Bauchi Solar Power Project

Environmental & Sampling and Analysis Plan (SAP)

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Appendix 1:

Terms of Reference

Bauchi Solar (PV) Power Project

Environmental & Social Impact Assessment (ESIA): Scope of Work

Introduction

NSCP is planning to develop a 100MW Solar PV Power Plant in Bauchi Nigeria.

Purpose

The Government and the World Bank, both require the preparation of an Environmental Impact $ Social Assessment (ESIA) prior to the establishment of the facility. Public consultation is an integral part of the ESIA process, and guidance is provided above.

Specific Objectives

EnvironQuest (consultant) shall undertake surveys, conduct studies, consult with the community and compile the ESIA report. The ESIA should cover all likely construction and operation activities and will include, but not to be limited to, an assessment of the environmental and social impacts relating to the:

a. physical and geographical suitability
b. land acquisition; displacement of people; and public acceptability of the proposed facility and transmission route;
c. waste management (transfer, treatment and disposal) technologies to be employed;
d. pollution abatement options to be employed;
e. management control and operational practices to be employed;
f. potential for accidents and failures to be foreseen and mitigated; and

Study Area

Following the conclusion of the site selection exercise, the Consultant shall obtain the concurrence of the FMEnv. In doing so the consultant will be guided by public consultation that was undertaken previously.

Scope of Work

The specific tasks for the ESIA process include:

(a) Task 1- Project Description. In reality, this can only be done only after much of the environmental assessment and site level investigations are completed and alternatives are analyzed. The Consultant shall provide a description of the scope and physical characteristics of the proposed facility. This will include information on the project site, its location map, survey plan, and general layout of the proposed power plant. The Consultant shall assist NSCP to provide maps of appropriate scale (1:5.000 - 1:1.000) showing the project site and facilities. Maps that will be provided should be such that the project facilities could easily be pin-pointed in relation to geographic and hydrogeological features, existing transport system and human settlement in the area.

(b) Task 2 - Project Alternatives The Consultant shall make a systematic comparison of alternatives taking into account environmental and social factors. (a) Sites -synthesize the site selection exercise (b) Technologies - Compare the alternate technology options for the facility, and their environmental and social impacts and costs.

The basis for the selection of the recommended option for the project design must be stated. Include the alternative of not constructing the project, in order to demonstrate environmental conditions without it.

(c) Task 3 - Existing Environment and Baseline Conditions Data Collection: The Consultant will assist NSCP to define the study area taking into account the probable regions of influence of major project related environmental impacts. The Consultant shall collect data on relevant physical, biological and socio-economic conditions. This task will draw upon existing, available information from state agencies and research organizations and third parties, supplemented as necessary by a field monitoring program. It must be noted some of the data mentioned here will be collected as part of the site selection exercise. Emphasis should be placed on hydrology, geology and hydrogeological information, and other data, in the opinion of the consultant, crucial to the assignment. The Consultant shall propose in their proposal/work plan, the parameters (timeline, distance and area, sample size etc.) of data collection:

- terrain - topography, soils, soil erosion, climate and meteorology, ambient air quality (mainly particulates);
- hydrology and water quality - geology, drainage, water abstraction and usage, surface and groundwater hydrology, existing water quality status (critical parameters);
- biological - an inventory of flora and fauna, sensitive habitats and endangered species, and forest lands;
- socio-economic conditions - Human factors: population, community structure, employment, distribution of income, goods and services, recreation, public health, presence of tribal groups, their customs, aspirations and attitudes.
- Land features: land ownership, landuse and zoning, proximity of site to residential and economic locations and archaeological and historical properties, planned development activities, transport access and availability of utilities and services.

(d) Task 4 - Determination of the Potential Impacts. The Consultant will assist NSCP to begin by identifying positive and negative impacts likely to result from the proposed project, interpreting "environmental" throughout the EIA study to include socio-economic impacts as well as impacts on the natural environment. Following this, the Consultant shallto prepare a description of the likely changes in the prevailing environmental conditions that may be brought about by establishing the proposed facility.

This part of the study should distinguish between effects on the immediate vicinity of the facility from repercussions further away and should identify both short term and long term environmental impacts. Where practicable, the size and severity of effects should be quantified, and attention should be drawn to specific issues of uncertainty and trade-off between competing/ conflicting impacts. The extent and quality of available data, key data gaps and uncertainties associated with predictions should be described. Topics that do not require further attention should be specified. Any impacts that are irreversible and/or cannot be avoided or mitigate should be identified.

(e) Task 5 - Analysis and Evaluation of Risks. The Consultant shall identify the impacts that can translate to potential risks in the construction and operation phases, and perform risk analysis.

(f) Task 6 - Formulation of Environmental Management Plan

(i) Mitigation Plan. For each significant negative impact or major risk, the Consultant shall recommend and describe a measure to avoid or mitigate (reduce to acceptable levels) or when unavoidable, to compensate for the damage. If needed, the Consultant shall prepare the plan in two parts -- one for impacts and the other for risks. The description should include an estimate of capital and recurring costs and should identify the party (ies) responsible for implementation.

The Consultant should assist NSCP, if required, to revise the disaster management and emergency response plan for the area. The Consultant shall propose options for compensation to affected parties for impacts which cannot be mitigated especially those being displaced as a result of the proposed development.

Allocation of institutional responsibilities should be clearly specified, including capacity building needs. Where possible, mitigation measures that will be the responsibility of the construction contractor or equipment supplier, should be included as contract clauses in the respective tender/bid documents. The O&M phase mitigation measures should be incorporated in the relevant legal documents. In addition, the government agency responsible for implementation and supervision should be identified.

(ii) Monitoring Plan. The Consultant shall specify the types of monitoring needed for measuring potential environmental and social impacts during construction and operation phases. The Consultant shall also include opportunities for community monitoring by stakeholders. As in the case of the mitigation plan, requirements should be specific as to what is to be monitored, how and by whom (with clear delineation of responsibilities between the Proponent/Operator, Community Groups, and the FMEnv. Cost estimates are necessary and where monitoring reports are to be prepared, the recipient responsible for review and any corrective action should be identified.

(g) Task 7 - Resettlement Action Plan The objective is to minimize or reduce project affected people. If the project affected or displaced people exceeds 200, then the Consultant shall prepare a detailed Resettlement and Rehabilitation Action Plan as per World Bank OD 4.3. If the proposed site/facility is likely to impact tribal people, then an IPDP should be prepared as per OD 4.2.

Report. The EIA Report should be concise and limited to significant environmental issues. The report should have chapter headings reflecting the above tasks.

Appendix 2: Sampling and Analysis Plan

Introduction

This Sampling and Analysis Plan (SAP) has been prepared for the performance of site investigation to describe the objectives and locations of sampling activities, as well as field methods and procedures. The SAP also presents project management, design and implementation of measurement systems, assessment/oversight of quality assurance/quality control (QA/QC) issues, data validation, and QA/QC protocols necessary to achieve data quality objectives (DQOs). Furthermore, this SAP describes the procedures for collecting and analyzing surface water, groundwater, sediments, vegetation, air and soil samples taken at the study area.

The objectives of this SAP are to provide a rationale for field sampling activities at the project area; describe and establish consistent field sampling and data gathering procedures as well as handling, and documentation methods that are precise, accurate, representative and complete to meet the QC requirements for the project and the DQOs. The information collected will be used to establish the existing environmental conditions at the study area.

The information presented in this SAP is organized into four sections according to their function as follows:

Section I: Project Management – this group is divided into elements that describe general areas of project management, project history and objectives, and roles and responsibilities of the participants.

Section II: Data Generation and Acquisition – this group is divided into elements that describe the experimental design, sampling and analytical methods, sample handling, and QC requirements.

Section III: Assessment and Oversight – this group is divided into elements that describe activities for assessing the effectiveness of sample collection and analysis and associated QA/QC requirements.

Section IV: Data Validation and Usability – this group is divided into elements that describe quality assurance (QA) activities that occur after the data generation and acquisition phase of the project has been completed to ensure that data conform to the specified criteria and thus are useful for their intended purpose.

Section 1.0: Project Management

1.1 Project Organization and Responsibilities

Key personnel for this investigation include the Federal Ministry of Environment (FMEnv) representatives, EnvironQuest Project Manager, QA/QC Officer, and the EnvironQuest Project Team. A key subcontracted service is anticipated to be an analytical laboratory for the analyses of water (surface and ground), sediments, and soil samples.

1.2 Problem Definition/Background

The purpose of the activity is to conduct site investigation work to determine pre-project baseline conditions of the soil, groundwater, surface water, sediment, air, and vegetation as well as the social structure of the neighboring populations.

1.3 Project/Task Description

The major activities for this task order are as follows:

- Develop a sampling strategy to evaluate areas of interest identified in the Environmental overview report and prepare a Sampling and Analysis Plan
- Perform fieldwork to establish the existing state of the environment. Data will also be collected on social environment.
- Prepare a site investigation (SI) data report based on field activities at the **Bauchi Solar Power Project**.
- Provide for site visits and meetings necessary to plan and coordinate project work with representatives of the client, Bauchi State Government and regulatory agencies.

1.4 Quality Objectives and Criteria for Measurement Data

This section presents the DQOs for the project and the performance criteria necessary to meet these objectives. The overall QC objective is to generate data that are of known, documented, and defensible quality.

1.4.1 Data Quality Objectives

The QC procedures as well as the associated field sampling procedures for this project will be focused on achieving the DQOs in a timely, cost-effective, and safe manner. Deviations from the DQOs will require defining the cause or causes for noncompliance and will initiate the process of determining whether additional sampling and analyses will be required to attain project goals.

1.4.2 Quantitative Objectives: Precision, Accuracy and Completeness

The laboratory will review the QC samples to ensure that internal QC data lies within the limits of acceptability. Any suspect trends will be investigated and corrective actions taken.

Accuracy refers to the percentage of a known amount of analyte recovered from a given matrix. Percent recoveries can be calculated for the project-specific matrix (i.e., water and solids). The recovery of most spiked organic compounds is expected to fall within a range of 70% to 130%.

Completeness refers to the percentage of valid data received from actual testing done in the laboratory. The target completeness goal for all compounds is 90%. The goal by holding times will be 100%.

1.4.3 Qualitative Objectives: Comparability and Representativeness

Comparability is the degree to which one data set can be compared to another. To ensure comparability, samples will be collected at specified intervals and in a similar manner, and will be analyzed within the required holding times by accepted and comparable methods. All data and units used in reporting for this project will be consistent with accepted conventions for environmental matrix analyses. This approach will ensure direct comparability between the results from this project and the results from other projects using the methods presented in this SAP.

Representativeness is the degree to which a sample or group of samples is indicative of the population being studied. Over the course of a project, samples will be collected in a manner such that they are representative of both the chemical composition and the physical state of the sample at the time of sampling.

1.5 Training/Certification

Individuals implementing this SAP must receive, at a minimum, orientation to the project's purpose, scope, and methods of implementation. This orientation is the responsibility of the Project Manager. Field, laboratory, and data management personnel must have documented experience or direct training in the procedures that they will be performing for this project, including any applicable standard operating procedures (SOPs).

1.5.1 Field Training

Field team members will be adequately trained in sampling methods and procedures outlined in this plan. Specifically, field team members will have training in the following field activities: groundwater, soil and sediment sampling; sample handling, packaging, and shipping.

Subcontractors are responsible for their own training records; however, the EnvironQuest Field Superintendent will review methods prior to commencing work. The Field Manager is responsible for identifying worker certification needs for the field unit and ensuring that all team members are adequately trained.

1.5.2 Laboratory Training

Each laboratory technician and analyst must demonstrate continued proficiency for the analyses that they are performing. The procedures used to ensure that staff training is current and documented is defined in laboratory SOPs. The laboratory manager of the subcontracted laboratory is responsible for determining specific training and certification needs, and for ensuring that any required training is completed.

1.6 Documentation and Records

The Project Manager is responsible for maintaining the records to meet the requirements of this SAP. This requirement includes the maintenance of all records and data necessary for QC reports to management, corrective actions, and other associated documentation. Project documentation will be maintained for a minimum of five years following completion of the project.

Section 2.0: Field Sampling Plan

This sampling plan is intended to document the procedural and analytical requirements for this and any subsequent sampling events performed to collect air, surface water, soil, vegetation, and groundwater samples. The samples will be used to characterize areas of the Bauchi Solar Power Project. Discrete sampling will be used to assess the surface water, Groundwater and surrounding soils. The sampling will be conducted using proper sampling equipment. Each sample will be collected in its appropriate container and then carefully packaged and capped. Once capped, the samples will be sealed, labelled and packaged for shipping to the laboratory.

Reusable sampling equipment will be decontaminated between each sampling event. Decontamination will carried out at pre-determined areas. Disposable equipment intended for one-time use will not be decontaminated, but will be packaged for appropriate disposal. Personnel who collect samples will be required to change their gloves between each sampling event. The equipment needed to perform the sampling is listed below.

- Soil Auger with extensions to reach 1 m
- 0.1 m^2 Van Veen grab
- Niskin bottle sampler
- Field log book
- Sampling containers
- Mailing labels and markers
- First aid kit and eye wash
- Cooler and ice or blue ice
- Rain-coats & gloves (PPE)
- Packing tape
- Chain of custody forms and custody seals
- Decontamination equipment
- Pocket thermometer
- Air Quality kits
- GPS Unit

The following sections describe the field activities that will be performed as part of the site investigation. These activities include a survey to identify locations at the project site for the collection of soil samples.

2.1 Sampling Procedures

This SAP has been prepared to ensure that the DQOs specified for this project are met, the field sampling protocols are implemented, documented, reviewed in a consistent manner, and the data collected are scientifically valid and defensible.

2.1.1 Water Quality Requirement

The team will assess the ground and surface water quality present on the Bauchi Solar Power Project site through sample collection and laboratory analysis. Surface water samples will be collected upstream and downstream of the Zongoro River and Maji River using the direct dip method. Surface Water sampling will be conducted at 24 sampling stations and groundwater will be collected in the 10 boreholes located throughout the site.

Pre-cleaned plastic and glass containers will be used to collect water samples from point source at the above mentioned sampling point. The glassware will be used to collect samples for heavy metal and oil & grease analyses while samples for other physiochemical analyses will be

collected using plastic containers. Samples for microbiology were collected in sterile pre-labeled McCartney bottles and stored on ice and transferred to a refrigerator at the field base. The samples will be placed in laboratory supplied container, labelled, and logged on the chain of custody document sealed and preserved under appropriate conditions. The coolers will be sealed for transportation to the laboratory.

2.1.3 Sediments

Sediment samples will be collected with a 0.1 m^2 Van Veen grab. To ensure that enough sediment samples are collected and of comparable size, three grab samples will be collected from each station. Each grab sample will be inspected after retrieval for disturbance such as washout; the sample will be discarded if significant disturbance is observed. 1–2 cm of accepted samples will be removed and stored for physical and chemical analyses while the bulk left will be collected into a bucket, carefully spread and washed through a set of sieves of mesh sizes 0.5 mm and 1 mm with water. The residual macrofauna will be preserved in labeled bottles containing buffered formalin solution diluted to 20% and transported to the laboratory for further analysis.

2.1.4 Soil

At each soil sampling location, representative soil samples will be collected at two depths (0–15 cm and 15–30 cm), representing the topsoil and subsoil, respectively. To ensure the collection of representative soil samples, 10 core soil samples taken within 5–10 m radius of the sampling location will be composited/bulked in plastic bucket, and thoroughly homogenized before sub-sampling for laboratory analysis. Soil profiling will also be carried out with a profile each at the upper, mid and lower slope physiographic units of the power generating land area. Along the transmission line proposed right of way (RoW), three soil profile pits were also established. Thereafter, soil samples will be collected at 0–50 cm and 50–100 cm soil depth for geotechnical determination of Triaxial Test, Atterberg Limit, Particle Size distribution and Soil Strength.

2.1.5 Air, Climate and Meteorology

The EnvironQuest field team shall undertake a limited air quality study focused on the vicinity of the Bauchi Solar Power project.

The gaseous air pollutants - nitric oxide (NO, nitrogen dioxide (NO_2), sulphur dioxide (SO_2), hydrogen sulphide (H_2S), ammonia NH_3, volatile organic compounds (VOCs), and carbon monoxide (CO_2) – will be monitored in-situ using various gas monitors (ToxiRAE Model PGM-1140 NO Monitor, ToxiRAE Model PGM-1150 NO2 Monitor, ToxiRAE Model PGM-1130 SO2 Monitor, ToxiRAE Model PGM-1110 CO Monitor, ToxiRAE Model PGM-1110 NH3 Monitor, MultiRAE PGM50-5P Monitor for VOCs and H2S; GT-331 Particle Counter/Dust Monitor).

Heavy metal content of the ambient air samples will be measured using 2.5 cm diameter Whatmann cellulose filter and a Negretti Air sampler. Particulate matter (PM) will be measured by the gravimetric sampling method using the GT-331 particle mass monitor. Five mass ranges of particulates were measured: less than 1µm in diameter (PM1), 2.5µm (PM2.5), 7 µm (PM7), 10 µm (PM10) and Total Suspended Particles (TSP).

For all the pollutants (gases and particulates) and ambient noise levels, a sampling period of 8 hrs will be adopted.

2.1.6 Noise

Noise measurements will be taken with a digital, battery-powered, sound pressure level meter (EXTEC Instruments, US Model 407730) for both day time and night time noise level a sampling period of 8 hrs will be adopted.

2.1.7 Vegetation

Vegetation will be sampled along transects using quadrats. At each sampling point, the floral diversity as well as the population density of key economic and medicinal species will be studied using quadrats.

The sampling quadrats will be 10 m × 10 m for trees and 1 m × 1m for herbaceous plants. The vertical structure of vegetation shall also be studied along the same transects. The position of trees along transects, the approximate height of tree canopy, sapling canopy and understory stratum will also be recorded. Plant health status will be visually assessed by recording any abnormal senescence, yellowing, insect/fungal damage or shedding of leaves.

Samples that cannot be identified in the field will be taken to a herbarium for identification. Plant species will be identified to family, generic and species levels either in the field or herbarium using relevant manuals (e.g., Hutchinson and Dalziel, 1954-72; Gledhill, 1970; Saunders, 1958; Akobundu amd Agyakwa, 1987; Keay 1989). The generic name and epithets of all species will be given.

2.1.8 Wildlife Studies

Wildlife observations will be conducted during the day and at night to cover for diurnal and nocturnal animals. Binoculars will be used to enable the study of birds and other far distant animals. Specimens of animals and other samples obtained in the field will later be studied in detail in the laboratory for proper identification of the animals

2.1.9 Socio - Economic

The field work will be conducted using the following techniques of data collection:

Census of Zongoro Village

The census of the entire village would be conducted using an informal “small group discussion” (SGD) technique based on the five geographic clusters that constitute Zongoro.

Focus Group Discussions (FGD)

During the field survey, the team will conduct three FGDs using the designed FGD guide - one for male community leaders and elders; the second for male community youth; while the third for female members of the community.

Questionnaire Interview

Questionnaire will be used to obtain socio-economic and demographic data such as age, sex, occupation, marital status, income, household size, and religion; awareness of the proposed projects; fears; aspirations and expectations. The questionnaire interview will target all household heads in the communities, as well as one female out of every four households. The fieldwork will be conducted on a sample of respondents from among the study population who would be selected using a convenience sampling technique.

Altogether, 250 individual respondents will be interviewed for the study, in addition to three FGD sessions in the study communities. Socio-economic survey tools are presented in Appendix 4.

2.2 Sample Handling and Custody

This section presents sample handling and custody procedures. These procedures will ensure proper handling, custody, and documentation of the samples from field collection through laboratory analyses.

2.2.1 Sample Containers, Preservation and Holding Time

Requirements for sample containers, preservation, and holding times are listed in Tables 1 and 2. Once collected, each containerized sample will be labeled and placed into a matrix-specific sample cooler. The sample cooler will serve as the shipping container and will be packed with ice to cool samples to the appropriate temperature for preservation.

Table 1: Sample Preservation Methods for Water and Wastewater

Parameter	Container	Preservation	Maximum Holding Time
Bacterial Test			
Coliform, faecal and total	P, G	Cool, 4ºC	6 hours
Physical			
Colour	P, G	Cool, 4ºC	48 hours
Conductivity	P, G	Cool, 4ºC	48 hours
Total Hardness	P, G	Cool, 4ºC add HNO_3 to pH<2	6 months
Odor	G	Cool, 4ºC	24 hours
pH	P, G	none	Analyze immediately
Turbidity	P, G	Cool, 4ºC	7 days
Metals			
Chromium	P, G	Cool, 4ºC	24 hours
Mercury	P, G	HNO_3 to pH<2	28 days
Metals, except above	P, G	HNO_3 to pH<2	6 months
Inorganics, Non-Metallics			
Acidity and alkalinity	P, G	Cool, 4ºC	14 days
Ammonia	P, G	Cool, 4ºC, add H_2SO_4 to pH<2	28 days
Bromide	P, G	none	28 days
Chloride	P, G	none	28 days
Chlorine	P, G	none	Analyze immediately
Cyanides	P, G	Cool, 4ºC, add NaOH to pH<12	14 days
Electrical	P, G	Cool, 4ºC	24 hours
Conductivity			
Total Nitrogen	P, G	Cool, 4ºC, add H_2SO_4 to pH<2	28 days
Total Phosphorus	P, G	Cool, 4ºC, add H_2SO_4 to pH<2	28 days
Dissolved Oxygen	G bottle+ stopper	None required	Analyze immediately
Salinity as Cl	P, G	None required	7 days
Organics			
Chemical Oxygen	P, G	Cool, 4ºC, add H_2SO_4 to pH<2	7 days
Demand (COD)			
Biological Oxygen Demand (BOD)	P, G	Cool, 4ºC	48 hours
Oil & Grease	G	Cool, 4ºC, add H_2SO_4 to pH<2	28 days

Parameter	Container	Preservation	Maximum Holding Time
Organic Carbon	P, G	Cool, 4°C, add H_2SO_4 to pH<2	28 days

Table 2: Sample Preservation Methods for Bio-solids

Parameter	Wide-Mouthed Container	Preservative	Maximum Storage Time	Minimum Volume
Metals				
Solid and semi-solid samples	P,G	Cool, 4°C	6 months	300 mL
Liquid (mercury only)	P,G	HNO_3 to pH<2	28 days	500 mL
Liquid (all other metals)	P,G	HNO_3 to pH<2	6 months	1,000 mL
Pathogen Density and Vector Attraction Reduction				
Pathogens	G,P,B,SS	1. Cool in ice and water to <10°C if analysis is delayed >1 hr, or	6 hours	1–4 liters
		2. Cool promptly to <4°C, or	24 hours (bacteria)	
			1 month (helminth ova)	
		3. Freeze and store samples to be analyzed for viruses at 0°C	2 weeks	
Vector Attraction Reduction		Varies	Varies	

2.2.2 Sample Numbering

Each sample collected will be given a unique sample identification number (ID). The sample ID is project specific and a record of all sample IDs will be kept with the field records and recorded on a chain-of-custody (COC) form. The labeling scheme for sample identification will include site identification number and monitoring well number (i.e., R1-GW01; SPN-GW01) for groundwater samples, or site number and sample depth (i.e., R1-0') for soil samples.

2.2.3 Sample Labeling

Each sample collected for a project will have a sample label affixed to the outside of the container in an obvious location. All information will be recorded on the label with water-resistant ink. The exact sample label information will include the sample identification number, date and time of sample, preservation used, analytical methods, and site name.

2.2.4 Sample Custody

All samples collected under this project will be logged onto a COC form in the field prior to shipment or pickup by the laboratory. The COC form will be signed by the individual responsible for custody of the sample containers, and the original will accompany the samples to the laboratory. One copy of the COC form will be kept by the project manager and included in the project files. Information to be recorded on the COC should include:

- Sample matrix
- Sample collector's name
- Dates/times of sample collection
- Sample identification numbers
- Number and type of containers for each sample aliquot

- Type of preservation
- QC sample designation
- Analysis method
- Special handling instructions
- Destination of samples
- Name, date, time, and signature of each individual releasing the shipping container

The laboratory will designate a sample custodian. This individual is responsible for inspecting and verifying the correctness of the chain-of-custody records upon sample receipt. The sample custodian will accept the samples by signing the COC and noting the condition of the samples in the space provided on the COC or other receipt form. The sample custodian will notify the Project Team Leader of any discrepancies. The COC is generally considered to be a legal document and thus will be filled out legibly and as error free as possible.

Samples received by the laboratory will be entered into a sample management system, which must include:

- Laboratory sample number
- Field sample designation
- Analytical batch numbers
- List of analyses requested for each sample container

Immediately after receipt, the samples will be stored in an appropriate secure storage area. The laboratory will maintain custody of the samples as required by the contract or until further notification by the EnvironQuest Project Manager. The analytical laboratory will maintain written records showing the chronology of sample handling during the analysis process by various individuals at the laboratory.

2.2.5 Sample Packing and Shipment

The samples will be packed with shock-absorbent materials, such as bubble wrap, to prevent movement or breakage of the sample jars during transport. The ice chest will be filled with wet ice which will be double bagged in re-sealable bags in order to meet the temperature requirements ($4 \pm 2°C$).

The COC will be placed in a re-sealable bag and taped to the lid of the cooler. The ice chest will be banded with packaging tape and custody seals will be placed along the ice chest lid in order to prevent or indicate tampering. The cooler containing the environmental samples will either be picked up by the laboratory or arrangements will be made to have the cooler delivered to the laboratory.

2.2.6 Field Documents and Records.

A project-specific field logbook will be used to provide daily records of significant events, observations, and measurements during field investigations. The field logbook also will be used to document all sampling activities. All logbook entries will be made with indelible ink to provide a permanent record. Logbooks will be kept in the possession of the field team leader during the on-site work and all members of the field team will have access to the notebook. These notebooks will be maintained as permanent records. Any errors found in the logbook will be verified, crossed-through, and initialed by the person discovering the error.

The field notebooks are intended to provide sufficient data and observations to reconstruct events that occurred during field activities. Field logbooks should be permanently bound and pre-paginated; the use of designated forms should be used whenever possible to ensure that field

records are complete. The following items are examples of information that may be included in a field logbook:

- Sample location and description
- GPS coordinates of sample location
- Sampler's name(s)
- Date and time of sample collection
- Designation of sample as composite or grab
- Type of sample (soil, sediment or water)
- Type of sampling equipment used
- Field instrument reading, if applicable
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.)
- Preliminary sample descriptions
- Sample preservation
- Sample identification numbers
- Description of field procedures and problems encountered
- Name of recipient laboratory

In addition to the sampling information, the following specific information will also be recorded in the logbook:

- Team members and their responsibilities
- Time of arrival and departure
- Deviations from the sampling plan
- Level of health and safety protection

2.3 Decontamination Procedures

All equipment that comes into contact with potentially contaminated soil/waste will be decontaminated in a predestined area. Decontamination will occur prior to and after each use of a piece of equipment. All sampling devices used, including trenching equipment, will be decontaminated by EnvironQuest staff.

The decontamination process will be conducted using a five-step process on all field equipment to avoid cross contamination between samples and to ensure the health and safety of field personnel. The following sequence will be used to clean equipment and sampling devices prior to and between each use:

- Rinse with potable water
- Wash with alconox (anionic-cationic detergent) and tap water and clean with a stiff-bristle brush
- Rinse with deionized (DI) water
- Rinse with reagent-grade methanol
- Place the sampling equipment on a clean surface and air-dry

2.4 Analytical Procedures

An analytical laboratory will perform all analyses. The Project Manager will communicate sampling and analysis schedules to the laboratory with sufficient lead-time to meet contractual agreements with the laboratory. All laboratory samples will be analysed in line with the methods

stipulated in the Standard Methods for Examination of Water and Wastewater (APHA, AWWA &WEF, 21st Edition, 2005) as described in Tables 3 to 6.

Table 3: Wastewater Analysis Methods

Parameter	Testing Method (APHA Code)
pH	4500 H (pH meter)
Turbidity	2130 B
Dissolved Oxygen (DO)	4500 (membrane Electrode)
Biological Oxygen Demand	
BOD	5210 (5-day test)
COD	
Solids	
Total Suspended Solids (TSS)	3750 (gravimetric Method)
Total Dissolved Solids (TDS)	
Carbon	
Total Organic Carbon (TOC)	5310 (Infrared Spectrometry)
Total Inorganic Carbon (TIC)	
Nitrogen	
Nitrate	4500-NO3-E (Automated Hydrazine Reduction)
Nitrite	4500-NO2-B (Colorimetry)
Ammonia	4500-NH3 C (Titration method)
Phosphorus	4500-P E (Automated Ascorbic Acid Reduction)
Metals	
Arsenic	3113 B (Atomic Absorption Spectrometry)
Cadmium	
Copper	
Chromium	
Lead	
Magnesium	
Manganese	
Nickel	
Selenium	
Mercury	4664 (Cold-Vapor Atomic Fluorescence Spectrometry, AFS)
Bacterial	
E-Coli	9222 (membrane Filtration)
Total Coliform	
Other	
Sulfide	4658 (Ion Selective Electrode)
Polychlorinated Biphenyls (PCB)	6431 C (Gas Chromatography/ Mass Spectrometry)

Table 4: Water Analysis Methods

Parameter	Testing Method (APHA Code)
pH	4500 H (pH meter)
Turbidity	2130 B (Nephelometric method)
Color	2120 C (Spectrophotometric method)
Odor	2120 B
Dissolved Oxygen (DO)	4500 (membrane Electrode)

Parameter	Testing Method (APHA Code)
Biological Oxygen Demand	
BOD	5210 (5-day test)
COD	
Solids	
Total Suspended Solids (TSS)	3750 (gravimetric Method)
Total Dissolved Solids (TDS)	
Carbon	
Total Organic Carbon (TOC)	5310 (Infrared Spectrometry)
Total Inorganic Carbon (TOC)	
Nitrogen& Phosphorus	
Nitrate	4500-NO3-E (Automated Hydrazine Reduction)
Nitrite	4500-NO2-B (Colorimetry)
Ammonia	4500-NH3 C (Titration method)
Phosphorus	4500-P E (Automated Ascorbic Acid Reduction)
Metals	
Arsenic	3113 B (Atomic Absorption Spectrometry)
Cadmium	
Copper	
Chromium	
Lead	
Magnesium	
Manganese	
Nickel	
Selenium	
Mercury	4664 (Cold-Vapor Atomic Fluorescence Spectrometry, AFS)
Bacterial	
E-Coli	9222 (membrane Filtration)
Total Coliform	
Other	
Sulfide	4658 (Ion Selective Electrode)
Phenols	6420 B (Liquid-Liquid Extraction Gas Chromatography)
PAH	6440 B, 6440C
Polychlorinated Biphenyls (PCB)	6431C (Gas Chromatography/ Mass Spectrometry)
Cyanide	4500-CN-E
Boron	4500-B B
Sodium	3500-Na B
Lindene	Gas Chromatography
DDT	
Chlorobenzene	
Ehtylbenzene	
Benzene	

Table 5: Soil Analysis Methods

Parameter	Method
Organics	
Total Organic Content (TOC)	SW 846-9060 (Infrared)

Total Hydrocarbon (THC)	EPA 413.2 (Spectrophotometry)
Total Petroleum Hydrocarbon (TPH)	EPA 418.1 (Infrared)
Polycyclic aromatic ydrocarbons(PAH)	SW846-8100 (gas chromatography)
Metals	
Heavy Metals (As, Cd, Cr, Cu, Fe, Pb, Zn, Ba, Ni)	EPA 200 (Atomic Absorption)
Mercury (Hg)	EPA 245.5 (Cold Vapor Atomic Absorption)
Physico-chemical	
Grain size	ASTM D422-63 (Hydrometer)
pH	Glass electrode pH meter
Total Kjeldahl Nitrogen	EPA 351.2 (Colorimetry)
Total Phosphorus	EPA 365.1 (Automated Colorimetry)

2.4.1 In-situ Measurements

In-situ measurements shall be analysed using HACH SensION156 Probe for the following parameters:

- pH
- Temperature
- Dissolved Oxygen
- Turbidity
- Electrical Conductivity

The instrument shall be calibrated prior to use and checked again after sampling is complete. For dissolved oxygen measurements, Winkler titration equipment and solutions shall be available as a back up to the probe.

2.4.2 Particle Size Distribution

Apart from physical and chemical analyses of the soil, a particle size distribution analysis shall also be carried out. It shall be done using the combination of wet sieving and pipette methods. Following the dispersion of the soil sample using 5% Calgon, the total sand fractions shall be removed by sieving through a 0.050 mm sieve. The sand fractions shall be subsequently oven dried and then fractioned into different size sand fractions going from very coarse (VC) to very fine (VF) by using a set of sieves with mesh sizes going from 1000 mm to 100 mm. The silt and clay in suspension shell be re-stirred at room temperature and oven dried in a crucible to estimate the mass of silt and clay particles. After allowing the suspension to stand for the time it would require particles with a spherical diameter of 2mm to settle over a distance of 10 cm, the second pipette samples should be taken at not more than from below 5cm of the surface of the suspensions. The sample aliquot shall be dried and the mass of clay in it computed. From there the mass of total clay shall be estimated.

2.5 Quality Assurance/Control Requirements

Quality assurance (QA) is an integrated system of activities in the area of quality planning, assessment, and improvement to provide the project with a measurable assurance that the established standards of quality are met. QC checks, including both field and laboratory, are specific operational techniques and activities used to fulfill the QA requirements.

2.5.1 Field Quality Control

The field QC samples will be assigned unique sample numbers and will be submitted to the analytical laboratory. If abnormalities are detected in field QC samples, the data associated with the QC samples will be flagged and appropriate actions will be taken to rectify issues.

Field Duplicate Samples

Field duplicate/replicate samples will be collected at a rate of 10% of the total number of samples during each sampling event. If fewer than 10 water samples are collected, one duplicate sample will be collected. For all water samples, duplicate samples will be collected by retaining consecutive samples from the sampling device. The duplicated sample is treated independently of its counterpart in order to assess laboratory performance through comparison of the results.

Field duplicate samples will not be collected for any soil samples collected during field activities because sample variability is likely and it would be difficult to produce consistent results between soil samples.

Source Blank

Source blanks will be collected from each source of water that is used to decontaminate sampling equipment or materials to ensure that contamination is not originating from any particular sources of water.

Equipment Rinsate Blank

Equipment rinsate blanks will be collected daily, during water sampling only, to ensure that non-dedicated sampling devices have been decontaminated effectively. Equipment rinsate blanks will consist of the rinsing water used in the final step of the sampling equipment decontamination procedure. Rinsate samples will be collected at a frequency of one per day during sampling events.

2.5.2 Laboratory Quality Control

Laboratory QC is addressed through the analysis of laboratory QC samples, documented internal and external laboratory QC practices, and laboratory audits. The types of laboratory QC samples will be project/chemical specific, but may include laboratory control samples, laboratory duplicates; matrix spikes (MSs), surrogate standards, internal standards, method blanks, and instrument blanks. Matrix spikes, matrix spike duplicates (MSDs), and a laboratory control standard (LCS) are analyzed for every batch of up to 20 samples and serve as a measure of analytical accuracy. Surrogate standards are added to all samples, blanks, MSs, MSDs, and LCSs which are analyzed for organic compounds in order to evaluate the method's accuracy and to help determine matrix interferences. Definitions of each type of laboratory QC sample are listed in the following subsections.

For laboratory measurements, if any of the QC checks are outside the acceptance criteria, corrective actions will be taken.

Laboratory Control Samples

Laboratory control samples include blank spikes and blank spike duplicates. Blank spike samples are designed to check the accuracy of the laboratory analytical procedures by measuring a known concentration of an analyte in the blank spike samples. Blank spike duplicate samples are designed to check laboratory accuracy and precision of the analytical procedures by measuring a known concentration of an analyte in the blank spike duplicate sample. Blank spike and blank spike duplicate samples are prepared by the laboratory using clean laboratory matrices spiked with the same spiking compounds used for matrix spikes at levels approximately 10 times greater than the MDL.

Laboratory Duplicates

Laboratory duplicates are two aliquots of a sample taken from the same sample container under laboratory conditions and analyzed independently. The analysis of laboratory duplicates allows the laboratory to measure the precision associated with laboratory procedures.

Matrix Spikes

MS and MSD samples are designed to check the precision and accuracy of the analytical methods through the analysis of a field sample with a known amount of analyte added. Additional sample volume for MS and MSD samples is collected in the field in the same manner as field duplicate samples. In the laboratory, two portions of the sample are spiked with a standard solution of target analytes. MS and MSD samples are analyzed for the same parameters as the field samples, and analytical results will be evaluated for precision and accuracy of the laboratory process and effects of the sample matrix. The number of MS and MSD collected from the field samples will be chemical dependent. A minimum of one MS/MSD will be analyzed each day that field samples are analyzed, at a rate of one per 20 field samples or one per batch, whichever is more frequent.

Surrogate Standards

Surrogates are chemical compounds with properties that mimic analytes of interest, but that are unlikely to be found in environmental samples. Surrogates will be added to all field and quality control samples analyzed by gas chromatography (GC) or GC/mass spectroscopy (GC/MS) to assess the recovery of the laboratory process, and to detect QC problems.

Internal Standards

Like the surrogate standard, an internal standard is a chemical compound unlikely to be found in environmental samples that is added as a reference compound for sample quantification. Internal standard procedures are used for the analysis of volatile organics and extractable organics using GC/MS and also can be used for other GC and high-performance liquid chromatography (HPLC) analytical methods.

Method Blanks

Method blanks are designed to detect contamination of field samples that may occur in the laboratory. Method blanks verify that method interference caused by contaminants in solvents, reagents, glassware, and other sample processing hardware are known and minimized. Method blanks are deionized water for aqueous samples, a clean solid matrix for soil and sediment, and clean filters or puffs for vapor and air samples. A minimum of one method blank will be analyzed each day that field samples are analyzed at the rate of 1 per 20 field samples. A method blank must be analyzed daily. The concentration of the target compounds in the method blank sample must be less than five times the method detection limit. If the blank is not under the specified limit, the source contamination is to be identified and corrective actions taken.

2.6 Instrument/Equipment Testing, Inspection and Maintenance

Various field instruments will be used during the field activities at the Abuja Airport. Such field instrument maintenance will be documented in the field logbook for each field instrument used during field activities. Field equipment will be maintained when routine inspections indicate the need for maintenance. In the event that a piece of equipment needs repair, a list of the field equipment manufacturers' addresses, telephone numbers, and points of contact will be maintained on site during field activities.

Field equipment routine maintenance may include the following:

- Calibrating equipment according to manufacturers' directions
- Removing surface dirt and debris
- Replacing/cleaning filters when needed
- Ensuring proper storage of equipment
- Inspecting instruments prior to use
- Charging battery packs when not in use
- Maintaining spare and replacement parts in field to minimize downtime

The primary objective of a preventive maintenance program is to help ensure the timely and effective completion of a measurement effort by minimizing the downtime of crucial equipment due to expected or unexpected component failure. Laboratory instrument maintenance including standard preventive maintenance procedures and schedules are contained in, and will be performed in accordance with, the Laboratory Quality Assurance Plan (LQAP) and the manufacturer's instructions. Instruments will be constantly monitored by the use of daily standards, sensitivity, and response checks to determine if maintenance is required.

2.7 Instrument/Equipment Calibration and Frequency

Methods for calibration of field instruments will follow the specific instrument manufacturers' recommendations. All field instruments will be calibrated before each day of use; and a calibration check at the end of the day will be performed to verify that the instrument remained in good working condition throughout the day. If the calibration check at the end of the day does not meet acceptance criteria, then that day's data will be flagged and the instrument calibration checks will increase to the operator's satisfaction that the instrument remains true to the initial calibration.

2.8 Inspection/Acceptance of Supplies and Consumables

Any supplies and consumables used in the sample collection process or instrument calibration, such as sample bottles, bailers, dedicated tubing, deionized water, calibration gases, etc., will be inspected upon receipt and prior to use. At a minimum, the Project Manager or a field team member will inspect the materials upon receipt for damage or broken seals.

The laboratories chosen to perform the analyses will be required to purchase and/or provide equipment, materials, and supplies that meet or exceed the requirements of the project and/or analytical methods. The laboratories will inspect their supplies and consumables prior to their use in analysis.

2.9 Data Management

The purpose of the data management section of this SAP is to describe the procedures that will be used to maintain data quality throughout the project. These operations include, but may not be limited to, data recording and data reporting.

2.9.1 Data Recording

All field observations and laboratory results will be linked to a unique sample location through the use of the sample identification system. Field observations and measurement data will be recorded on the field forms and in a field notebook to provide a permanent record of field activities. All data that are hand-entered will be subjected to a review by a second person to minimize data entry errors. A check for completeness of field records (logbooks, field forms, databases, electronic spreadsheets) will ensure that all requirements for field activities have been fulfilled, complete records exist for each activity, and the procedures specified in this SAP have

been implemented. Field documentation will ensure sample integrity and provide sufficient technical information to recreate each field event.

2.9.2 Data Reporting

Hard copies of the data reports received from the laboratories will be filed chronologically and will be stored separately from the electronic files. Hard copies of data signed by a representative of the analytical laboratory will be compared to any electronic versions of the data to confirm that the conversion process has not modified the reported results. Any additional reporting formats will be completed and electronic and hard copies will be stored in different locations at the EnvironQuest facilities.

2.9.3 Electronic Deliverables

Following the data review process, EnvironQuest will enter the sample results into an electronic database. Data will be compiled with spatial and temporal qualifiers so that it will be possible to rapidly plot or review changes in the concentration of target analytes at each sampling point over time.

Section 3.0: Assessment/Oversight

This section describes the activities for assessing the effectiveness of the project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the SAP is implemented as prescribed.

3.1 Assessments and Response Actions

Assessments that may be performed during this project include, but are not limited to technical systems audits and data quality assessments.

3.1.1 Technical Systems Audits

Technical Systems Audits (TSAs) of the analytical laboratories will be conducted by the EnvironQuest QA/QC Officer if required to assess compliance with QA procedures and SOPs. Results of the TSAs will be reported in an audit report to the laboratory manager.

Technical systems audits and audits of data quality will be conducted periodically, if required, during site assessment activities by the EnvironQuest QA/QC Officer. In addition, the EnvironQuest Project Manager and QA/QC Officer will conduct regular audits of the field and laboratory data as they are generated as well as data/sample collection procedures. This schedule of QA checks will require the cooperation of the laboratory regarding timely delivery of reports. However, it will ensure that data quality issues are identified early, rather than at the end of the investigation.

If significant variances are found during the audit, the EnvironQuest QA/QC Officer may, at his or her discretion, conduct additional audits. Additional audits may include a visit to the laboratory, if required and if determined to be necessary by the EnvironQuest QA/QC Officer. For those audits resulting in variances, the Project Team Leader or the laboratory coordinator will submit a response in writing to the EnvironQuest QA/QC Officer.

3.1.2 Data Quality Assessment Report

Data collected during the field efforts will be reconciled with the project DQOs by preparing summary tables, charts, figures, or performing other types of data analyses that facilitate direct comparison of data collected through the entire extent of the project.

Comparisons will be made on a parameter-specific basis, concentrating on the contaminants of concern. Comparisons also will facilitate an analysis of contaminant concentration trends through time and space.

3.1.3 Corrective Action

Corrective actions may be initiated by any of the participants of the data generation (field technician or laboratory analyst), reporting (laboratory director or field team leader), and validation process (EnvironQuest Project Manager or QA/QC Officer). Note that it is important to generate corrective actions early in the process so that the problem has a greater chance of being resolved in a timely and cost-effective manner.

For field measurements, if the final calibration check is outside acceptable limits, then the associated data collected that day will be flagged. On the following day, a single point continuing calibration check will be run after every five samples analyzed to determine how long the initial calibration holds. Calibration frequencies will be adjusted accordingly.

For laboratory measurements, if any of the QC checks (MS, MSD, laboratory control samples, or laboratory blank) are outside the acceptance criteria (for accuracy, precision, and cross contamination), the laboratory will follow the corrective actions that are outlined in the LQAP.

Section 4.0: Data Validation and Usability

This section is divided into three elements that describe the QA activities that occur after the data collection phase of the project has been completed to ensure that data conform to the specified criteria and thus are useful for their intended purpose.

4.1 Data Review, Verification, and Validation

All project data will be reviewed by EnvironQuest to determine if the qualitative parameters of representativeness and comparability have been achieved. In general, the review will be accomplished by comparing the chain of custody and field notebook entries with the data for the sample. If the reported concentrations of a field sample from a specific location do not reflect historical data, then efforts will be made to determine if the data reflect an actual change in environmental conditions at that sampling point, or if the integrity of the sample was compromised during collection, preservation, shipping, or analysis.

Conversely, if some level of analyte historically present in samples from a specific location is no longer present, then similar efforts will be made to confirm that change in concentration. QA/QC requirements that bracket questionable data will be reviewed to confirm the performance of instrumentation during the time when questionable data were generated. Any deviations will be documented, and corrective actions will be taken to determine if the data meet project goals. If the data do not meet project goals, then the need for additional sampling and analysis will be determined.

The laboratory that generates the analytical data will have the primary responsibility for the correctness and completeness of the data. Before releasing any analytical data, the laboratory will review and verify that the data has met all of the method criteria and is scientifically correct. Data reviews include the evaluation of information, as presented by the analyst or staff member, for accurate representation of the samples submitted.

All data will be subjected to a tiered review process before it is released from the laboratory. First, the analysts will review the quality of their work based on established guidelines. This includes reviewing and performing the following activities:

- Check that calibrations, tunes, blanks, and any other instrument QC criteria were done during the analysis reported;
- Confirm that calculations of individual analytes and detection limits were carried out;
- Verify that holding times or extraction times were met; and,
- Make notes or footnotes on the report if abnormalities occurred during the analysis or any other QA/QC problems associated with the sample occurred.

The next step is performed by a supervisor or data review specialist whose function is to provide an independent review of data packages. This person will verify that all dates, sample identification, detection limits, reported analyte values, concentration units, header information, and footnotes or comments were transcribed accurately. This person will also check to ensure that data that do not meet project DQOs will be flagged with the appropriate data qualifiers. All information on the final report that can be verified against the chain of custody will be checked for errors and completeness.

The third step is done by the Laboratory Director or other designee who will sign the final reports. This person spot-checks activities associated with the log-in, tracking, extraction, sample analysis, and final reporting for technical and scientific soundness.

4.2 Verification and Validation Methods

The data generated for a project will be reviewed and verified by the EnvironQuest QA/QC Officer and validated by an independent outside reviewer (i.e., Laboratory Data Consultants). Data verification involves the process of generating qualitative and quantitative sample information through observations, field procedures, analytical measurements and calculations. The data verification and reporting process for the field data involves ensuring that calibration of instruments, field blanks, and field duplicates defined in this SAP are within the acceptance criteria. The verification process for the laboratory data involves ensuring that the holding times, precision, accuracy, laboratory blanks, and detection limits are within the acceptance criteria outlined in the project-specific data quality plan.

The field and laboratory personnel will provide the EnvironQuest QA/QC Officer with all the data. The EnvironQuest QA/QC Officer will be responsible for overall review of the data verification results, for compliance with the specified DQOs. After this QC procedure is complete, the EnvironQuest Project Manager will incorporate the verified data into the site assessment reports.

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Appendix 3:

Laboratory Data

Appendix 3.1: Meteorology and Air Quality Data

Table A3.1: Rainfall and Relative Humidity of Bauchi (1987 – 2012). NIMET, 2013

Month	Rainfall (mm)			Relative Humidity (%)		
	Min	Max	Mean	Min	Max	Mean
Jan	0	0	0	14	62	26.8
Feb	0	1.9	0.1	15	47	24.7
Mar	0	33.8	2.7	12	48	20.5
Apr	0	162.6	40.2	17	56	37.4
May	17.3	277.7	101.2	41	83	58.6
Jun	33.7	267	162.3	57	73	66.7
Jul	123.1	535.3	249.9	71	84	74.8
Aug	54.9	624.7	313.7	74	87	78.1
Sep	4.1	489.3	193.5	66	85	73.8
Oct	0	186.3	45.4	40	77	57.1
Nov	0	2.7	0.1	18	67	30.6
Dec	0	0	0	17	63	28.1

Table A3.2: Air Temperature of Bauchi (1987 – 2012). NIMET, 2013

Month	T_{min} (°C)			T_{max} (°C)		
	Min	Max	Mean	Min	Max	Mean
Jan	10.8	20.7	14.8	27.1	34.3	31.5
Feb	13.6	22.9	17.5	30	37	33.8
Mar	18	25	21.3	32	38.5	36.7
Apr	21.9	25	23.6	29	40	37.3
May	21.7	24.8	23.5	31.8	38.4	35.3
Jun	20.4	23.2	22.1	30	34.9	32.9
Jul	19.4	23	21.1	28.9	32.9	30.6
Aug	19.2	21.8	20.7	27.3	31.9	29.5
Sep	19.4	22	20.8	28.6	35	30.8
xOct	18.8	22.3	20.2	29.9	34.1	32.7
Nov	14.6	19	16.5	31.4	34.7	33.3
Dec	12.5	17.6	14.4	28.9	33.7	31.4

Table A3.3: Sunshine, Cloud Cover and Visibility of Bauchi (1987 – 2012). NIMET, 2013

Month	Sunshine Period (Hrs)			Cloud Cover (Oktas)			Visibility (km)		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Jan	3.4	9.8	6.9	5.5	7	6.3	3	26	12.3
Feb	4.5	9.3	7.3	5.3	7.4	6.4	4	24	10.7
Mar	2.9	8.8	6.7	5.7	7.1	6.4	1	25	10.9
Apr	5.8	7.5	6.5	5.9	7.1	6.5	1	16	6.4
May	5.3	8.5	6.9	6.2	7	6.6	1	25	3.5
Jun	4.4	8.2	6.5	5.9	7	6.6	1	7	2.3
Jul	2.3	7.4	4.8	6.4	7.9	6.9	1	6	2.4
Aug	4.9	7.7	6	6.3	7	6.7	1	10	2.9
Sep	2.4	7.2	5.3	6.1	7	6.5	1	4	1.9
Oct	4	9.1	6.4	5.8	7	6.5	1	21	5.6
Nov	5.1	9.9	7.6	5.4	7.1	6.2	1	18	9.4
Dec	4.9	10.2	6.9	4.7	7.3	6.1	1	23	10.5

Table A3.4: Measured Microclimatic Data

Level	Air Temperature (°C)		Relative Humidity (%)		Wind Speed (m/s)			
					Northeast		Southwest	
	Wet Season	Dry Season	Wet S	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
Minimum	23.5	30.4	45.6	13	0.5	0.4	0.5	0.5
Maximum	36	38.6	82.7	24.9	4	3.7	5.3	3.5
Mean	32.5	35.4	56.1	16.5	1.9	2	2.1	2

Table A3.5: Mean Gaseous Pollutants Levels around the Project Site

Sampling Station	Code	Concentrations (ppm)													
		Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
		CO		NO		NO_2		SO_2		VOCs		H_2S		NH_3	
Proposed Solar Power Generating Site	AQ1	0.1	0	0	0	0.13	0	0	0	0	0	0	0	0.13	0
	AQ2	0.1	1	0	0	0	0	0	0	0	0	0	0	0	3
	AQ3	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0
	AQ4	0.1	1	0	0	0	0.5	0	0	0	0	0	0	0	1
	AQ5	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0
	AQ6	0	1	0	0	0	0	0	0	0	0	0	0	0.13	6
	AQ7	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0
Proposed Transmission Line Corridor	AQ9	0	0	0	0	0.05	0	0	0	0	0	0	0	0.13	0
	AQ11	0	0	0	0	0	0	0	0	0	0	0	0	0.25	3
	AQ12	0	0	0	0	0.06	0	0	0	0	0	0	0	0.25	2
	AQ13	0	0	0	0	0	0	0	0	0	0	0	0	0.38	3
	AQ14	0	0	0	0	0	0	0	0	0	0	0	0	0.63	0
	AQ17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	AQ18	0	0	0	0	0	0	0	0	0	0	0	0	0.63	0
	AQ19	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	AQ20	0	1	0	0	0	0	0	0	0	0	0	0	0.75	0
	AQ21	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Neighbouring Communities	AQ8	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0
	AQ10	0	1	0	0	0.05	0	0	0	0	0	0	0	0.13	9
	AQ15	0.1	1	0	0	0	0	0	0	0	0	0	0	0.5	1
	AQ16	0.3	0	0	0	0	0	0	0	0	0	0	0	0.5	0

Table A3.6: Extrapolated 24-Hour Gaseous Pollutants Levels around the Project Site

Sampling Station	Sampling Code	Concentrations (ppm)													
		Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
		CO		NO		NO_2		SO_2		VOCs		H_2S		NH_3	
Proposed Solar Power Generating Site	AQ1	0.1	0	0	0	0.1	0	0	0	0	0	0	0	0.1	0
	AQ2	0.1	0.5	0	0	0	0	0	0	0	0	0	0	0	1.54
	AQ3	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
	AQ4	0.1	0.5	0	0	0	0.26	0	0	0	0	0	0	0	0.51
	AQ5	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
	AQ6	0	0.5	0	0	0	0	0	0	0	0	0	0	0.1	3.08
	AQ7	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
Proposed Transmission Line Corridor	AQ9	0	0	0	0	0.04	0	0	0	0	0	0	0	0.1	0
	AQ11	0	0	0	0	0	0	0	0	0	0	0	0	0.2	1.54
	AQ12	0	0	0	0	0.05	0	0	0	0	0	0	0	0.2	1.03
	AQ13	0	0	0	0	0	0	0	0	0	0	0	0	0.3	1.54
	AQ14	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0
	AQ17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	AQ18	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0
	AQ19	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0
	AQ20	0	0.5	0	0	0	0	0	0	0	0	0	0	0.6	0
	AQ21	0	0	0	0	0	0	0	0	0	0	0	0	0	1.54
Neighbouring Communities	AQ8	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0
	AQ10	0	0.5	0	0	0.04	0	0	0	0	0	0	0	0.1	4.62
	AQ15	0.1	0.5	0	0	0	0	0	0	0	0	0	0	0.4	0.51
	AQ16	0.2	0	0	0	0	0	0	0	0	0	0	0	0.4	0

Table A3.7: Mean Measured Particulate Concentrations in the Study Area

Sampling Station	Sampling Code	Concentration (µg/m^3)									
		Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
		PM_1		$PM_{2.5}$		PM_7		PM_{10}		TSP	
Proposed Solar Power Generating Site	AQ1	1.8	3.3	16.7	47.2	30.8	101.6	47.8	162.7	54.7	302.3
	AQ2	1.6	2.3	16.3	36.5	25.9	68.5	28.5	84.7	29.9	100.2
	AQ3	1.4	2.4	15.7	27.5	27.1	60.3	28.5	69.3	36.1	82.3
	AQ4	1.7	1.5	19.5	18.2	29.4	57.5	32.3	64	35.9	85.4
	AQ5	1.5	2.2	17.6	27.7	31.2	57	35.8	77.8	41.8	88.9
	AQ6	1.2	1.5	15.3	23.8	22.8	51.5	26.1	100.4	31.2	122.9
	AQ7	1.4	1.9	6.4	26.1	13.9	55.5	27.8	76.9	31.7	92.3
Proposed Transmission Line Corridor	AQ9	1.6	3.9	11.4	182.8	37	198.8	43.1	287.6	58.7	314.9
	AQ11	2.2	1.5	17.2	21.8	28.9	60.7	34.1	74.1	40	100.1
	AQ12	2	2.3	25.1	38.4	46	75.1	53.6	81.3	64.6	95.7
	AQ13	2	1.9	5.4	28.4	14.4	69	24.7	84.1	37.1	99.8
	AQ14	1.3	1.5	6.5	26.7	15.9	61.5	23.4	74.9	33.6	98.1
	AQ17	1.4	1.9	15.6	29.4	24.2	61.6	36.5	65.4	40.6	102.2
	AQ18	1.5	1.5	18.2	23.5	43.7	56.9	52.2	77.9	51.6	97.5
	AQ19	1.6	1.6	11.2	28.3	28.1	67	44.9	81.6	47.9	95.3
	AQ20	2.2	2.2	20.6	40.1	32.9	92	45.1	104.4	54.5	117.1
	AQ21	1.6	2.2	21.6	40.8	26.9	85	40.9	104.5	48	232.8
Neighbouring Communities	AQ8	1.4	1.7	7.8	24.8	41.8	50.2	63.5	53.5	68.8	83.8
	AQ10	1.5	3.6	5.8	113.3	18	154.1	23.1	163.7	15.1	176.7
	AQ15	2.7	2.3	7.1	43.3	14.9	92.4	23.4	112	29.9	167
	AQ16	1.6	2	9.2	32.5	20.3	72.6	21.4	90.3	55.8	132

Table A3.8: Daily Extrapolated Particulate Concentrations in the Study Area

Sampling Station	Sampling Code	Concentration (µg/m^3)									
		Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season
		PM_1		$PM_{2.5}$		PM_7		PM_{10}		TSP	
Proposed Solar Power Generating Site	AQ1	1.4	2.6	13.3	37.5	24.5	80.7	38	129.2	43.4	240
	AQ2	1.3	1.8	12.9	29	20.6	54.4	22.6	67.2	23.7	79.6
	AQ3	1.1	1.9	12.5	21.8	21.5	47.9	22.6	55	28.7	65.3
	AQ4	1.3	1.2	15.5	14.5	23.3	45.7	25.6	50.8	28.5	67.8
	AQ5	1.2	1.7	14	22	24.8	45.3	28.4	61.8	33.2	70.6
	AQ6	1	1.2	12.1	18.9	18.1	40.9	20.7	79.7	24.8	97.6
	AQ7	1.1	1.5	5.1	20.7	11	44.1	22.1	61.1	25.2	73.3
Proposed Transmission Line Corridor	AQ9	1.3	3.1	9.1	145.1	29.4	157.8	34.2	228.3	46.6	250
	AQ11	1.7	1.2	13.7	17.3	22.9	48.2	27.1	58.8	31.8	79.5
	AQ12	1.6	1.8	19.9	30.5	36.5	59.6	42.6	64.5	51.3	76
	AQ13	1.6	1.5	4.3	22.5	11.4	54.8	19.6	66.8	29.5	79.2
	AQ14	1	1.2	5.2	21.2	12.6	48.8	18.6	59.5	26.7	77.9
	AQ17	1.1	1.5	12.4	23.3	19.2	48.9	29	51.9	32.2	81.1
	AQ18	1.2	1.2	14.5	18.7	34.7	45.2	41.4	61.9	41	77.4
	AQ19	1.3	1.3	8.9	22.5	22.3	53.2	35.6	64.8	38	75.7
	AQ20	1.7	1.7	16.4	31.8	26.1	73	35.8	82.9	43.3	93
	AQ21	1.3	1.7	17.1	32.4	21.4	67.5	32.5	83	38.1	184.8
Neighbouring Communities	AQ8	1.1	1.3	6.2	19.7	33.2	39.9	50.4	42.5	54.6	66.5
	AQ10	1.2	2.9	4.6	90	14.3	122.4	18.3	130	12	140.3
	AQ15	2.1	1.8	5.6	34.4	11.8	73.4	18.6	88.9	23.7	132.6
	AQ16	1.3	1.6	7.3	25.8	16.1	57.6	17	71.7	44.3	104.8

Table A3.9: Mean Ambient Noise Levels in the Area during the Study

Sampling Station	Sampling Code	Wet season						Dry Season					
		Day-Time, dB(A)			Night-Time, dB(A)			Day-Time, dB(A)			Night-Time, dB(A)		
		L_{min}	L_{max}	L_{90}	L_{min}	L_{max}	L_{90}	L_{min}	L_{max}	L_{90}	L_{min}	L_{max}	L_{90}
Site	AQ1	38.4	64.7	44.2				29.4	40.9	29.9			
	AQ2	39.4	66.9	42				32	41.9	32.2			
	AQ3	39.3	58.3	42.7				31.3	44	32.8			
	AQ4	38.6	55.4	48	36.6	50	38.2	35.2	42.8	35.9	32.4	41.9	34.1
	AQ5	33.1	45	40.7				31.3	44	32			
	AQ6	36.4	50.6	40.5				29.3	40.7	30.1			
	AQ7	31.8	48.8	40.4	29.6	54.8	36.2	29.1	41.1	29.9	27.4	35.3	32.5
Transmission Line Corridor	AQ9	34.4	44.8	40.3				32.3	52.5	32.9			
	AQ11	32.4	50.3	40.1				26.8	42.6	29.2			
	AQ12	31.4	44.6	40.4				27	36.9	27.9			
	AQ13	35.2	46.2	41.7				38.2	44.3	38.8			
	AQ14	31.6	42.9	41.4				32.4	43.9	32.9			
	AQ17	32.4	46.2	40.9				29.7	47.9	30			
	AQ18	30.5	41.1	40.2	32.1	40.2	32.5	30.5	42.4	30.7			
	AQ19	43.6	51.5	43.8	37.4	43.2	37.5	44	50.6	44	29.6	37.0	31.2
	AQ20	32.5	42	41.2				45.1	58	45.3			
	AQ21	37.8	44.5	40.8				28.2	40.1	29			
Neighbouring Community	AQ8	33.4	55.7	46.4	31.2	36.9	33.1	34.4	54.2	34.7	40.2	55.9	43.1
	AQ10	43.4	57.1	48.8	32.2	46.7	37.3	38.7	56.6	38.9	29.0	38.2	34.1
	AQ15	47.7	71.3	57.8	34.2	49.6	34.4	49.7	73.7	49.8	30.8	42.0	31.3
	AQ16	37	57.8	47.5	34.7	50.8	41.7	35.9	54.8	36.8	29.3	38.7	34.8

Table A3.10: Concentration of Heavy Metal in the Proposed Project Area

Sampling Station	Sampling Code	Concentration (µg/m^3)														
		Cd	Pb	Cr	Si	Ti	V	Mn	Fe	Ni	Zn	Cu	Se	As	Sn	Sb
Proposed Solar Power Generating Site	AQ1	1.49	0.94	0	0.75	0.26	0	0	0	0	0	0	0.07	0	0	0
	AQ2	0	0	0	1.69	0.18	0	0	0	0	0.02	0.02	0	0	3.21	0
	AQ3	0	0	0	0	0.1	0	0	0	0.01	0.03	0	0	0	1.65	0
	AQ4	0	0	0	0	0.1	0	0	0	0	0.04	0	0.03	0	2.81	0
	AQ5	0.95	0	0	0.23	0	0	0	0	0	0	0.03	0	0	3.58	0
	AQ6	2.2	0	0	0.27	0	0.02	0.03	0	0	0.01	0	0	0	0	4.63
	AQ7	0.32	0	0	0.95	0	0	0	0	0	0.02	0.03	0	0.04	0.62	0
Transmission Line Corridor	AQ9	0.7	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0
	AQ11	0	0	0	0	0	0	0.02	0	0	0.03	0	0	0	1.75	0
	AQ12	0	0	0	0	0	0.03	0	0	0	0	0	0.07	0	0	0
	AQ13	0	0.19	0	1.66	0.06	0.08	0.04	0.08	0.02	0.21	0	0.02	0	3.54	0
	AQ14	2.74	0	0	2.73	0.18	0.04	0.04	0.52	0.08	0.65	0.12	0.02	0	2.74	0
	AQ17	0	0	0	0.75	0	0	0.04	0	0.03	0.03	0	0.11	0.01	0	0
	AQ18	0.77	0	0	0.04	0.09	0	0	0	0.04	0	0.1	0	0.02	0	2.68
	AQ19	3.66	0.18	0.05	0.46	0	0	0.02	0	0	0.02	0	0.12	0	0	0
	AQ20	0	0.18	0	0.02	0	0.07	0	0	0.01	0	0.01	0.03	0	3.54	0
	AQ21	0	0	0.07	0.14	0	0	0.07	0	0.01	0.03	0	0.11	0	7.97	0
Neighbouring Community	AQ8	0	0	0	0	0.09	0	0	0	0	0	0	0	0.08	0	6.33
	AQ10	2.36	0.09	0	0	0	0.02	0	0	0	0	0.02	0.08	0	0	0
	AQ15	0	0	0	1.15	0.04	0	0	0	0.01	0	0.01	0.16	0.02	0	0
	AQ16	0	0	0	0	0.07	0	0.04	0	0	0	0.01	0	0	5.6	0

Appendix 3.2: Groundwater Data

Table A3.11: Physico-Chemical Characteristics of Groundwater

Parameters	Wet Season												FEPA Limit
	Site						Transmission Line						
	GW1	GW2	GW3	GW4	GWC1	GWC2	GW5	GW6	GW7	GW8	GW9	GW10	
pH	7.11	7.47	6.11	6.63	6.43	7.1	7.3	7.1	7.19	6.73	7.2	6.76	6.5-8.5
E. Cond(uS/cm)	155.9	532	105.8	92.6	83.6	108.3	183.1	128.3	129.3	80.6	90.3	83.6	-
Salinity(o/oo)	0.1	0.7	0.2	0	0	0.1	0.1	0.1	0.1	0	0.1	0	-
Temperature(^{o}C)	27.2	27.4	27.1	25.6	24.6	20.4	24.5	27.4	25.7	21.6	23.4	22.6	-
TDS(mg/l)	86.1	293.7	40.1	51.2	49.2	50.8	101.1	70.8	71.35	61.2	40.8	44.2	500
TSS(mg/l)	Nil	Nil	Nil	0.8	Nil	Nil	1	Nil	1.3	0.7	Nil	Nil	10
Turbidity(NTU)	BDL	BDL	BDL	1	1	BDL	1.3	BDL	1.1	1	BDL	1	1
Nitrate(mg/l)	1.82	3.4	1.93	2.02	1.02	1.1	1.09	1.16	1.53	1.02	1.1	1.02	10
Phosphates(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Acidity(mg/l)	12	16	12	13.8	12.7	17	7.5	18	17.2	11.8	16	11.7	-
Hardness(mg/l)	18	40.2	17	12	12.3	23	16	22	28	12.1	21	13.3	-
BOD(mg/l)	0.8	0.4	0.7	0.6	0.5	0.8	0.6	0.8	0.1	0.3	0.7	0.4	-
Sulphate(mg/l)	2.8	9.11	1.9	10.85	11.35	8.58	21.13	8.58	12.04	10.45	8.58	11.15	50
Chloride (mg/l)	15	68	14	13.4	14.3	12	12.9	15	10.4	13.1	11	14.1	250
THC(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
COD(mg/l)	8	5.6	5	3.4	3.2	6.2	4.1	7.2	5.8	4.4	6.1	3.1	-
Cu(mg/l)	0.018	0.02	0.03	0.011	0.01	0.01	0.01	0.01	0.03	0.02	0.01	0.01	-
Pb(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05
Fe(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
K(mg/l)	2.02	6.88	2.01	1.42	1.52	2.08	2.6	2.28	1.9	1.32	2.18	1.42	-
Ba(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
Cr(mg/l)	BDL	BDL	BDL	BDL	BDL	0.01	BDL	0.006	BDL	BDL	0.01	BDL	-
Cd(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.007	BDL	BDL	BDL	-
Dry Season													
pH	7.30	7.39	8.00	7.20	6.78	7.4	7.20	7.30	7.50	7.30	7.40	7.22	6.5-8.5
E. Cond(uS/cm)	298.00	864.00	522.00	272.40	422.60	1013	278.00	274.40	629.00	286.00	228.00	268.00	-
Salinity(o/oo)	0.10	1.40	0.70	0.00	0.10	1.2	0.00	0.00	0.10	0.10	0.00	0.10	-
Temperature(^{o}C)	27.20	27.60	27.40	27.70	28.60	26.9	25.20	28.70	27.80	24.20	26.90	25.70	-
TDS(mg/l)	149.10	438.00	261.00	136.00	210.00	506	144.00	138.00	313.00	143.10	114.00	132.80	500
TSS(mg/l)	2.00	22.00	Nil	2.00	12.00	4	1.00	2.00	1.00	1.00	1.00	26.00	10
Turbidity(NTU)	BDL	1.01	BDL	1.30	1.00	1	1.80	1.80	2.00	BDL	2.00	1.00	1
Nitrate(mg/l)	4.20	6.80	4.60	1.80	8.50	2.8	3.20	2.80	4.20	2.00	2.00	4.10	10
Phosphates(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Acidity(mg/l)	16.00	46.00	18.40	12.30	13.80	16	18.00	12.80	16.00	14.00	14.00	17.20	-
Hardness(mg/l)	26.60	58.80	38.40	26.00	68.00	20	20.00	28.00	20.00	26.60	16.00	18.60	-
BOD(mg/l)	<0.05	0.80	<0.05	<0.05	6.30	<0.05	BDL	BDL	BDL	BDL	BDL	0.10	-
Sulphate(mg/l)	4.60	12.80	14.60	6.00	26.40	34.2	14.20	7.00	8.00	4.00	10.40	12.04	50
Chloride (mg/l)	34.80	138.40	78.80	30.40	42.00	120.8	44.60	32.60	64.90	32.80	42.70	26.20	250
THC(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
COD(mg/l)	8.00	6.40	6.80	4.00	6.30	13.6	7.40	6.00	6.00	5.00	5.60	5.80	-
Cu(mg/l)	0.02	0.068	0.03	0.16	0.04	0.011	0.01	0.02	0.03	0.02	0.01	0.016	-
Pb(mg/l)	BDL	0.003	0.00	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.05
Fe(mg/l)	0.03	0.66	0.02	0.01	<0.002	0.04	0.34	0.03	0.05	0.02	0.06	BDL	1
K(mg/l)	6.90	18.34	10.60	3.10	6.2	1.42	8.20	4.20	2.28	4.90	4.22	10.3	-
Ba(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-
Cr(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.01	BDL	BDL	BDL	-
Cd(mg/l)	BDL	BDL	BDL	0.01	BDL	BDL	BDL	0.01	BDL	BDL	0.01	0.02	-

Appendix 3.3: Sediment Data

Table A3.12: Physico-Chemical Characteristics of Sediment

Sampling Code	Wet Season								Dry Season							
	pH	E.Con	SO_4^{2-}	TOC	Cl^-	T. Nit	T. Phos	Ex. Acid	pH	E.Cond	SO_4^{2-}	TOC	Cl^-	T. Nit	T. Phos	Ex Acid
		µS/cm	mg/kg	%	mg/kg	%	%	Cmol/ kg		µS/cm	mg/kg	%	mg/kg	%	%	Cmol/ kg
SD 1	5.03	17.57	3.99	1.75	10.60	0.07	0.04	1.00	6.18	86.20	0.09	0.08	1.54	37.900	4.080	1.20
SD 2	5.26	30.30	1.24	1.59	13.86	0.09	0.04	0.80	6.60	78.6	0.05	0.08	1.09	64.3	8.6	1.2
SD 3	5.78	98.50	1.30	1.50	22.22	0.10	0.01	1.00	6.28	96.35	0.07	0.04	1.84	34	6.2	0.86
SD 4	5.80	38.00	1.88	1.40	12.13	0.07	0.04	1.20	6.22	94.20	0.03	0.03	1.62	20.400	6.730	1.40
SD 5	5.14	62.70	2.46	1.50	22.09	0.09	0.02	0.90	5.40	90.45	0.08	0.07	1.9	28	6.44	1.4
SD 6	6.22	79.30	1.47	1.60	29.07	0.11	0.01	0.40	6.25	82.8	0.6	0.07	1.6	42.4	4.41	0.9
SD 7	5.84	24.60	2.66	1.40	10.42	0.10	0.02	0.90	6.3	84.33	0.4	0.02	1.64	28.6	7.36	1
SD 8	5.32	41.30	3.46	1.20	16.53	0.08	0.00	0.90	6.35	98.34	0.09	0.06	1.32	36.8	6.4	1.3
SD 9	5.95	50.50	1.82	1.50	11.40	0.06	0.05	0.70	5.88	87.3	0.2	0.04	1.97	38.2	5.88	1.2
SD 10	5.02	19.57	3.40	1.80	10.40	0.04	0.43	1.03	6.36	70.20	0.08	0.06	1.34	28.400	5.230	0.90
SDC11	5.60	41.40	1.42	1.60	13.90	0.06	0.06	0.60	5.7	86.38	0.14	0.03	1.8	34.8	6.04	1.2
SDC 12	5.70	95.50	1.96	1.90	22.18	0.13	0.05	1.03	6.37	78.34	0.08	0.05	1.88	22.300	6.110	1.40
SDC 13	5.40	37.00	1.82	1.60	12.28	0.07	0.04	1.30	6.28	38.30	0.04	0.08	1.78	18.600	7.550	1.00
SD 14	5.29	60.70	2.56	1.40	22.90	0.05	0.17	0.50	6.46	78.40	0.12	0.04	1.56	26.35	8.30	1.20
SD 15	6.35	80.30	1.68	1.70	29.72	0.13	0.06	0.70	6.36	84.30	0.08	0.06	1.47	78.40	7.26	1.18
SD 16	5.67	27.60	2.56	1.60	10.18	0.12	0.19	0.40	5.80	70.40	0.16	0.06	1.39	26.37	6.46	1.16
SD 17	5.54	45.30	3.56	1.40	16.28	0.05	0.04	0.70	6.34	76.80	0.10	0.08	1.06	34.200	4.320	1.00
SD 18	5.92	18.67	3.88	1.55	10.70	0.08	0.43	1.01	6.38	64.90	0.10	0.02	1.63	38.30	8.45	1.18
SD 19	5.45	34.20	1.42	1.56	13.76	0.05	0.36	0.12	6.29	86.45	0.07	0.08	1.33	64.30	10.40	1.14
SD 20	5.56	62.00	1.82	1.90	12.28	0.08	0.04	1.50	6.37	64.22	0.10	0.15	1.60	46.200	3.400	1.40
SD 21	5.00	17.00	1.34	1.13	10.34	0.05	0.00	0.41	6.80	67.40	0.14	0.96	1.70	80.34	8.38	1.04
SD 22	6.10	98.00	4.03	2.03	28.30	0.09	0.42	1.10	5.97	78.46	0.11	0.06	1.97	30.400	6.520	1.00
SDC 23	5.40	1.74	1.34	1.36	12.87	0.06	0.21	0.03	5.60	74.28	0.21	0.03	1.39	68.40	5.90	1.20
SDC 24	5.56	49.94	2.25	1.56	16.23	0.08	0.06	0.87	6.65	30.30	0.09	0.14	1.22	46.300	4.960	1.00

Table A3.13: Wet Season Heavy Metal Concentration of Sediment

Sampling Code	Concentration (ppm)												
	Basic Metals				Heavy Metals								
	Ca	Mg	Na	K	Ba	Mn	Pb	Cd	Ni	Cu	Zn	Cr	Fe
SD 1	0.81	0.15	3.11	1.00	0.03	0.11	4.37	2.30	0.03	5.65	5.76	0.37	367.86
SD 2	0.70	0.22	1.45	2.05	0.08	0.18	5.19	3.17	0.08	8.58	6.52	0.56	563.57
SD 3	0.23	0.28	14.53	3.20	0.06	0.03	3.82	3.09	0.06	7.26	4.46	0.31	312.14
SD 4	0.70	0.30	4.33	2.23	0.06	0.04	6.64	2.15	0.06	3.84	6.05	0.41	413.57
SD 5	1.17	0.33	7.83	2.17	0.04	0.34	2.45	4.51	0.04	9.29	4.18	0.32	320.71
SD 6	2.35	0.04	10.74	2.00	0.04	0.24	5.83	7.09	0.04	8.10	5.66	0.44	438.57
SD 7	1.17	0.08	3.38	1.88	0.03	0.09	5.56	4.20	0.03	3.73	2.93	0.21	205.55
SD 8	2.11	0.12	2.42	1.76	0.08	0.11	6.22	6.37	0.08	8.97	3.93	0.19	190.01
SD 9	3.05	0.21	3.69	1.37	0.02	0.11	4.29	4.41	0.07	5.01	4.29	0.57	442.86
SD 10	0.27	0.26	14.50	3.21	0.05	0.05	3.82	3.05	0.06	7.25	4.46	0.32	312.12
SDC 11	1.12	0.05	3.32	1.76	0.02	0.04	5.56	4.15	0.02	3.80	2.27	0.25	205.55
SDC 12	0.37	0.24	4.71	2.94	0.13	0.39	6.43	2.52	0.03	3.38	6.07	53.00	423.71
SDC 13	0.81	0.23	3.11	1.00	0.03	0.11	4.37	2.30	0.03	5.65	5.76	0.37	367.86
SD 14	0.37	0.49	1.45	2.93	0.05	0.07	5.15	3.15	0.07	8.54	6.51	0.53	503.53
SD 15	0.23	0.30	13.42	3.20	0.51	0.04	3.34	3.08	0.08	7.21	4.71	0.30	112.18
SD 16	0.60	0.36	4.11	2.51	0.02	0.04	6.36	2.32	0.05	3.71	5.01	0.40	333.51
SD 17	1.28	0.38	6.99	2.10	0.34	0.37	2.30	4.60	0.05	9.20	4.00	0.22	310.14
SD 18	0.46	0.34	14.11	3.20	0.07	0.02	3.45	3.80	0.07	7.50	4.60	0.31	312.14
SD 19	0.70	0.32	4.64	2.23	0.64	0.02	5.60	2.45	0.04	3.09	5.90	0.41	413.57
SD 20	0.56	0.33	4.17	2.23	0.05	0.07	6.78	2.13	0.05	3.67	6.10	0.41	413.57
SD 21	2.57	0.45	10.04	2.00	0.07	0.45	5.91	7.03	0.03	8.04	5.66	0.44	438.57
SD 22	2.13	0.13	2.95	1.76	0.02	0.12	6.32	6.40	0.06	7.58	4.50	0.19	190.01
SDC 23	2.43	0.12	2.88	1.76	0.05	0.23	6.35	6.50	0.07	7.80	4.10	0.19	190.01
SDC 24	3.41	0.35	3.24	1.37	0.09	0.15	5.68	4.32	0.05	5.10	4.89	0.57	442.86

Table A3.14: Dry Season Heavy Metal Concentration of Sediment

Sampling Code	Concentration (ppm)												
	Basic Metals				Heavy Metals								
	Ca	Mg	Na	K	Ba	Mn	Pb	Cd	Ni	Cu	Zn	Cr	Fe
SD 1	2.640	0.870	6.230	1.440	BDL	2.220	1.640	1.56	0.062	1.74	4.96	0.28	473.29
SD 2	1.94	0.62	6.30	2.10	BDL	2.40	2.00	3.80	0.07	1.86	4.20	0.48	683.50
SD 3	2.10	1.70	5.80	1.90	BDL	1.78	1.64	2.64	0.03	2.30	2.20	0.33	723.72
SD 4	2.090	1.050	7.260	3.080	BDL	1.480	2.090	2.450	0.084	2.6	2.8	0.26	742.9
SD 5	2.16	0.48	6.60	1.53	BDL	1.60	2.02	4.24	0.02	2.74	5.06	4.20	458.26
SD 6	2.11	0.68	6.28	2.1	BDL	2.09	2.95	1.08	0.089	1.8	6.23	1.08	738.53
SD 7	2.16	1.20	8.20	3.20	BDL	1.62	1.63	2.82	0.07	2.77	3.06	3.08	2428.30
SD 8	2.04	0.63	12.80	1.46	BDL	2.02	1.62	1.93	0.02	3.06	2.84	2.25	1642.97
SD 9	2.14	1.70	7.80	1.83	BDL	1.34	2.24	2.82	0.05	2.21	2.62	1.93	856.30
SD 10	2.080	0.840	12.300	3.230	BDL	1.441	3.640	1.340	0.033	2.8	3.72	0.77	1427.99
SDC 11	1.66	0.83	17.40	2.80	BDL	1.20	2.08	3.60	0.06	1.84	1.95	0.42	1422.87
SDC 12	1.700	1.080	16.720	2.004	BDL	1.830	2.020	2.040	0.024	1.78	3.2	0.59	648.45
SDC 13	1.980	1.066	6.830	1.770	BDL	0.350	2.200	1.1	0.05	2.98	7.4	0.49	565.2
SD 14	2.62	0.58	12.22	2.08	BDL	0.43	3.40	1.30	0.35	3.60	10.33	0.64	1256.30
SD 15	1.53	1.68	7.83	2.30	BDL	0.27	2.09	1.44	0.28	3.02	3.50	0.41	8567.34
SD 16	1.62	2.05	8.24	1.87	BDL	0.22	3.11	1.34	0.22	2.20	7.38	0.85	744.30
SD 17	1.220	0.960	10.300	3.800	BDL	0.640	2.056	1.63	0.34	1.8	8.34	0.33	1156.3
SD 18	2.06	0.63	7.36	2.98	BDL	0.32	2.35	2.08	0.41	2.62	2.94	0.42	689.30
SD 19	1.62	0.86	9.02	3.62	BDL	0.37	2.87	0.42	0.20	2.44	4.03	0.75	834.20
SD 20	0.780	0.770	7.230	3.204	BDL	0.420	1.980	0.56	0.71	2.07	3.9	0.42	842.99
SD 21	1.24	0.64	5.38	2.85	BDL	0.26	2.26	1.06	0.84	3.51	3.42	0.39	1642.90
SD 22	1.340	0.340	8.200	2.067	BDL	0.210	1.060	1.43	0.066	1.45	10.330	0.56	1045.34
SDC 23	1.64	1.53	6.51	2.22	BDL	0.24	2.36	1.66	0.04	2.82	4.88	0.60	1244.34
SDC 24	1.940	0.830	2.860	1.430	BDL	1.260	1.550	1.96	0.073	3.2	8.460	0.43	833.28

Table A3.15: Particle Size Distribution of Sediment

Sampling Code	Particle Size								
	VCS (%)	CS (%)	MS (%)	FS (%)	VFS (%)	Total Sand (%)	Total Silt (%)	Total Clay (%)	Texture
	Wet Season								
SD 1	1.48	14.98	56.25	10.19	1.2	84	9	7	Loam Sand
SD 2	0.5	2.71	24.64	47.38	0.99	76	15	9	Sandy Loam
SD 3	0	2.6	0.72	3.41	0.9	8	56	36	Silty Clay Loam
SD 4	0.1	0.28	3.72	66.76	16.48	87	7	5	Sand
SD 5	0	0.1	0.39	0.79	0.49	2	59	39	Silty Clay Loam
SD 6	4.92	11.85	14.56	14.73	1.4	46	31	23	Loam.
SD 7	0.09	0.57	1.64	1.88	0.82	5	81	14	Silty Loam
SD 8	1.45	18.8	38.86	19.09	0.96	79	9	12	Sandy Loam
SD 9	0.88	14.88	39.65	26.53	2.64	84	8	8	Loam Sand
SD 10	0	2.6	0.72	3.41	0.9	8	56	36	Silty Clay Loam
SDC 11	0.09	0.67	1.54	1.48	0.62	6	51	16	Silty Loam
SDC 12	0	0.1	0.4	0.8	0.5	3	60	40	Silty Clay Loam
SDC 13	1.48	14.98	56.25	10.19	1.2	84	9	7	Loam Sand
SD 14	0.5	2.71	24.64	47.38	0.99	76	15	9	Sandy Loam
SD 15	0.89	15.88	40.65	26.59	2.7	90	7	7	Loam Sand
SD 16	0.11	0.3	3.45	65.74	17.45	89	8	6	Sand
SD 17	1.48	14.67	55.26	10.2	1.3	83	10	6	Loam Sand
SD 18	4.92	11.45	13.58	15.83	1.6	49	39	25	Loam
SD 19	0.5	2.74	24.66	47.4	0.77	78	15	8	Sandy Loam
SD 20	1.45	19.8	40.86	20.09	0.76	78	8	12	Sandy Loam
SD 21	0	2.6	0.74	2.51	0.7	7	58	34	Silty Clay Loam
SD 22	1.45	18.6	39.88	16.09	0.76	79	6	12	Sandy Loam
SDC 23	0.88	14.67	37.75	27.83	2.76	84	9	9	Loam Sand
SDC 24	0.1	0.34	3.62	65.46	15.47	87	6	7	Sand

Appendix 3.4: Surface Water Data

Table A3.16: Wet Season Physio-Chemical Characteristics of Surface Water around the Site (WT1 – WT10)

Parameters	Concentration											
	WTC1	**WT1**	**WT2**	**WT3**	**WT4**	**WT5**	**WTC2**	**WT6**	**WT7**	**WT8**	**WT9**	**WT10**
pH	8.10	8.09	8.17	8.13	8.07	8.20	7.90	8.00	8.10	8.30	8.22	7.90
Conductivity (µS/cm)	94.00	93.00	93.00	93.00	96.00	93.00	95.00	84.00	97.00	94.00	93.00	90.00
Temperature (0C)	30.54	31.01	29.29	28.36	28.70	27.30	29.80	27.90	27.90	30.30	30.20	29.30
TDS (mg/l)	55.00	54.00	54.00	54.00	55.00	54.00	56.00	53.00	57.00	56.00	54.00	58.00
DO(mg/l)	7.60	7.20	8.20	7.80	7.20	8.00	7.40	6.80	8.40	6.40	8.60	7.60
Salinity(mg/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turbidity(mg/l)	35.00	37.60	34.80	30.30	44.00	34.00	32.00	34.00	36.00	34.00	34.40	36.00
TSS(mg/l)	91.00	88.00	66.00	54.00	78.00	72.00	80.00	70.00	74.00	86.00	54.00	68.00
Color(Pt -Co)	40.00	35.00	30.00	30.00	40.00	25.00	40.00	25.00	30.00	30.00	42.00	25.00
COD(mg/l)	4.80	6.40	7.64	6.11	6.56	6.40	8.20	6.40	6.80	6.20	8.30	7.80
BOD(mg/l)	1.20	1.80	2.10	2.40	1.80	0.60	2.20	2.10	1.80	0.60	1.40	2.20
Total Hardness(mg/l)	19.00	10.00	12.00	10.00	14.00	8.00	12.00	16.00	22.00	16.00	14.00	10.00
Ammonium(mg/l)	0.52	0.52	0.65	0.82	0.85	0.48	0.88	0.62	0.69	0.42	0.29	0.84
Sulphate(mg/l)	3.19	4.00	3.00	8.00	5.00	6.40	2.80	2.80	9.11	8.58	7.72	7.83
Chloride(mg/l)	15.00	20.99	15.00	13.00	13.00	15.00	14.40	12.20	14.20	18.00	12.40	16.80
Nitrate	1.20	0.18	0.26	0.52	1.32	0.09	0.09	0.62	0.06	1.08	0.47	0.68
Avail. Phosphorous	0.88	1.06	1.44	0.38	0.58	1.20	1.03	0.08	0.94	1.04	0.24	0.56
Total Phosphorous	3.90	2.40	4.60	2.02	3.40	2.40	4.20	1.24	1.48	1.80	1.08	1.29
Alkalinity	52.00	48.00	46.00	48.00	54.00	42.00	40.00	46.00	50.00	42.00	44.00	38.00
Bicarbonate(mg/l)	63.44	58.56	56.12	58.56	65.88	51.24	48.80	56.12	61.00	51.24	53.68	46.36
Carbonate (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Metals												
Cupper(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chromium(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Iron(mg/l)	0.82	1.37	0.79	0.85	0.82	0.78	1.87	1.09	0.56	0.91	2.01	0.74
Nickel(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Vanadium(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Arsenic(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Magnesium	2.80	1.36	0.22	0.19	1.08	2.40	2.90	2.40	1.06	0.86	1.22	4.03
Organics												
Oil & Grease(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
TPH(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
THC(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Microbiology												
Coliform (MPN/100ml)	10	22	Nil	Nil	32	8	Nil	10	Nil	14	20	16
THB($X10^2$ cfu/ml)	1.28	1.22	1.26	1.14	1.22	1.34	1.24	1.10	1.22	1.28	1.30	1.26
THF($X10^2$ cfu/ml)	1.13	1.09	1.04	1.11	0.34	0.22	0.68	0.24	0.56	0.88	0.67	0.82

Table A3.17: Wet Season Physio-Chemical Characteristics of Surface Water around the Site (WT11 – WT20)

Parameters	Concentration											
	WTC3	**WT11**	**WT12**	**WT13**	**WT14**	**WT15**	**WTC4**	**WT16**	**WT17**	**WT18**	**WT19**	**WT20**
pH	8.01	7.80	8.20	8.20	8.09	8.10	8.30	7.70	7.90	8.10	8.10	8.20
Conductivity (µS/cm)	98.00	93.00	97.00	90.00	97.00	93.00	93.00	98.00	97.00	94.00	96.00	94.00
Temperature (^{o}C)	28.90	28.90	30.30	29.60	28.80	30.40	30.10	29.30	29.60	28.90	29.20	28.70
TDS (mg/l)	56.00	54.00	56.00	58.00	53.00	54.00	54.00	56.00	53.00	54.00	58.00	53.00
DO(mg/l)	8.40	8.00	7.40	6.40	7.00	6.80	8.00	6.80	6.40	8.60	7.80	8.00
Salinity(mg/l)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Turbidity(mg/l)	33.00	35.20	40.00	36.00	36.00	34.00	36.30	33.90	34.00	36.20	34.80	36.00
TSS(mg/l)	52.00	82.00	48.00	76.00	80.00	55.00	46.00	94.00	48.00	80.00	76.00	63.00
Color(Pt -Co)	30.00	30.00	35.00	56.00	30.00	45.00	20.00	30.00	15.00	25.00	20.00	25.00
COD(mg/l)	8.20	6.40	7.22	6.08	8.30	6.00	6.20	4.80	7.20	4.80	8.20	6.00
BOD(mg/l)	1.60	2.00	1.20	0.80	1.20	1.00	1.60	0.80	1.20	1.40	1.80	1.80
Total Hardness(mg/l)	18.00	28.00	24.00	16.00	12.00	34.00	22.00	26.00	16.00	42.00	38.00	14.00
Ammonium(mg/l)	0.54	0.32	0.78	0.60	0.58	0.64	0.86	0.55	0.68	0.54	0.38	0.30
Sulphate(mg/l)	8.77	4.90	6.80	4.33	2.90	5.10	6.80	8.20	5.30	8.10	5.20	2.00
Chloride(mg/l)	16.20	12.80	12.60	10.40	12.60	18.40	12.60	20.80	16.90	14.80	20.20	16.00
Nitrate	1.98	0.06	0.28	0.08	0.33	1.06	0.74	0.44	0.62	1.08	0.93	0.62
Avail. Phosphorous	0.84	0.06	0.42	0.09	0.48	0.26	1.43	1.02	0.08	1.14	0.04	0.62
Total Phosphorous	1.34	1.02	0.89	2.01	1.22	1.52	1.84	1.68	1.06	2.05	2.80	3.30
Alkalinity	40.00	52.00	36.00	42.00	46.00	30.00	48.00	42.00	54.00	44.00	52.00	42.00
Bicarbonate(mg/l)	48.80	63.44	43.92	51.24	56.12	36.60	58.56	51.24	65.88	53.68	63.44	51.24
Carbonate (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Metals												
Cupper(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chromium(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Iron(mg/l)	0.82	1.08	0.77	0.71	1.43	0.80	1.22	0.95	2.60	2.11	0.84	1.41
Nickel(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Vanadium(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Arsenic(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Magnesium	1.62	2.80	3.10	1.84	4.10	2.60	3.08	2.66	3.12	2.42	1.94	1.22
Organics												
Oil & Grease(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
TPH(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
THC(mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Microbiology												
Coliform (MPN/100ml)	10	Nil	Nil	Nil	Nil	14	Nil	10	Nil	Nil	18	Nil
THB(X10^{2} cfu/ml)	1.26	1.22	1.32	1.28	1.12	1.56	1.26	1.22	1.28	1.28	1.20	1.42
THF(X10^{2} cfu/ml)	1.11	0.34	0.58	0.44	0.89	0.38	1.09	1.03	0.58	1.02	0.66	1.01

Table A3.18: Dry Season Physio-Chemical Characteristics of Surface Water around the Site (WT1 – WT10)

Parameters	Concentration											
	WTC1	**WT1**	**WT2**	**WT3**	**WT4**	**WT5**	**WTC2**	**WT6**	**WT7**	**WT8**	**WT9**	**WT10**
pH	7.10	7.00	7.80	7.40	7.20		7.20	7.20	7.20	7.22		
Conductivity (µS/cm)	126.20	109.70	129.60	134.80	109.70		127.20	114.40	124.80	142.00		
Temperature (0C)	29.29	28.70	30.60	26.00	27.30		28.36	27.90	26.40	29.00		
TDS (mg/l)	63.60	54.00	63.90	67.20	54.40		63.50	57.20	63.00	70.30		
DO(mg/l)	5.60	5.80	5.40	6.00	8.40		6.30	5.40	6.00	5.40		
Salinity(mg/l)	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00		
Turbidity(mg/l)	32.00	28.00	30.00	18.00	28.00		30.00	29.00	26.00	22.00		
TSS(mg/l)	60.00	68.00	48.00	40.00	64.00		46.00	52.00	37.00	16.00		
Color(Pt -Co)	24.00	26.00	28.00	24.00	20.00		22.00	18.00	18.00	20.00		
COD(mg/l)	6.20	4.40	6.40	4.90	4.80		5.40	4.20	4.00	6.20		
BOD(mg/l)	1.40	2.80	2.10	2.40	1.60		4.60	2.10	2.90	1.20		
Total Hardness(mg/l)	28.40	32.80	32.00	28.00	14.83		16.88	30.20	30.00	28.00		
Ammonium(mg/l)	0.44	0.62	0.84	0.63	0.40		0.46	0.48	0.69	0.60		
Sulphate(mg/l)	12.30	12.60	16.40	22.90	10.40		14.20	10.80	16.00	14.40		
Chloride(mg/l)	18.40	20.60	38.34	36.20	22.60		16.40	18.40	22.80	28.30		
Nitrate	0.68	2.08	8.40	4.60	0.66		1.40	0.84	0.06	1.33		
Avail. Phosphorous	1.02	0.64	2.10	0.80	1.06		0.38	0.08	1.20	0.89		
Total Phosphorous	2.89	4.10	3.80	1.40	3.40		1.76	1.20	1.80	1.40		
Alkalinity	48.00	64.00	62.90	68.00	58.00		56.00	40.00	50.00	48.00		
Bicarbonate(mg/l)	58.56	78.08	76.74	82.96	70.76		68.32	48.80	61.00	58.56		
Carbonate (mg/l)	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		
Metals												
Cupper(mg/l)	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		
Chromium(mg/l)	0.02	0.01	BDL	BDL	BDL		0.02	BDL	BDL	BDL		
Cadmium(mg/l)	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		
Lead(mg/l)	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		
Iron(mg/l)	1.44	1.42	0.79	2.01	1.22		1.86	1.76	0.56	0.91		
Nickel(mg/l)	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		
Vanadium(mg/l)	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		
Zinc(mg/l)	BDL	BDL	0.02	1.28	BDL		BDL	BDL	BDL	BDL		
Arsenic(mg/l)	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		
Mercury(mg/l)	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		
Magnesium	8.26	1.08	1.84	3.20	2.40		4.62	2.40	1.06	0.86		
Organics												
Oil & Grease(mg/l)	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		
TPH(mg/l)	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		
THC(mg/l)	BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL	BDL		
Microbiology												
Coliform (MPN/100ml)	22	80	24.00	16.00	18		56	10	Nil	14.00		
THB($X10^{-2}$ cfu/ml)	1.69	1.56	0.98	1.06	1.48		1.24	1.48	1.22	1.28		
THF($X10^{-2}$ cfu/ml)	1.09	0.8	0.66	1.20	0.28		1.22	0.29	0.56	0.88		

Table A3.19: Dry Season Physio-Chemical Characteristics of Surface Water around the Site (WT11 – WT20)

Parameters	Concentration											
	WTC3	**WT11**	**WT12**	**WT13**	**WT14**	**WT15**	**WTC4**	**WT16**	**WT17**	**WT18**	**WT19**	**WT20**
pH	7.72	9.10		7.72	7.20	9.00	7.40	7.40		9.40	7.20	7.40
Conductivity (µS/cm)	318.00	187.70		318.00	186.00	185.20	178.00	363.00		185.40	174.00	182.00
Temperature (^{o}C)	30.54	29.30		30.54	28.80	30.30	31.01	31.01		30.20	28.60	28.40
TDS (mg/l)	159.00	93.80		159.00	94.00	92.00	89.00	181.00		92.00	87.00	91.00
DO(mg/l)	7.40	6.20		7.40	6.20	7.20	6.80	6.80		6.40	5.90	5.40
Salinity(mg/l)	0.01	0.00		0.01	0.01	0.00	0.01	0.01		0.00	0.01	0.01
Turbidity(mg/l)	32.00	36.00		32.00	31.00	38.00	30.00	30.00		34.00	31.00	28.00
TSS(mg/l)	56.00	46.00		56.00	54.00	70.00	58.00	58.00		38.00	36.00	42.00
Color(Pt -Co)	26.00	20.00		26.00	18.00	18.00	30.00	30.00		24.00	26.00	28.00
COD(mg/l)	16.80	5.00		16.80	2.80	4.20	2.80	22.80		6.40	6.20	6.00
BOD(mg/l)	0.80	2.20		0.80	1.20	0.60	1.20	1.20		1.40	1.40	1.20
Total Hardness(mg/l)	34.20	36.00		34.20	18.00	16.00	18.60	18.60		48.00	30.00	26.00
Ammonium(mg/l)	7.40	0.48		7.40	4.60	0.22	8.40	8.40		0.24	1.20	0.86
Sulphate(mg/l)	22.80	7.83		22.80	22.00	8.58	16.80	16.80			34.80	16.20
Chloride(mg/l)	34.80	26.90		34.80	64.60	20.40	42.20	42.20		28.50	20.20	22.90
Nitrate	2.10	0.68		2.10	0.88	0.78	0.56	0.56		0.46	1.24	1.90
Avail. Phosphorous	1.02	0.56		1.02	0.10	0.62	1.06	1.06		0.24	0.69	1.04
Total Phosphorous	3.20	0.81		3.20	3.90	0.96	2.80	2.80		0.82	2.80	1.62
Alkalinity	64.00	44.00		64.00	68.00	34.00	60.00	60.00		40.00	64.00	39.00
Bicarbonate(mg/l)	78.08	53.68		78.08	82.96	41.48	73.20	73.20		48.80	78.08	47.58
Carbonate (mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
Metals												
Cupper(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
Chromium(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
Cadmium(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
Lead(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
Iron(mg/l)	1.03	2.10		1.03	2.10	1.84	2.40	2.40		2.64	0.84	1.41
Nickel(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
Vanadium(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
Zinc(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
Arsenic(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
Mercury(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
Magnesium	6.40	4.03		6.40	6.80	0.86	4.64	4.64		1.22	1.94	1.22
Organics												
Oil & Grease(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
TPH(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
THC(mg/l)	BDL	BDL		BDL	BDL	BDL	BDL	BDL		BDL	BDL	BDL
Microbiology												
Coliform (MPN/100ml)	68	50		68	56.00	54.00	68	84.00		46.00	42.00	12.00
THB($X10^{-2}$ cfu/ml)	1.46	1.48		1.46	0.86	1.26	1.10	1.32		1.11	1.60	1.80
THF($X10^{-2}$ cfu/ml)	1.18	0.74		1.18	0.24	0.78	0.9	1.12		0.46	1.30	1.20

Appendix 3.5: Soil

Table A3.20: Physio-Chemical Characteristics of Soil around the Site

Sampling Code	pH	TOC	Avail-P	Exch. Cations				EC	T-N	SO_4^{2-}	Cl^-	THC
				Na	K	Mg	Ca					
		%	mg/kg	Cmol/kg				µS/cm	%	mg/kg		
	Wet Season											
SL1(1-15cm)	6.8	0.35	10.98	0.19	0.21	1.39	5.08	141	0.84	26.23	70.4	BDL
SL1(15-30cm)	6.6	0.66	26.01	0.13	0.17	1.34	4.86	221	0.66	22.11	14.08	BDL
SL2(1-15cm)	6.6	1.4	27.79	0.2	0.22	1.53	5.12	207	0.49	68.58	56.32	BDL
SL2(15-30cm)	6.3	0.62	29.47	0.17	0.38	1.61	5.27	223	0.43	76.12	42.24	BDL
SL3(1-15cm)	5.9	0.86	28.78	0.24	0.27	1.78	5.63	121	0.28	41.15	42.24	BDL
SL3(15-30cm)	5.5	0.55	15.23	0.21	0.16	1.84	5.63	220	0.3	44.1	56.32	BDL
SL4(1-15cm)	6.4	0.43	15.53	0.33	0.23	1.63	7.79	256	0.21	55.34	28.16	2.03
SL4(15-30cm)	6.2	0.47	9.99	0.3	0.19	1.53	8.1	250	0.2	53	42.24	2.23
SL5(1-15cm)	6.8	0.62	11.08	0.19	0.11	1.43	5.09	117	0.22	79.41	42.24	5.66
SL5(15-30cm)	6.6	0.27	14.54	0.15	0.19	1.35	5.41	221	0.21	76.22	42.24	3.12
SL6(1-15cm)	6.7	0.72	16.23	0.18	0.22	1.52	5.11	279	0.23	66.17	55.42	2.14
SL6(15-30cm)	6.5	0.52	12.33	0.13	0.17	1.12	4.87	239	0.23	68.11	43.32	2.13
SL7(1-15cm)	6.8	0.66	14.56	0.22	0.21	1.52	6.03	223	0.22	58.92	44.12	BDL
SL7(15-30cm)	6.3	0.53	13.32	0.2	0.18	1.23	5.34	203	0.2	60.12	42.76	BDL
SL8(1-15cm)	6.8	0.46	12.14	0.18	0.16	1.31	5.12	145	0.21	56.74	44.13	BDL
SL8(15-30cm)	6.4	0.32	12	0.16	0.14	1.23	5	243	0.2	63.12	44.23	BDL
SL9(1-15cm)	6.8	0.88	19.56	0.21	0.15	1.44	5.11	208	0.24	48.17	32.67	BDL
SL9(15-30cm)	6.3	0.63	17.13	0.18	0.15	1.22	4.98	228	0.22	55.12	36.17	BDL
SL10(1-15cm)	5.8	0.67	15.66	0.22	0.14	1.42	5.01	234	0.32	66.33	44.12	5.12
SL10(15-30cm)	5.6	0.54	13.42	0.2	0.12	1.32	4.76	214	0.22	66	42.76	BDL
SLC1(1-15cm)	6.8	1.01	17.31	0.23	0.22	1.67	5.11	119	0.48	40.43	42.24	4.33
SLC1(15-30cm)	6.4	0.86	15.21	0.21	0.29	1.57	4.87	221	0.46	54.13	28.16	3.32
SLC2(1-15cm)	5.8	0.92	20.22	0.19	0.21	1.48	5.08	126	0.33	38.33	39.12	4.13
SLC1(15-30cm)	5.6	0.76	15.11	0.16	0.13	1.35	4.88	223	0.31	47.78	40.23	2.13
	Dry Season											
SL1(1-15cm)												
SL1(15-30cm)												
SL2(1-15cm)												
SL2(15-30cm)												
SL3(1-15cm)												
SL3(15-30cm)												
SL4(1-15cm)												
SL4(15-30cm)												
SL5(1-15cm)												
SL5(15-30cm)												
SL6(1-15cm)												
SL6(15-30cm)												
SL7(1-15cm)												
SL7(15-30cm)												
SL8(1-15cm)												
SL8(15-30cm)												
SL9(1-15cm)												
SL9(15-30cm)												
SL10(1-15cm)												
SL10(15-30cm)												
SLC1(1-15cm)												
SLC1(15-30cm)												
SLC2(1-15cm)												
SLC1(15-30cm)												

Table A3.21: Heavy Metal Concentration of Soil around the Site

Sampling Code	Fe	Cu	Mn	Zn	Pb	Ni	Co	Cd	V	Cr
	(mg/kg)									
	Wet Season									
SL1(1-15cm)	44.3	0.44	44.25	15.8	0.06	0.02	0.07	0.07	BDL	BDL
SL1(15-30cm)	32.11	1.94	44.66	18.64	0.08	0.03	0.03	0.06	0.03	0.03
SL2(1-15cm)	45.5	2.8	45.96	17.1	0.06	0.02	0.07	0.06	BDL	BDL
SL2(15-30cm)	42.86	1.34	48.11	9.13	0.04	0.03	0.03	0.06	0.03	0.05
SL3(1-15cm)	33.1	2.66	25.34	27	0.05	0.04	0.01	0.02	BDL	BDL
SL3(15-30cm)	33	1.98	35.97	22.11	0.05	0.05	0.03	0.05	0.05	0.05
SL4(1-15cm)	41.13	1.25	59.97	23.12	0.13	0.03	0.05	0.12	0.06	0.05
SL4(15-30cm)	40	1.2	44.13	20.18	0.12	0.05	0.08	0.09	0.05	0.05
SL5(1-15cm)	42.1	2.1	55.64	22.18	0.78	BDL	0.06	0.03	0.04	0.04
SL5(15-30cm)	35.12	2.72	51.44	23.19	0.74	0.07	0.05	0.06	0.05	0.05
SL6(1-15cm)	33.17	1.92	44.67	21.65	0.65	0.33	0.04	0.02	0.03	0.06
SL6(15-30cm)	33	1.65	45.6	17.23	0.6	0.3	0.06	0.04	0.05	0.08
SL7(1-15cm)	23.11	1.67	12.34	16.66	0.09	0.28	0.06	0.02	0.03	0.03
SL7(15-30cm)	22.15	1.35	22.89	22.11	0.07	0.22	0.06	0.04	0.05	0.05
SL8(1-15cm)	33.21	1.83	17.82	34.12	0.34	0.08	BDL	0.04	0.03	0.03
SL8(15-30cm)	33	1.92	27.8	24	0.46	0.07	0.05	0.04	0.05	0.05
SL9(1-15cm)	40.12	0.98	29.24	22.87	BDL	BDL	BDL	0.06	BDL	BDL
SL9(15-30cm)	42	1.87	39	22	BDL	0.07	0.05	0.03	0.03	0.05
SL10(1-15cm)	29.23	1.23	56.13	13.76	0.83	BDL	0.04	0.03	BDL	BDL
SL10(15-30cm)	30.66	1.11	46.12	15.12	0.33	0.06	0.04	0.03	0.03	0.05
SLC1(1-15cm)	39.82	2.31	43.12	23.14	0.12	0.2	BDL	0.11	0.05	0.04
SLC1(15-30cm)	35.13	1.97	45.1	20	0.22	0.23	BDL	0.06	0.05	0.04
SLC2(1-15cm)	40.24	2.34	44.23	22.67	0.05	0.1	BDL	BDL	BDL	BDL
SLC1(15-30cm)	38.97	2.55	38.28	20.18	0.15	0.09	0.04	0.05	0.05	0.05
	Dry Season									
SL1(1-15cm)										
SL1(15-30cm)										
SL2(1-15cm)										
SL2(15-30cm)										
SL3(1-15cm)										
SL3(15-30cm)										
SL4(1-15cm)										
SL4(15-30cm)										
SL5(1-15cm)										
SL5(15-30cm)										
SL6(1-15cm)										
SL6(15-30cm)										
SL7(1-15cm)										
SL7(15-30cm)										
SL8(1-15cm)										
SL8(15-30cm)										
SL9(1-15cm)										
SL9(15-30cm)										
SL10(1-15cm)										
SL10(15-30cm)										
SLC1(1-15cm)										
SLC1(15-30cm)										
SLC2(1-15cm)										
SLC1(15-30cm)										

Table A3.22: Microbial Content in Soil around the Proposed Project Area

Sampling Code	Wet Season					Dry Season				
	THB at 35°C	THF at 30°C	HUB at 30°C	HUF at 30°C	SRB at 30°C	THB at 35°C	THF at 30°C	HUB at 30°C	HUF at 30°C	SRB at 30°C
	x 10^7 cfu/g)	(x 10^4 cfu/g)	(x 10^5 cfu/g)	(x 10^2 cfu/g)	(x 10^2 cfu/g)	(x 10^7 cfu/g)	(x 10^4 cfu/g)	(x 10^5 cfu/g)	(x 10^2 cfu/g)	(x 10^2 cfu/g)
SL1(1-15cm)	2.6	4	2	1.6	NIL					
SL1(15-30cm)	1.1	2	0.8	0.2	NIL					
SL2(1-15cm)	1.3	4	5.6	0.5	3					
SL2(15-30cm)	1	1.2	0.4	0.2	0.3					
SL3(1-15cm)	1	0.11	3.8	1	4					
SL3(15-30cm)	0.6	1.1	2.1	0.3	0.8					
SL4(1-15cm)	2	0.27	3.4	11	3. 0					
SL4(15-30cm)	1	0.2	0.6	2.1	0.4					
SL5(1-15cm)	1.8	1.7	2	1,3	2.1					
SL5(15-30cm)	0.5	2	0.7	0.6	0.7					
SL6(1-15cm)	1.1	1	1.6	1.2	1.8					
SL6(15-30cm)	0.6	1.2	0.5	0.4	0.6					
SL7(1-15cm)	0.8	0.6	2	1.1	1.2					
SL7(15-30cm)	0.8	0.3	0.6	0.3	0.8					
SL8(1-15cm)	0.7	0.6	1	1	1.5					
SL8(15-30cm)	0.6	0.3	0.5	0.2	0.7					
SL9(1-15cm)	0.9	0.7	1.1	0.8	0.9					
SL9(15-30cm)	0.3	0.5	0.7	0.4	0.5					
SL10(1-15cm)	2.2	2	2.1	0.6	1.1					
SL10(15-30cm)	0.8	0.6	0.6	0.5	0.5					
SLC1(1-15cm)	2.1	4	2.2	1.2	2					
SLC1(15-30cm)	1.1	2	1.1	1	1.1					
SLC2(1-15cm)	2	3.1	2	1	1.2					
SLC1(15-30cm)	1	1.1	1.3	0.8	1					
SL13(1-15cm)	1.4	3.4	2.2	1.4	2					
SL13(15-30cm)	0.8	0.7	0.7	0.3	0.3					
SL14(1-15cm)	1.2	4.1	3.6	0.3	2.1					
SL14(15-30cm)	0.7	0.3	0.3	0.1	0.8					
SL15C(1-15cm)	1.1	0.4	2.4	1.2	2.3					
SL15C(15-30cm)	0.7	0.2	0.9	0.4	0.6					
SL16C(1-15cm)	1.8	0.4	2.2	1.2	2.2					
SL16C(15-30cm)	0.8	0.3	0.6	0.3	0.8					
SL17(1-15cm)	2.1	0.5	2.1	1.3	2.1					
SL17(15-30cm)	0.6	0.3	0.5	0.2	0.7					
SL18(1-15cm)	1.5	3.4	2.2	1.9	2.9					
SL18(15-30cm)	0.3	0.2	0.4	0.2	0.3					
SL19(1-15cm)	1.3	4.4	3.5	0.8	2.6					
SL19(15-30cm)	0.26	0.68	0.48	0.54	0.25					
SL20(1-15cm)	1.1	0.4	2.4	1.7	2.5					
SL20(15-30cm)	0.61	0.39	0.6	0.29	0.61					
SL21(1-15cm)	1.8	0.4	2.3	1.5	2.7					
SL21(15-30cm)	0.2	0.17	0.19	0.11	0.18					
SL22(1-15cm)	2.5	0.4	2.1	1.4	2.2					
SL22(15-30cm)	0.78	1.04	0.83	0.58	0.67					
SLC23(1-15cm)	2.2	3.2	1.7	1	2.1					
SLC23(15-30cm)	0.3	0.5	0.7	0.4	0.5					
SLC24(1-15cm)	2	2.1	2.1	1.1	2.2					
SLC24(15-30cm)	0.4	0.4	0.5	0.3	0.6					

Table A3.23: Physio-Chemical Characteristics of Soil along the Transmission Line

Sampling Code	pH	TOC	Avail-P	Exch. Cations				EC	T-N	SO_4^{2-}	Cl^-	THC
				Na	K	Mg	Ca					
		(%)	(mg/kg)	(Cmol/kg)				(µS/cm)	(%)	(mg/kg)		
	Wet Season											
SL13(1-15cm)	6.9	0.35	14.14	0.23	0.21	3.82	5.67	161	0.32	31.28	28.16	2.11
SL13(15-30cm)	6.6	0.9	15.03	0.21	0.1	5.03	6.72	180	0.3	33.22	42.24	3.1
SL14(1-15cm)	6.8	1.05	10.09	0.25	0.24	5.61	6.46	217	0.39	34.17	28.16	1.27
SL14(15-30cm)	6.4	0.62	19.39	0.22	0.17	5.99	6.78	210	0.35	36.1	42.24	2.33
SL15C(1-15cm)	6.7	0.78	19.29	0.42	0.67	6.24	10.05	221	0.35	24.06	28.16	5.16
SL15C(15-30cm)	6.4	0.16	15.83	0.33	0.71	1.98	10.19	211	0.33	28	42.24	2.34
SL16C(1-15cm)	6.6	0.16	8.6	0.32	0.48	1.77	6.74	236	0.35	47.16	56.32	11.12
SL16C(15-30cm)	6.4	0.55	9.79	0.3	0.39	1.79	6.89	198	0.33	45.11	28.16	5.67
SL17(1-15cm)	6.7	1.09	7.91	0.21	0.16	1.65	6.87	214	0.49	31.28	42.24	8.27
SL17(15-30cm)	6.5	0.39	46.68	0.21	0.08	1.28	5.51	210	0.46	38.32	56.32	4.12
SL18(1-15cm)	6.6	0.52	11.14	0.21	0.22	4.5	6.75	234	0.4	35.13	24.12	2.13
SL18(15-30cm)	6.4	0.4	15.23	0.25	0.12	5.03	6.79	190	0.5	34.22	45.24	3.62
SL19(1-15cm)	6.9	1.03	10.09	0.27	0.24	4.5	6.34	216	0.32	35.23	41.3	1.3
SL19(15-30cm)	6.4	0.57	19.32	0.24	0.37	5.97	6.58	220	0.36	37.1	45.24	2.45
SL20(1-15cm)	6.7	0.88	10.26	0.52	0.87	6.56	8.05	225	0.35	25.15	24.56	5.02
SL20(15-30cm)	6.4	0.15	15.84	0.34	0.74	1.68	8.19	231	0.34	20	41.24	2.87
SL21(1-15cm)	6.5	0.16	7.62	0.34	0.46	5.57	6.89	245	0.35	39.14	54.23	11.34
SL21(15-30cm)	6.4	0.67	9.59	0.32	0.69	1.69	6.89	138	0.37	46.01	22.19	6.77
SL22(1-15cm)	6.8	1.09	6.81	0.25	0.17	1.71	7.09	306	0.45	34.13	41.23	6.27
SL22(15-30cm)	6.3	0.4	47.68	0.23	0.04	1.25	5.61	220	0.46	37.34	33.56	4.24
SLC23(1-15cm)	6.8	1.25	41.74	0.32	0.37	1.46	5.14	232	0,82	32.14	28.16	6.14
SLC23(15-30cm)	6.6	0.32	16.78	0.3	0.13	1.33	5.23	231	0.76	36.13	48.92	4.34
SLC24(1-15cm)	6.9	1.23	10.22	0.23	0.24	4.12	4.22	203	0.49	31.22	28.15	BDL
SLC24(15-30cm)	6.6	1.25	41.74	0.22	0.26	1.44	5.13	221	0.38	36.22	56.32	BDL
	Dry Season											
SL13(1-15cm)												
SL13(15-30cm)												
SL14(1-15cm)												
SL14(15-30cm)												
SL15C(1-15cm)												
SL15C(15-30cm)												
SL16C(1-15cm)												
SL16C(15-30cm)												
SL17(1-15cm)												
SL17(15-30cm)												
SL18(1-15cm)												
SL18(15-30cm)												
SL19(1-15cm)												
SL19(15-30cm)												
SL20(1-15cm)												
SL20(15-30cm)												
SL21(1-15cm)												
SL21(15-30cm)												
SL22(1-15cm)												
SL22(15-30cm)												
SLC23(1-15cm)												
SLC23(15-30cm)												
SLC24(1-15cm)												
SLC24(15-30cm)												

Table A3.24: Heavy Metal Concentration of Soil along the Transmission Line

Sampling Code	Concentration									
	Fe	Cu	Mn	Zn	Pb	Ni	Co	Cd	V	Cr
	(mg/kg)									
	Wet Season									
SL13(1-15cm)	34.12	0.55	43.52	15.11	0.05	BDL	0.06	0.12	BDL	BDL
SL13(15-30cm)	44.19	0.66	45.78	13.1	0.06	0.03	0.08	0.11	0.03	0.03
SL14(1-15cm)	42.23	0.42	26.32	12.46	BDL	BDL	0.05	0.03	BDL	BDL
SL14(15-30cm)	40.87	0.54	35.17	10.35	0.08	0.03	0.03	0.04	0.04	0.04
SL15C(1-15cm)	43.22	1.18	28.17	10.16	BDL	BDL	0.12	0.04	BDL	BDL
SL15C(15-30cm)	44.12	1.11	37.18	9.16	0.04	0.002	0.09	0.04	0.04	0.03
SL16C(1-15cm)	17.64	1.11	44.32	9.35	BDL	0.04	0.13	0.11	BDL	BDL
SL16C(15-30cm)	26.89	1.11	40.87	9.3	0.03	0.03	0.08	0.1	0.05	0.03
SL17(1-15cm)	42.13	1.1	42.43	17.62	0.06	0.04	0.13	0.12	BDL	BDL
SL17(15-30cm)	43.66	1.13	40.78	12.89	0.04	0.05	0.76	0.1	0.05	0.14
SL18(1-15cm)	35.24	0.52	44.34	15.67	BDL	BDL	0.05	0.11	BDL	BDL
SL18(15-30cm)	43.29	0.46	42.75	12.1	0.06	0.05	0.04	0.14	0.04	0.05
SL19(1-15cm)	41.13	0.411	25.34	12.56	BDL	BDL	0.06	0.04	BDL	BDL
SL19(15-30cm)	42.37	0.74	32.37	11.85	0.06	0.05	0.03	0.04	0.05	0.04
SL20(1-15cm)	42.12	1.15	27.45	10.34	BDL	BDL	0.14	0.05	BDL	BDL
SL20(15-30cm)	44.24	1.51	34.28	9.1	0.05	0.07	0.05	0.06	0.06	0.03
SL21(1-15cm)	18.15	1.14	43.23	9.12	BDL	BDL	0.15	0.12	BDL	BDL
SL21(15-30cm)	25.67	1.31	41.97	8.5	0.04	0.05	0.06	0.6	0.06	0.03
SL22(1-15cm)	43.14	1.12	43.56	17.34	BDL	BDL	0.13	0.11	BDL	BDL
SL22(15-30cm)	42.46	1.15	40.78	12.89	0.03	0.04	0.87	0.1	0.05	0.14
SLC23(1-15cm)	32.17	1.98	33.12	30.78	0.08	0.04	0.07	0.13	0.06	0.05
SLC23(15-30cm)	33.33	1.38	31.44	22.18	0.04	0.05	0.05	0.09	0.04	0.05
SLC24(1-15cm)	36.12	1.78	23.28	16.23	0.04	0.05	0.05	0.06	0.05	0.12
SLC24(15-30cm)	32.16	1.58	19.17	13.87	0.04	0.05	0.05	0.05	0.04	0.12
	Dry Season									
SL13(1-15cm)										
SL13(15-30cm)										
SL14(1-15cm)										
SL14(15-30cm)										
SL15C(1-15cm)										
SL15C(15-30cm)										
SL16C(1-15cm)										
SL16C(15-30cm)										
SL17(1-15cm)										
SL17(15-30cm)										
SL18(1-15cm)										
SL18(15-30cm)										
SL19(1-15cm)										
SL19(15-30cm)										
SL20(1-15cm)										
SL20(15-30cm)										
SL21(1-15cm)										
SL21(15-30cm)										
SL22(1-15cm)										
SL22(15-30cm)										
SLC23(1-15cm)										
SLC23(15-30cm)										
SLC24(1-15cm)										
SLC24(15-30cm)										

Table A3.25: Particle Size Distribution of Soil

Sampling Code	Wet Season				Wet Season			
	Sand	Silt	Clay	Textural Class	Sand	Silt	Clay	Textural Class
SL1(1-15cm)	76	13	11	SL				
SL1(15-30cm)	72	16	12	SL				
SL2(1-15cm)	67	22	11	SL				
SL2(15-30cm)	64	22	14	SL				
SL3(1-15cm)	66	18	16	SL				
SL3(15-30cm)	64	17	19	SL				
SL4(1-15cm)	68	23	9	SL				
SL4(15-30cm)	66	20	14	SL				
SL5(1-15cm)	76	16	8	SL				
SL5(15-30cm)	70	14	16	SL				
SL6(1-15cm)	75	15	10	SL				
SL6(15-30cm)	70	12	18	SCL				
SL7(1-15cm)	69	20	11	SL				
SL7(15-30cm)	72	15	13	SL				
SL8(1-15cm)	68	22	10	SL				
SL8(15-30cm)	64	20	16	SCL				
SL9(1-15cm)	68	20	12	SL				
SL9(15-30cm)	65	18	17	SCL				
SL10(1-15cm)	72	18	10	SL				
SL10(15-30cm)	70	16	14	SL				
SLC11(1-15cm)	52	28	20	SL				
SLC11(15-30cm)	46	20	34	SL				
SLC12(1-15cm)	70	15	15	SL				
SLC12(15-30cm)	66	18	16	SCL				
SL13(1-15cm)	78	14	8	LS				
SL13(15-30cm)	56	24	20	SL				
SL14(1-15cm)	66	20	14	SL				
SL14(15-30cm)	68	16	16	SL				
SL15C(1-15cm)	30	32	38	CL				
SL15C(15-30cm)	30	36	34	CL				
SL16C(1-15cm)	56	28	16	SL				
SL16C(15-30cm)	46	25	29	SCL				
SL17(1-15cm)	44	36	20	SL				
SL17(15-30cm)	50	35	15	L				
SL18(1-15cm)	75	16	9	LS				
SL18(15-30cm)	50	24	26	SL				
SL19(1-15cm)	64	25	11	SL				
SL19(15-30cm)	60	24	16	SL				
SL20(1-15cm)	34	32	34	CL				
SL20(15-30cm)	32	44	34	CL				
SL21(1-15cm)	50	26	24	SL				
SL21(15-30cm)	46	26	28	SCL				
SL22(1-15cm)	47	37	16	SL				
SL22(15-30cm)	52	34	14	L				
SLC23(1-15cm)	76	14	10	SL				
SLC23(15-30cm)	80	10	10	SL				
SLC24(1-15cm)	75	15	10	SL				
SLC24(15-30cm)	73	15	12	SL				

Appendix 3.6: Hydrobiology

Table A3.26: Taxa composition, Relative Abundance and Spatial Distribution of Benthic Macro Invertebrates

Taxonomic List	Wet Season																							Total
	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SD8	SD9	SD10	SDC 11	SDC 12	SDC 13	SD14	SD15	SD16	SD17	SD18	SD19	SD20	SD21	SD 22	SDC 23	SDC 24	
Nematoda																									
Paragordius sp	1	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	**7**
INSECTA																									
Cloeon bellum	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Coenagrion scitulum					1																				**1**
Dytiscus marginalis	1		1	1					1																**4**
Nepa apiculata							1																		**1**
Notonecta sp.		1			1	1			1		1	1	1	0	0	0	0	1	0	0	0	0	0	0	**8**
Pentaneura sp	1						1	1																	**3**
DECAPODA																									
Caridina africana				1					1	1				0	0	0	0	0	0	0	0	0	0	0	**3**
Annelida																									
Eiseniella tetrahedra	0	1	1	0	0	1	0	1	0	0	0	0	0	0	1					1					**6**
Nais communis	0	1	0	0	1	0	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	**6**
Mollusca: Gastropoda																									
Physa sp	0	0	0	0	0	0	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**
Melanoides tubaculata	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
Total	**3**	**3**	**3**	**3**	**3**	**4**	**5**	**3**	**5**	**2**	**4**	**3**	**1**	**0**	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**47**

Taxonomic List	Dry Season																							Total
	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SD8	SD9	SD10	SDC 11	SDC 12	SDC 13	SD14	SD15	SD16	SD17	SD18	SD19	SD20	SD21	SD 22	SDC 23	SDC 24	
Nematoda																									
Paragordius sp	1	0	0	1		0	0	0			1		0	0	0	0		0	0	0	0	0	1	1	**5**
INSECTA																									
Cloeon bellum	1	0	0	2		0	0	1			2		0	0	0	1		0	0	0	0	1	1	1	**10**
Coenagrion scitulum	1	0	0	0		0	0	1			1		0	0	0	0		0	0	0	0	0	1	0	**4**
Dytiscus marginalis	1	0	0	0		0	0	1			1		0	0	0	0		0	0	0	0	0	1	0	**4**
Nepa apiculata	1	0	0	0		0	0	1			1		0	0	0	0		0	0	0	0	0	1	0	**4**
Notonecta sp.	1	0	0	0		0	0	1			2		0	0	0	0		0	0	0	1	0	1	0	**6**
Pentaneura sp	1	0	0	1		0	2	1			2		2	0	0	0		0	0	0	0	0	2	0	**11**
DECAPODA																									
Caridina africana	1	0	1	0		0	0	0			2		0	0	2	0		0	0	0	0	0	0	0	**6**
Annelida																									
Eiseniella tetrahedra	1	0	0	0		0	0	0			2		0	0	1	0		0	0	0	0	0	0	0	**4**
Nais communis	0	0	0	0		0	0	0			2		0	0	0	0		0	0	0	0	0	0	0	**2**
Mollusca: Gastropoda																									
Physa sp	0	0	2	0		0	0	0			2		0	0	0	0		0	0	0	0	0	0	0	**4**
Melanoides tubaculata	0	0	2	0		0	0	0			2		0	0	0	0		0	0	0	0	0	0	0	**4**
Total	**10**	**0**	**5**	**4**		**0**	**2**	**6**			**22**		**2**	**0**	**3**	**1**		**0**	**1**	**0**	**1**	**1**	**8**	**2**	**68**

Table A3.27: Taxa Composition, Relative Abundance and Spatial Distribution of Phytoplankton

Taxonomic List	Wet Season																							Total
	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SD8	SD9	SD10	SDC 11	SDC 12	SDC 13	SD14	SD15	SD16	SD17	SD18	SD19	SD20	SD21	SD22	SDC 23	SDC 24	
Bacillariophyta																									
Frustulia rhomboides	0	0	0	3	5	3	0	0	0	5	0	1	1	0	0	2	0	0	2	0	3	0	2	2	**29**
Surirella elegans	4	0	0	4	0	2	0	5	0	6	0	3	3		1	0	0	0	0	0	1	0	0	0	**29**
Chlorophyta																									
Closterium moniliferum	4	0	6	0	2	3	0	3	0	5	0	0	0	3	0	2	0	0	0	2	0	0	0	0	**30**
Cosmarium contractum	5	0	6	2	7	2	0	2	0	4	2	3	0	1	0	0	1	0	0	3	0	2	0	4	**44**
Euastrum didelta	2	3	0	0	0	0	7	0	3	0	4	0	2	0	0	0	3	0	4	0	0	2	0	0	**30**
Eudorina elegans	0	2	0	2	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	**9**
Micrasteria radians	3	0	0	2	0	0	0	0	2	0	0	4	1	0	3	0	0	0	2	0	0	1	0	0	**18**
Mongeilia spherocarpa	0	4	0	0	3	0	1	0	0	4	5	0	1	2	0	0	0	0	3	0	0	0	2	1	**26**
Oedogonium crassum	2	0	2	0	4	0	3	0	1	0	0	4	0	0	1	0	3	0	0	3	0	0	1	0	**24**
Pediastrum duplex	4	7	2	2	0	0	2	4	0	4	0	2	0	1	0	0	3	0	2	0	0	1	0	0	**34**
Spirogyra dubia	2	3	0	2	0	4	0	1	0	2	0	3	2	0	0	1	2	0	0	2	3	0	1	0	**28**
Spirogyra communis	3	0	2	0	2	0	2	3	0	4	0	3	0	0	1	0	0	2	0	2	0	0	0	0	**24**
Staurastrum gracile	0	0	2	2	1	0	2	0	2	0	0	1	0	2	0	0	3	0	1	0	0	1	0	0	**17**
Ulothrix zonanta	0	4	0	3	0	2	0	5	0	3	0	2	0	0	2	0	0	0	0	1	0	0	0	2	**24**
Zygnema pectinatum	0	3	0	5	0	2	0	2	8	2	4	2	0	0	1	0	0	1	3	0	2	0	4	0	**39**
Cyanophyta																									
Anabaena solitaria	0	3	0	4	0	3	0	4	0	2	0	3	0	3	0	1	0	0	1	1	0	1	0	0	**26**
Chroococcus limieticum	4	0	2	0	5	0	3	0	4	0	1	0	0	2	0	0	2	0	0	0	0	3	0	1	**27**
Microcystis aeruginosa	4	0	3	0	1	0	3	0	4	0	2	4	0	0	4	0	0	1	0	0	0	3	0	0	**29**
Oscillatoria borneltia	0	3	4	3	0	2	0	3	0	5	2	0	0	0	0	2	0	0	3	0	0	0	1	0	**28**
Spirulina aeruginosa	0	6	2	0	0	4	0	0	3	0	0	2	0	0	3	0	0	0	2	0	2	0	0	0	**24**
Euglenophyta																									
Euglena acus	5	3	0	3	0	4	0	3	5	3	3	2	0	0	4	0	1	4	0	1	0	0	0	0	**41**
Phacus birgei	2	0	2	0	4	0	4	0	2	0	3	0	0	0	0	0	2	0	3	0	0	0	0	0	**22**
Total(N)	44	41	33	37	34	32	27	35	35	49	26	40	10	14	20	8	20	9	26	15	11	15	11	10	**602**

Taxonomic List	Dry Season																							Total
	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SD8	SD9	SD10	SDC 11	SDC 12	SDC 13	SD14	SD15	SD16	SD17	SD18	SD19	SD20	SD21	SD22	SDC 23	SDC 24	
Bacillariophyta																									
Frustulia rhomboides	0	0	0	1		2	0	0			0		0	0	0	0		0	0	0	0	0	2	2	**7**
Surirella elegans	4	0	0	4		2	0	5			0		3		1	0		0	0	0	1	0	0	0	**20**
Chlorophyta																									
Closterium moniliferum	4	0	6	0		3	0	3			0		0	3	0	2		0	0	2	0	0	0	0	**23**
Cosmarium contractum	5	0	6	2		2	0	2			2		0	1	0	0		0	0	3	0	2	0	4	**29**
Euastrum didelta	2	3	0	0		0	7	0			4		2	0	0	0		0	4	0	0	2	0	0	**24**
Eudorina elegans	0	2	0	2		1	0	0			0		0	0	0	0		1	0	0	0	1	0	0	**7**
Micrasteria radians	3	0	0	2		0	0	0			0		1	0	3	0		0	2	0	0	1	0	0	**12**
Mongeilia spherocarpa	0	4	0	0		0	1	0			5		1	2	0	0		0	3	0	0	0	2	1	**19**
Oedogonium crassum	2	0	2	0		0	3	0			0		0	0	1	0		0	0	3	0	0	1	0	**12**
Pediastrum duplex	4	7	2	2		0	2	4			0		0	1	0	0		0	2	0	0	1	0	0	**25**
Spirogyra dubia	2	3	0	2		4	0	1			0		2	0	0	1		0	0	2	3	0	1	0	**21**
Spirogyra communis	3	0	2	0		0	2	3			0		0	0	1	0		2	0	2	0	0	0	0	**15**
Staurastrum gracile	0	0	2	2		0	2	0			0		0	2	0	0		0	1	0	0	1	0	0	**10**
Ulothrix zonanta	0	4	0	3		2	0	5			0		0	0	2	0		0	0	1	0	0	0	2	**19**
Zygnema pectinatum	0	3	0	5		2	0	2			4		0	0	1	0		1	3	0	2	0	4	0	**27**
Cyanophyta																									
Anabaena solitaria	0	3	0	4		3	0	4			0		0	3	0	1		0	1	1	0	1	0	0	**21**
Chroococcus limieticum	4	0	2	0		0	3	0			1		0	2	0	0		0	0	0	0	3	0	1	**16**
Microcystis aeruginosa	4	0	3	0		0	3	0			2		0	0	4	0		1	0	0	0	3	0	0	**20**
Oscillatoria borneltia	0	3	4	3		2	0	3			2		0	0	0	2		0	3	0	0	0	1	0	**23**
Spirulina aeruginosa	0	6	2	0		4	0	0			0		0	0	3	0		0	2	0	2	0	0	0	**19**
Euglenophyta																									
Euglena acus	5	3	0	3		4	0	3			3		0	0	4	0		4	0	1	0	0	0	0	**30**
Phacus birgei	2	0	2	0		0	4	0			3		0	0	0	0		0	3	0	0	0	0	0	**14**
Total(N)	**44**	**41**	**33**	**35**		**31**	**27**	**35**			**26**		**9**	**14**	**20**	**6**		**9**	**24**	**15**	**8**	**15**	**11**	**10**	**413**

Table A3.28: Taxa Composition, Relative Abundance and Spatial Distribution of Zooplankton

Taxonomic List	Wet Season																							Total
	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SD8	SD9	SD10	SDC11	SDC12	SDC13	SD14	SD15	SD16	SD17	SD 18	SD 19	SD 20	SD 21	SD22	SDC23	SDC 24	
Copepoda																								
Ectocyclops ilariensis	1	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**
Eucyclops agiloides	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**3**
Mesocyclops ogunnus	0	2	1	0	0	0	1	0	0	1	1	1	0	1	0	0	0	0	1	0	0	1	0	2	**12**
Microcyclops varicans	0	0	1	1	1	0	0	0	0	0	0		0	0	0	1	0	0	0	0	0	0	0	0	**4**
Thermocyclops neglectus	0	2	0	2	1	2	0	1	1	0	0	2	0	0	0	1	0	0	0	0	1	0	0	0	**13**
Thermodiaptomus sp	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Cladocera																								
Alona quadrangularis	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**
Chydorus spaericus	1	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**5**
Diaphanosoma sarsi	0	0	0	1	0	0	2	0	1		0	0	0	0	0	0	0	1	0	0	0	0	0	0	**5**
Ilyocrptus spinifer	0	1	0		0	0	0	0	0	2	0	0	2	0	2	0	0	0	0	0	0	0	0	0	**7**
Macrothrix laticornis	0	0	0	1	0	0	0	0	0		1	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
Moina micrura	1	0	0	0	2	0	1	2	0	1	0	1	0	0	0	0	0	2	0	0	0	0	0	0	**10**
Rotifera																								
Keratella tropica	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
Lecane lunaris	0	1	0	0	0	0	0	1	0		1	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**
Platyias quadricornis	0	0	1	0	0	0	1		1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	**6**
Protozoa																								
Colpidium calpoda	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**3**
Difflugia sp	0	0	0	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	**5**
Ostracoda																								
Cypris sp	0	0	2		0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**
Total(N)	5	6	5	6	7	6	7	7	6	8	6	7	2	1	2	2	2	1	1	2	1	1	1	2	**94**

Taxonomic List	Dry Season																							Total
	SD1	SD2	SD3	SD4	SD5	SD6	SD7	SD8	SD9	SD10	SDC11	SDC12	SDC13	SD14	SD15	SD16	SD17	SD18	SD19	SD20	SD21	SD22	SDC23	SDC24	
Copepoda																								
Ectocyclops ilariensis	1	0	0	0		0	1	0			0		0	0	0	0		0	0	0	0	0	0	0	**2**
Eucyclops agiloides	0	0	0	0		0	0	1			1		0	0	0	0		0	0	0	0	0	0	0	**2**
Mesocyclops ogunnus	0	2	1	0		0	1	0			1		0	1	0	0		0	1	0	0	1	0	2	**10**
Microcyclops varicans	0	0	1	1		0	0	0			0		0	0	0	1		0	0	0	0	0	0	0	**3**
Thermocyclops neglectus	0	2	0	2		2	0	1			0		0	0	0	1		0	0	0	1	0	0	0	**9**
Thermodiaptomus sp	0	0	0	0		0	1	0			0		0	0	0	0		0	0	0	0	0	0	0	**1**
Cladocera																								
Alona quadrangularis	1	0	0	0		1	0	0			1		0	0	0	0		0	0	0	0	0	0	0	**3**
Chydorus spaericus	1	0	0	0		1	0	1			0		0	0	0	0		0	0	0	0	0	0	0	**3**
Diaphanosoma sarsi	0	0	0	1		0	2	0			0		0	0	0	0		1	0	0	0	0	0	0	**4**
Ilyocrptus spinifer	0	1	0			0	0	0			0		2	0	2	0		0	0	0	0	0	0	0	**5**
Macrothrix laticornis	0	0	0	1		0	0	0			1		0	0	0	0		0	0	0	0	0	0	0	**2**
Moina micrura	1	0	0	0		0	1	2			0		0	0	0	0		0	0	0	0	0	0	0	4
Rotifera																								
Keratella tropica	1	0	0	0		0	0	0			0		0	0	0	0		0	0	0	0	0	0	0	**1**
Lecane lunaris	0	1	0	0		0	0	1			1		0	0	0	0		0	0	0	0	0	0	0	**3**
Platyias quadricornis	0	0	1	0		0	1				0		0	0	0	0		0	0	1	0	0	0	0	**3**
Protozoa																								
Colpidium calpoda	0	0	0	0		0	0	1			0		0	0	0	0		0	0	0	0	0	1	0	**2**
Difflugia sp	0	0	0	1		1	0	0			0		0	0	0	0		0	0	1	0	0	0	0	**3**
Ostracoda																								
Cypris sp	0	0	2			1	0	0			1		0	0	0	0		0	0	0	0	0	0	0	4
Total(N)	**5**	**6**	**5**	**6**		**6**	**7**	**7**			**6**		**2**	**1**	**2**	**2**		**1**	**1**	**2**	**1**	**1**	**1**	**2**	**64**

Appendix 4:

Public Consultation

Consultation Report

1. Introduction

This section describes the consultation activities that were carried out to engage and consult with key stakeholders during the ESIA process. It describes:

- the process by which stakeholders were identified;
- the means by which they were consulted by the project; and
- the outcomes of the consultations to date.

This document also describes a framework for a plan to ensure that stakeholders continue to be engaged during the remainder of the Environmental Impact Assessment (EIA) process and into the construction of the facilities and ultimately during operations.

2. Stakeholder Engagement

Stakeholder engagement is an ongoing process of sharing project information, understanding stakeholder concerns, and building relationships based on collaboration. Stakeholder consultation is a key element of engagement and essential for effective project delivery. Disclosure of information is equally vital.

If there are risks or adverse impacts from a project, consultation must be inclusive and culturally appropriate and provide stakeholders with opportunities to express their views. In line with current guidance from the International Finance Corporation (IFC), consultation should ensure *"free, prior and informed consultation of the affected communities* (1)*".* In other words, effective consultation requires the prior disclosure of relevant and adequate project information to enable stakeholders to understand the risks, impacts, and opportunities.

In concert with the aforementioned, the project's consultation program was carried out to ensure that stakeholder concerns are considered, addressed and incorporated in the development process, especially during the EIA.

a. Objectives

The stakeholder engagement process was designed to conform to the Nigerian Environmental Impact Assessment (EIA) Act (Act No. 86 of 1992) and international standards, including the IFC Performance Standards.

For this project, the key objectives for stakeholder engagement were to:

- inform and educate stakeholders about the project;
- gather local knowledge to improve the understanding of the environmental and social context and to better understand locally important issues;
- enable stakeholders to input into the project planning process;
- take into account the views of stakeholders in the development of effective mitigation measures and management plans; and
- provide a basis for future stakeholder engagement.

b. Stakeholder Engagement Plan

Approach

To fulfil the objectives for stakeholder engagement, the project developed a plan for engagement with stakeholders through the project life-cycle. The plan included the following key steps:

- The identification of stakeholders and appropriate mechanisms for engagement (meetings, focus group discussion, key-informant interviews and letters).
- The creation of documents to facilitate information dissemination including a project proposal.

- Development of a timetable for when in the EIA cycle certain stakeholders should be contacted.

All the stakeholders outlined in Table 1 below (national, regional and local government, Non-Governmental Organizations (NGOs), private sector, and the general public) were engaged through consultation meetings and correspondence.

Table 1: Stakeholder Engagement Matrix

Stakeholder Group and interest in the project	Stakeholder Name	Stakeholder Level			Notification Method
		Federal	State	Local	
Scoping Phase					
Regulatory agencies: national and state and LGAs administratively responsible for EIAs and land use regulation	FMEnv	✓			Letter/Meeting
	BSMEnv,		✓		Letter/Meeting
	LGAs			✓	Letter/Meeting
EIA Phase					
Regulatory agencies: national and state and LGAs administratively responsible for EIAs and land use regulation	FMEnv	✓			Letter/Meeting
	BSEnv,		✓		Letter/Meeting
	LGAs			✓	Letter/Meeting
	Others: NERC, NBET etc				
NGOS				✓	Meeting
Communities	Local Chiefs			✓	Meeting
	Farmers			✓	Meeting
	Men's Group			✓	Meeting
	Women Group			✓	Meeting
	Youth Group			✓	Meeting

2.1 Scoping Phase

Stakeholder Identification

A preliminary list of project stakeholders was identified. These consisted of individuals, groups, and organizations that might be affected by or who might influence project development positively or negatively. The list was developed using international guidance and considered the following:

- federal, state and local government:
- local community leaders;
- community members including vulnerable sub-groups such as women;
- local environmental and social Non-Government Organisations (NGOs); and
- local businesses/cooperatives and associations.

Scoping Phase Consultations

Initial consultations were carried out during the week of 10 September 2012 with the following organisations:

- Federal Ministry of Environment (FMEnv);
- Ganjuwa/Bauchi Local Government;
- Bauchi State Ministry of Environmental;

Only government representatives and adjacent landowners were directly consulted during the Scoping Phase. These stakeholders were thought to adequately represent community concerns at this stage. Communities were to be fully engaged during the EIA study.

The scoping consultations served to provide stakeholders with information about the proposed project and to gather information important to the subsequent EIA and permitting process to inform the project development.

The objective was to identify any key concerns or high level issues that the stakeholders had at this early stage.

Reconnaissance Visit

EnvironQuest and FMEnv representative carried out a site reconnaissance on 26th February, 2013. It was noted that the nearest communities to the project site were Zongoro, Waya, Yuli and Dungulbi, which are located 400 m south, 10 km south-east, 12 km south and 18 km south-west of the site respectively.

The main purpose of the visit was to undertake a site reconnaissance and to observe the sensitivity of the surrounding environment. Officials commented that it was also to verify the information provided in the EIA application form and to confirm that no development activities have started on site.

The FMEnv and Bauchi State Ministry of Environment representatives inspected the site and the surrounding area. The following comments were noted:

- FMEnv requested that environmental and socio-economic baseline studies needed to be undertaken as part of the EIA to verify existing baseline conditions.
- FMEnv emphasized the importance of socio-economic issues being properly addressed in the EIA and inquired about the relationship between NSCP and surrounding communities.

The information gathered during this visit as well as that contained in the screening report was used by FMEnv to categorize the Project in line with the EIA Act.

Findings of Scoping Consultation

Issues identified during scoping consultations are summarized in Table 2. Records of scoping consultation meetings and meeting minutes are attached in Appendix 4.2.

Table 2: Records of Scoping Consultation Meetings

Stakeholder	Issues	Comments
FMEnv	Permit application procedure, EIA process	– need for two season sampling
Ganjuwa/Bauchi LGA	Environmental management plans	- Welcome development project - Requested that community view be taken into consideration - Suggested a remedial measure to manage environmental damages if any - Concern about noise and loss of farmland

Engagement carried out at the EIA study stage was undertaken to inform regional level authorities, NGOs and local stakeholders about project design and to obtain their key concerns in order to inform the team's development of mitigation measures for the project (particularly with respect to assessing the relative significance of impacts and designing appropriate mitigation measures).

2.2 EIA Phase

Community Engagements

– *Engagement Process*

During a preliminary visit to the project area on 26th February 2013, Yuli, Zongoro, Dulqubi and Waya were identified as the communities most likely to be impacted by the Project due their proximity to the project site. On 17th August, 2013, community engagement was initiated by the EnvironQuest social research team. Consultation was carried out with local community leaders in Zongoro and Yuli to inform the community leadership of the intention to consult with the wider community on the project.

Community consultation and engagement meetings were subsequently carried out with small groups of key stakeholders in Zongoro, Yuli, Duqulbi and Waya as well as key informants found on the project site (e.g. farmers). Table 3 shows the consultation methods undertaken in each of the communities.

Table 3: Engagement Methods

Communities	Focus Group Discussion	Interviews	Questionnaire
Yuli		x	x
Zongoro	x	x	x
Waya		x	x
Duqulbi		x	x


Figure 1: Key Informant Interview


Table 4: Summary of Issues Raised during Community Engagement

Issue	Potential Impact	Response
Land Acquisition	Negative	Compensation required
Improved Infrastructure	Positive	Seen as progress
Noise during construction	Negative	Should be minimized
Cultural Interference	Negative	Should be avoided

– *Community Meeting/ FGD*

A community meeting/FGD was convened at Zongoro town on 18th August, 2013 (Figure 2). Sarkin Zongoro Hassan requested this meeting to ensure that all his Ward Heads were fully informed about the proposed project. The social research team then used the opportunity to carry out a FGD with the community elders, the youth and women in separate sessions. Nearly 100 people attended the meeting/FGD, including the following people:

- wazirin

- a youth group representative,
- a woman group representative; and
- two representatives from the community development committee.

The objectives of the meeting were to present the preliminary findings of the EIA, present the mitigation measures developed and obtain feedback and input from community members. Key issues raised at the meeting are outlined in Table 4. Complete meeting notes and copies of attendance registers are provided in Appendix 4.2.

2.2.1 Consultation to be carried out during EIA disclosure

– *Regulatory Requirements*

Once the draft EIA report has been submitted, it will be subjected to a review by a panel of experts constituted by FMEnv. The panel would likely comprise experts from within FMEnv as well as external specialists included because of their topic expertise. Prior to this review meeting, the draft EIA report would be publicly displayed for 21 days.

There would be radio and newspaper announcements informing the public about the project and where the draft EIA reports are available for consultations. Comments arising from the public review of the draft EIA report would also be addressed during the panel review meeting.

Following the review period, the findings will be presented to the Project. The Project will then need to take appropriate action to address the findings. This may include additional studies; revision to the report text to correct or clarify content; or development of additional mitigation measures or management actions. Upon satisfactory completion of the actions required to address the findings, the Final EIA report will be submitted to the FMEnv. In line with the requirements of Nigerian EIA regulations, at least one Impact Mitigation Monitoring (IMM) visit would be carried by FMEnv officials during construction phase prior to the issuance of the Final EIA permit by the FMEnv.

– *Public Disclosure*

As part of the formal regulatory review process, FMEnv will make a public notice of the opportunity for information and comment on the draft EIA report for the project. This notification is typically done through a newspaper announcement.

The notification will provide:

- a brief description of the project;
- a list of venues where the EIA report is on display and available for viewing;
- duration of the display period; and
- contact information for comments.

The FMEnv requires a twenty-one (21) working day display period. Display venues will be decided by FMEnv but would be expected to include:

- Federal Ministry of Environment, Abuja office;
- Federal Ministry of Environment, Lagos office;
- Federal Ministry of Environment, Bauchi office;
- Bauchi State Ministry of Environment, Bauchi; and
- Ganjuwa/Bauchi Local Government headquarters, Bauchi.

i. Consultation to be undertaken during project execution

– *Ongoing Engagement*

Ongoing engagement after submission of the EIA will be taken forward within the framework of a Stakeholder Engagement Plan (SEP) to be developed by the project. Stakeholder participation will be

fundamental to the success of project implementation, and stakeholder feedback will be a key component in monitoring the success of mitigation measures.

- *Grievance Mechanism*

The Stakeholder Engagement Plan will include the development and implementation of a Grievance Mechanism. Grievances are any complaints or suggestions about the way a project is being implemented. They may take the form of specific complaints for damages/injury, concerns about routine project activities, or perceived incidents or impacts. Grievance mechanisms therefore provide a formal and ongoing avenue for stakeholders to engage with the company, whilst the monitoring of grievances provides signals of any escalating conflicts or disputes.

The IFC Performance Standards and the Equator Principles outline requirements for grievance mechanisms for some projects. Grievance mechanisms to be proposed should receive and facilitate resolution of the affected communities' concerns and grievances. Concerns should be addressed promptly using an understandable and transparent process that is culturally appropriate and readily acceptable to all segments of affected communities, at no cost and without retribution. Mechanisms should be appropriate to the scale of impacts and risks presented by a project.

The project will appoint a Community Liaison Officer (CLO) who will be responsible (along with management) for the implementation of the Stakeholder Engagement Plan and the functioning of the Grievance Mechanism.

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PROJECT NAME

NAME OF COMMUNITY/VILLAGE

LOCAL GOVERNMENT AREA

DATE

COMMUNITY REPRESENTATIVE($)

S/N	NAME	SEX	POSITION	SIGNATURE

PROJECT NAME

NAME OF COMMUNITY/ VILLAGE

LOCALGOVERNMENT AREA

DATE

COMMUNITY REPRESENTATIVE (S)

S/N	NAME	SEX	POSITION	SIGNATURE
2.				

COMMUNITY CONSULTATION

PROJECT NAME: ((}DVII ;?hol"o l(o(t(,_-1-tC(PvJ fry:f_fdj2vlcLerJ-- (CSUJ_b PYJ.Uc

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SOCIO -ECONOMIC IMPACT ASSESSMENT OF NSCP 100MW PHOTOVOLTAIC POWER PROJECT AT ZONGORO VILLAGE, GANJUWA LGA, BAUCHS TATE.

IN-DEPTH INTERVIEW SCHEDULE FOR KEY IMFORMANTS & LOCAL STAKEHOLDERS

QUESTIONNAIRE No:-----

1. Host Commuity . .) n I lA 1\BI) Hint\ I 5\-\Ct\
Name of mterv1ewer. -- ----------
Date of interview: --L-- ?:1)_(:2_ _____
Name community:. --C----=f(P)----------
Local Govt. Area. ----------

2. RESPONDENTS PERSONAL INFORMATION

{A) Name of Local Head: ----------
(B) Sex: Male [ ] . Female [vJ

{C) Age:
10-20 years [ ] 21-30 years [ ] 31-40 years [ ] 41-50 years [v]
50-60 years [ ] 61-70 years [ ] 70 yrs above [ ]

(D) How would you describe yourself in this Community?
Indigene [V"] Settler [ ] Visitor [ ] Tenant [ ]

(E) If you are a visitor/settler, where is your hometown?----------

(F) How long have you lived in this Community?
Less than 5 years [ ] 6-10 years [ ] 11-15 years 16-20 yrs above [

(G) Marital Status
Single [ ] Married [Divorced [ ] Widow/widower [ ]

(H) What position do you hold in this Community?
raditional ruler [ ] Religiouleader [ ] Famil y heo.d. [j Social club [ ]
Others {Specify): ------- ! ▾ ----------

{I) What is your level of Education?
Primary [ ] Secondary [ ] Tertiary [ ] No formal education [

3. DEMOGRAPHIC CHARACTERISTICS

(A) Family size (Husband, wife/wives and children)
1-3 [ ] 4-6 [ ] 7-10 [11-15 [ ] 15 above [ ]

(B) Sex: How many are:
Male [}- Female [

(C) How many births in your family in the last 12 months? [✓]

(D) How many deaths in your family in the last 12 months?
0 [()] 1 [ ] 2 [ ] 3 [ ] 4 above [ ]

4. ECONOMIC ENVIRONMENT

(A) What is your occupation?
Farming [ ] Hunting [ ] Civil Servant [ ] Trading [ ] Business [ ]
Industrial worker [ ] Others (specify):-----

CB) If farmer, what crops do you grow? -

(C) Yearly quantity of farm produces in the last 5 yrs. --

(D) How long have you been in the occupation?
0-5 yrs. [ ] 6-10 yrs. [ ] 11-20 yrs. [ ] 21-30 yrs. [ ] 30 yrs. above [ ]

(E) Please state the number of your household who have attained 18 years and above but are not employed.
None [ ] 1 [ ] 2 [ ] 3 [ ]4 [ ] 5 [ ] 6 [ ] Others (specify) ----------

(F) Does any of the persons above have any form of technical training related to the operations of farming company? If yes how many?
1 [✓] 2 [ ] 3 [ ] 4 [ ] 5 [ ]

(G) Please briefly specify the nature of the traini g an indicate the number of persons who have such training ----------!

(H) How much do you realize from farming in a month?
NO.O - 250.00 [ ] N250.00 - N500.00 [ ] !501.00 - N750.00 [ ]
N751.00 - N1,000.00 [ ] Nl ,001.00 - N1,500.00 [ ] N1, 501.00 - N1,750.00 [ ] N1,751.00- N2,000.00 [ ] N2, 000.00 above [ ].

(I) How much do you realize from other activities/sources in a week?
NO.OO- N500.00 [ ] N501.00 - N1000.00 [1.00 -1,500.00N
[ ] 1,501.00- N2, 000.00 [ ] Others-- ----:----------

(J) What is your annual income?
N11, 000 - N20, 060 [ ] N21, OOO- N30, 000 [ ] N31, 000 - N40, 000 [ ]
N41, 000- N50, 000 [ ] N51, OOO- N60, 000 [ ] N61, OOO- N70, 000 [ ]
N71, 000- N80, 000 [ ] N81, OOO- N90, 000 [ ] N91, OOO- N100, 000 [ ]
Other range------- -- ---------- ----------

(K) How much do you spend on your family a week?
N250.00- N500.00 [ ] N501.00- N1000.00 [ ] N1, 001.00- N1, 500.00 [v]
Nl, 50100 - N2, 000.00 [ ] N2, 500.00 - N3, 000.00 [ ] N3, 001.00 - N3, 500.00 [ ]
Other range -------- ----------

(L) How much do you spend on?
Food items] Household item [ ] Clothing - Education of Children[5o
Medical care [...] Transport [ ] Others (specify) ----------

(M) How much are you able to save in a year?
No savings [v] N10,000 - N20,000.00 [ ] N21,000.00 - N30,000.00
N31,000.00 - N40,000.00 [ ] Nl,OOO.OO - N50,000.00 [ ] N51,000.00 – N60,000.00 [ ] Other ra nge ---------- -- ----------

(N) Which of these properties do you own?
Bicycle[ ] Motor cycle [ ] Motor vehicle [ ] Others (specify) -- P-

(0) \ Do you own any land in the community? If yes, what is the size in hectares?
\\· 0 - 1 [2 - 3 [ ] 4 - 5 [ ] 6 - 7 [ ] 8 above

(P) What is the nature of land ownership?
Personal [ ] Family [ ] Communal Lease hold [ ] Free hold [ ]
Others (specify):----------

(Q) Do you have a house in the community?
Thatch roof/mud [ ] Zinc roof block [ ] Zinc roof/wooden
Others (specify) ----------

5. SOCIAL/CULTURAL ENVIRONMENT

What is your religion?
Christianity [ ] Islam [Traditional [·] Others (specify) ---------

b Which of the following do you have around this community: (Please show us the location) Shrines [ ] Sacred ground/forest [ ] Historical/archaeological site [ ]
Religious houses [ ] Others (Specify) _ffi2 _dvt.-_____

(_ Which of these social problems do you have in your neighbourhood?
Youth/juvenile delinquency/unrest [ ] Land dispute [ ] Chieftancy problem [ ]
Inter-village problem [ ] Inter-family problem [ ] Unemployment [
Others (specify) ---------- None of the above [ ]

d What is your source of water supply?
Pipe-borne water [ ] Hand dug well ['-''] Streams [ ] Rainfall [ ] Others (specify) ----------

e. What are your sources of energy?
Wood [ ] Kerosene [ ] Petrol [ ] Coal [ ] Electricity [ ]

..:t-Are you willing to pay more than you currently pay for a better energy (electricity) supply?

3 How much are you willing to pay per month for improved electricity? ()lNh (ft. PHCN possib

h Are you aware about the proposed lOOMW energy project in this area? Yes] No [ ]

If "Yes", how d id you first know about the planned project? eighbour

___What are you fears about this proposed project?
Loss of land (land acquisition) [ ] Damage of agricultural land] Cultural interference [ ] Noise nuisance from working equipment [ ]
Pollution of fishing ground [ ] Others (specify): ----------

What benefits do you expect from the Company in the course of the execution of this project and subsequent operations in the area? Please rank them in

order of importance by placing 1 against the most im portant, 2 against, next important etc.

Employment of indigenes [] Scholarship for indigenes [ ] Electricity [
Primary school [ ] Water project [S] Health centers [ ]
Others (specify):----------

How do you think the location of the project in this area could affect you as an individual? (Probe for effects on daily life activities, economic activities, social activities, etc .)....\.....

How do you think the location of the project in this area could affect your family/household? (Probe for effects on daily life activities, economic activities, social activities, grazing land; farm land, water, etc.).....

How do you think the location of the project in this area could affect your community? (Probe for effects on daily life activities, economic activities, social activities, grazing land, farm land, water, etc.).....,.....

What are the problems that the location of the project is likely to bring to this community? (Probe for impact on sources of livelihood, accommodation, social facilities and infrastruCture, etc.).....:.....

Do you foresee any possible conflict betеen the indigenes of this community and the project? Yes [ ] No [

What do you think should be done to avoid such conflicts?...None..... ...

If your farm land were to be acquired, what would be your fears/concerns?.....L.'.....

If you were to be compensated for your farm land, what form of compensation would you prefer?
Financial compensation [ ]

Material compensation [ ]

Financial and material [

Other compensations (specify).....

6. SOCIAL STATISTICS

(For interviewer only) Note and record the following:

- School statistics
- Primary school enrolment data Primary I to *IV*
- Secondary school enrolment data JSS 1-3, SSS 1-3
- Other educational institutions

What are the common illnesses in this community?

Malaria Yellow fever[ ] Dysentery/diarrhea [ ] Measles/any other contagious disease [ ] Cough [ ] Skin diseases ( ]

Others (specify):----------

What are the common environmental problems in the neighborhood/community?

Flooding [Deforestation State of infrastructure [ ] Roads [ ]
Building materials [ ] Sanitation [ ] Others (specify):----------

Please list the type of wild animal and birds you normally see or catch in this area

----

In the last two years have you noticed any changes in the population of animals and birds in the forest? What are the changes?

Increasing [ ] The same [ ] Decreasing [

If decreasing what do you think is responsible (record answer verbatim)

In the last two years have you noticed any changes in the types of animal and birds in the forest?

No [YES [ ]

If your answer to question 7.8 is yes, what are the changes (record answer verbatim).

In the last two years have you noticed any changes in the ways trees in the forest and around the village have changed? What are the changes? ----

---------- ----------

Appendix 5:

Topography Maps of the Study Area

ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION LINE FROM ZONGORO VILLAGE ALONG BAUCHIKARI ROAD TO DUNGULBE NEAR GRAVEYARD ALONG BAUCHI GOMBE ROAD. BAUCH!, BAUCfll STATE.

FOR

NI6£RIA SOLAR CAPITAL PARTNERS.

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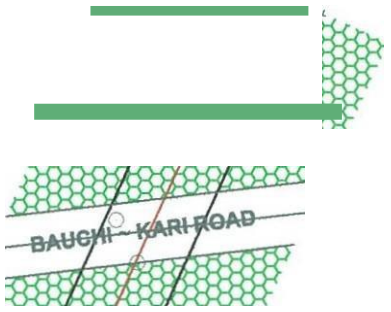

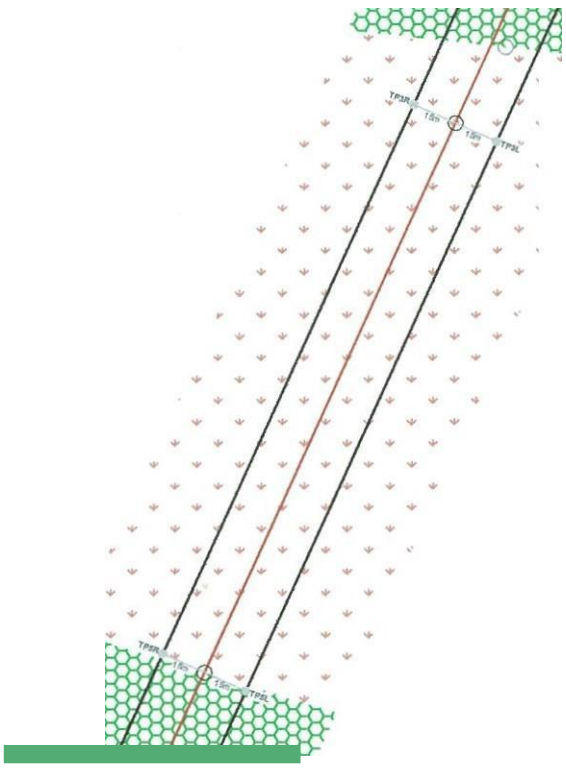

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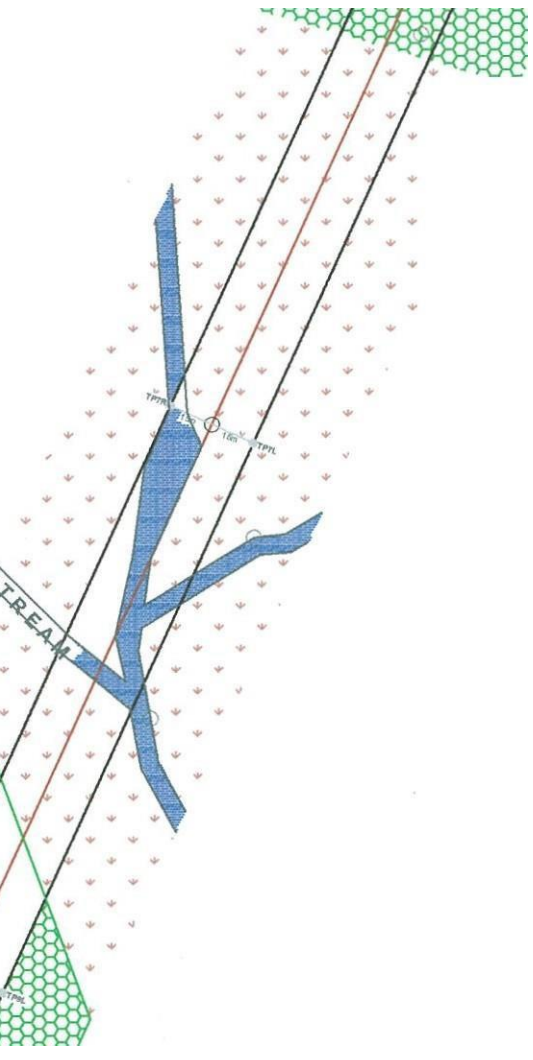

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—FARMLAND

— WATERBODY (RIVER/STREAM)

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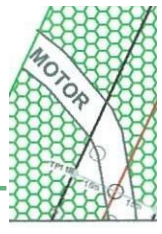

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SURV. I.A. SULAIMAN
FOR:

GEOINFORTECH INVESTMENT LTD.

NOVEMBER, 2013

ROUTE SURVEY/CORRIDOR MAPPING OF
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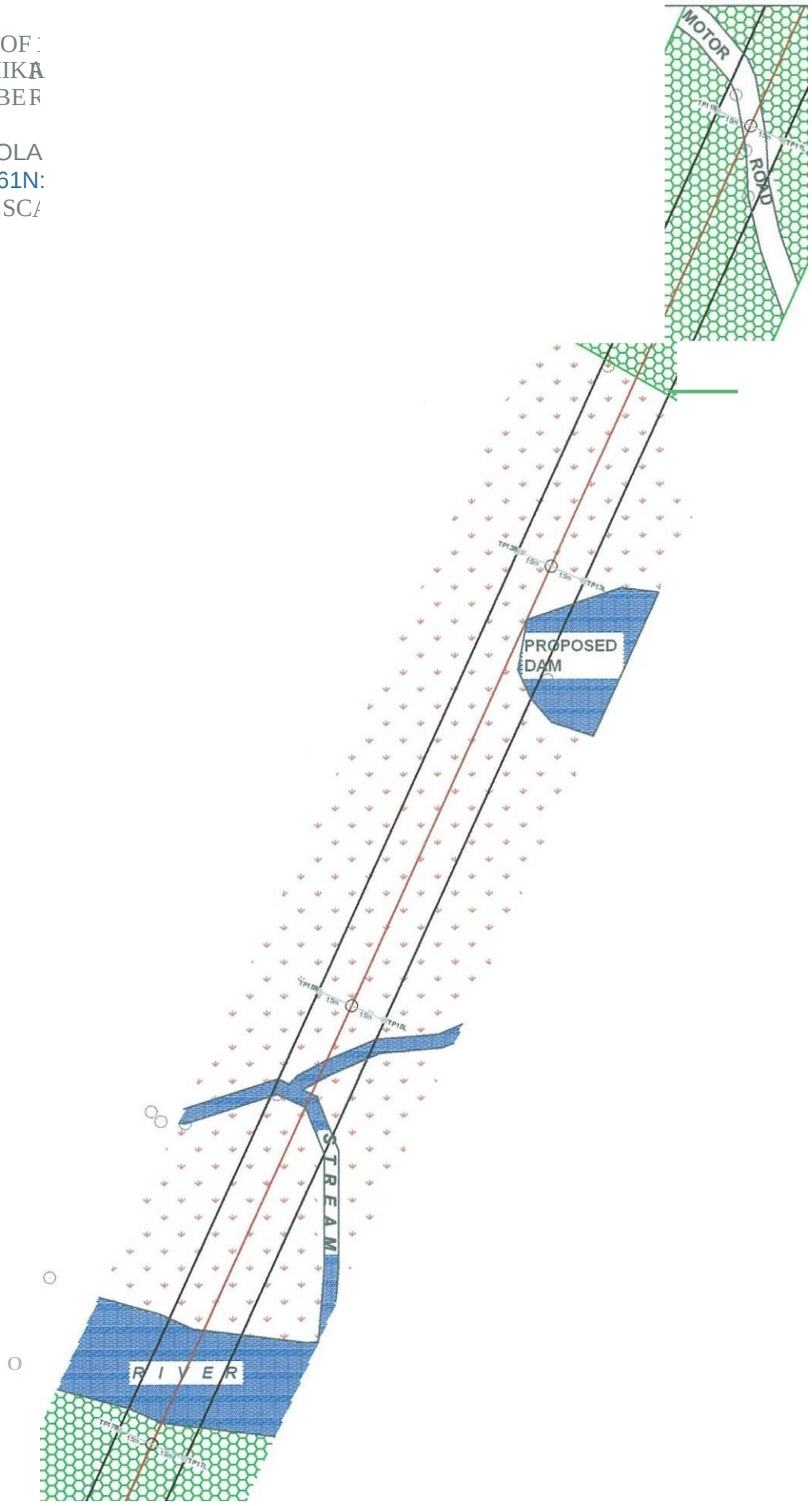

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(RIVER/STREAM)

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ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION LINE FROM ZONGORO VILLAGE ALONG BAUCHI-KARI ROAD TO DUNGULBE NEAR GRAVE YARD ALONG BAUCID-GOMBE ROAD. BAUCID, BAUCID STATE.

FOR

NI6ERIA SOLAR CAPITAL PARTNERS.

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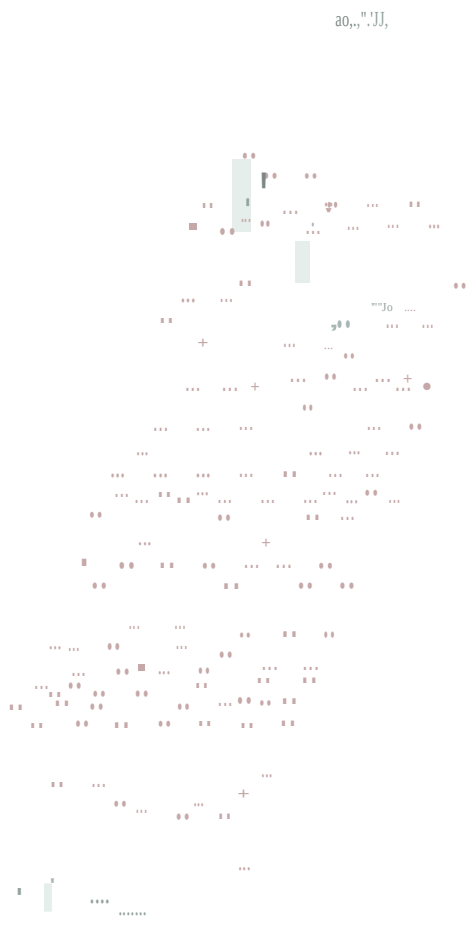

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FLAT ROCK

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CHECK BY: V .A SULAIMAN

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NOVEMBER 2013

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ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION LINE FROM ZONGORO VILLAGE ALONG BAUCHIKARI ROAD TO DUNGULBE NEAR GRAVEYARD ALONG BAUCHIGOMBE ROAD. BAUCH!, BAUCH! STATE.

FOR

NI6ERIA SOLAR CAPITALPARTNERS.

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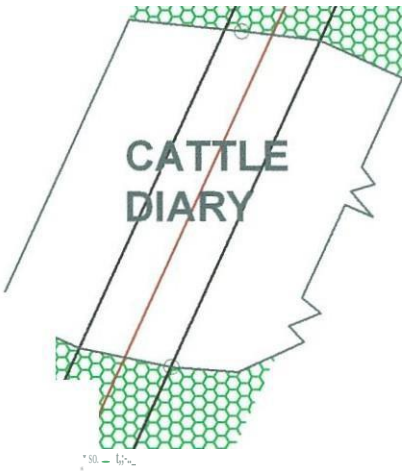

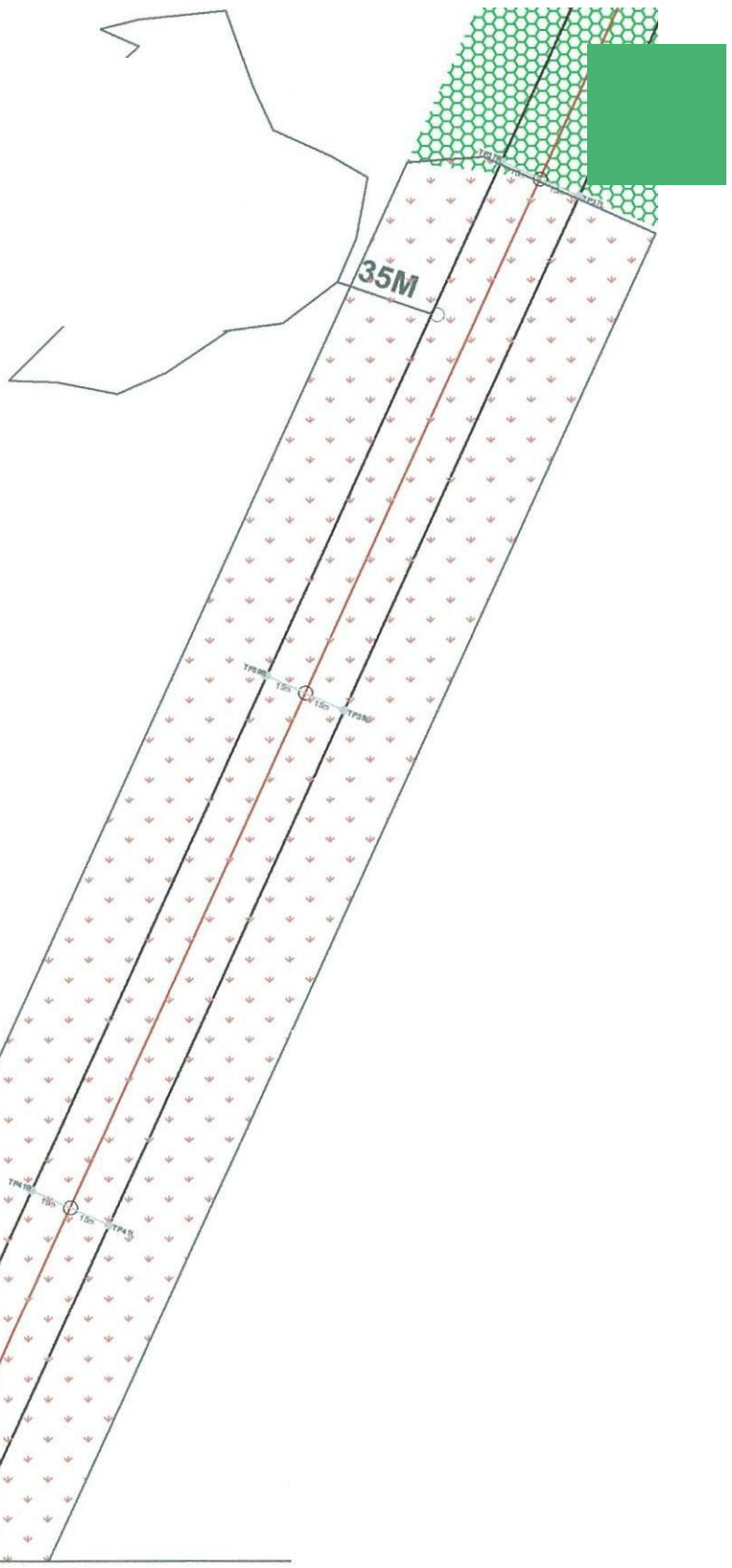

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WATERBODY (RIVER/STREAM)

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FOR:

GEOINFORTECH INVESTMENT LTD

NOVEMBER, 2013

ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION LI NE FROM ZONGORO VILLAGE ALONG BAUCHI-KARI ROAD *TO* DUNGULBE NEAR GRAVE YARD ALONG BAUCHI-GOMBE ROAD. BAUCH!, BAUCH! STATE.

FOR

Nl6£RIA SOLAR CAPITALPARTNERS.

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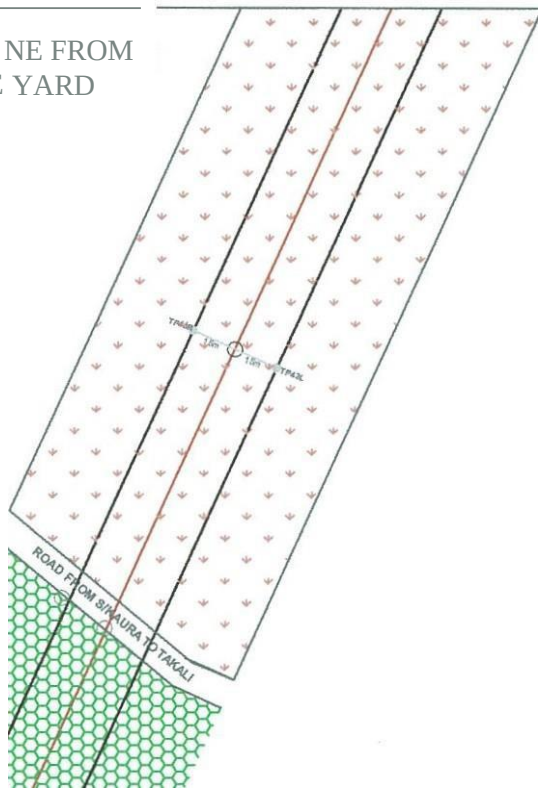

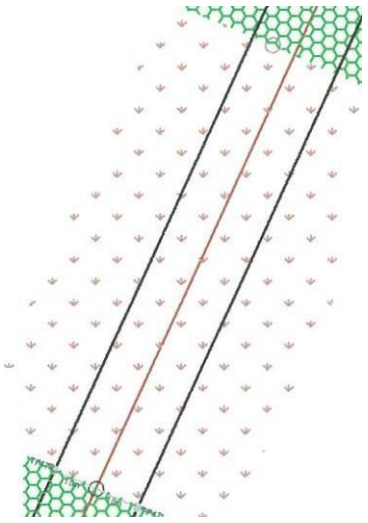

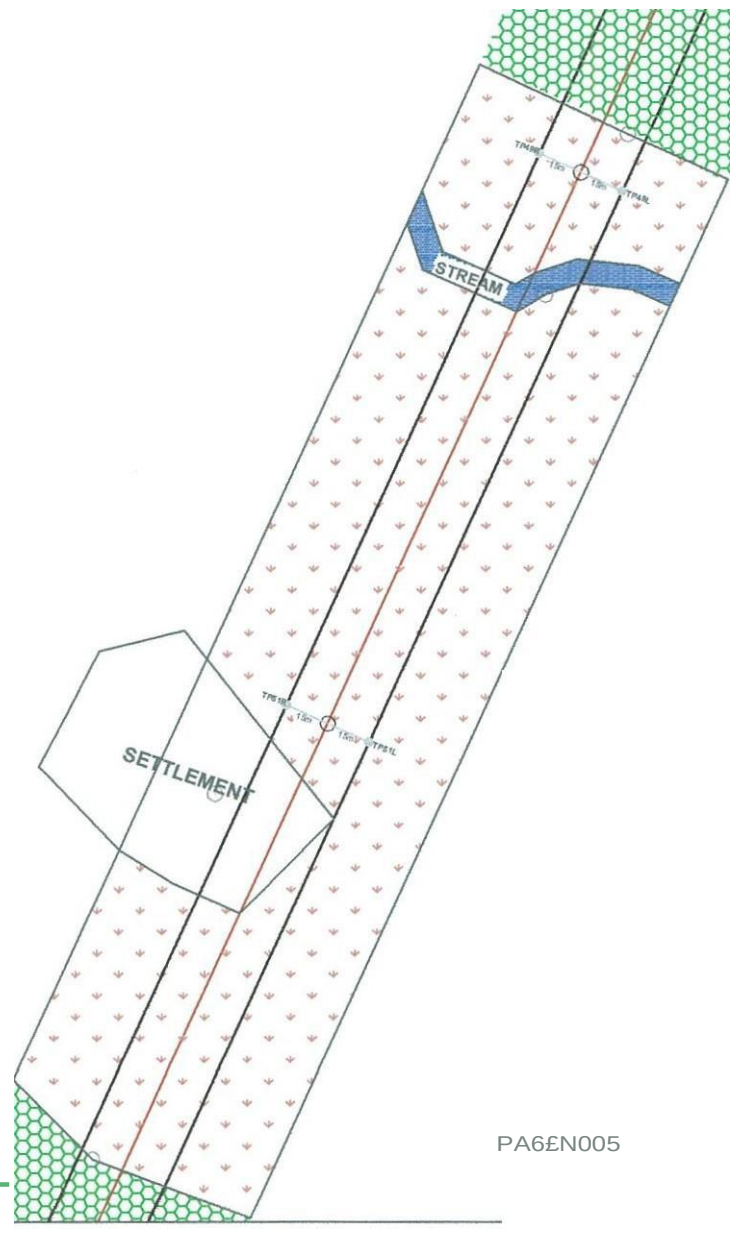

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FARMLAND

WATERBODY (RIVER/STREAM)

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SURVEY BY:

AHMED BABAYO

Y: SURV. I.A. SULAIMAN

GEOINFORTECH INVESTMENT LTD.

NOVEMBER, 2013

ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION LINE FROM ZONGORO VILLAGE ALONG BAUCHIKARI ROAD TO DUNGULBE NEAR GRAVE YARD ALONG BAUCHI GOMBE ROAD. BAUCHI, BAUCHI STATE.

FOR

NI6ERIA SOLAR CAPITAL PARmERS.

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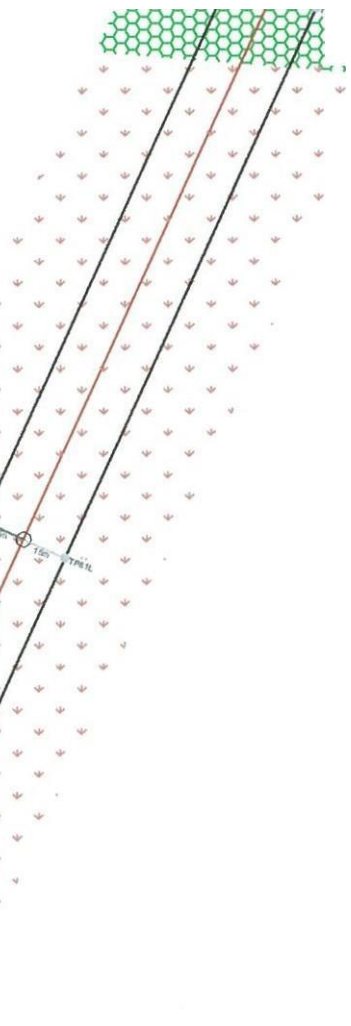
RIVER



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FARMLAND

WATERBODY (RIVER/STREAM)

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SURVEY BY:

AHMED BABAYO

:SURV. I.A. SULAIMAN

GIL GEOINFORTECH INVESTMENT LTD.

ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION LINE FROM ZONGORO VILLAGE ALONG BAUCHIKARI ROAD TO DUNGULBE NEAR GRAVEYARD ALONG BAUCHI– GOMBE ROAD. BAUCHI, BAUCID STATE.

FOR

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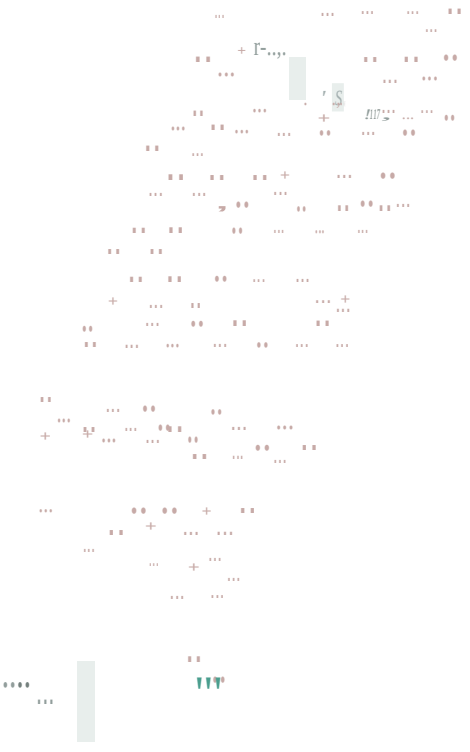

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SURVEYBY: DBABAYO

CHECKED1 : I.A.SULAJMAI\

FOR:

GEO STl'JI'.i ''•t LTD•

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ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION LINE FROM ZONGORO VILLAGE ALONG BAUCHI KARl ROAD TO DUNGULBE NEAR GRAVEYARD ALONG BAUCID GOMBE ROAD. BAUCH!, BAUCH!STATE.

FOR

NI6£RIA SOLAR CAPITAL PARTN£RS.

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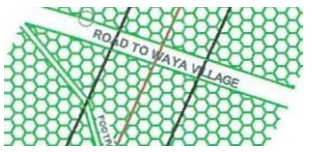

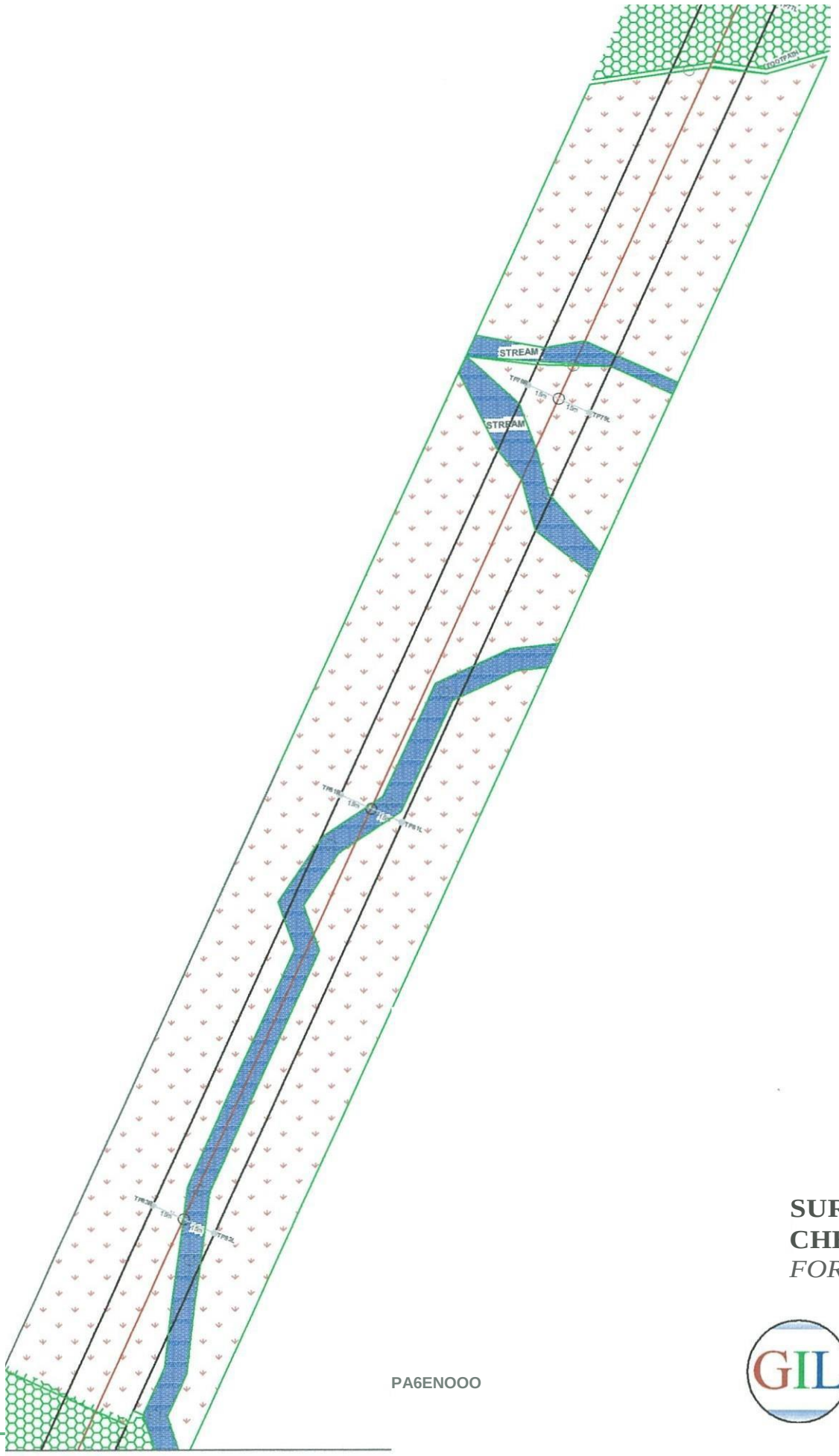

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SURVEY BY: AHMED BABAYO

CHECKEDBY: SURV. I.A. SULAIMAN

FOR:

GIL GEOINFORTECH INVESTMENT LTD

NOVEMBER, 2013

ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMJSSION LINE FROM ZONGORO VILLAGE ALONG BAUCHI-KARI ROAD TO DUNGULBE NEAR GRAVEYARD ALONG BAUCHI-GOMBE ROAD. BAUCH!, BAUCH! STATE.

FOR

Nl6£RIA SOLAR CAPITAL PARTNKRS.

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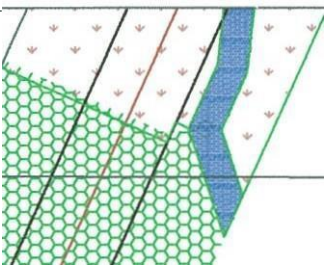

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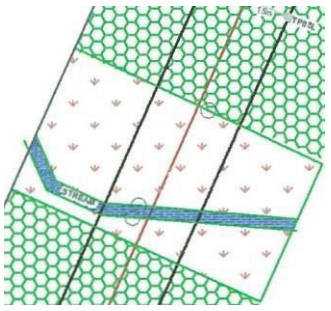

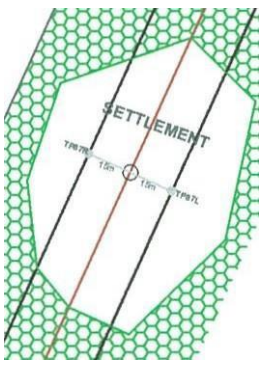

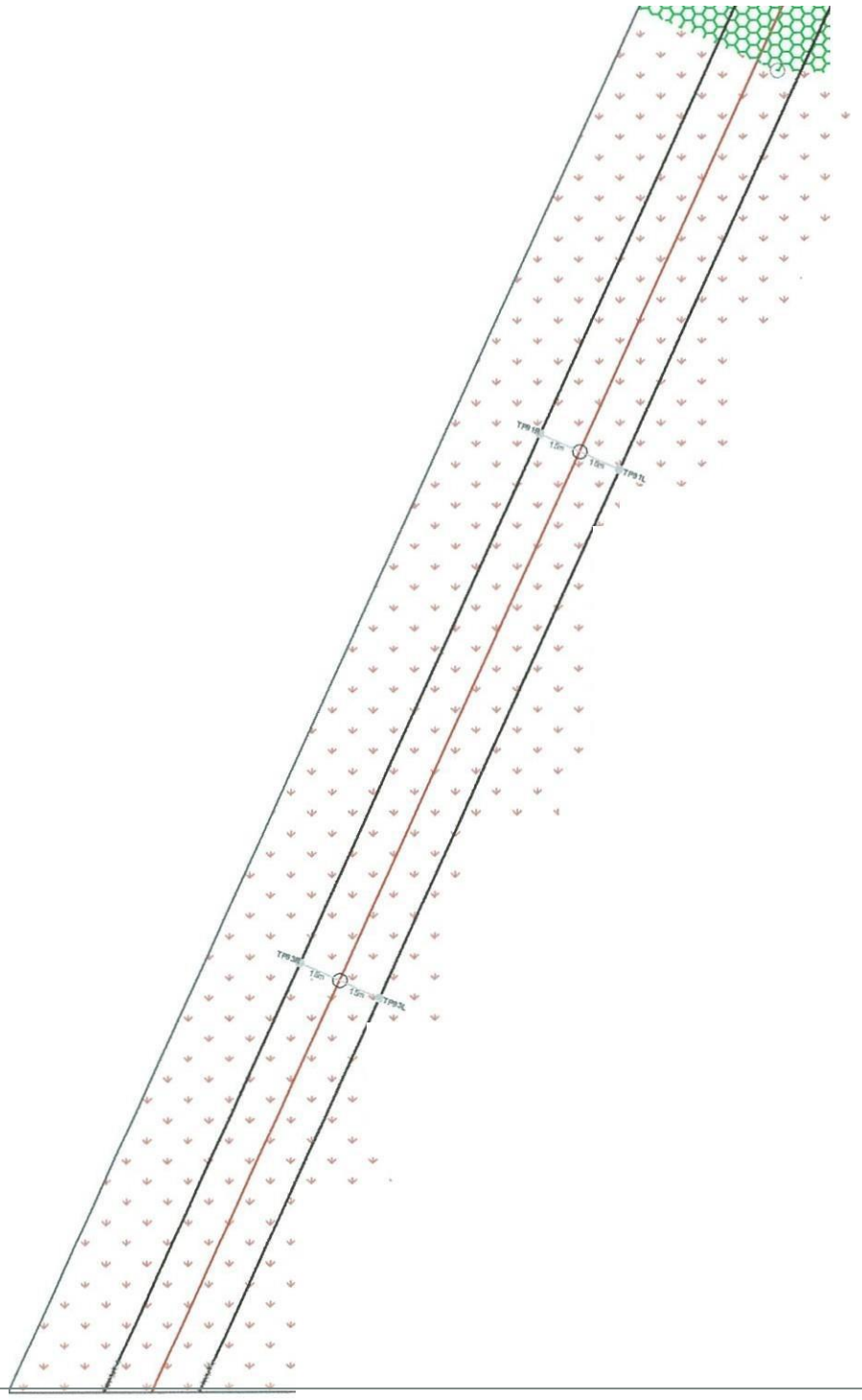

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FOOTPATH

SURVEYBY: DBABAYO

CHECK BY:(SYR\J. I.A. SULAIMAN

FOR:

GEOINFORTECH INVESTMENT LTD

NOVEMBER, 2013

ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION
ZONGORO VILLAGE ALONG BAUCHI-KARI ROAD TO DUNGULBE NEAR GR /
ALONG BAUCID-GOMBE ROAD. BAUCH!, BAUCHI STATE.
FOR
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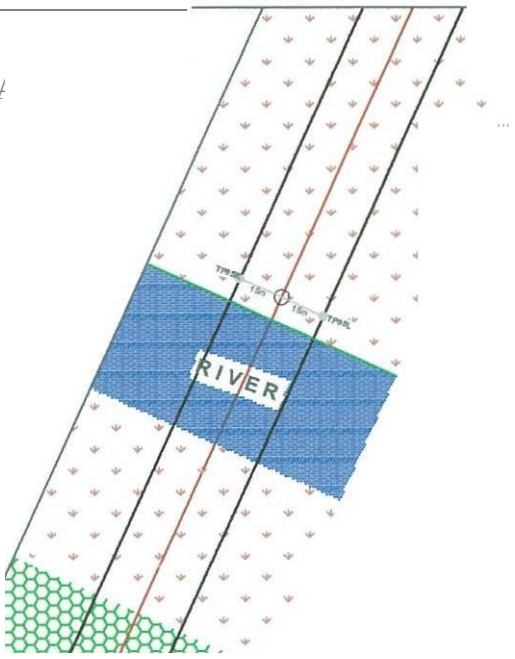

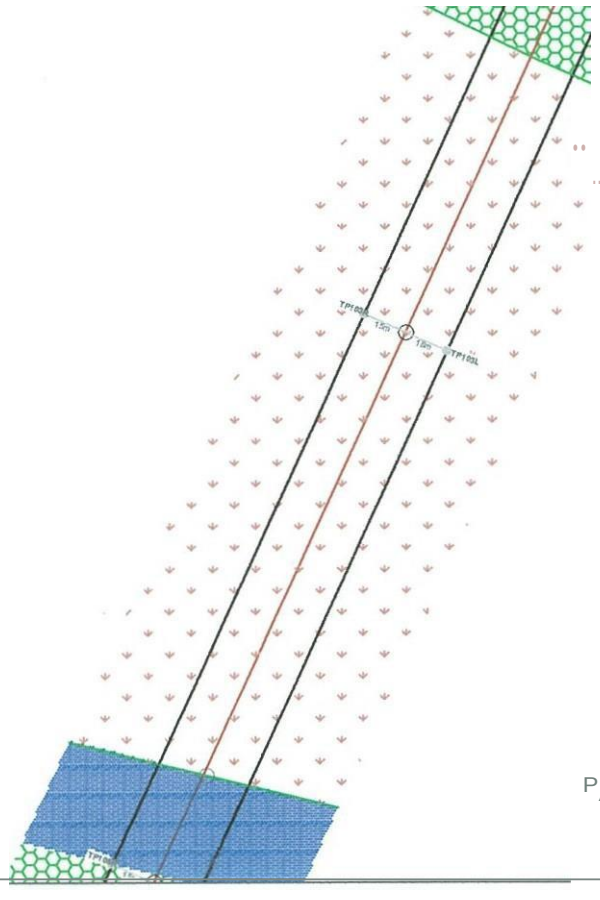

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ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION LINE FROM ZONGORO VILLAGE ALONG BAUCHIKARI ROAD TO DUNGULBE NEAR GRAVEYARD ALONG BAUCHI-GOMBE ROAD. BAUCH!, BAUCH!STATE.

FOR

Nl6£RIA SOLAR CAPITAL PARTNERS.

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NOVEMBER, 2013

ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION LINE FROM ZONGORO VILLAGE ALONG BAUCHI---KARI ROAD TO DUNGULBE NEAR GRAVEYARD ALONG BAUCIU GOMBE ROAD. BAUCH!, BAUCH! STATE.

FOR

NI6ERIA SOLAR CAPITAL PARTNERS.

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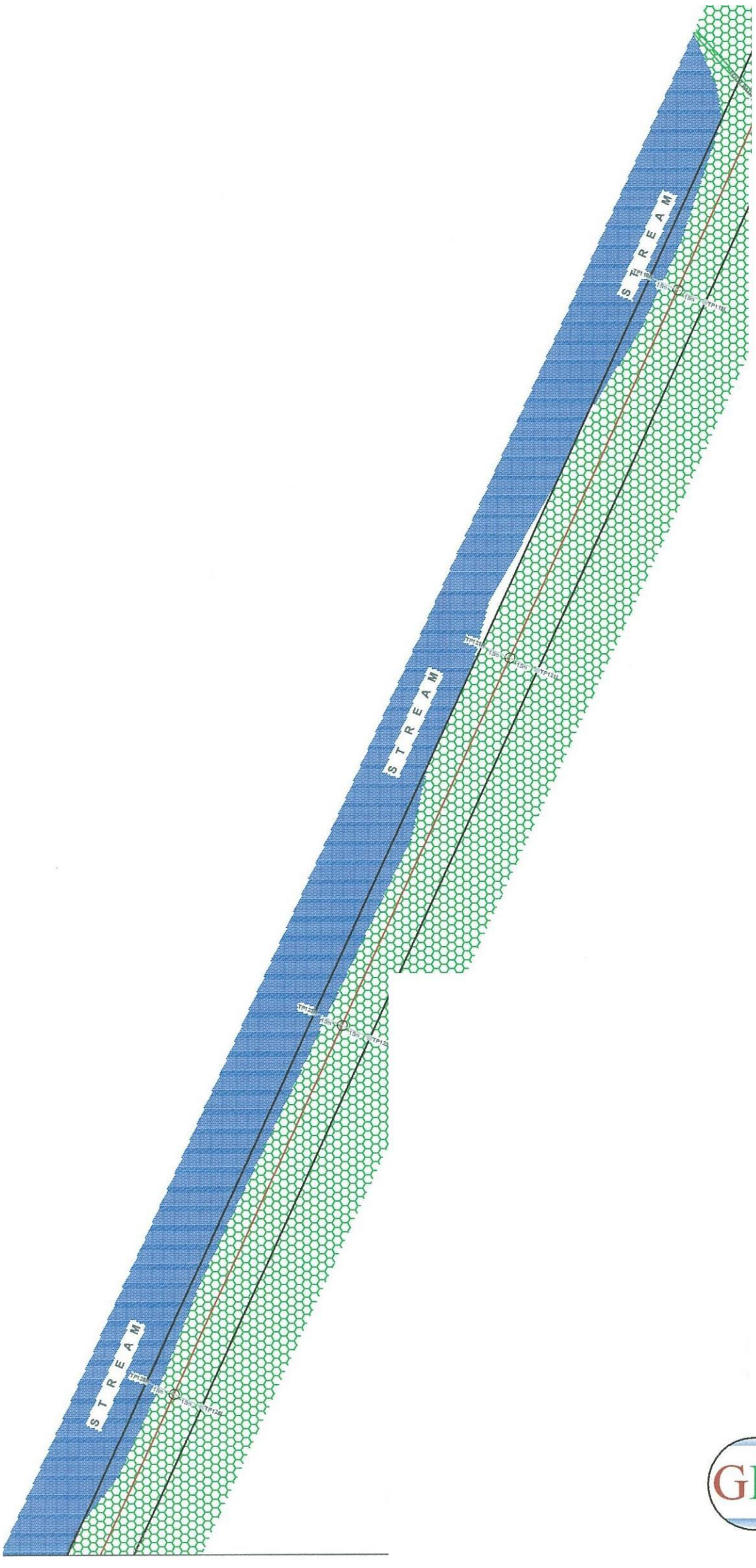

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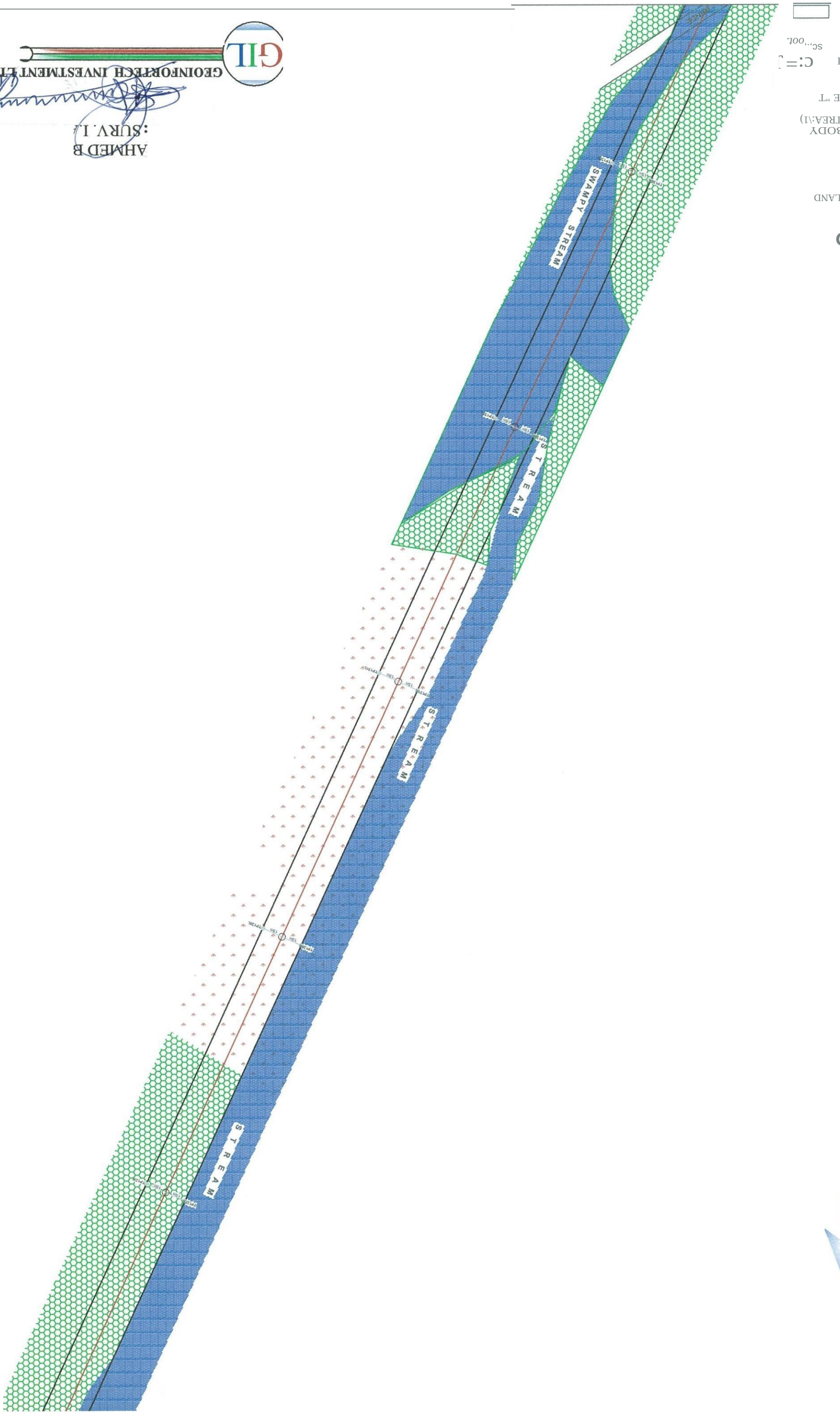

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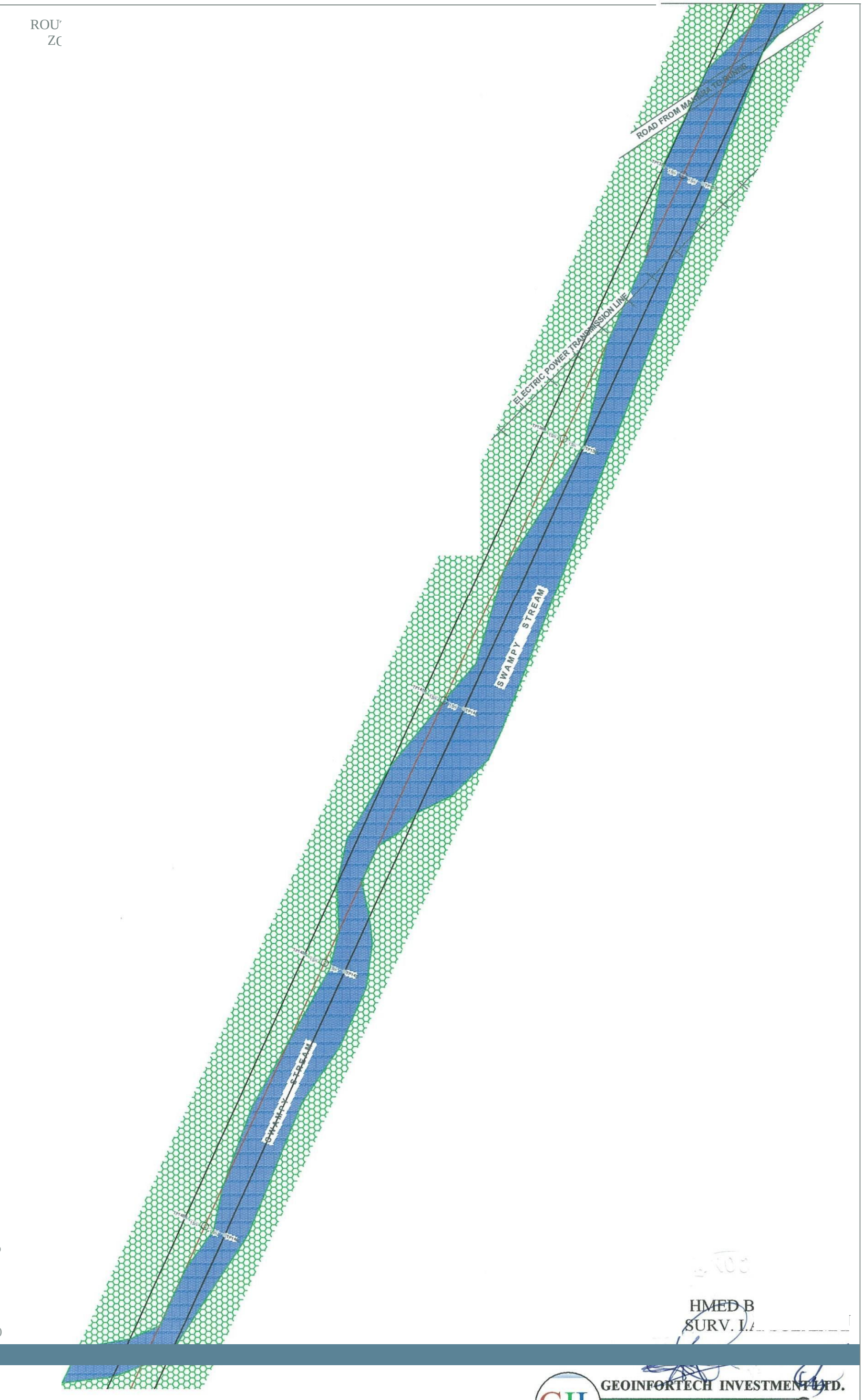

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ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION LINE FROM ZONGORO VILLAGE ALONG BAUCHI KARI ROAD TO DUNGULBE NEAR GRAVEYARD ALONG BAUCHI GOMBE ROAD.'BAUCH!, BAUCHI STATE.

FOR

NI6£RIA SOLAR CAPITAL PARTN£RS.

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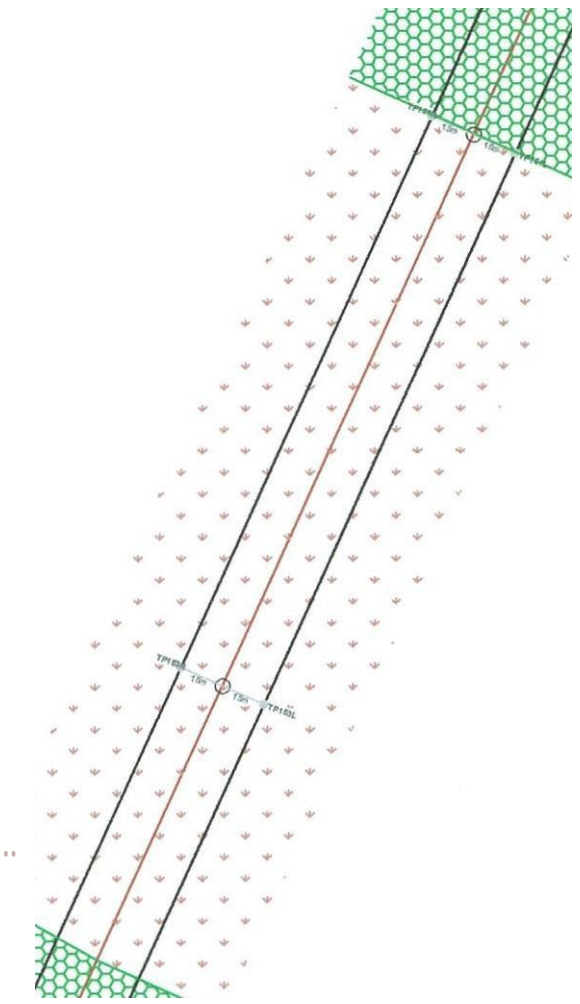

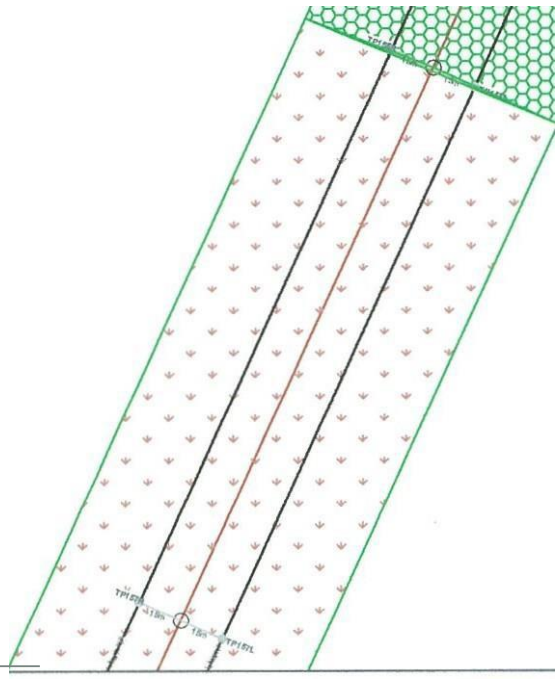

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GEOINFORTECH INVESTMENT LTD.

ROUTE SURVEY/CORRIDOR MAPPING OF l8KM SOLAR POWER TRANSMISSION LINE FROM ZONGORO VILLAGE ALONG BAUCHIKARI ROAD TO DUNGULBE NEAR GRAVEYARD

ALONG BAUCHI GOMBE ROAD, BAUCHI, BAUCHI STATE.

FOR

NI6£RIA SOLAR CAPITAL PARTN£RS..

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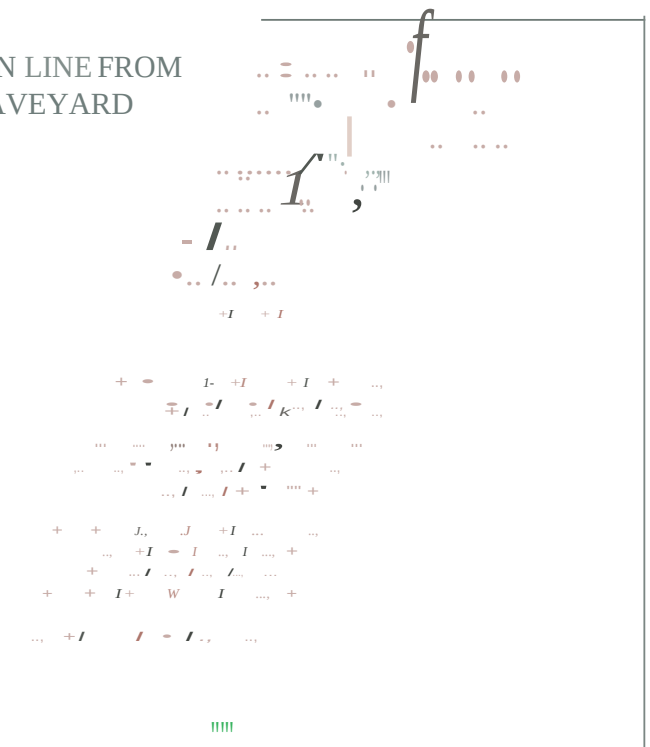

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SURVEY BY:
CHECKED BY
FOR:

NOVEMBER, 2013

ROUTE SURVEY/CORRIDOR MAPPING OF 18KM SOLAR POWER TRANSMISSION LINE FROM ZONGORO VILLAGE ALONG BAUCHIKARI ROAD TO DUNGULBE NEAR GRAVEYARD ALONG BAUCHI GOMBE ROAD. BAUCID, BAUCID STATE.

FOR

NI6ERIA SOLAR CAPITALPARTNERS.

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SCALE:-1:250

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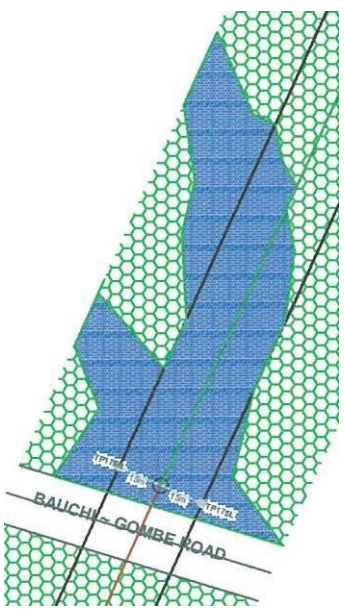

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FARMLAND

WATERBODY (RIVER/STREAM)

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SURVEY BY: AHMED BABAYO
CHECKED BY: SURV. I.A. SULAIMAN
FOR:

GEOINFORTECH INVESTMENT LTD.

NOVEMBER, 2013

Appendix 6:

Geophysical Survey Report

Geotechnical Tests Report: Solar Power Generating Project at Zongoro Village, Bauchi State

Preliminary Report

EnvironQuest

September 2013

1.0 Preamble

This is the report of the laboratory test conducted on the soil samples collected from six locations at the proposed site for the construction of solar power generating project at Zongoro Village, Bauchi State. The soil samples, disturbed, were taken to the geotechnical engineering laboratory for test, to determine the relevant engineering parameters of the sub-soil strata overlying the site. The sampling depth varied from 0 to 100cm

Geotechnical testing is generally directed towards both classification and characterization. Classification is typically based on particle size and consistency, while engineering behavior is defined by an assessment of bulk density and strength.

The aim of testing is to obtain reasonably representative values of the soil properties that are reliable and have a direct and significant bearing upon the solution of the practical problems involved.

Natural moisture content (NMC), particle size analysis, consistency, dry density and triaxial tests were carried out on the samples collected from the proposed project location in Bauchi State.

2.0 Results and Discussion

2.1 Soil Classification

The result of the soil classification is as shown in Table 2.1. The soils, according to AASHTO classification, fall under between A-1-b to A-7-6. These indicate a gravel, sand and clayey material, with gravel and sand being dominant material. The liquid limits values vary between 27% and 46% while the plasticity indices are all above 7 and vary between 8% and 19%.

2.2 Engineering Properties

The engineering properties of the soils from the six locations are as shown in Table 2.2

From the data derived from the laboratory investigation of the soil samples, it can be concluded that the sub-soil analysis is mainly mixture of gravel, fine sand and clay of medium plasticity index which will tend to medium swelling. When compacted and saturated, the shear strength will be good while its compressibility is at lower range. The soil permeability when compacted can be described as semi-impervious to pervious while its workability as construction materials is good. Proper channelization should be put in place.

Table 2.1: Soil Classification

Sample No & ID	Sieve Test			LL %	PL %	PI %	AASHTO Classification
	% Passing No 8 Sieve	% Passing No 40 Sieve	% Passing No 200 Sieve				
Lower Toppgraphy (LT) (0-50cm)	56.38	27.26	14.95	31.22	23.10	8.12	A-1-b
Lower Topography (LT) (5-100cm)	53.81	20.85	8.41	27.34	20.08	8.26	A-1-b
Mid Slope (MS) (0-50cm)	86.24	71.07	58.44	43.62	24.65	18.97	A-7-6
Mid Slope (MS) (50-100cm)	88.07	73.71	65.34	46.10	26.62	19.48	A-7-6
Upper Slope (TL) (0-50cm)	94.86	47.76	22.08	38.44	23.47	14.97	A-2-6
Upper Slope (TL) (50-100cm)	64.85	26.7	12.37	28.72	20.76	8.96	A-1-b

2.2: Engineering Properties

Sample No & ID	NMC (%)	Bulk Density (Kg/m^3)	Dry Density (Kg/m^3) & OMC (%)	Allowable Bearing Capacity.
LT (0-50cm) Lower Topography	8.66	2169.17	1922.34 kg/m^3 Omc=12.84%	Conts. footing = 242.82 Square footing = 243.53
LT (50-100cm) Lower Topography	8.3	2220.59	1964.08 kg/m^3 Omc=13.06%	Conts. footing = 252.40 Square footing = 253.62
MS (0-50cm) Mid-Slope	12.36	2153.15	1806.33 kg/m^3 Omc= 19.20%	Conts. footing = 160.26 Square footing = 161.32
MS (50-100cm) Mid-Slope	11.74	2156.95	1795.66 kg/m^3 Omc= 20.12%	Conts. footing = 158.22 Square footing = 159.28
TL (0-50cm) Upper Slope	10.64	2158.27	1896.71 kg/m^3 Omc= 13.79	Conts. footing = 231.66 Square footing = 232.58
TL (50-100cm) Upper Slope	10.09	2190.82	1940.32 kg/m^3 Omc=12.91%	Conts. footing = 238.42 Square footing = 239.16

2.3 Bearing Capacity

The bearing capacity value for all the locations are generally above 100KN/m^2. If the structure to be built on the site is of medium rise type, pad footing is recommended while for a high rise building, pile foundation is recommended.

The bearing capacity of the area can safety be used as 200KN/M^2

Appendix 7:

Sampling Locations

Appendix 9 – Table 1: Coordinates of Sampling Points

Soil and Vegetation			Water and Sediment			Groundwater			Air Quality and Noise		
Code	**Latitudes (N)**	**Longitudes (E)**	**Code**	**Latitudes (N)**	**Longitudes (E)**	**Code**	**Latitudes (N)**	**Longitudes (E)**	**Code**	**Latitudes (N)**	**Longitudes (E)**
SLV1	9.98788	10.44683	WS1	9.99653	10.4372	GW1	9.95926	10.25466	AQ1	9.98501	10.44366
SLV2	9.99232	10.44337	WS2	9.99546	10.43682	GW2	9.95901	10.26391	AQ2	9.98962	10.44314
SLV3	9.99135	10.43896	WS3	9.99488	10.43538	GW3	9.95952	10.26047	AQ3	9.99014	10.44173
SLV4	9.99227	10.43201	WS4	9.99488	10.4341	GW4	9.95953	10.26093	AQ4	9.98787	10.4392
SLV5	9.98911	10.4333	WS5	9.99609	10.43264	GWC1	9.93614	9.918378	AQ5	9.99435	10.44108
SLV6	9.98503	10.44569	WS6	9.98446	10.44128	GWC2	9.95926	10.25466	AQ6	9.98885	10.43521
SLV7	9.98931	10.43929	WS7	9.98713	10.43875	GW5	9.95902	10.25183	AQ7	9.99283	10.4346
SLV8	9.99366	10.43627	WS8	9.98911	10.43637	GW6	9.95511	10.17534	AQ8	9.99608	10.43364
SLV9	9.99651	10.43599	WS9	9.99061	10.43377	GW7	9.9575	10.22329	AQ9	9.99166	10.43206
SLV10	9.98974	10.43712	WS10	9.9901	10.43101	GW8	9.95515	10.1753	AQ10	9.99199	10.44194
SLV11	9.97027	10.38851	WSC11	9.99767	10.43967	GW9	9.95522	10.17058	AQ11	9.99548	10.44341
SLV12	9.95110	10.34616	WSC12	9.99315	10.42807	GW10	9.94253	10.32167	AQ12	9.98719	10.42938
SLV13	9.93240	10.30531	WSC13	9.98182	10.44389				AQ13	9.97141	10.3877
SLV14	9.92440	10.28356	WS14	9.98362	10.41666				AQ14	9.96964	10.38815
SLVC15	9.9826	10.43787	WS15	9.98458	10.41639				AQ15	9.97315	10.38709
SLVC16	9.99646	10.4447	WS16	9.97057	10.38583				AQ16	9.95208	10.34542

SLV17	9.97158	10.38804	WS17	9.97146	10.38598
SLV18	9.97356	10.38829	WS18	9.95422	10.35304
SLV19	9.95283	10.34712	WS19	9.95494	10.35173
SLV20	9.95215	10.34567	WS20	9.95137	10.34394
SL?21	9.93385	10.3057	WS21	9.95253	10.3442
SLV22	9.93413	10.30458	WS22	9.9409	10.32109
SLV23	9.92382	10.28382	WSC23	9.94253	10.32167
SLV24	9.92161	10.28501	WSC24	9.92501	10.28639

AQ17	9.95031	10.34598
AQ18	9.95402	10.34539
AQ19	9.93409	10.30619
AQ20	9.93227	10.3066
AQ21	9.9358	10.30555
AQ22	9.92364	10.28355
AQ23	9.92237	10.2844
AQ24	9.92502	10.28330

Appendix 8:

Geology of the Study Area

Table A10.1: VES, Lithostratigraphy and Description of Drill Cuttings at the study area

VES Location	Coordinates	Layer No	Resistivity (□)(Ωm)	Layer Thickness(m)	Inferred Lithology
1	N10º 25' 46.6''	1	115	1.04	Top soil
		2	19.9	1.68	Decomposed crystalline rock
	E09º 59' 25.8''	3	56.4	14.7	Weathered crystalline rock
		4	7741	∞	Weathered to fresh crystalline rock
2	N10º 25' 45.5''	1	241	1.71	Top soil
		2	27.5	2.51	Decomposed crystalline rock
	E09º 59' 26.1''	3	10.2	3.06	Fractured crystalline rock
		4	281	∞	Weathered to fresh crystalline rock
3	N10º 26' 39.1''	1	295	0.798	Top soil
		2	55.2	1.19	Decomposed crystalline rock
	E09º 59' 01.4''	3	235	23.9	Weathered crystalline rock
		4	17013	∞	Weathered to fresh crystalline rock
4	N10º 25' 32.9''	1	10.2	1.77	Top soil
		2	40	4.38	Ferruginous concretions
	E09º 58' 57.6''	3	198.8	2.49	Weathered crystalline rock
		4	1988	∞	Weathered to fresh crystalline rock
5	N10º 26' 04.7''	1	32.6	4.42	Top soil
		2	13.9	2.86	Decomposed crystalline rock
	E09º 59' 51.5''	3	1417	1.67	Weathered crystalline rock
		4	1317	∞	Weathered to fresh crystalline rock
6	N10º 26' 09.3''	1	139	0.762	Top soil

VES Location	Coordinates	Layer No	Resistivity (□)(Ωm)	Layer Thickness(m)	Inferred Lithology
		2	42.2	8.29	Decomposed crystalline rock
	E09º 59’ 53.4’’	3	1357	0.752	Weathered crystalline rock
		4	810	∞	Fractured to fresh crystalline rock
7	N10º 26’ 33.5’’	1	290	1	Top soil
		2	123	8.75	Decomposed crystalline rock
	E09º 59’ 08.2’’	3	692	0.451	Weathered crystalline rock
		4	691	∞	Weathered to fresh crystalline rock
8	N09º 18.378’’	1	336	0.75	Top soil
		2	93.1	2.09	Decomposed crystalline rock
	E09º 36.143’’	3	140	7.93	Weathered crystalline rock
		4	431	∞	Weathered to fresh crystalline rock

Appendix 9:

Species Lists

Table A11.1: Dominant Plant Species Composition, Growth Habit and Frequency of Occurrence in the Study Area

#	***Scientific name***	**Common name**	**Growth habit**	**Occurrence Frequency (%)**
1	*Andropogon gayanus*	Bluestem grass	Herb	19
2	*Brachiaria deflexa*	Signal grass	Herb	28
3	*Capparis corymbosa*		Herb	32
4	*Cenchrus ciliaris*	Common African foxtail	Herb	43
5	*Combretum binderianum*		Tree	15
6	*Combretum micranthum*		Climber	18
7	*Ctenium newtonii*	sickle grass	Herb	62
8	*Dactyloctenium aegyptium*	Common crowfoot	Herb	68
9	*Dichrostachys glomerata*		Herb	42
10	*Heteropogon contortus*	Spear grass	Herb	25
11	*Hyparrhenia rufa*	Brown hood grass	Herb	73
12	*Isoberlina doka*		Tree	62
13	*Monocymbium ceresiiforme*	Wild oatgrass	Herb	46
14	*Monotes kerstingi*i		Tree	58
15	*Parinari curatellifolia*		Tree	35
16	*Pennisetum purpureum*	Elephant grass	Herb	18
17	*Piliostigma reticulata*		Shrub	28
18	*Sporobolus pyramidalis*	Pyramid dropseed	Herb	33
19	*Strychnos spinosa,*		Shrub	25
20	*Uvaria chamae*		Climber	16
21	*Terminalia glaucescens*		Tree	18
22	*Ximenia americana*		Shrub	16
23	*Anchomanes sp.*		Herb	4
24	*Aspilia africana*		Herb	25
25	*C vulgaris*	Melon	Creeper	4

#	*Scientific name*	Common name	Growth habit	Occurrence Frequency (%)
26	*Calopogonium mucunoides*	Calapo	Creeper	2
27	*Citrullus lanatus*	Water melon	Creeper	6
28	*Cleome viscosa*		Herb	32
29	*Euphorbia heterophylla*		Herb	56
30	*Hibiscus sabdariffa*	Sorrel	Herb	26
31	*Hyptis suavolens*		Herb	28
32	*Ipomoea batatas*	Sweet potato	Creeper	4
33	*Lycopersicon esculentum*	Tomato	Herb	68
34	*Mangifera indica*	Mango	Tree	8
35	*Pennisetum milliaceaum*	Millet	Herb	28
36	*Phyllanthus amarus*		Herb	29
37	*Sesamine indica*	Beninseed	Herb	24
38	*Sorghum bicolour*	Guinea corn	Herb	18
39	*Tridax procumbens*	Goat weed	Herb	65
40	*Vitellaria paradoxa*	Shear butter tree	Tree	4

Table A11.2 List of Endangered, Threatened and Rare Wildlife Species in Nigeria

S/N	FAMILY	COMMON NAME	SCIENTIFIC NAME	STATUS
1	Pteomedusidae	African keeled mud	*Pelosiso carinus*	Endangered
2			*Pelusions castaneeus*	Endangered
3			*Pelusions nanus*	Endangered
4		William's African Mud turtle	*Pelusions williamsi*	Endangered
5	Trionychidae	Abry's flapshell turtle	*Cycloderma aubryii*	Endangered
6		Namibain flapshell turtle	*Cyslonorbis elegans*	Endangered
7		Senegal flapshell turtle	*Cyclonorbis senegansis*	Endangered
8	Dermochelidae	Leatherback turtle	*Dermochelys coriacea*	Endangered
9	Chelonidae	Green turtle	*Chelonia mydas*	Endangered
10		Olive ridley	*Lepidochelys olivacea*	Endangered
11		Hoaksbill turtle	*Eretmochelys imbircata*	Endangered
12		Nile crocodile	*Crocodylus Loticus*	Endangered
13		Slender snouted crocodile	*Crocodylus catapractus*	Endangered
14		African dwarf crocodile	*Osteolamus tetrapis*	Endangered
15	Veranidae	Nile monitor lizard	*Varamus niloticus*	Endangered

S/N	FAMILY	COMMON NAME	SCIENTIFIC NAME	STATUS
16		Monitor lizard	*Varanus exanthematicus*	Endangered
17	Pythonidae	Royal Python	*Python regius*	Endangered
18		Rock Python	*Python sebae*	Endangered
19	Struthionidae	Ostrich	*Struthio camelus*	Endangered
20	Pelethronodae	Pinkbacked pelican	*Pelecanus rufescens*	Endangered
21	Adeidae	Grey heron	*Ardea cinerea*	Endangered
22		Goliath heron	*Ardea goliath*	Endangered
23		Breen heron	*Bruorides virescens*	Endangered
24		Purple heron	*Ardea purpurea*	Endangered
25		Great Egret	*Egretta alba*	Endangered
26		Little egret	*Egretta garzetta*	Endangered
27		Cattle egret	*Ardeola ibis*	Endangered
28		Squocco heron	*Ardeola rolloides*	Endangered
29		Black-crowned night heron	*Nycticorax nycticorax*	Endangered
30	Scopidae	Hammercop	*Scopus unbretta*	Terminated
31	Ciconodae	White stork	*Ciconia ciconia*	Endangered
32		Abdims stork	*Ciconia abdimii*	Endangered
33		Saddle-billed stork	*Ephippiorhynchus senegalensis*	Endangered
34		Marabou stork	*Leptoptilus crumeniferus*	Endangered
35		Wood ibis	*Ibis ibis*	Endangered
36	Threskiornithidae	African spoonbill	*Platelea alba*	Endangered
37		Sacred ibis	*Threskiomis aethiopica*	Endangered
38		Glossy ibis	*Plegadis falcinelus*	Endangered
39		Hadada ibis	*Bostrychia hagedash*	Endangered
40	Accipitaridae	Nubian vulture	*Aegypius tracheliotus*	Endangered
41		Rappels griffon vulture	*Gyps ruppellii*	Endangered
42		White-backed vulture	*Gyps bengalensis*	Endangered
43		Palm-nut vulture	*Gypohierax angolensis*	Endangered
44		Hooded vulture	*Neophron monachus*	Endangered
45		West African River Eagle	*Haliaetus vocifer*	Endangered
46		Short toed eagle	*Cricaetus gallicus*	Endangered
47		Marital eagle	*Polemaetus bellicosus*	Endangered
48		Bateleur eagle	*Terathopius ecaudatus*	Endangered
49		Common buzzard	*Buteo buteo*	Threatened
50		Montaguas harrier	*Cyrcus pygargus*	Threatened
51		Goshawk	*Accipitar genitilis*	Threatened
52		Sparrow hawk	*Accipitar nisus*	Threatened
53	Fa;cpmodae	Hobby	*Falco subbuteo*	Threatened
54		Kestrel	*Falco innunculus*	Threatened
55	Sagisttariidae	Secretary bird	*Sagittarius serpentarious*	Endangered
56	Phasianidae	Helmet guinea-fowl	*Numida meleagris*	Threatened
57		Crested guinea-fowl	*Guttera edourdi*	Endangered
58		Blue-breasted kingfisher	*Halcyon malimbica*	Threatened
59		Malachite kingfisher	*Alcedo cristata*	Threatened
60		Pied kingfisher	*Ceryle rudis*	Threatened

S/N	FAMILY	COMMON NAME	SCIENTIFIC NAME	STATUS
61		Pigmy kingfisher	*Ceryx picta*	Threatened
62		Senegal Kingfisher	*Halcyon senegalensis*	Threatened
63	Upupidae	Hoopoe	*Upupa epos*	Endangered
64	Bucerotidae	Abyssianian Ground Hornbill	*Bucorvus abyssinicus*	Endangered
65	Ploeceidae	Ibadan malimbus	*Malimbus ibadansis*	Endangered
66		Black mountain weaver	*Ploceus melanogaster*	Endangered
67	Cercopithecidae	Colobus monkey (Guereza	*Colobus polykomos*	Endangered
68		Olive Colobus	*Procolobus verus*	Endangered
69		Red-eared Guenon	*Cercopithecus erythrotis*	Endangered
70		Moustached Monkey	*Cercopithecus cephus c.*	Endangered
71		Mona Monkey	*Cercopithecus mona*	Threatened
72		White throated monkey	*Cercopithecus eruthrogaster*	Endangered
73		Patas monkey	*Erythrocebus patas*	Threatened
74		Olive baboon	*Papio anubis*	Threatened
75	Ceropithecus	White hosed monkey	*C. Nictitans*	Extinct
76		Green (tantelus) monkey	*C. aethiops*	Extinct
77		Rensiss monkey	*C. preussi*	Extinct
78		Ground monkey	*C. Poganis*	Extinct
79		Grey-checked mangabey	*C. albigenia*	Extinct
80		Red-capped mangabey	*C. torguatus*	Extinct
81		Drill baboon	*Mandrillus*	Endangered
82		Chimpanzee	*Pan troglodytes*	Endangered
83	Pongidae	Western lowland gorilla	*Gorilla gorilla*	Endangered
84		Manis gigantean	*Giant pangolin*	Threatened
85	Manidae	Treep pangolin	*Manis tricuspis*	Threatened
86		Crested porcupine	*Hystrix cristata*	Threatened
87	Hystricidae	Brush-tailed porcupine	*Atherurus African*	Threatened
88		Hunting dog	*Lycaon pictus*	Endangered
89	Canidae	Side-striped jacka	*Canis adustus*	Rare
90		Pale fox	*Vulpes pallida*	Rare
91		Honey badger	*Mellivora capensis*	Rare
92	Mustelidae	Cape clawless otter	*Aonys capensis*	Rare
93	Viverridae	African Civet cate	*Civettictis civetta*	Endangered
94		Cusimanse	*Crossarchus crossarchs*	Rare
95		Cusimanse	*Crossrchus crossarchs*	Rare
96		Spotted hyaena	*Crocuta crocuta*	Rare
97	Hyaenidae	Striped hyaena	*Hyaena hyaena*	Endangered
98		Serval cat	*Leptailuru serval*	Rare
99	Feidae	Caracal or desert hynx	*Caracal caracal*	Rare
100		Leopard	*Panthera pardus*	Endangered
101		Lion	*Panthera leo*	Endangered
102		Cheetah	*Acinonyx jubatus*	Endangered
103	Oryeteropidae	Aardvark	*Orycteropus afer*	Extinct
104	Elephanitidae	African bush elephant	*Loxodonta Africana africana*	Endangered
105		African forest elephant	*Loxodonta africana cyclotis*	Endangered
106	Procaviidae	Rock hyrax	*Procavia capensis*	Rare

S/N	FAMILY	COMMON NAME	SCIENTIFIC NAME	STATUS
107		Three hyrax	*Dendrohyrax*	Rare
108	Trichechidae	Manatee	*Trichechus senegalensis*	Endangered
109	Suidae	Red river hog	*Potamochoerus aethipicus*	Rare
110		Wart hog	*Phocochoerus aethipicus*	Threatened
111		Giant forest hog	*Hylochoerus Meinertzhagani*	Endangered
112	Hippopotamidae	African hippopotamus	*Hippopotamus amphibious*	Endangered
113		Pigmy hippopotamus	*Hexaprotodon liberensis helsopi*	Endangered
114	Tragulidae	Water chevretain	*Hymoschus acquaticus*	Endangered
115	Giraffidae	Giraffe	*Giraffa camelopardalis*	Endangered
116	Bovidae	African buffalo	*Cyncerus cafer cafer*	Threatened
117		Dwart buffalo	*Cyncerus cafer nanus*	Threatened
118		Mountain reedbuck	*Redunca fulvirufula*	Endangered
119		Bohor reedbuck	*Redunce redunca*	Endangered
120		Giant eland	*Taurotragus derbianus*	Endangered
121		Western hartebeest	*Alcelahpus b. major*	Endangered
122		Roan antelope	*Hippotragus equines*	Endangered
123		Korrigum (topi)	*Damaliscus l. korrigum*	Endangered
124		Western kob	*Kobus kob kob*	Endangered
125		Bush buck	*Tragelahpus scriptus*	Endangered
126		Sitatunga	*Tragelahpus spekii*	Endangered
127		Red-fronted gazelle	*Gazalla rufifrons*	Threatened
128		Dorcas gazelle	*Gazelle dorcas*	Endangered
129		Dama gazelle	*Gazelle dama*	Endangered
130		Yellow backed duiker	*Cephalophys sylvicultor*	Endangered
131		Red flanked duiker	*Cephalophus rufilatus*	Endangered
132		Maxwells duiker	*Cephalophus maxwellii*	Endangered
133		Black duiker	*Cephalophus niger*	Endangered
134		Blue duiker	*Cephalophus monticlla*	Endangered
135		Bay duiker	*Cephalophus dorsali*	Endangered
136		Klipspringer	*Oreotragus oreotragus*	Endangered
137		Royal antelope	*Neotragus pygmaeus*	Endangered

Appendix 10:

Summary of Laboratory Analytical Methods

Table A12.1 Summary of Laboratory Analytical Methods

Sample Matrix	Parameter	Method
Soil	Grain Size Distribution	Hydrometer (Bouyoucos, 1951)
Soil	Total Hydrocarbon Content (THC)	Xylene extraction followed by the use of Spectrophotometer
Soil	Total Organic Carbon (TOC)	Dichromatic Wet Oxidation (Walkley and Black, 1934) as reviewed by Spark *et al.*, 1996
Soil	Exchangeable Bases (K, Na, Ca, Mg)	Ammonium Acetate Extraction, followed by the use of Flame Photometry and Atomic Absorption Spectrophotometry (Jones, 1988)
Soil	Heavy metals (Cd, Cr, Cu, Fe, Mn, Pb, Zn, Co, Ni, V)	Digestion, followed by the use of Atomic Absorption Spectrophotometry (AAS) (Jones, 1998, Allen, 1974)
Soil	pH	Glass electrode pH meter
Soil	Available phosphorus	Colorimetric (Jones, 1998; Murphy and Riley, 1962)
Soil	Sulphate	Turbidimetric (Tabatabi, 1974)
Soil	Chloride	Titrimetric method (Jones, 1998)
Water	pH	APHA 4500H+B
Water	Temperature (^oC)	APHA 2550B
Water	Chloride	APHA 4500 Cl -
Water	Nitrate	EPA 352.1
Water	Sulphate	APHA 4500-SO^4
Water	Magnesium	APHA 3111B/ASTM D 3561
Water	Potassium	APHA 3111B/ASTM D 3561
Water	Sodium	APHA 3111B/ASTM D 3561
Water	Calcium	APHA 3111D
Water	Cadmium	APHA 3111B
Water	Total Chromium	APHA 3111C

Water	Copper	APHA 3111B
Water	Total Iron	APHA 3111B
Water	Lead	APHA 3111B
Water	Nickel	APHA 3111B
Water	Zinc	APHA 3111B
Water	Silver	APHA 3111B
Water	Manganese	APHA 3111B
Water	Mercury	APHA 3112B
Water	Vanadium	APHA 3111D
Water	salinity	APHA 2520
Water	DO	APHA 4500-OG
Water	Turbidity	APHA 2130B
Water	Redox Potential	ASTM D1498
Water	TOC	BS 1377
Water	TDS	APHA 2510A
Water	TSS	APHA 2540D
Water	BOD5	APHA 5220D
Water	COD	APHA 5220D
Water	Total Hardness	APHA 2340C
Water	Oil & Grease	ASTM D 3921
Water	BTEX	EPA 8240
Water	Microbiology	ASTM D5465-93
Water	Zooplankton	APHA 10200 G
Water	Phytoplankton	APHA 10200 F
Air Quality	Gaseous pollutants: NO_x, SO_2, CO, NH_3	FEPA 1991
Air Quality	Gaseous pollutants: VOCs, H_2S,	FEPA 1991
Air Quality	Particulates	FEPA 1991

Air Quality	Heavy Metals	FEPA 1991
Noise		FEPA 1991