole (Commercial) Borehole (private) Commercial tanker Bottled water Sachet (pure) water
	What is the main source of water for cooking and washing for members of your household	River/Stream Well Rain Water Public pipe-borne water Mono pump Piped into toilets and kitchen Borehole (Commercial) Borehole (private) Commercial tanker
	What is the average distance you have to cover to fetch water from the main water source in	Piped supply

	your community	Less than 15 minutes 15 – 30 minutes 31 – 60 minutes More than one hour
	How long does it take to fetch enough water that will take care of the needs of the household for a day	Piped supply Less than 30 minutes 31 – 60 minutes 1 – 2 hours More than two hours
	Who usually fetch the water for the household?	Adult women Adult women and children Adult men Children Any member of the household
	Do you do anything to the water to make it safer to drink?	Yes (Go to the next question) No (Skip the next question)
	What do you usually do to make the water safer to drink? (Don't read out the categories, but circle as they are mentioned)	Boiling Alum Cloth filtration Waterguard Allowed to settle Household commercial filter Others:
	What kind of toilet facility do members of your household usually use?	Water closet toilet Pour flush (squat toilet) Pit latrine Bucket toilet Jetty-type (overhung toilet) Open defecation/ bush Disposal with refuse
	Do you share this toilet facility with other households?	Yes (Go to the next question) No (Skip the next question)

	How many households use this toilet facility?	Less than five households More than ten household
	Do you wash your hands after using the toilet	Yes No
	INTERVIEWER: DON'T ask the respondent, but look at his residential house, and record the following observations	The type of house: The materials used for the roof: The material used for the floor The number of windows:
	How many members of your household sleep in a room?	
	Do you have a separate room which is used as a kitchen? (Please observe and record your finding)	
	What type of fuel does your household mainly use for cooking?	Electricity Gas Kerosene stove Firewood
	Which types of wastes does your household regularly generate?	Food and kitchen wastes Agricultural wastes Electronics Wastes from manufacturing activities
	Can you estimate the quantity of wastes generated by your household in a day?	1 – 2 kg/day 2 – 5 kg/day More than 5 kg/day

	Do you store these wastes in a container?	Yes No
	How do you dispose these wastes?	Dumped at the nearest bush Refuse pit Burning River/ stream Communal dump site Collected by waste disposal authority

SECTION 4: Nutritional status

s/no	Questions and filters	Categories
	What are the major foods items eaten in your household?	
	How many times does the children in household eat in a day	
	How many times does the adults in household eat in a day	
	Can you tell me what your household ate yesterday for breakfast, lunch and dinner (24-hour dietary recall)	
	Have you had any worry about what to eat the next day in recent times?	
	Anthropometric measurements: Please let me take the measurements of your under-five children No: Age:	No: Age:

	Sex: Weight; Height: MUAC:	Sex: Weight; Height: MUAC:
	No: Age: Sex: Weight; Height: MUAC:	No: Age: Sex: Weight; Height: MUAC:

SECTION 5: Lifestyle and use of alcohol and tobacco

s/no	Questions and filters	Categories
	Do you have sexual partners not married to you?	Yes (Go to the next question) No (Skip the next question)
	How many are they?	
	Have ever paid for sex before?	

	How many different persons have you made love to in your lifetime?	
	Do you regularly use condom when you make love to your sexual partners not married to you?	
	Have you ever had a sexually Transmissible Infection before?	Yes (Go to the next question) No (Skip the next question)
	If yes, how did you treat it?	Self medication Chemist Native treatment Private hospital Government hospital
	Do you smoke?	Yes (Go to the next question) No (Skip the next question)
	How many sticks of cigarette do you smoke in a day?	
	Does your smoking affect your ability to take care of your household?	Yes No
	Do you take alcohol regularly?	Yes (Go to the next question) No (Skip the next question)
	How many bottles of your favorite alcoholic drink do you take in a week?	
	Have you been drunk before?	Yes (Go to the next question) No (Skip the next question)
	How often many times have you been drunk in the past two months?	
	Have you been drunk while drinking with a sexual partner?	

SECTION 6: Knowledge of HIV/AIDS

	Have you ever heard of an illness called AIDS?	Yes (Go to the next question) No (Skip the next question)
	Do you know how HIV can infect somebody?	Yes (Go to the next question) No (Skip the next question)
	Can you name the methods	Able to mention just 1 - 3

		Mentioned more than three
	Can people reduce their chance of getting the AIDS virus by not having sexual intercourse at all?	Yes No Don't know
	Can people reduce their chance of getting the AIDS virus by having just one uninfected sexual partner who has no other sex partner?	Yes No Don't know
	Can people reduce their chance of getting the AIDS virus by regularly using condom?	Yes No Don't know
	Has any case of HIV/AIDS been reported in your community?	Yes (Go to the next question) No (Skip the next question)

SECTION 7: Morbidity and Mortality information

Please list the common health problems of members of your household?

Health problem (Local name)	Approximate English name	How common?	How severe?	Any seasonal trend?

Household Mortality information

s/no	Questions and filters	Categories
	Has there been any death of a child in the household in the past one year?	Yes (Go to the next question) No (Skip the next question)
	If yes, how old is the child?	
	What sickness killed him?	
	Was the child taken to the hospital?	
	If no, why	



	Has there been any death of a pregnant woman in the household in the past one year?	
	If yes, what killed the woman?	
	Was the woman taken to the hospital?	
	If no, why	

SECTION 7: Health Service information

s/no	Questions and filters	Categories
	Tell me the government facilities that serve your community?	
	How far are they from the community?	Within 30 minutes walking distance 30 – 60 minutes walking distance More than one hour walking distance
	Are you satisfied with the quality of services in the health facilities	Yes No
	Are the government health facilities adequately staffed and properly equipped?	Yes No
	Does the staff treat patients with courtesy?	Yes No
	What are the things that will encourage members of the community to use government health facilities?	
	Is the cost of modern medical care affordable to most members of the community?	Yes No
	If no, what are your suggestions to ensure that medical care are affordable to all?	

SECTION 8: Impact of project information


s/no	Questions and filters	Categories
------	-----------------------	------------

	Are you aware of plans to execute this pipeline project?	Yes No
	In what ways do you foresee that the project may POSITIVELY change the lives of the people of your community	
	In what ways do you foresee that the project may NEGATIVELY change the lives of the people of the community	
	What are the best ways of ensuring that the POSITIVE effects of the project get to every member of the community?	
	What are the best ways of handling the adverse effects of the project?	
	Do you think the project would have any health effect?	
	If yes, can you list the possible health effects?	
Health effect	Those most likely to be affected	Possible remedial actions

Appendix 4 SOKU PIPELINE MAP



Appendix 5
CRUDE OIL SHOC

 SAFE HANDLING OF CHEMICALS (SHOC)			
			SHOC NO: 110
CRUDE OIL			
COMPOSITION:	Benzene; Butane; N-Heptane; Cyclohexane; Cyclopentane; Hexane; Hydrogen sulphide; Nonane; Octane; etc.	APPEARANCE AND ODOUR:	Dark brown/black liquid with hydrocarbon/sulphide odour.
USAGE:	To generate refined products	INCOMPATIBILITIES:	Strong oxidising agents, strong acids, caustics
TYPES OF HAZARD/ EXPOSURE	HAZARDS/SYMPTOMS:	PRECAUTIONS:	FIRE EXTINGUISHING AGENTS / FIRST AID:
SAFETY:			
FIRE:	Flammable	No open flames, no sparks no smoking.	Foam, carbon dioxide, dry chemical and halon are all right. Foam/water fog causes frothing.
STABILITY:	Stable.	Avoid heat, sparks, open flame & ignition	
HEALTH			
INHALATION (BREATHING):	Respiratory tract irritation, central nervous system effects, anaemia.	Proper respirator and ventilation.	Remove to fresh air. Treat symptomatically. Obtain medical attention.
SKIN:	Irritation, cracking, redness, itching, inflammation, dizziness	Protective gloves and impervious clothing / boots.	Wash with soap and water. Take off contaminated clothing. Obtain medical attention.
EYES:	Irritation, redness, tearing, blurred vision.	Safety glasses, goggle (chemical splash type)	Flush eyes with plenty of water and obtain medical attention.
INGESTION (SWALLOWING):	Diarrhoea, Harmful or fatal if swallowed. Vomiting. Gastrointestinal disturbance	Do not eat, drink, or smoke during work.	Do not induce vomiting. Give vegetable oil. Get medical attention.
ENVIRONMENT / ECOLOGY			
	Toxic to aquatic and terrestrial life.	Avoid contamination of soil and water.	
SPILLAGE MITIGATION:	Stay upwind and away from spill. Isolate hazard area. Recover as much as possible. Absorb with earth.		PACKAGING MATERIAL:
DISPOSAL OPTION:	Dispose via crude delivery line / saver pit or incinerate.		STORAGE: Keep away from heat, sparks & flames Do not pressurise, cut, weld, braze, solder or drill near this container.
		FLASH POINT:	-40 to 200°F
		AUTO IGNITION TEMPERATURE:	500°F
VERSION: 05	DATE OF ISSUE: MARCH 2004		



GENERAL PURPOSE GREASE SHOC

**SAFE HANDLING OF CHEMICALS (SHOC)**

GENERAL PURPOSE GREASE		SHOC NO:	185
COMPOSITION:	Non-hazardous ingredients.	APPEARANCE AND ODOUR:	Yellow semi - solid.
USAGE:	Lubricating material.	INCOMPATIBILITIES:	Oxidising materials.
TYPES OF HAZARD/ EXPOSURE	HAZARDS/ SYMPTOMS:	PRECAUTIONS:	FIRE EXTINGUISHING AGENTS / FIRST AID
SAFETY:			
FIRE:	Combustible		Dry chemical, foam, water spray.
STABILITY:	Stable	Not applicable.	
HEALTH			
INHALATION (BREATHING):	No hazard expected.	Adequate ventilation.	Move to fresh air. Support breathing.
SKIN:	No hazard expected.	Wear appropriate protective clothing & gloves. Safety shower.	Wipe off and wash with water.
EYES:	No hazard expected.	Protective eyeglasses or chemical safety goggles. Eyewash.	Flush with water for 15 minutes.
INGESTION (SWALLOWING):	No hazard expected.	Do not eat, drink, or smoke during work. Wash hands to eat.	Contact a doctor immediately.
ENVIRONMENT / ECOLOGY			
	Toxic to aquatic and terrestrial life	Avoid contamination of soil and water	
SPILLAGE MITIGATION:		PACKAGING MATERIAL:	



Use absorbent materials to collect & contain for salvage or disposal.	STORAGE: Store in a cool, dry place. Store in a tightly closed container. Reasonable care should be taken.
DISPOSAL OPTION: Incinerate or discharge into CRUDE OIL CARRIER	FLASH POINT: AUTO IGNITION TEMPERATURE:
VERSION: 05	DATE OF ISSUE: MARCH 2004

BENTONITE SHOC



SAFE HANDLING OF CHEMICALS (SHOC)

SHOC NO: 046



BENTONITE (Alumina Silicate)			
COMPOSITION:	Aluminium silicate; crystalline silica.	APPEARANCE AND ODOUR:	Odourless granules or powder in variable colour.
USAGE:	Drilling mud.	INCOMPATIBILITIES:	Heat.
TYPES OF HAZARD/ EXPOSURE	HAZARDS/SYMP TOMS:	PRECAUTIONS:	FIRE EXTINGUISHING AGENTS / FIRST AID:
SAFETY:			
FIRE:	Not combustible		Use extinguishing agent appropriate to the surrounding fire conditions.
STABILITY:	Stable.	Avoid heat.	
HEALTH			
INHALATION (BREATHING):	May have effects on the lungs resulting in silicosis.	Avoid inhalation of fine dust and mist. Use masked respirator with dust filter cartridge.	Fresh air. Seek medical advice.
SKIN:	Irritation	Use protective gloves.	Wash thoroughly with soap and water. Seek medical advice.
EYES:	Redness, pain.	Use safety spectacle.	Flush with plenty of water.
INGESTION (SWALLOWING):	Intestinal discomfort.	Do not eat, drink or smoke during work.	Seek medical attention immediately.
ENVIRONMENT / ECOLOGY			
	Significantly toxic to terrestrial and aquatic life.	Avoid contamination of soil and water.	
SPILLAGE MITIGATION: Sweep spilled substance into containers. If appropriate, moisten first to prevent dust. Disperse remainder with plenty of water.		PACKAGING MATERIAL: Paper bags or pallets.	
		STORAGE: Keep dry in a cool area.	
DISPOSAL OPTION: Re-use or dispose off in a controlled landfill or incinerate.		FLASH POINT:	N/A
		AUTO IGNITION TEMPERATURE:	N/A



VERSION: 05

DATE OF ISSUE:
2004.

MARCH

APPENDIX 6 – Samples and location coordinates

Air Quality		
Samples	XFIELD	YFIELD
AQ01	462682.232	71301.469
AQ02	466139.259	67332.944
AQ03	468026.513	64122.848
AQ04	467373.911	60612.907
AQ05	469067.149	56609.106
AQc01	466880.050	71266.193
Boreholes		
Samples	XFIELD	YFIELD
BH01	461694.511	73135.810
BH02	460512.772	72059.898
BH03	462100.182	70772.332
BH04	469578.648	58020.137
BH05	468590.926	57296.984
BH06	469102.425	56256.348
Soil/Vegetation		
Samples	XFIELD	YFIELD
SS/VG01	461800.338	71160.366
SS/VG02	464569.487	69890.438
SS/VG03	464957.520	68567.596
SS/VG04	465839.415	67544.598
SS/VG05	467038.791	65551.517
SS/VG06	468396.909	63646.624
SS/VG07	466880.050	61847.560
SS/VG08	468626.202	59554.634
SS/VG09	469472.820	57014.778
SS/VGc01	466668.396	70825.246
Surface Water/Sediments		
Samples	XFIELD	YFIELD
SW/SD01	460212.928	72624.311
SW/SD02	462258.923	71671.865
SW/SD03	462470.578	70666.505
SW/SD04	465539.571	68391.217
SW/SD05	464886.969	67668.064
SW/SD06	465786.501	66415.773



SW/SD07	468273.444	63223.315
SW/SD08	468343.995	59731.013
SW/SD09	469455.183	59977.943
SW/SDc01	466403.827	71336.745