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Environmental Impact Assessment for a Pilot Project for Integrated Solid Waste Management in Makurdi, Nigeria

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Abstract: The Environmental Impact Assessment (EIA) of the Integrated Waste Treatment Facility (IWTF) was conducted through multidisciplinary assessment of the baseline status of the site specific environment using standard methods for EIA in Nigeria. The impact assessment took into consideration the project activities and their interactions with environmental components. In order to influence the layout of facilities and infrastructure and maintain environmental sustainability throughout the project cycle, Environmental Sensitivity Index (ESI) mapping was carried out to delineate the sensitivity of the IWTF site. The interaction of the environmental aspects of the project and site specific baseline status of the area defined the potential impact of the IWTF project. Residual potential impacts were identified in order to understand the levels of environmental review and performance needed for the entire project. Ameliorative measures were proffered for the significant potential environmental impacts most of which were recommended for incorporation in the design and layout of the entire project. The residual impacts shall be continuously monitored through the use of environmental performance indicators as specified by the regulatory bodies on environment in Nigeria. An Environmental and Social Management Plan (ESMP) was developed for the project to allow for environmentally sustainable operations if those initially established proved inadequate, to cover the residual impacts. Socio-economic and health aspects of the project were defined to guarantee sustainability. Based on the study, the project was found to be economically, commercially, technically, managerially and environmentally sustainable.

Keywords: Environmental impact assessment, baseline characteristics, integrated solid waste management, Makurdi, Nigeria

INTRODUCTION

The Environmental Management Steering Committee (EMSC) and the Technical Working Group (TWG) working with support from the Department for International Development (DFID) funded State and Local Government Programme (SLGP) have initiated a pilot project for integrated solid waste management in Makurdi, Benue State, Nigeria. This pilot project will test and demonstrate service-oriented governance through implementing new and improved solid waste management services. An Integrated Waste Treatment Facility (IWTF) will be constructed as part of this pilot project. An Environmental Impact Assessment (EIA) of the IWTF is required to be carried out as an integral part of the detailed design, planning and approval process (Whiteman, 2004; Whiteman *et al*., 2004).

Waste management is referred to as the proper and correct handling of waste products at the lowest cost and with minimum destruction and pollution to the environment. Improper management of waste has caused numerous cases of contamination of surface and soil water and the atmosphere and threatens the health of the exposed populace. There is therefore need to manage waste to reduce the threat to the environment and to the populace. The waste management methods in use throughout the world are namely:

- Waste prevention
- Recycling (recovered valuable materials such as paper, cardboard, aluminum, glass, plastics, building materials, metal scraps, used tyres, etc and composting)
- Incineration with or without energy recovery
- Dumping/Land filling

A field survey carried out to determine the waste generation profile in parts of Makurdi Urban Area that make up the Pilot Project Area (PPA) indicates that the bulk (approx. 82%) of the solid waste generated in the PPA originates from households rather than from commercial, institutional or industrial premises (Sha'Ato *et al*., 2003). The type of waste generated generally include putrescible materials, ash/dust/sand, plastics/cellophane materials, paper, glass, metals (mostly cans and bottle corks), textiles, materials such as wood, stones, pebbles, discarded shoes and other foot wears, wood shavings (from carpenter's shops), bits of styrofoam, snail shells, discarded dry cells, etc. Waste moisture content was between 19.3-49% while bulk density ranged from 138-425kg/m^3. Generally solid waste generation based on population figures was found to be circa 49,000 tonnes/annum and was recommended as the baseline for the PPA and diagnostic for Makurdi as a whole. The study therefore indicated that based on the

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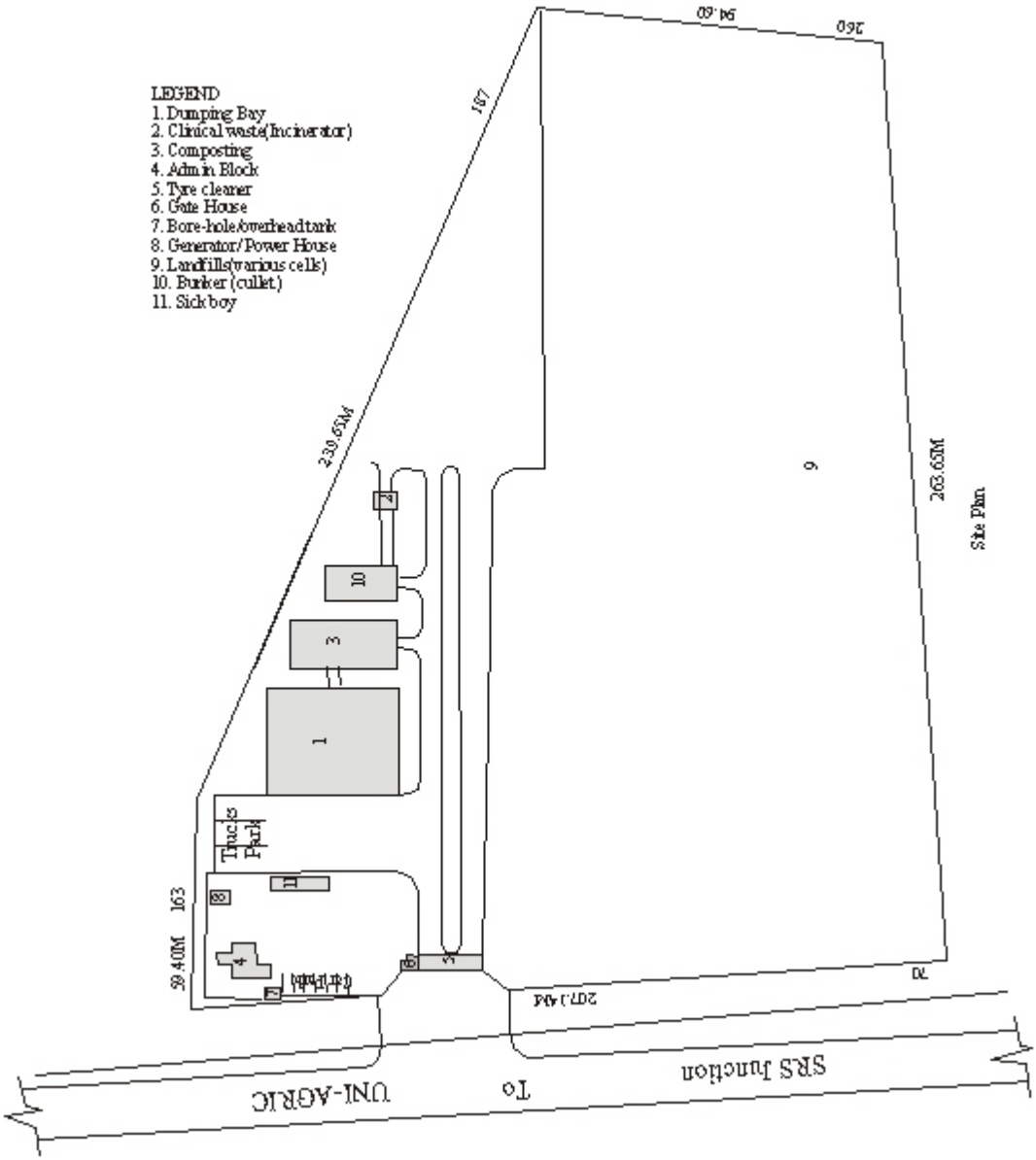


Fig 1: Conceptual design of the Integrated Waste Treatment Facility (IWTF) site lay-out (Source: SLGP Benue)

general composition of these wastes, the most viable treatment options, for now, were composting and land filling and these were recommended as the major treatment options at the IWTF. Nevertheless, the report further recommended that the possibility of material re-use should not be discounted, as this offers opportunities for revenue through contracting/private enterprise. Incineration was considered as the best option for clinical waste. Based on these findings, a preliminary conceptual design for the site (showing overall layout for the proposed facilities) was prepared by the SLGP Benue (Fig. 1). The IWTF will consist of a combination of recycling, incineration (clinical waste) without energy recovery and sanitary landfill. Other facilities include a dumping bay, administrative block, tyre cleaner, gate house, borehole/overhead tank, generator/power house, bunker and sick bay.

The broad objectives of the EIA is to understand the likely environmental consequences of the new development, identify the measures by which such impacts can be mitigated and present the results in such a way that they can provide the data needed for decision making by policy makers, planners, engineering and design team, affected groups as well as government agencies.

The specific objectives of the EIA are to

- to advise on the environmental acceptability of the IWTF
- recommend mitigation measures for any areas of potential impact during the construction, operation, closure and aftercare phases
- advise on the appropriateness of the conceptual

design, and any mitigation measures which should be included in order to minimize environmental and socio-economic impacts.
- design and facilitate the public consultation process which is an integral part of the EIA process
- undertake surveys, conduct studies, evaluate potential environmental impacts, and manage consultation with the community.
- evaluate the significance of all potential areas of impact during construction, operation, closure and aftercare.
- assess the environmental and social/socio-economic impact relating to
  - Physical and geographical suitability of the proposed facility and haulage routes to the site from major centres of waste generation;
  - Waste treatment and disposal technologies to be employed;
  - Proposed layout of the facilities within the site;
  - Pollution abatement options to be employed;
  - Management control and operational practices to be employed;
  - Public acceptability of the proposed facility;
  - Potential for accidents and failures to be foreseen and mitigated; and
  - Monitoring and long-term restoration of the land filling area.

The benefits of EIA include

- identification of environmental issues that a project design should address
- prevention of delays and additional costs caused by unanticipated environmental problems during project implementation
- integration of essential considerations in project selection, siting and design decisions
- provision of assurance to investors and decision makers that the project is environmentally sustainable
- guarantee that all environmental liabilities have been considered and measures put in place to address them
- provision of formal mechanisms for inter-agency co-ordination for addressing the concerns of potentially affected groups
- building environmental capability within the country

The benefits that may result from the IWTF, which justifies the project, are as follows:

- Employment generation-labor to operate the facility can easily be sourced from the nearby community and Makurdi which is already a cosmopolitan township.
- Prevention of indiscriminate dumping of refuse and elimination of illegal dumpsites obstructing water courses and causing flooding of the town.
- Contribution to local economies-empowerment of Private Service Providers (PSPs) and local communities leading to improved standard of living as dividends of improved democratic governance
- Increased economy/enterprise activities-payment for refuse disposal and treatment by generators and sale of recyclable components extracted from the refuse and compost for use in agriculture
- Improved public image of the State through improved environmental quality and health of the people
- Health and reduced environmental emissions

The purpose of this study is therefore to assess the environmental impact for the pilot project for the integrated solid waste management in Makurdi using standard methods for EIA in Nigeria (EIA Act, 1992). The EIA Act No. 86 of 1992 requires that where the extent, nature or location of a proposed project or activity is such that it is likely to significantly affect the environment, its EIA is undertaken in accordance with the provision of the Act. The procedure prescribed by the Federal Ministry of Environment (FMENV) for undertaking EIA to satisfy the requirements of the Act is presented schematically in Fig. 2. It involves (Ameyan, 2008):

- submission of the project proposal by the proponent to Federal Ministry of Environment
- initial evaluation of the proposal is done by the ministry to categorise the project
- screening and scoping of the proposal
- preparation of draft report by the proponent through literature review and field data gathering exercise
- passing of the report through either public hearing, review panel or mediation
- sending the review report to the proponent for preparation of the final report before approval by a technical committee

MATERIALS AND METHODS

This study was conducted between June-December 2004. The existing environmental status of the study area is summarized in this study. This is to enable realistic predictions of the likely environmental effects of the proposed development on the area in particular and the global environment in general. In establishing the environmental baseline conditions of the project area, a systematic approach was adopted in obtaining relevant general environmental characteristics through literature survey and site specific characteristics through field data gathering exercise.

EIA Assessment Methodology and Impact Identification: The methodology for environmental impact assessment available in the World Bank's Strategic Planning Guide for Municipal Solid Waste Management (Wilson *et al*., 2001) was used as a guide on issues of methodology and presentation, in addition to methodologies presented by E&L International Development Resources Ltd (2005). The determination/assessment/evaluation of the associated and potential impacts of the IWTF project was carried out

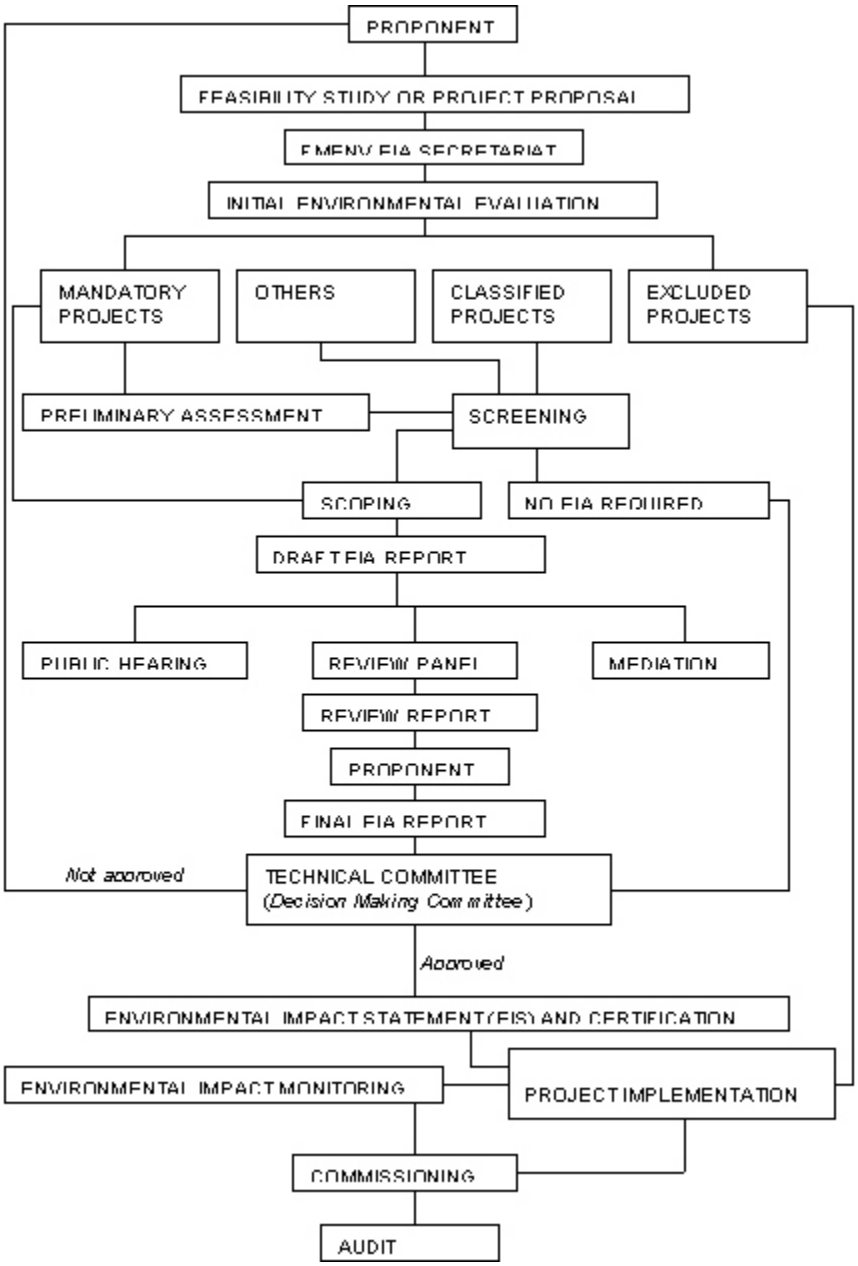


Fig 2: EIA Procedural Flowchart in Nigeria (Source: Ameyan, 2008)

through review of industry experience, consultations and series of brainstorming sessions by experienced multidisciplinary team of engineers and scientists. Based on source reference materials as project environment description (baseline data), project activities (land acquisition, mobilization, construction, operation and abandonment), FMENV EIA procedural guidelines for infrastructural development, ISO 14000 (EMS) guidelines and World Bank source book, the associated and potential impacts of the IWTF project were identified. In understanding the potential environmental impacts of the proposed development project, there was need to consider those aspects of the project activities that has influence on the environment:

- Construction activities (excluding welding works) and infrastructural development
- Vegetation removal
- Groundwater extraction/exploitation
- Emissions from exhausts and vents
- Excavation
- Incineration
- Composting
- Land fill cells
- Spills (oil, diesel, etc)
- Mobilisation of equipment and personnel

When these activities interact with the project environment, significant potential impacts may result

which may be direct, indirect, adverse, beneficial, cumulative, residual, long term or short term.

Impact categorisation and Delineation:
Direct - these are impacts resulting directly from a project activity
Indirect-these are impacts that do not follow directly from a project activity but at least one step removed from it
Adverse-these are impacts that would produce negative effects on the biophysical or socio-economic environment
Beneficial-these are impacts that would produce positive effects on the biophysical or socio-economic environment
Cumulative-these are impacts resulting from interaction between project activities with other activities taking place simultaneously
Residual-these are impacts that would still remain after mitigation measures have been applied
Long term- these are predicted adverse impacts which remain after mitigation measures have been applied (period of about 5 years)
Short term-these are impacts that are removed after mitigation measures have been applied (period of about 1 year)

Impact Criteria/Evaluation: The framework criteria used was based on the following impact criteria conducted using the ISO 14001 (EMS) as presented by Odan (2004):

- legal/regulatory requirements
- risk
- requency
- importance
- public concern

Evaluation criteria focused on whether the impacts were significant in terms of people and their health and safety, environmental pollution and deterioration, asset/property damage, statutory/regulatory compliance and finally image and reputation. Barriers to prevent adverse effects, control of escalation factors and recovery preparedness measures were conducted through impact control (prevention, reduction and control strategies) and impact management plan (management responsibilities, monitoring plan, auditing and review).

Legal/Regulatory Requirements (L): Is there a legal/regulatory requirement or a permit required based on national and international laws/guidelines/standards relating to the project activity?

0=There is no legal/regulatory requirement
3=There is a legal/regulatory requirement
5=There is a permit required

Risk (R): What is the risk or hazard rating based on the Risk Assessment Matrix (RAM) presented in Fig. 3?

1=Low risk
3=Medium/intermediate risk
5=High risk

Environmental Impact Frequency (F): The frequency of impact occurrence was determined using historical records of accidents/incidents and consultation with experts.

1=Low frequency (will happen < 1 year)
3=Medium frequency (will happen > 5 years)
5=High frequency (will happen almost throughout the project lifespan > 25 years)

Importance (I): This has to do with the importance of the affected environmental component and impact. What is the rating of importance based on consensus of opinions among the project stakeholders?

1=Low (imperceptible outcome; insignificant alteration in value, function or service of impacted resource; within compliance, no controls required)

3=Medium (Negative outcome; measurable reduction or disruption in value, function or service of impacted resource; potential for non-compliance)

5=High (Highly undesirable outcome such as impairment of endangered, protected habitat, species; detrimental, extended animal behavioural change such as breeding, spawning, moulting; major reduction or disruption in value, function or service of impacted resource; impact during environmentally sensitive period; continuous non-compliance with statute).

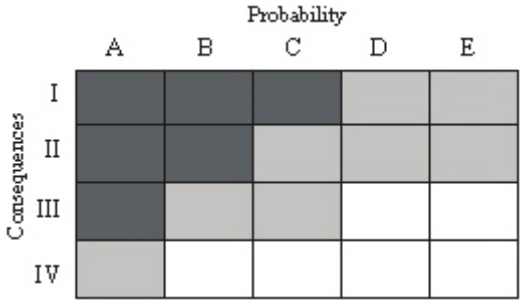
Public Perception (P): This aspect addresses the rating of public perception and interest in the proposed project and impacts based on consensus opinion of stakeholders:

1=Low (No risk to human health, acute and/or chronic; no possibility of life endangerment for residents, abutting communities; minor reduction in social, cultural and economic value; unlikely adverse perception among population)

3=Medium (Limited incremental risk to human health, acute and/or chronic; unlikely life endangerment for residents, abutting communities; some reduction in social, cultural and economic value; possibility of adverse perception among population; potential for non-compliance)

5=High (Elevated incremental risk to human health, acute and/or chronic; possibility of life endangerment for residents, abutting communities; major reduction in social, cultural, economic value; continuous non-compliance with statute; any major public concern among population in study area).

The ranking criteria for determination of the significant (S) and insignificant (I) potential impacts of the IWTF development project was as follows:
(L+R+F+I+P)³15: Sum of weight of legal requirements, risk factor, frequency of occurrence, importance and public perception greater than or equal to the benchmark (15).



.Probability Category	Definition
A	Possibility of Repeated Incidents
B	Possibility of Isolated Incidents
C	Possibility of Occurring Sometime
D	Not Likely to Occur
E	Practically Impossible

Consequence Category	Considerations			
	Safety/Health	Public Disruption	Environmental Aspects	Financial aspects
I	Fatalities/Serious Impact on public	Large Community	Major/Extended Duration /Full Scale Response	High
II	Serious Injury to Personnel/Limited Impact on Public	Small Community	Serious/Significant Resource Commitment	Medium
III	Medical Treatment for Personnel/No Impact on Public	Minor	Moderate/Limited Response of Short Duration	Low
IV	Minor Impact on Personnel	Minimal to None	Minor/Little or No Response Needed	None

Fig 3: Risk Assessment Matrix (Source: Odan, 2004)

(F+I) >6: Sum of weights of frequency of occurrence and importance of affected environmental component exceeds the benchmark (6).
P=5: The weight of the public perception/interest in the potential impact equals the benchmark (5).

Mitigation Measures: Mitigation measures were proffered where appropriate to minimize the residual effects to levels that are considered as low as reasonably practicable. In judging reasonable practicability, reference was made to best industry practice, and to economic, environmental, technical, health and safety considerations. The associated and potential impacts as well as measures for mitigation that have been incorporated into the design and those going to be adopted by the managers of the facility for the residual impacts were identified based on impact significance evaluation for each environmental impact covering

- Land acquisition
- Mobilisation of men and materials to site
- Site preparation (land clearing and stripping)
- Infrastructural development and installations (electrical, carpentry, and cement works)
- IWTF operations (land filling, recycling, composting and sewage sludge, incineration at 500-600ºC, on- and off-site traffic impacts, socio-economic and cultural aspects and global impact)
- Support services (sewage treatment, power supply, clinic/sick bay/first aid, water supply, maintenance, security at site) and
- Abandonment and Decommissioning

In order to offset, control or minimize these potential impacts, cost effective mitigation measures were proposed for the identified significant impacts. The residual potential impacts shall be ameliorated through monitoring and review programmes.

Analysis and Evaluation of Environmental Sensitivity Index (ESI): An Environmental Sensitivity Index (ESI) mapping was conducted based on environmental and economic values of each identified ecological habitat in the area. The sensitivity rating on environmental values was adopted from Hann's index of relative biological value of different ecosystems (Table 1). The indices taken into consideration for sensitivity ranking of the environmental values include biological productivity, ecological significance and unique habitat. Socio-economic values (Table 1) were rated by taking into consideration income derived from the environment, natural resource damage and relocation and resettlement possibilities and damage to cultural heritage.

RESULTS AND DISCUSSIONS

In order to enable realistic predictions of the likely environmental effects of the proposed development on the area in particular and the global environment in general the existing baseline environmental characteristics of the study area is summarized as follows:

Project Site Selection and Description: The TWG carried out a field evaluation of a long list of 9 potential sites and an evaluation matrix was used to rank the sites

Table 1: Matrix for sensitivity ranking of environmental and economic values (Source: Odan, 2004)

Environmental and Economic Values	Increasing sensitivity				
	Non sensitive (ESI 1-2)	Less sensitive (ESI 3-4)	Medium sensitive (ESI 5-6)	Moderately sensitive (ESI 7-8)	Most sensitive (ESI 9-10)
Environmental Values					
Biological Productivity	No species available	Few species with low productivity	Small population of significant organism	Large population of significant organisms with moderate seasonal productivity	High productivity with high densities and diversity of organisms
Ecological Significance	No food chain, importance used only for resting	No food chain only importance, used for resting	Little food chain importance , used intermittently	Moderate food chain importance; used for breeding purposes	Great food chain importance, good breeding and resting places
Unique Habitat Uses	No unique uses or endangered species	Unknown unique uses but no endangered species	Unknown unique uses and rare endangered species sighting	Some unique uses and frequent endangered species	Endangered or threatened and rare species
Economic Values					
Income use reduction	No income or use reduction potential	Potential income use loss; slight reduction in potential use	Slight income or use loss or reduction	Moderate income or use reduction or loss	Total income or use loss
Natural resources damage	No resources damage and degradation	Potential resource damage and degradation	Slight resource damage or degradation	Moderate resource damage or degradation	Sever damage or degradation
Relocation and resettlement of people	No resettlement necessary	Potential relocation and resettlement of people	Minimal relocation and resettlement of people	Moderate relocation and resettlement of people	Significant relocation and resettlement of people
Damage to cultural heritage	No damage to cultural resources	Potential damage to cultural resources	Slight damage to cultural resources	Moderate damage or degradation	Severe damage or degradation

in relation to a range of key suitability criteria (Whiteman *et al*., 2004). The outcome of this exercise was that the present site selected for the EIA scored significantly higher than all other potential sites. Based on other incremental studies carried out by the SLGP (Barrat *et al*., 2002; Bdliya, and Lyam, 2002; Sha'Ato and Ikor, 2003; Whiteman *et al*., 2003; Sha'Ato *et al*., 2003; Lyam, 2003; Barrat and Sha'Ato, 2004; Crawhurst, 2004), a preliminary conceptual design for the site was prepared by the SLGP (Fig. 1). The IWTF will consist of a combination of recycling, incineration (clinical waste) without energy recovery and sanitary landfill. Other facilities include a dumping bay, administrative block, tyre cleaner, gate house, borehole/overhead tank, generator/power house, bunker and sick bay. Based on this brief and other studies by the SLGP, a phased approach to facility development, maintenance programme and closure/restoration plan was recommended.

Terrain/Topography: The total land area is 4.42 ha with the lowest contour occurring at 96m while the highest contour occurred at 109m. The land generally slopes eastward towards river Jamo and southwards along the river.

Climate and Meteorology: The climate of the area is characterised by wet and dry seasons. Makurdi has a mean annual precipitation of 1093mm with the highest rainfall occurring in August. The lowest temperatures of about (26ºC) are usually recorded in January while the highest (32ºC) monthly temperatures are recorded in March/April. Like other tropical wet and dry regions, Makurdi experiences three temperature periods namely: the cool dry season between November – January; the hot dry season between February-early April and the hot wet season between mid April – October. The humidity in Makurdi is closely related to the prevailing wind system. Wind speeds are generally low throughout the year within the range of 29-68 m/s. The south west humid winds come during the wet season. This is the time when solid waste dumps can become smelly because of the wetness. Wet winds are also more likely to accommodate more odour and carry it through longer distances. Currently the nearest settlements that could have been easily affected are situated before the treatment site but the proposed GOSA College which is within the vicinity of the site if not relocated will be affected by odours. On the other hand the dry harmattan winds which reach the treatment site before the settlements do not enhance smelly conditions. They could however blow much of the light waste into the settlements of the site if not properly fenced.

Landownership, Land Use and Zoning: The land on which this site is situated belongs to the Mbagune community. There are no sites of cultural or archaeological and historical importance within the proposed enclosure of the IWTF. Shrines and graves of relations which could be of historical significance are all located outside this enclosure. Small farms surround the site while short savanna bush and shrubs occupy the

greater part of the site with a lone mature *Daniella oliveri* tree standing by the road. Since the Nigerian Forestry Act of Nigeria states that it is an offence, punishable with up to six months imprisonment, to cut down trees over 2ft in girth (Forestry Act, 1958), there is need to preserve the tree for visual and ecological purposes. Palm trees found on the site provides high grade palm wine for the drinking pleasure of the community.

Soil Quality: The soils of the area generally have coarse textured surface and fine textured subsurfaces. The occurrence of indurated and coherent sandstone within 120cm of the soil surface is a very striking feature of these soils. Water that percolates through the permeable surface horizons accumulate at the indurated layers. The sloppy nature of the land allows for lateral flow within the profile on the indurated surfaces. Effluents from the landfills and dumping bays are likely to flow over the indurated layers into River Jamo and finally River Benue. The results of soil analysis for plant nutrients elements and heavy metals indicates that the soils at the site are weakly acidic with the pH values normal for plant growth. While organic matter and total nitrogen were found to be below the average for tropical soils, Ca, available P, CEC and other exchangeable cations (Na, K and Mg) were below the critical levels for normal plant growth. The concentrations of the heavy metals indicate that they are available in far minute quantities to pose any hazard to plants and the environment in general.

Geological Formations Underneath the Project Site: The geological map of the proposed IWTF site shows that the site is underlain by Makurdi sandstone and superficial deposits with the lateritic clay over burden on the Makurdi sandstone exhibiting very low coefficient of permeability.

Hydrology and Water Quality: The discharge measurement of River Jamo was determined as 0.464 m^3/sec and is not enough to cause flooding of the IWTF. The chemical parameters of the water samples fall within the World Health Organization (WHO) recommended values for domestic, industrial and agricultural uses.

Groundwater Geophysical Survey and Hydrogeology: Drillers log shows superficial deposits, weathered Makurdi sandstone, fresh fractured Makurdi sandstone as aquifers. Pre-drilling geophysical investigation of the study area had indicated that there is no prolific aquifer in the whole area even though the gage height hydrographs for River Benue at Makurdi indicates abundance of groundwater over surface water.

Ambient Air Quality: Values obtained for major pollutants, suspended particulate matter (SPM), respirable suspended particulate matter (PM_{10}), ammonia (NH_3), hydrogen sulphide (H_2S), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2), are within the allowable limits.

Ecology of the Project Site and Surroundings: A total of 78 plant species were identified and recorded. Herbs were more abundant than trees and shrubs characteristic of the physiognomic feature of the Guinea Savanna Zone where Makurdi is located. A total of 40 plant species with trado-medicinal importance were identified and recorded. These plants are also in abundance outside the IWTF site. The microbial status of river Jamo waters is indicative of pollution as it originates from various erosion outlets. Total coliforms ranged from 350–900; while faecal coliforms ranged between 45 and 275. WHO limits for total and faecal coliforms is 0.00 cfu/100 ml.

Noise: The environmental noise level as a function of time indicates a good baseline noise level within the recommended ambient noise level of 40-55 dB(A) for office buildings.

Public Consultation: This was executed in line with the objectives for the EIA study and all the major outcomes enumerated in addition to the livelihood strategies, socio-economic resources and public concerns and expectations of the community. Compensation for land is expected to be paid by Government as required by law before commencement of infrastructural development on site.

Assessment of the Potential Environmental Impacts: In understanding the potential environmental impacts of the development project, the following aspects of the project activities that has influence on the environment were considered:

- Construction activities (excluding welding works) and infrastructural development
- Vegetation removal
- Groundwater extraction/exploitation
- Emissions from exhausts and vents
- Excavation
- Incineration
- Composting
- Land fill cells
- Spills (oil, diesel, etc)
- Mobilisation of equipment and personnel

When these activities interact with the project environment (baseline environmental characteristics), significant potential impacts which may be direct, indirect, adverse, beneficial, cumulative, residual, long term or short term may result as follows:

Visual impacts on the landscape

- Destruction of natural habitats and disturbance of local ecosystem
- Alteration of landscape, physical surroundings and natural cycles and ecology
- Open dumping and littering of bay due to improper site management

Air quality impacts

- Increase in dry season particulates especially during harmattan
- Production of undesirable and nauseous odours especially in wet season
- Generation of hazardous and toxic gases during operational and abandonment/decommissioning phases
- Possible loss of assets and investments and injury/death to personnel in the event of fire/explosion due to exothermic reactions

Land

- Land degradation and contamination of soils
- High cost of excavation due to outcropping of Makurdi sandstone in some land fill designated areas

Ecological impacts (flora and fauna)

- Leachate discharge damaging flora and fauna, and food chain during operational and abandonment/decommissioning phases
- Sewage and wastewater discharge

Socio-economic and cultural impacts

- Need for proper acquisition of land from customary land owners
- Unrest due to non payment of compensation
- Potential for communal clashes during payment of compensation
- Problem of establishment of GOSA college in close proximity to the project area

Hydrology, hydrogeology and water quality impacts

- Contamination of surface and underground water from landfilling and composting activities
- Lateral flow of leachate into the Jamo stream channel which drains into River Benue damaging flora and fauna, and food chain

Health and safety impacts

- Introduction of and exposure to alien diseases
- On- and off-site traffic impacts related to workplace accidents during loading and offloading

Analysis and Evaluation of Risks/Mitigation: The ecosystem habitat types encountered in the study area exhibit unique environmental characteristics, thus different levels of sensitivity. Long term adverse impacts are foreseeable only on land. These are the predicted adverse impacts which remain after mitigation measures have been applied (period of about 5 years). Most other impacts are short term and are removed after mitigation measures have been applied (period of about 1 year). The site specific residual potential environmental impacts are land, water and air quality. An environmental sensitivity analysis of the ecological and socioeconomic components of the project site is as follows:

Farm land (ESI 5): This represents lands that are put under cultivation. Cultivated crops are to be found within and immediate vicinity of the project site. The crops observed within the project site include maize which is ready for harvesting; guinea corn and yam. Some form of land preparation after corn harvest was in progress as at 31st August 2004. The soil is of low fertility and productivity being an excavation site with short savannah bush and shrubs. The habitat is ranked medium (ESI 5) as it contains small population of significant crops. There is also no food chain of importance as is mostly used as resting place for animals. The effect of the project would result into a slight loss to farm crops.

Bush fallow (ESI 6): Bush fallow is described as abandoned farm land that is left to regenerate. In this case, the land being an excavation site for road construction has been left fallow to regenerate and was just at the verge of recovery. Bush fallows are more vegetated ecological habitats than farmlands. Since the fallow period has been long, the area has gradually been turning into a secondary forest. Small populations of significant organisms characterize this habitat. The area is of low biological productivity with little food chain importance and of slight socio-economic value. The area is of medium sensitivity (ESI 6) to disruption that would arise from the IWTF project.

Medicinal plants (ESI 5): There were neither endangered species nor sensitive habitats. The community still has abundant trado-medical plant reserves in the surrounding environment from where they can source their requirements for their health care delivery and other needs. The site is therefore of medium sensitivity rating (ESI 5).

Water (ESI 7): Microbial evaluation of the stream indicates water is polluted being a drainage outlet for the study area making borehole sinking imperative. However it serves as water source for the communities for their domestic and agricultural needs. Since stream is seasonal, during dry season shallow wells are found all along the stream channel which serves as water source. Fishing activities are also carried on here. The existing food chain is of great importance with high productivity. The IWTF will further impact adversely on the stream waters. This aspect is therefore moderately sensitive (ESI 7)

Air (ESI 8): Wet season winds accommodate more smell and carry it through longer distances and impact adversely on GOSA; dry harmattan winds will blow light waste into the settlements if not properly fenced. The environmental

sensitivity with respect to impact on air quality is rated moderately sensitive (ESI 8).

Economic Values (ESI 6): The community comprises of pockets of slightly clustered houses made of bricks/mud walls and zinc roofs. Source of drinking water is the stream. The prevalent diseases/ailments in the area include malaria, typhoid fever, etc. The project is acceptable to the community. The economic resources (fishing, farming, and lumbering) that could be damaged as a result of perturbation are quite minimal compared to the benefits that would be derived from the project execution. The sensitivity is therefore rated medium (ESI 6).

Based on the analysis of the risks, it is recommended that the site be used for the IWTF subject to all potential and acceptable impact mitigation measures. In order to offset, control or minimize these potential impacts, cost effective mitigation measures have been recommended for some of the identified impacts as follows:

- Payment of adequate financial compensation to the community for land acquisition
- Sourcing of alternative site by proponents of GOSA college
- Highly erodible soils around the Jamo stream bridge which should be stone pitched to avoid future flooding of project site
- Adoption of strict management/HSE plan and techniques for infrastructural development, operations, maintenance and decommissioning
- Provide penalties for non compliance with operational standards
- Construction of effective sewage system to prevent pollution
- Proper fencing of the facility
- Provide for pre-sorting of waste at generation sources and sorting equipment on treatment site
- Use of best available technology for composting and incineration
- Use of engineered sanitary landfills and engineered leachate drainage trench with holding lagoon for leachate control
- Provision of landfill gas vents
- Provision of boreholes for the community as an alternative source of water
- Adoption of a strict waste management plan and an effective environmental management and monitoring system
- Preservation of the large lone *Daniella oliveri* tree in the North East corner of the site for visual, ecological and legal purposes.
- Adequate consultation with all stakeholders including the local community throughout the project life cycle
- Enhancement of environmental awareness campaigns and capacity building in IWTF management and operations protocol
- Use of professionally recognised experts, competent personnel and Private Service Providers (PSPs)

The residual potential impacts shall be ameliorated through monitoring and review programmes.

Formulation of Environmental and Social Management Plan (ESMP): The ESMP ensures that all significant associated and potential impacts of the IWTF project are either prevented or reduced to acceptable limits. The plan presented in this study provides guidelines, criteria, specifications and procedures for implementing the mitigation measures. The objectives of the ESMP for the IWTF are as follows:

- To show that the environmental aspects and potential impacts of the proposed IWTF project have been identified and evaluated and that measures have been put in place for mitigation against significant adverse impacts;
- To present a system of management that will be used for ensuring appropriate control recovery preparedness and compliance with relevant environmental regulations, standards, guidelines and codes of practice during project development;
- To present an effective monitoring plan that shall be used for ensuring the effectiveness of mitigation measures and for identifying unforeseen impacts arising during implementation of the project.

In order to ensure environmental sustainability of the IWTF through its life cycle, an environmental management plan has been prepared and the specific elements of the plan are as follows:

- Management and expertise resourcing
- Design guidelines
- Mitigation measures guidelines and delineation of responsibilities for the significant impacts
- Health, safety and environment training
- Waste management guidelines
- Emergency response guidelines
- Environmental monitoring guidelines
- Audits
- Decommissioning and abandonment guidelines; and
- Consultation guidelines

Management and Expertise Resourcing: It is proposed that the first six months of operation be treated as a research and development consultancy assignment, potentially hiring a local University to carry out operations, determine the potential for utilisation of wastes, and prepare an operational management protocol which can be used to establish contract/site licence conditions (Whiteman *et al*., 2004). The six months period of research and development consultancy ties in with the horizon envisaged for the grace period for licence fees from PSPs. Ministry of Water Resources and Environment (MWRE) registered engineers and architects shall design the master plan. Where professional registration/recognition is lacking in MWRE, qualified

persons shall be hired to supervise and stamp the designs. A reputable company shall be engaged to construct and install the facilities. Issues of land acquisition and compensation shall be the responsibility of the Government of Benue State through MWRE.

Design Guidelines: The design and installation of the IWTF shall be in line with national and international codes, standards and guidelines. A check list of the comments and potential/significant impacts generated as a result of the EIA must be developed by design engineers and architects. While conforming to the design concepts and technical specifications, all the EIA key issues must be addressed. After installation, the equipment shall be test run before full commissioning of equipment for operation.

Significant Impacts Mitigation Measures Guidelines and Delineation of Responsibilities: In order to avoid, minimise or reduce such effects to allowable limits, mitigation measures have been proffered for all the significant impacts with clear delineation of responsibilities between the proponent/operator, community groups, and government agencies as shown in Table 2.

Training in Health, Safety and Environment (HSE): Training of IWTF workers with respect to health, safety and environment is imperative. This capacity building training programme will impart knowledge and proficiency in performing critical functions in relation to the project activities. The identified training needs include:

- Waste recycling and recovery
- Composting
- Land filling and leachate control processes
- Incineration
- Associated fire, chemical and toxic hazards
- First aid administration procedures
- Workplace safety standards

Waste Management Guidelines: Effective waste management shall be accomplished through the hierarchical application of the practices of source reduction, waste reuse, recycling, recovery and treatment. The waste management guidelines shall take into consideration the nature of the waste being handled. It shall be structured to achieve

- Waste prevention/reduction at sources of generation
- Establishment of waste segregation systems at source into bins prior to transportation for disposal at the IWTF
- Enactment of environmental policies encouraging waste management plans through incentives and penalties
- Sourcing of approved waste vendors (PSPs) for collection and conveyance of waste to treatment site
- Provision for disposal of liquid waste such as waste water, sanitary waste and spills. These wastes must be treated to regulatory limits before discharge into the environment. Where discharges are unavoidable, they shall be closely monitored.
- Utilization of best available technology, best improved equipment and facility design so as to minimize the emission of gaseous wastes/atmospheric pollutants.

Emergency Response Guidelines: Emergency issues are unforeseen situations which could be fire and explosion, leakages/spillages, flooding, injury/death, etc. This could result from an accident or offset in the normal operating condition of the facility.

Fire and Explosion: Fire is a complex exothermic reaction between fuel, oxygen and ignition sources. These fuels may be in solid, liquid, vapour or gaseous state. Solid and liquid state fuels normally vaporize before burning. If the combustion process results in a rapid pressure rise, an explosion may occur. Identified sources of ignition within the IWTF include

- Hot surfaces
- Frictional heat
- Spontaneous heating
- Electric sparks
- Overheated materials
- Smoking, matches and lighters
- Open flames
- Combustion particles

The above listed sources of ignition are capable of releasing sufficient energy for enough duration to cause the initial chemical reaction for combustion to occur. Project managers must ensure appropriate flammable limits. All possible fire causes must be considered during design and operation. In the minimum

- Sufficient physical separation must be allowed in layout of facilities to limit the project activity and materials that could become involved in fire
- Avoidance of combustible materials of construction
- Proper selection of materials of construction to limit the ability of fire to spread
- Use of fire resistant materials and barriers in the direction of the normal prevailing winds
- Provision of emergency escape routes and accessibility for the fire brigade

The overall goal of the fire system shall seek to achieve the following:

- Monitor all areas of installation where either a fire hazard may exist or an accumulation of flammable gas may occur on a continuous bases

Table 2: Mitigation Measures Management Guidelines

Environmental Aspect	Associated and Potential Impact	Mitigation Measures	Responsibility
Land acquisition	Need for proper acquisition of land from customary land owners	• Identification of rightful land owners and beneficiaries and adequate consultation with them • Evaluation of land value by Ministry of Lands and Survey	MWRE
Land Filling	Land degradation due to land filling	• Adopt strict management plan for decommissioning and restoration of site	IWTF Managers/MWRE
	Outcropping of Makurdi sandstone in most land fill designated areas leading to high cost of excavation	• Adopt appropriate excavation techniques • Use hydraulic exavators	IWTF Managers
	Enrichment of leachate by inorganic materials such as nitrates causing severe pollution of drinking water sources and eutrofication of surface water in surrounding areas	• provide boreholes for community • Use engineered sanitary land fills	MWRE/IWTF Managers
	Generation of hazardous and toxic gases such as methane and hydrogen sulphide through biodegradation of organic matter	• Provide landfill gas vents if cells are ≥5m • Adequate sorting of waste at dumping bay • Consider installation of waste sorting equipment	IWTF Managers
	Production of undesirable and nauseous odours especially in the wet season and increase in dry season particulates especially during harmattan	• Cover trash with a layer of top soil weekly to help keep the smell down and further keep litter from flying around • Fencing of the dumping bay and the facility • Prevention of establishment of a college within vicinity of the site	IWTF Managers/MWRE
	Contamination of soil and water through leaching of toxic substances as heavy metals and metalloids and nitrogen compounds, chlorinated compounds and other organics such as hydrocarbons	• Use engineered leachate drainage trench with holding lagoon at a low elevation in view of the excellent low permeability of the underlying bedrock • Strata provides an excellent degree of vertical containment	IWTF Managers
	Introduction of alien diseases	• Cover trash with a layer of top soil daily to contain the spread of disease through flies and rodents • Provision of sick bay for workers and community • Continuous monitoring of community health	IWTF Managers/MWRE
	Lateral flow of leachate into the stream channel which drains into River Benue damaging flora and fauna, and food chain	• Provision of borehole for community due to pollution of water source • Use engineered leachate drainage trenches, allow for evaporation; pump residual leachate onto the composting area to accelerate decomposition	MWRE/IWTF Managers
Recycling	Open dumping and littering of bay due to inability to sort waste (typical of our environment)	• Persuade consumers to pre-sort their refuse at generation sources • Consider use of sorting equipment at site • Use trained personnel • Penalties for non compliance with operational standards	PSP Waste Collectors/IWTF Managers/MWRE
Composting and sewage sludge	Trickling of rain water from the compost pile leading to soil penetration and pollution of surface and ground water	• Carry out compost process on inclined concrete surfaces that allows liquid to runoff • Use harvested runoff liquids as moisture for the compost • Use of best available technology	IWTF Managers
	Sewage sludge contains live and harmful disease causing microbes	• Awareness campaign against indiscriminate dumping by the roadsides, water courses and open spaces • Use sludge to further enrich the organic fertilizer or manure	MWRE/IWTF Managers

Table 2 Continued

Incineration (500-600ºC)	Emission of waste gases such as CO_2 and heavy metals such as mercury cadmium and lead into the environment	• Carry out smoke purification • Use of best available technology • Use of experts, competent personnel and PSPs as managers	IWTF Managers/MWRE
	Release of highly toxic products of incomplete combustion such as dioxins and furans	• Carry out smoke purification • Use of best available technology • Use of experts, competent personnel and PSPs as managers	IWTF Managers/MWRE
	Formation of highly toxic products of polyuromatic hydrocarbons such as benzo(a)pyrene	• Carry out smoke purification • Use of best available technology • Use of experts, competent personnel and PSPs as managers	IWTF Managers/MWRE
	Hazardous substances associated with filter residues such as slag and ashes	• Safe disposal of filter residues • Use of best available technology • Use of experts, competent personnel and PSPs as managers	IWTF Managers/MWRE
On- and off-site traffic impacts	Workplace accidents and incidents during loading and offloading of materials and equipment	• Use of competent operators • Carry out safety briefings before commencement of work • Awareness training in the use of Personal Protective Equipment (PPE)	MWRE/IWTF Managers
Socio-economic and cultural aspects	Unrest due to non payment of compensation	• Adequate consultation with all stakeholders especially the local community	MWRE
	Potential for communal clashes during payment of compensation	• Early identification of rightful land owners and beneficiaries	MWRE
	Proposed establishment of college in close proximity to the project area	• Sourcing of alternative sites by proponents	Proponents of GOSA College
Power supply	Loss of assets, investments and injury/death to personnel in the event of fire/explosion	• Provision of fire fighting equipment • Train personnel in use of fire fighting equipment • Periodically check generators for leaks • Fuel storage tanks/containers to be away from generator	IWTF Managers
Abandonment and Decommissioning	Generation of landfill gases and leachate (for a period exceeding 50 years)	• Provision of landfill gas vents • After care and proper leachate management procedures	MWRE

- Alert IWTF management of the presence, location and nature of the fire or gas emergency
- Automatic activation of fixed fire protection systems and reduction of risk to personnel by implementing executive automated systems
- Detection of fire by the quickest most reliable means through use of fire detectors (smoke, heat, flame, fire, gas, etc), alarms and control systems to minimize injury and property damage
- Location of the fire detectors shall be in line with standards on automatic fire detectors taking into consideration the (i) distance limitation between devices; (ii) physical layout of the area; (iii) point of fire origin; and (iv) expected air movement pattern.
- Provision of fire extinguishers within the facility for easy access in the event of an emergency. The extinguisher types shall include (i) CO_2 for electrical and flammable liquid fires; (ii) foam for flammable liquids and (iii) dry chemical for electrical hazard fires.
- Risk analysis studies of the facility layout shall be conducted to determine the location of the muster points. The definition of the extent of protection required for personnel mustering will be based on the hazard scenarios to which personnel could be exposed.

Leakages/Spillages: Leakages and spillages are inevitable and should be handled in a way not to affect the health and safety of the workers as well as degradation of the environment. There is need for development of comprehensive leakage/spillage emergency plan during the six months of research and development management of the facility. This contingency plan shall

- outline coordinated and integrated response actions to be implemented in the event of leakages and spills
- highlight the roles and responsibilities of key personnel in operations and list equipment and materials required to combat spills for attention of MWRE.

The IWTF PSP managers shall be responsible for ensuring compliance with the plan while the EMSC will coordinate these actions during the full operational phase of the facility.

Flooding of the Project Site: Although the EIA studies indicate that flooding of the facility is a remote possibility, yet it can be an unforeseen phenomenon. Use of dikes along the stream channel and adequate drainage is recommended as a prevention measure.

Health Aspects: The health of the people is very important in ensuring the smooth run as well as the

productivity of an organisation. In the IWTF layout, a sick bay is conceived to address any emergencies as relates to health in addition to training of personnel in first aid.

Maintenance Culture: A culture of maintenance is essential for a facility to maintain its operations at a cost effective, safe and environmentally sound manner. A sound maintenance system will result in improved productivity, better safety, health, and environmental protection, and desirable public, customer, and employee relations. The aspects of a well conceived and organized maintenance culture include

- long term care of equipment, buildings and grounds
- routine attention to service and appearance; and
- improvements in service and appearance

Preventive maintenance and inspections shall be emphasized in the maintenance programme to discover potential problems. There shall be proper monitoring of operating equipment and structures to alert trained personnel in a timely manner before actual breakdown. The goals of maintenance shall make effective use of appropriate personnel and systematic planning and tracking techniques. Maintenance of equipment shall be governed by inherent reliability, failure experience, and the ability to perform effective failure analysis and trouble shooting. Maintenance safety procedures shall be strictly followed to protect other employees, the facility property, and the surrounding communities from accidents and disasters.

Environmental Monitoring Guidelines: Monitoring provides feedback to the management on what is working and what is not working. It is a tool to

- ensure adherence to agreed actions
- assess compliance to environmental and social standards
- provide enhanced data for risk management purposes and
- facilitate any needed project design or operational changes

Piping systems shall be periodically checked for leaks and records kept. The overall social and environmental monitoring plan for the IWTF project is presented in Table 3.

Environmental Audits: In order to ascertain extent of compliance with set guidelines, policies and requirements, HSE audits of the facility is imperative. The audit, which shall be carried out by qualified auditors and in accordance with standard guidelines, shall ensure that

- all necessary codes, standards and procedures are complied with;
- line management systems, operations, monitoring practices, etc are adhered to;
- current and potential environmental problems especially during the operational phase of the project are identified;
- predictions in EIA are checked against implementation and application of recommended practices and procedures; and
- recommendations for the improvement of the management system of the operation are made

Decommissioning, Abandonment and Restoration Guidelines: A detailed decommissioning and abandonment guideline shall be developed with the relevant regulatory bodies at the expiration of the project's lifespan. The plan shall consider all technically feasible options for restoration, decommissioning and abandonment, including alternative uses for the asset in accordance with national and international regulations. Pertinent considerations include:

- use of overburden and topsoil for reclamation;
- restoration of land to conditions capable of prior land use, equivalent uses or environmentally acceptable uses;
- re-contouring of slopes of more than 30° to minimise erosion and run-offs;
- planting of vegetation to prevent erosion and encourage self sustaining development of a productive ecosystem on the reclaimed land.

Consultation Guidelines: Public involvement in planning and implementing projects can be brought about through consultation and participation. It involves soliciting people's views on the proposed actions and engaging them in dialogue. It is characterised by a two way information flow, from project proponent to the people and from the people to project proponents. Public consultation continues to be a very important factor throughout the project life cycle from site identification, EIA, construction, operations and decommissioning. Public consultation

- plays a critical role in raising awareness of a project's impacts and gaining agreement on management and technical approaches in order to maximise benefits and reduce negative consequences;
- leads to reduced financial risks (from delays, legal disputes and negative publicity), direct cost savings, increased market share (through good public image) and enhance benefits to local communities;
- helps improve understanding of the potential impacts of the proposed project;
- is critical in identifying alternative sites or designs, and mitigation measures, to improve environmental and social soundness
- helps in clarifying values of trade-offs associated with these different alternatives;
- guarantees the establishment of transparent procedures for carrying out proposed projects; and
- creates accountability and a sense of local ownership during project implementation

Table 3: Recommended Project Life Cycle Environmental and Social Management Plan (ESMP)

Impact Indicator	Monitoring Method/Location	Frequency	Responsibility
• Air pollutants (SPM, NO_2, CO_2, SO_2, etc)	Source points and nearest settlements along prevailing wind direction	Quarterly	IWTF EIA Consultants
• Noise	Source points. Entire project location	Quarterly	IWTF EIA Consultants
• Soil characteristics (microbiology, soil physico-chemistry)	Randomized	Yearly	IWTF EIA Consultants
• Surface water quality (BOD, nutrients, turbidity, coliform)	River Jamo (within the corridor of the IWTF project area)	Yearly	IWTF EIA Consultants
• Hydrology and hydrogeology (chemical analysis)	Monitoring boreholes at IWTF project site	Yearly	IWTF EIA Consultants
• Wildlife (species diversity and conservation status)	Sampling through interviews and walk through to ascertain the presence of animals by sighting and correlation of cries and footprints	Bi-annually	IWTF EIA Consultants
• Vegetation (species diversity, abundance and conservation status)	Sample collection by use of established quadrats around the project area.	Bi-annually	IWTF EIA Consultants
• Community health (common prevalent diseases in the host communities)	Use of questionnaires within the host communities as well as collection of health statistics from clinics and hospitals within the host communities	Yearly	IWTF EIA Consultants
• Demographic pattern (accommodation, markets, social infrastructure, cultural life/norms, etc)	Consultations, interviews and observations within the host communities	Yearly	IWTF EIA Consultants
• Employment (contractors/suppliers, part/full time employment, skilled/unskilled labour recruitment)	Consultations, interviews and review of employment quota	Yearly	IWTF EIA Consultants
• Compensations/homages (community leaders and other pressure groups)	Consultations	Yearly	IWTF EIA Consultants

Table 4: Project Life Cycle Consultation Plan

Institution	Consultation Goal	Responsibility
BESEPA*	Environmental Procedures and Standards	IWTF Managers
BESEPA and Makurdi LGA	Determine stakeholders concern and capacity building	IWTF Managers
Host Communities	Identification of concerns, areas of conflict and formation of appropriate mitigation	IWTF Managers

*Benue State Environmental Protection Agency

The BNSG through the MWRE shall optimise these advantages through the following consultations techniques:

- holding informal field visits and courtesy calls on the community heads and other stakeholders to discuss the effectiveness of the addressed social issues on the lives of the people
- direct contact with the affected populations for their opinions (through questionnaires, interviews and visual observations) on the project;
- holding focus group discussion to discuss welfare, clarify misconceptions and address issues as regards the project; and
- holding focus group discussion aimed at identifying new ways of rendering socio-economic assistance for the local people.

The consultation programme is presented in Table 4

Project Sustainability:

Economic and Commercial Sustainability: The estimated cost of the pilot project is put at US $70,750.00 ($1=₦147) covering EIA, detailed design, construction, operation and environmental monitoring. Even though the economic and commercial feasibility study has not been done for the project, it is envisaged that in view of emphasis on use of organic fertilizer for agricultural production worldwide, establishment of plastic industry in Makurdi with the capability for re-cycle of plastic and other materials and enforcement of environmental sanitation laws in the State, the project will be economically and commercially sustainable. An earlier study for establishment of Domestic Industrial Refuse Sorting, Composting and Land Filling Plant in Benue State indicated economic viability based on perception of market potentials of organic compost and other recyclable refuse such as plastics, bottles, paper and cartons, various metals, etc (FAIP, 2002). However, the key point is not the emphasis on organic fertilizer and recycling but the development of an essential environmental service industry, which will have significant economic and enterprise development benefits.

Technical and Management Sustainability: To ensure technical sustainability, the project should be designed by

expert registered engineers and architects who will be held responsible by law in case of technical project failure. The construction and installation of structures and facilities should be handled by qualified local contractors/consultants that are known to have successfully executed similar projects in Nigeria. This will assure the development of a formidable facility thereby conferring on it technical sustainability. In earlier reports, arrangements have been made to develop human capital in the area of solid waste management facilities operation through use of research and development approach (Crawhurst, 2004; Westlake, 2004; Whiteman *et al*., 2004). It has been planned that an operational contract will be let through competitive tender to competent persons (PSPs) with potential to develop professional skills in scientific and management methods of waste treatment/disposal to develop the IWTF operations management protocol and establish contract/site license conditions.

Environmental Sustainability: The project will be carried out in line with Benue State environmental and safety principles and guidelines with the aim of pollution prevention and safety to life and property. Importantly, the findings and recommendations of this EIA would be integrated into the various stages of the project. This will ensure environmental sustainability.

CONCLUSION

Based on the multidisciplinary assessment of the baseline status of the site specific environment using standard methods for EIA in Nigeria and international conventions to which Nigeria is signatory, an assessment of the potential environmental impacts was made and measures for mitigation proffered. An Environmental Sensitivity Index (ESI) was conducted based on environmental and economic values and an Environmental and Social Management Plan (ESMP) formulated. The project is economically, commercially, technically, managerially and environmentally sustainable. The EIA has provided all necessary information and evidence required by the regulators of environment to develop an Environmental Impact Statement (EIS) for the IWTF for Makurdi. It has also served as a guide to planners, decision makers and the public on the various environmental concerns as it is related to the activities for the IWTF. Based on the analysis of the risks, it is recommended that the site be used for the IWTF subject to availability of funds to pay for excavation costs and application of potential and residual impact mitigation measures.

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