ENVIRONMENTAL IMPACT ASSESSMENT

PROPOSED OBAJANA EARTH DAM PROJECT
(OBAJANA, KOGI STATE)

SUBMITTED BY

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EXECUTIVE SUMMARY

Introduction

The proposed project is the construction and operation of an earth dam at Obajana in Kogi State of Nigeria. The dam shall be sited across the semi-seasonal River Oinyi and is meant to supply water to Obajana cement factory, which is currently under construction. Before the choice of the dam project, several alternatives were considered. The need for the proposed Obajana Dam project arises from the need to ensure sustainable water supply for the Obajana Cement Plant.

In Nigeria, Environmental Impact Assessment (EIA) must be carried out prior to the construction of a dam. The Federal Ministry of Environment of Nigeria has laid down procedures for conducting the environmental impact assessment (EIA) and enforces the EIA Decree No. 86 of 1992, which sets out the requirements, procedures and methods for conducting EIA.

This EIA was carried out in accordance to Nigeria's EIA procedures, using appropriate guidelines and standards. The objectives of the EIA study are as follows:

- to assess/evaluate the potential impacts of the dam project on the ecology, and socio-economics/health status of the people;
- to identify mitigation/amelioration measures; and
- develop environmental management plan for the dam project.

Project Alternatives Considered

Prior to the choice of the proposed project, five alternatives were considered and these include:

1. *'No project' scenario:* This was rejected as it counters development, since the cement plant cannot be operated without water.

2. *Exploitation of groundwater:* This is not feasible as investigations revealed that groundwater resources are inadequate to sustain the establishment of the cement plant: the geology of the study area is underlain by basement complex rocks, characterized by igneous and metamorphic formations with low aquifer porosity and slow recharge capacity.

3. *Source water from elsewhere:* **T**his option is also not feasible as Obajana and its environs are devoid of municipal waterworks. Besides, there are no nearby water sources that can sustain the operations of the proposed Obajana Cement Plant.

4. *Obtain from River Oinyi (without dam):* This entails pumping water from River Oinyi without damming, which is also not feasible because the river is seasonal and dries up during the dry season. Besides, there are no permanent water bodies in the area.

5. *Construct a dam:* This is the proposed project, which is the construction of an earth fill dam across River Oinyi. This option was considered the best option because it shall guarantee sustainable water supply to the proposed cement factory, utilise rainwater that would otherwise be wasted, and provide other opportunities like provision of recreational site, increase in fisheries resources, and potential for improvement of biodiversity conservation.

Description of Proposed Project

The scope of work of the proposed Obajana Earth Dam project is as follows:

- Installation of penstock inlet/outlet works;
- Construction of embankment and related facilities;
- The construction of spillway and related facilities; and
- Construction/installation of Pump House, pump assemblage and pipeline for transporting water to the Obajana Cement plant

The details of design parameters of the dam are as follows:

Total Annual Rainfall	1071.3 mm
Catchment's Area	70 km^2
Average Annual Runoff	74,988,620 m^3
Type of Dam	Homogenous (Zone Earth Fill)
Total Volume of Earth Fill	68,826.0 m^3
Total Storage (at crest level)	5,166,666.66 m^3
Active Storage Capacity (ASC)	4,277,666.67 m^3
Dead Storage Capacity (5% of ASC)	258,333.33 m^3
Surface Area	130 Hectares
Expected Time of filling	2 days
Maximum Base Width	75.95 m
Maximum Height	12.9 m
Top Width	5.0 m
Crest Length	360 m
Crest Elevation	206.9 m a.s.l. (above sea level)
Full Supply Level	204.9 m a.s.l.
Freeboard	2.0 m
Spillway Type	Broad Crested, Uncontrolled
Spillway discharge rate	377 $m^3 s^{-1}$
1000-year return flood	145 $m^3 s^{-1}$
Penstock Discharge	0.18 $m^3 s^{-1}$
Seepage Losses	0.103 $m^3 s^{-1}$
Expected Lifespan	50 years

Direction of Embankment	NE – SW
Direction of Pipeline to Factory	N – S

The dead storage is independent of active storage other: dead storage water cannot be released (even through penstock control valve) under any condition.

Operations and Maintenance Philosophy

The dam design incorporates features that will guarantee a desired economic lifespan of 50 years. The dam is designed for unmanned operations, but the reservoir shall be monitored periodically. Although detailed geophysical and geotechnical investigations indicate that the embankment strength is sufficient for the reservoir, a standard water reservoir monitoring policy shall be put in place.

Baseline Environmental Conditions

Climate / Air quality: The project area lies within the sub-humid tropical zone, and has a mean annual rainfall that ranges from 1100 to 1320mm. It experiences two main alternating seasons: dry and wet seasons. Rainfall lasts from April/May to September/October, characterised by moisture laden South Westerly winds blowing from the Atlantic Ocean, while the dry season lasts in-between with predominantly North-East trade winds.

Total suspended particulate (TSP) concentrations along River Oinyi range from 5.0 to 25.0 $\mu g\ m^{-3}$. The upstream areas of River Oinyi (mostly remote and pristine) had lower concentrations of TSP, while the Obajana area is moderately inhabited, busy and had higher ambient concentrations of TSP. The downstream sections are also generally without any significant human habitation, except for some nomadic Fulani tribesmen who live in the interior of the forests, with near pristine air quality. The concentrations of air pollutant gases (H_2S, CO, SOx, NOx) along River Oinyi were generally below detection limits.

Geology of the Area: The geology of the study area consists of Basement Complex rocks, predominantly composed of folded gneisses and metasediments. The Kabba-Jakura Formation, which consists of five rock units underlies the Obajana area and its environs. These include Obajana gneiss member, garnetiferous biotite-gneiss, schists, quartzites, limestone and marble.

The limestone in the area occurs within the schist quartzite series overlying the Obajana gneiss member. It is generally a white coarse-grained rock, with other varieties been fine-grained and greyish in colour. The limestone contains appreciable amounts of calcium carbonate, with the content of magnesia below the limit for cement manufacture.

From the outline geological investigation of the area a number of geologic structures (e.g., fractures, joints and faults) were observed associated with the basement rocks of Obajana area, but the geology can support dam construction. The general topography of the study area is undulating with scattered hills, forming the watershed for easterly flowing drainage lines, which flow into River Niger at Lokoja (about 38km downstream). The dam site is characterised by two types of landforms: domed shaped residual hills and river valleys. The hills are generally aligned in a NW-SE direction.

Drainage: Drainage is defined by rivers/streams, which flow in a dendritic to rectilinear pattern, mainly controlled by joint systems in older rock units. The streams are turbid at the beginning of the rainy season due to high clay content of runoff water that drains into the river during this period. The dam study area is drained by a single river of third (Strahler) order called River Oinyi which is a tributary of River Niger to its west. It has second and third order tributaries of about 2 km and 9km long respectively. The Oinyi River is semi-perennial with portions of it seasonal in nature (ephemeral), flowing only after rains. The Oinyi River has a semi–perennial flow, while most of the smaller stream and drainage lines that dissect the hills are water-barren during the dry season. The surface water resources of Obajana are used for domestic, agricultural and industrial purposes.

Hydrogeology / Hydrology: There are two types of aquifers in the Obajana area: fractured crystalline aquifer and soft overburden aquifer. The overburden aquifers usually consist of 2 to 3 layer sequences made up of sands, gravel, silts and clays. Groundwater in these aquifers occurs mainly under unconfined water table conditions. The water table is not so deep, mostly not more than 20 - 30m below ground level. The groundwater level in this aquifer type is a function of depth and degree of weathering.

Water Availability: There are serious water supply problems in the area of study due to its geologic history, basement nature and difficult terrain. Groundwater reserves in the area are generally low, because there is high run-off of rainfall and slow aquifer recharge due to the nature of topsoil in the area, and the migmatitic-gneiss basement terrain of the area. However, potentials for the development of surface water resources exist.

The inhabitants in the area source their water from hand-dug wells and the semi-perennial Oinyi river system. This river serves as a major source of domestic water for the inhabitants of Obajana area and other settlements in the area. Rain harvesting is a good source of clean water, more especially as there is abundance of rainfall in the area during the

wet season. It is one of the major sources of water for domestic purposes in the area, though little attention is given to its importance.

Other sources of water in the area are streams and crudely excavated wells. As these shallow water wells dry up, the people (usually women and children), are often forced to trek long distances to fetch water, thus wasting a lot of energy and time finding water to drink. At the moment Obajana village is being supplied water by Julius Berger Plc, a civil engineering contractor to Dangote Industries Ltd.

Surface Water Quality: The surface water was not polluted and there were no obvious differences in measured physico-chemical parameters of the river in both wet and dry seasons. The pH, total hardness, DO, BOD, concentration of dissolved cations and heavy metals, and those of the nitrates, sulphates and phosphates have similar ranges in both the dry and wet seasons. However, the river has slightly higher conductivity in the wet season.

Hydrobiology: Phytoplankton recorded in the area belonged to four families namely, Baccilariophyceae, Chlorophyceae, Cyanophyceae and dinophyceae, with the Baccilariophyceae constituting >50% of the total count. The zooplankton consisted of rotifers, calanoid and cyclopoid copepods as well as insect larvae especially those of mosquitoes and similum flies.

The benthic realm consists of rock outcrops / coarse sandy sediments. The riverbed is poor in terms of species diversity and numerical abundance of macrofaunal species. However species of the families Oligochaetes, Naididae, tubificidae, Lumbriculidae and Lumbricidae were more or less common. Two species of the Phylum Mollusca were identified one each belonging to the class bivalvia and gastropoda. The bivalve was identified as *Mya* while the gastropod was identified as *Limnaea*.

Although fishes constitute part of the ecology of the temporary pools of surface waters that abound in the valleys within the study area, there is a general absence of fishermen in the study area mainly because of the absence of fishes in the river to warrant profitable exploitation. However, youths do catch fish in the numerous pools of water, using fish nets/hooks, and their catch included *Sarotherodon niloticus* and *Tilapia zilil* (Family Cichlidae) and *Clarias gariepinnis* (Family Claridae).

Soils/Vegetation/Biodiversity: The soils found in the study area are generally friable and slightly acidic (mean pH 5.82) with organic matter content ranging from 1.14% to 2.35% and total N of 0.06-0.14%. The soils are generally very productive and farmers do not need to add fertilizers to obtain ‘good’ crop yields.

The vegetation pattern of the study area is basically moist savannah, characterized by mixtures of trees, shrubs, tall grasses, and herbs. There are economic trees in the study area and these trees include *Daniella oliveri*, *Parkia clappertonia*, and *Vitex doniana*, *Lophira anceolata*, the trees tend to be slender with low timber value. The dominant trees include *Lophira anceolata, Daniella oliveri and Parkia clappertonia,* with scattered stands of oil palm trees (*Eleis guinensis*) around settlements, and riparian vegetation along river river/stream courses.

The hilly areas located westwards from the proposed dam site is known to contain a rich assemblage of wildlife species: a previous study has listed a total of 38 species, belonging to 24 families, as existing in the Obajana area. These include 17 mammals, 14 birds, 5 reptiles and 2 amphibian species. The most frequently hunted animals include antelopes, monkeys, hares, rats, and guinea fowl.

Affected Settlements: There are no settlements within or in close proximity to the proposed dam impoundment zone. The settlements that have direct/indirect effect on the quality of water to be stored in the proposed dam are those located or have access to the upstream locations of the dam, and these include Oyo-Iwa, Obajana, Oile, Oshokoshoko/Eshi and Nyamako and its environs. Apart from Obajana and Oshokoshoko, all the other settlements are remotely located and not easily accessible. All these communities are inhabited by the native landowners, except Nyamaku and environs which are inhabited by Tiv settlers on Oyo-Iwa land. These communities satisfy their water needs from hand-dug wells as well as Oinyi River. The hand dug wells supply drinking water, while water for other domestic purposes is mostly obtained from the river.

The downstream communities would suffer the downstream impacts of the dam, but anthropogenic activities in these sections would not affect the quality of water stored in the reservoir. The downstream communities include Fulani migrant settlements (Wuro Gada Biyu, Wuro Ardo, Wuro Mashu, and Wuro Jahun) and 'Shagari Town' which is inhabited by Bassa people (on Igbira land).

The Fulani settlements are remotely located and access is only via footpaths. Although the Fulani are nomadic by nature, they tend to settle where ever they find favourable conditions for both themselves and their cattle. In this case, these communities have been settled for about 20 years.

Population/Age Structure: Apart from Obajana that had been enumerated during the 1991 national census exercise there is no official records for the rest of the affected settlements. Due to the influx of people accentuated by the cement development project, Obajana has experienced a population boom. An estimate of the present population was conducted using the estimate of household size and number of dwelling houses.

There are more men than women at Obajana, Wuro Ardo, Wuro Jangale, Shagari Town and Nyamako, while the reverse is the case for Wuro Gada Biyu, Wuro Jahun, and Wuro Mashu. There are plenty (20.1 – 39.2% of total population) of children (under 15 years of age) in the study area, indicating a huge presence of dependent population. Obajana, which is accessible by tarred road and host to the Obajana Cement Plant, had the lowest proportion of children, largely due to high influx of people in search of construction jobs. On the other hand, the settler communities had higher proportion of their population as children probably because the adults have migrated in search of greener pastures.

Ethnic/Religious Compositions: The peoples of Obajana belong to Lokoja LGA and they are Oworos, which the people claim originates from Yoruba. There are also Fulani and some other tribes (Hausa, Tiv, Igbo, Bassa, etc.) in the study are, although they are not indigenous. The main occupations of the people include farming, fishing, hunting, petty trading, small businesses, etc. Obajana is a rural community, characterised by low income and absence/shortages of social amenities. The predominant religions in the area are Christianity and Islam, although a few of the peoples practice African traditional religions.

Housing Pattern: The settlements within the area are mostly linear and typically rural consisting mostly of mud houses and thatch huts. The thatch hut system is usually found in Fulani settlements which are usually found far off the road.

Means of communication: Oworo language is the major medium of communication. Other languages spoken include Hausa, Yoruba, Fulfulde (Fulani), English, Tiv, and Igbo, as there are people from these other tribes mainly employed as factory workers and businessmen. Access from one community to the other is usually by foot and bikes, although there is a major road that passes through Obajana.

Occupational Pattern: Occupations of the people include cattle rearing, rain fed farming, hunting and petty trading. Agriculture in the area is basically that of arable cultivation and animal husbandry. Since the only source of water (R. Oinyi) dries up during the dry season, there is generally no irrigation farming in the study area. Farming is carried out

using simple tools such as hoes, cutlasses, etc. Crops grown in the rain-fed agriculture include maize, millet, guinea corn, groundnuts, cocoyam, cassava, etc.

Health Care Facilities and Services: There is no healthcare facility in all the affected communities. There is only one drug dispensing store in Obajana. Majority of the people resort to self-help medical care or they patronise herbal medicine men. For those that can afford it, they travel to Lokoja for the treatment of their ailments.

Housing/Household Energy: most houses in the communities are mud house and lack proper ventilation. As the source of energy is firewood, there is a high risk of occurrence of indoor pollution resulting from incomplete combustion of the firewood

Households rely on firewood as the basic source of energy, which due to combustion inefficiency constitutes a substantial source of indoor pollution. The sources of lighting at nights are mostly kerosene lanterns and/or candles as there is no electricity (a very few people own small power generators).

Waste Disposal: Since the communities are rural and lack basic amenities with no good water supply, there is a general absence of standard toilets (with flush system). The people use pit latrines and/or bush to discharge their excreta. They bury their dead ones in cemeteries (none is located within the project area).

The waste types generated are mostly leftover food materials, peels, food processing wastes, etc., mostly biodegradable. The people usually feed their waste foods to animals, while those that cannot be used as animal feed are burnt. There are no heaps of garbage around any of the communities. Wastes generated after sweeping compounds are also burnt in the backyard and the ashes are added to the soil for micro-scale vegetable cultivation (in backyard gardens).

Morbidity/Mortality pattern: There is no recognised health institution in Obajana and environs therefore there are no detailed records on mortality and morbidity. However, records of clinical diagnosis for the Oworo people at the General Hospital in Lokoja shows that majority (80%) of the ailments affecting the people are communicable diseases. Only 9% of the complaints of Oworo people are as a result of non-communicable disease, while 11% of the people attend hospital to undergo surgical procedures

Amongst the communicable diseases, malaria was the most prevalent followed by gastroenteritis and then sexually transmitted diseases.

That malaria and gastroenteritis were the two most prevalent is expected since malaria is the number one cause of morbidity in sub-Saharan Africa, and the study area is devoid of potable water (gastroenteritis). However, the fact that STDs are the third group of the most prevalent communicable disease is worthy of note. This signals the danger of possible presence (or even high prevalence) of HIV amongst the people. Since there are no screening centres in the area, and people hardly subject themselves to voluntary screening, it is difficult to actually determine the occurrence of HIV/AIDS in the affected communities.

A recent survey (2003) carried out by the Federal Ministry of Health of the Federal Republic of Nigeria shows that Kogi State is amongst the 13 states with highest sero-prevalence of HIV. The average percentage of people infected with the HIV virus in Kogi State (5.7%) is higher than the national average (5.0%). Generally the level of HIV prevalence in Kogi State is higher amongst the less educated populace, and those living in or around urban centres (7.0% for urban and 4.4% for rural population). HIV prevalence is remarkably higher amongst the younger people: in the North Central zone of Nigeria (Kogi State inclusive), 6.7 – 8.2% of people aged 15 to 29 years tested positive, as compared to 2.6 – 5.8% of those aged 30 to 49 years.

Community Consultations

Consultation visits were paid to the communities that would be affected by the proposed Obajana Dam project. The purpose of the visit was to intimate the communities about the EIA of the proposed Obajana Dam project and solicit their views. The general strategy was to reach out to as much interest groups/individuals as possible.

The modalities for the meetings varied with each community, but the general trend was that community members were made to understand that the consultants were not speaking on behalf of Dangote Industries Ltd., but that the meeting was part of the data gathering process for an EIA study. The meetings involved free discussions.

Outcome of Consultation (Concerns/Wishes)

The outcome of the consultation revealed the community concerns and wishes are summarised as follows:

- People of Obajana complained of lack of potable water and loss of access to the dam site and adjoining areas. The greatest concern of the Fulani communities is also lack of water, especially in the dry season. They wished to have a reliable source of potable water within their communities and they were specifically delighted to know that the river could flow during dry season (via penstock releases).

- Although Julius Berger Plc, the civil contractor for the cement plant, has provided concrete water tanks, as a temporary measure, to store water for inhabitants of Obajana village, they are not refilled regularly.
- They wished the present ad hoc water supply arrangement be changed to a more permanent solution, e.g., drilling of boreholes to supply water to Obajana community, and also demanded to be supplied with electricity, and a hospital established to cope with the massive influx of people, in part due to dam construction.
- Oyo people's concerns bother around lack of compensation paid to them for the acquired land and lack of compensation for their economic trees and inadequacy of monies given them for farm crops were inadequate.
- In addition, the Chief of Oyo is concerned that the usual rituals of 'appeasing the gods' for the new development (dam) to be sited on their land has not been performed, which is repugnant to their cultural norms.
- Other important concern of the Fulani is lack of schools, as they are desperately in need of a primary school, having been settled in the area for >20 years yet no school for their kids.
- The Tiv (Nyamaku) and Bassa (Shagari Town) settlements on the other hand are basically concerned with respect to dam construction is lack of water; hence their greatest need is the provision of water.

Potential Ecological Impact/Mitigation Measures

Ecological Impacts	Mitigation Measures
Sedimentation in the reservoir.	• Ensure regular penstock releases • Increase frequency of releases when sediment load of inflowing water increases. • Ensure catchment protection and watershed management
Release / accumulation of bye-products of anaerobic decomposition	• Ensure regular penstock releases • Monitor water quality, including penstock releases
Migration and productivity of fish species.	• Ensure spillway is free from any blockage • Seed fish, if necessary, to maximise fisheries productivity.
Changes in primary productivity due to biochemical reactions	• Ensure penstock releases (from the lower depth of the dam) • Spillway shall release water from the surface
Risk of eutrophication / growth of non-native and/or invasive species.	• Monitoring of in-stream water quality • Partner in enlightenment for increased

	environmental awareness in surrounding communities.
Opportunistic growth of aquatic macrophytes in the littoral and sub-littoral zone of the reservoir	• Monitor for any unusual floral species • Remove such species when seen.
Creation of favourable habitats for the growth and proliferation of disease vectors	• Monitor the presence of disease vectors • Contribute to strengthening of local health facilities through public enlightenment • Contribute public health programmes to eradicate / protect against malaria, schistosomiasis &, etc • direct contributions in terms of drugs, provision of infrastructure, etc. • Spillway ensures continuous flows, hence the likelihood of creation of habitats for bilharziasis is remote
Alterations in the flow of water and changes in water quality during the construction of the dam embankment	• Adequately divert the river away from construction areas • Ensure good practices
Obstruction of flow of the River Oinyi during dam filling.	• Carry out commissioning at the peak of the rainy season • Ensure penstock releases if flow is critically below expectations.
Changes in downstream water quality	• Ensure regular penstock releases, • Monitor quality of penstock releases • Increase frequency if necessary.
Impacts due to air emissions/noise, and dust generated during earthwork / construction	• Ensure that emission levels of machinery are within permissible limits. • Ensure that there is no night work
Enhanced erosion / changes in topography due excavation.	• Put erosion control measures • Obtain earth fill from flooding zone. • Re-vegetate with native species
Risk of accidental drowning. Injuries during dam construction and/or due to vehicular traffic	• Keep unauthorised persons away from dangerous zones • Put warning signs (written in English and local languages) at strategic sites • Ensure regular monitoring of embankment, penstock and spillway.
Changes in downstream ecology	• Ensure minimum ecological releases, • Monitor seepage /penstock release volumes
Possibility of creation of mosquito breeding grounds due to the alteration of the natural flow pattern of river Oinyi through penstock releases during dry season	• Minimise penstock releases during the dry season and monitor and control the possible creation of mosquito breeding sites
Loss of terrestrial habitats due to impoundment	• To put in place catchment protection and watershed management plan

Potential Socio-Economic & Health Impact/Mitigation Measures

Socio-Economic/Health Impacts	Mitigation Measures
Loss of control / income of land to be inundated by the reservoir	• Compensate for farm crops and/or economic plants. • Liaise with chiefs to allocate alternative land to farm. • Subsidise clearing new farmlands and assist affected farmers
Risk of introduction of new diseases as schistosomiasis	• Monitor for the presence of snails of *Bulinus* species • Contribute to strengthening of local health facilities
Changes in downstream water quality	• Monitor water quality • Provide appropriate alternative source of water for downstream settlers
Gender disparity in the adverse effects of landtake	• Gender equity in compensation • ensure payment is to affected women.
Massive influx of people during dam construction	• Strengthen basic facilities • Avoid actions that could cause or escalate tension • An influx management plan being prepared to address influx related issues
Changes in sexual behaviours leading to the spread and/or escalation of sexually transmitted diseases (including HIV/AIDS) and unwanted pregnancies	• Enlighten personnel about STDs (HIV/AIDS) and use of condoms. • Partner with NGOs in campaign to stop the spread of HIV/AIDS. • Help strengthen healthcare system
Conflicts resulting from insensitivities of dam construction personnel to the local culture, traditions and lifestyles	• Educate workers on the cultural sensitivities in the host communities. • Identify with the host communities during festivals
Reduced availability of river water, downstream (especially during dry season) to downstream users	• Ensure penstock releases during dry season to mimic minimum ecological flows

Compensation Measures

Some measures of compensation are considered as part of the environmental management plan. This is considered as some form of repayment for residual adverse effects, or impacts that can neither be avoided nor adequately mitigated. These include the following:

- Compensation in the form of direct monetary payment to people affected by land-take and/or loss of crops has been put in place.
- Ensure the preservation of the dam catchments area especially the hills to the northwest of the proposed dam site.

- Collaborate with Kogi State government and relevant NGOs/CBOs to adopt measures that shall enhance the protection of the watershed as compensation for biodiversity losses due to the proposed dam.
- Seeding of dam with fingerlings to enhance fisheries potentials.
- Explore the possibility of integrating the dam and the watershed into a nature reserve.

Waste Management Plan

A comprehensive waste management plan shall be put in place for the Obajana dam project. The plan shall, as much as possible utilise the principle of waste reduction, reuse, recycling, and recovery. All wastes that require treatment shall be treated in accordance to acceptable standards prior to disposal (in a responsible manner).

Environmental Monitoring Plan

Both international and Nigeria's environmental guidelines and standards require environmental monitoring development projects. Monitoring shall involve sampling and analysis of environmental components like soils, vegetation, water, air and biota, as well as emissions, effluents or systems, at regular intervals.

Decommissioning/Abandonment Plan

At the end of the design life, the dam shall be decommissioned and abandoned. A comprehensive plan shall be prepared for the restoration and subsequent protection of the ecosystem. The decommissioning and abandonment activities shall comply with international standards (world commission on dams).

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%	-	Percentage
$	-	Dollar
µg	-	microgramme
@	-	at
<	-	Less than
>	-	Greater than
a.s.l.	-	Above Sea Level
AIDS	-	Acquired Immune Deficiency Syndrome
ASC	-	Active Storage Capacity
BO	-	Business Objectives
BOD	-	Biochemical Oxygen Demand
CBO	-	Community Based Organisation
cm	-	Centimeter
cm^3		Cubic centimetre
CO	-	Carbon monoxide (Carbon II Oxide)
CO	-	Carbon Monoxide
CO_2	-	Carbon Dioxide (Carbon IV Oxide)
COD	-	Chemical Oxygen Demand
dBA	-	Decibel (A-weighted)
DO	-	Dissolved Oxygen
E	-	East
e.g.	-	For example
EIA	-	Environmental Impact Assessment
EMP	-	Environmental Management Plan
etc.	-	et cetera
Fe	-	Iron
FEPA	-	Federal Environmental Protection Agency
FMoE	-	Federal Ministry of Environment
ft	-	Feet
g	-	gram
H_2S	-	Hydrogen Sulphide
H_2S	-	Hydrogen sulphide
HEM	-	Hazard and Effect Management
HIV	-	Human Immunodeficiency Virus
HSE	-	Health, Safety and Environment
HSE-MS	-	Health,Safety & Environmental Management System
i.e.	-	That is
IITA	-	International Institute of Tropical Agriculture
km	-	Kilometre
km^2	-	Square Kilometre
KW	-	Kilowatt
L	-	Litre
LEF	-	Living Earth Foundation
LGA	-	Local Government Area
Ltd.	-	Limited

m	-	Metre
$m^3 s^{-1}$	-	Cubic meter per second
mg	-	Milligramme
mg/kg	-	Milligramme per kilogramme
mg/l	-	Milligrame per litre
ml	-	Millilitre
mm	-	Milimetre
N	-	North
NCF	-	Nigerian Conservation Fund
ND	-	Not Detected
NE	-	North East
NGO	-	Non-Governmental Organisation
NIWA	-	National Inland Waterways Authority
NOx	-	Nitrogen Oxides
NW	-	North West
^oC	-	degree Celsius
pH	-	Hydrogen ion activity
Plc	-	Public Limited Company
ppm	-	Parts per million
PVC	-	Polyvinylchloride
QMS	-	Quality Management System
S	-	South
SE	-	South East
SOx	-	Oxides of Sulphur
SW	-	South West
TSP	-	Total Suspended Particulate
TSS	-	Total Suspended Solids
VES	-	Vertical Electrical Sounding
W	-	West
WHO	-	World Health Organisation

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J. Omweugbu (B. Sc.)	Laboratory Analysis
D. Eka (HND)	Cartographer
A. Agbor	Field Assistant
M. J. Nwatabunor	Field Assistant
S. Pene	Secretarial Assistant

Dangote Industries Limited

D. V. G. Edwin	Executive Director (Dangote Group)
B. Kashinath	Chief General Manager (Dangote Industries Ltd.)
Alh. I. Zubairu	General Manager (Dangote Group)
A. Zubairu	Head Environmental Services (Dangote Group)
R. Swamy	Dangote Industries Limited