Assessment of the Avenor Pilot Community Composting Facility and its Adaptability in Other Accra Sub-Metro Areas

Report Prepared for:

CHF International Ghana

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1.0 EXECUTIVE SUMMARY

Solid waste management presents a major challenge in Accra, Ghana, primarily among residents living within low-income communities and informal housing arrangements. Deficiencies in urban infrastructure and solid waste management remain a crucial problem within the city, which has contributed to indiscriminate refuse dumping into open areas and storm drains. This has not only introduced various public health hazards into communities, but has also caused severe storm drain clogging, further exacerbating sewage and sanitation problems and leading to subsequent flooding and pollution. Slum communities in Accra are particularly affected by the inadequacies of solid waste management.

Refuse generation in Accra is estimated to have increased three-fold over the last two decades due to factors including population growth and increased urbanization, with future projections indicating the urban population will double within the next decade. At the current population, records indicate that 2,000 tonnes of waste are generated each day, but only 1,500 tonnes are properly collected. As such, determining solutions to solid waste management in Accra is an extremely time sensitive debate.

The inefficiencies of the sanitation system in Accra call for new and innovative interventions in the solid waste management sector. The integration of composting facilities in solid waste management presents a means to transform waste into a valuable commodity. Composted organic matter is a nutrient-rich soil amendment, which can be utilized in the agricultural and landscaping/real estate development market as a chemical-free fertilizer. The potential benefits of composting initiatives include the reduction of solid waste, benefits to health and hygiene, greening of the environment, increasing the capacity of landfill sites, and the creation of job opportunities for youth within this new market.

The slum community of Avenor in Accra is the main focus of this report. Avenor represents one of the many communities in the Accra area with lack of sufficient solid waste service delivery systems. The thoughtful integration of a variety of intervention strategies into the sector, including composting initiatives, could provide a potential solution to solid waste management inefficiencies.

The CHF International Youth Engagement in Service Delivery (YES) project seeks to create sustainable urban youth employment within the solid waste management sector through a series of interventions that address rising issues in solid waste management. The creation of community level compost facilities is one of the many interventions being promoted by the YES project. CHF International and Nimba Community Support Services (NIMCOSS) initiated a pilot composting project in the community of Avenor in June 2008.

This report seeks to review composting methods in order to determine the most successful and sustainable method to manage the Avenor facility, and to ascertain whether this operation can be effectively adopted in other low-income areas within Accra. Obstacles to the operationalization of community-scale composting in Accra under the YES Project are identified, and possible solutions and recommendations are offered.

Conclusions of this report have revealed the importance of composting as a solid waste management intervention; meanwhile it has also identified key elements in the successful incorporation of this strategy. The component of highest priority in a workable community-scale composting operation is proper *source separation*, primarily by households and secondarily by participating employed youth. Cooperation of households and youth must be sought and promoted and parties should be properly trained and sensitized. Youth training is also important for *appropriate management* of the facility, in order to achieve optimal conditions for a composting environment. *Market assessment and promotion* are additional essential ingredients in the success of a composting project. A specific market should be identified and targeted prior to large capital investments and full-scale project implementation.

Overall, a composting project should be incorporated as an integrated response to interventions in solid waste management systems, as it is best utilized in cooperation with other efforts (i.e. recycling programs). More cost effective and sustainable composting programs under the YES project can be achieved through integrated strategies, whereby revenues collected in other solid waste management areas can provide necessary support to composting efforts.

2.0 Introduction

CHF International and Nimba Community Support Services (NIMCOSS) initiated a pilot composting project in the community of Avenor in June 2008. The project included the introduction of an elevated composting latrine (ECL) as well as the construction of a small-scale composting facility within the community. The project was meant to better the living environment of Avenor residents through the provision of additional household toilets, community sanitation education, development of the relationship between tenants and landlords, and the overall improvement of sanitation within the community.

The ECL, a dry latrine system, was completed in 2009 and is currently in use by a household in the community. The composting facility was initially developed to complement this ECL system and be utilized as a location to compost fecal matter (mixed with household organic waste) from the latrine.

Since the inception of the pilot project, the focus has shifted from the installation of ECLs, to the construction of composting facilities in other Accra low-income areas, to be managed by community youth. The CHF International Youth Engagement in Service Delivery (YES) project seeks to create sustainable urban youth employment within the solid waste management sector through a series of interventions that address rising issues in solid waste management. The creation of community level compost facilities is one of the many interventions being promoted by the YES project. This intervention involves encouragement and training in household waste separation, door-to-door collection of waste by local youth, and the decomposition of household organic waste in community-based compost centers.

This report seeks to assess the viability of utilizing the Avenor pilot compost facility to its capacity as a fully functional composting operation under the YES project. This assessment is two-fold—to review composting methods in order to determine the most successful and sustainable method to manage the Avenor facility; and to ascertain if this operation can be effectively adopted in other low-income areas within Accra. The success of this intervention also rests on its ability to create youth employment and engagement within these communities.

3.0 Background

Solid waste management presents a major challenge in Accra, primarily among residents living within low-income communities and informal housing arrangements. Although the Accra Metropolitan Assembly (AMA) spends 65-70% of its estimated revenue on sanitation, deficiencies in infrastructure and management in the solid waste sector remains a crucial problem.[1] The inability of the Accra Metropolitan Assembly (AMA) to adequately manage solid waste has resulted in a large majority of domestic refuse being dumped into open areas and storm drains. In addition to introducing public health hazards into these communities, the clogging of storm drains has further exacerbated sewage and sanitation problems, leading to subsequent flooding and pollution problems. Issues in sanitation unfortunately span the entire sector, from management and collection, to transportation and disposal of waste.

According to the 2000 Ghana National Population Census, the population of Accra is approximately 1.7 million people with an annual growth rate of 4.3%.[2] Refuse generation in Accra is estimated to have increased three-fold over the last two decades due to factors including population growth, increased urbanization, and life-style changes. Furthermore, the population in urban areas is projected to double within the next decade.[3] At the current population, records indicate that 2,000 tonnes of waste are generated each day, but only 1,500 tonnes are properly collected.[4] Given future population increases, determining solutions to solid waste management in Accra has become an extremely time sensitive debate.

Slum communities in Accra are particularly affected by the inadequacies of solid waste management. The lack of organized solid waste collection routes and passable road networks in slum areas has introduced additional difficulties in an already underserviced and ineffective system of waste collection

[1] United Nations Human Settlement Program (UN Habitat) (2010). *Ghana: Accra Urban Profile.* Regional and Technical Cooperation Division; Nairobi, Kenya.

[2] United Nations Human Settlement Program (UN Habitat) (2010). *Ghana: Accra Urban Profile.*

[3] WaterAid and European Union (2008). *Urban Sector Assessment Report.* Accra, Ghana.

[4] Accra Metropolitan Assembly (AMA), 2010, "Accra, the Millennium City: A New Accra for a Better Ghana." Urban Planning Department Lecture, Spring 2010. Columbia University, New York, NY.

and transport. In addition, weak government contracts to collection companies by the AMA have resulted in unreliable collection services. Currently, community residents in low-income areas drop off their waste in central refuse containers located within the slum areas for a small fee (cost ranges between 20 to 50 pesewas per dump for an average household of five members)[5]. However, residents reluctant to walk to the skips or those unable to pay these fees commonly dump their waste into open areas.

In response to budget shortfalls, the AMA has introduced a fee-based refuse collection system for all households in Accra (as of June 2010).[6] This new environmental sanitation policy should help to relieve some of the financial burdens of the AMA, but its success is yet to be assessed at this early date.

The inefficiencies of the sanitation system in Accra call for new and innovative interventions in the solid waste management sector. The integration of composting facilities in solid waste management presents a means to transform waste into a valuable commodity. Composted organic matter is a nutrient-rich soil amendment, which can be utilized in the agricultural and landscaping/real estate development market as a chemical-free fertilizer. According to a 2002 report by the African Development Bank (ADB), over 360,000 tons of organic waste is available for composting annually.[7] Given the rise in population growth since the publication of the ADB report, it is likely this value has increased. In addition, the AMA reports that 65% of waste composition by weight within Accra consists of organic matter. [8] Organic waste figures are estimated to be higher within slum communities. The significant fraction of organic matter in the waste stream not only adds to the viability of composting as a workable intervention strategy in the waste management sector, but also demonstrates the high potential for waste reduction in Accra via composting methods. The possible results of composting initiatives are many fold--the reduction of solid waste, benefits to health and hygiene, greening of the environment, increasing the capacity of landfill sites, and the creation of job opportunities for youth within this new market.

The slum community of Avenor in Accra is the main focus of this report. There are currently seven refuse skip bins (central container units) in the entire community of Avenor, with a population of 8,725 residents.[9] This amounts to approximately one skip container per every 1,250 people. This figure exhibits how grossly underserved the community remains at present. Many low-income communities in

[5] Amfo-Out, Richard. CHF International. Meeting. 1 June 2010. Accra, Ghana.

[6] Accra Metropolitan Assembly (AMA), 2010, "A New Accra for a Better Ghana: Waste Management Department," Urban Planning Department Lecture, Spring 2010. Columbia University, New York, NY.

[7] Asomani-Boateng, Raymond (2007). "Closing the Loop: Community-Based Organic Solid Waste Recycling, Urban Gardening, and Land Use Planning In Ghana, West Africa." *Journal of Planning, Education, and Research*. 27: 132-145.

[8] Accra Metropolitan Assembly (AMA), 2010, "A New Accra for a Better Ghana: Waste Management Department."

[9] Interview with Senior Environmental Technologist of the AMA Waste Management Department, 14 April 2009. Cited in "A Narrative Report on the Viability of Manual Composting in Avenor." NIMCOSS, April 2009.

Accra are serviced by fewer community containers by comparison. Excess waste in the Avenor neighborhood (estimated at 10% of a total of 17.45 tons per day)[10] typically ends up in the highly polluted and malodorous Odaw flood drain that flows through the Avenor community.

Avenor represents one of the many communities in the Accra area with lack of sufficient solid waste service delivery systems. The thoughtful integration of a variety of intervention strategies into the sector, including composting initiatives, could provide a potential solution to solid waste management inefficiencies.

4.0 Goal of the Study

1. To evaluate the viability of the pilot community composting center in Avenor and operationalize it as a sustainable intervention in the solid waste management sector.
2. To determine if a similar system can be adopted in other slum communities in Accra and the requirements necessary to provide for the successful implementation and on-going composting operations in these communities.

5.0 Objectives of the Report

1. To assess the technical capacity of the pilot composting facility in Avenor in order to facilitate optimal utilization.
2. To determine proper and sustainable management procedures for the Avenor facility based on previous small-scale composting initiatives, and utilizing this information to inform future community compost centers in Accra.
3. To assess possible obstacles to implementing small-scale composting projects in Accra and to offer possible solutions to these problems.
4. To assess if the successful engagement and employment of community youth is obtainable under compost intervention strategies.

6.0 Methodology

Data on composting practices and systems were collected mainly from secondary sources, including published research papers and case studies, as well as scientific manuals on composting. Local sanitation and waste management information was obtained from the AMA and the Environmental Protection Agency (EPA), as well as from a previous report by NIMCOSS (2009).

[10] Interview with Senior Environmental Technologist of the AMA Waste Management Department, 14 April 2009.

First hand observations were conducted based on site visits to the pilot facility in Avenor. Primary data on planned compost operations was collected via meetings at CHF with community members from several neighborhoods in Accra, as well as through interviews with NIMCOSS members.

7.0 Scope

This report focuses on solid waste management in Avenor and the evaluation of the pilot composting system implemented within the community in 2008-2009. The study specifically centers on the review and assessment of technical and logistical aspects of the pilot facility in Avenor, including its design, capacity, sourcing of organic waste, proper management, and youth involvement. This report is part of a comprehensive analysis of composting interventions as a key component in new waste management strategies in low-income communities within Accra.

8.0 Literature Review on Composting

8.1 *Composting: The Basics and its Benefits*

Composting is the controlled process by which organic waste materials are broken down and transformed into *humus*, a material which makes an excellent soil conditioner and fertilizer. As landfills continue to reach capacity, composting has become an increasingly attractive and viable means of organic waste management and minimization. Not only does the process of composting reduce bulk solid waste, but it transforms this waste into a useable and valuable soil resource. In addition, composting aids in increasing the recovery rate of recyclable materials by removing organic material from the waste stream.[11] Since the YES project seeks to promote and integrate plastic, e-waste, and metals recycling into its programming, the ability of composting to better facilitate these recycling efforts is of particular relevance to the project.

There are a number of benefits of adding compost to soils, as compost has the unique ability to improve chemical, physical, and biological characteristics of soils. The use of compost can improve water retention, promote soil structure, increase soil fertility, reduce fertilizer requirements, and increase resistance to plant pathogens. Compost can also be utilized in environmental remediation activities. Compost increases microbial activity in soil, which aids in accelerating the breakdown of pesticides and other synthetic chemical compounds and heavy metals.

[11] Hoornweg, Daniel et. Al (1999). *Composting and its Applicability in Developing Countries.* Working Paper Series. Published for the Urban Development Division, The World Bank. Washington, D.C.

BENEFITS OF ADDING COMPOST TO SOILS
- IMPROVES WATER RETENTION OF SOIL - PROMOTES SOIL STRUCTURE - INCREASES SOIL FERTILITY - REDUCES CHEMICAL FERTILIZER REQUIREMENTS - INCREASES RESISTANCE TO PLANT PATHOGENS - INCREASES MICROBIAL ACTIVITY IN SOIL - AIDS IN ACCELERATING THE BREAKDOWN OF PESTICIDES AND ENVIRONMENTAL CONTAMINANTS

8.2 Benefits of Community Composting

The physical layout as well as socio-economic considerations in middle and low-income countries is better suited for decentralized and community-scale composting operations compared to single and large-scale centralized facilities. Small-scale systems require less technology and infrastructure, making these types of operations much less of a cost burden. Simple, low-cost technologies can be utilized in small-scale facilities. Given the need for greater technical machinery in centralized systems, this requires higher capital costs, maintenance, and skilled labor. All of these factors also increase the financial risks involved in creating a large composting plant.

Small-scale composting operations also generate employment opportunities for the poor, meanwhile increasing the environmental awareness of the beneficiaries of these operations (local households/communities, youth, local farmers, landscapers, real-estate developers, etc.). Proper source segregation at the household level reduces the volume of landfilled solid waste, while also improving the recovery rate of recyclables. Community-scale composting also has the potential to reduce the cost burden of refuse collection, transport, and disposal incurred by waste collection companies and therefore municipal authorities (who contract waste collection companies, as in the case of Accra).[12]

[12] Enayetullah, Iftekhar and Rothenberger, Silke (2006). "Decentralized Composting for Cities of Low- and Middle-Income Countries: A User's Manual." Published by Waste Concern and Eawag/Sandec. Dhaka, Bangladesh and Duebendorf, Switzerland.

8.3 *Benefits of Composting: Specific to Accra*

Soils in Ghana are predominantly described as sandy loams.[13] Sandy soil typically is characterized by low water retention capacity and higher rates of erosion compared to clayey soil types. Tropical soil in particular is characterized by low content of organic matter. The use of compost on sandy and/or tropical soil can benefit consumers by increasing water content and water retention of the soil, and enhancing the aggregation of soil particles (allowing for more optimal porosity of the soil and hence better aeration). Greater water retention capacity also reduces soil erosion by helping to hold soil in place and preventing cracking of the soil, increasing its defense against erosion from wind and weather events.[14]

Urban agriculture in Accra is particularly intensive and requires that the farmer cultivate the same parcel of land for a long period of time. Given the intensive nature of production necessary for the typical urban farmer on the same small plot of land, the natural soil fertility cannot alone sustain this high production. In addition, soils in Accra have high salt content and are poorly drained in some areas, which can lead to soil degradation after a few years time.[15] The supplementation of organic matter in the form of compost to Accra soils are necessary in order to sustain its fertility to allow for intensive farming typical to local urban farmers.

8.4 *Composting Science: Managing the Compost Environment*

In order to procure an environment for successful composting, a number of conditions must be met. Optimal conditions will allow for more rapid breakdown into finished compost and can also determine the quality of the compost. There are *three factors* in the production of compost which interact with one another in order to produce higher-quality compost: the makeup of the organic ingredients in the pile (the ***"feedstock"***), the size and shape of the pile (its ***"porosity"***), and the amount and type of **microbes** in the composting environment. Specific conditions, as listed below, affect the ability to achieve the optimal interaction of these components.

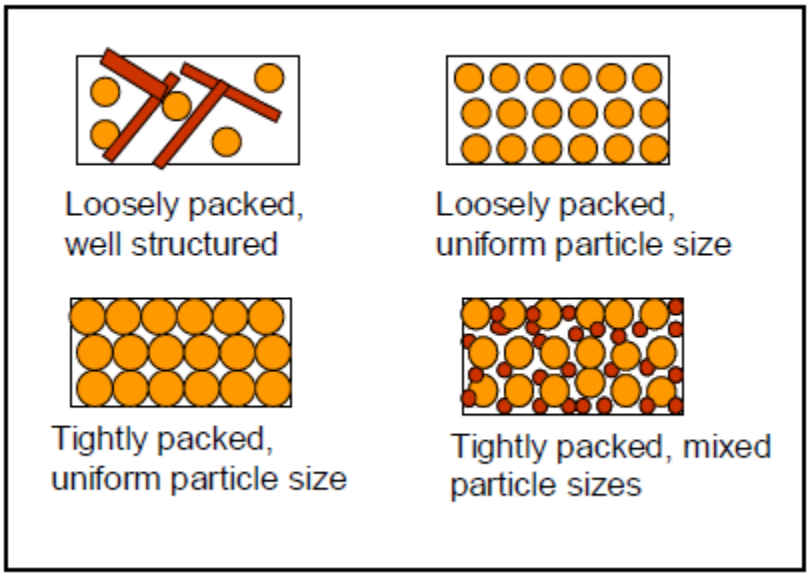
[13] FAO Corporate Document Repository. Fertilizer Use by Crop in Ghana, Chapter 1: Introduction. Retrieved 15 June 2010. Web. http://www.fao.org/docrep/008/a0013e/a0013e05.htm

[14] Strauss, Martin et. al (2003). "Co-composting of Faecal Sludge and Municipal Organic Waste: A Literature and State-of-Knowledge Review." *Swiss Federal Institute of Environmental Science& Technology (EAWAG) and Dept. of Water & Sanitation in Developing Countries (SANDEC).* Duebendorf, Switzerland & Accra, Ghana.

[15] Asomani-Boateng, Raymond (2007). "Closing the Loop: Community-Based Organic Solid Waste Recycling, Urban Gardening, and Land Use Planning In Ghana, West Africa."

Oxygen, Aeration, and Turning Frequency: The right oxygen content of the compost pile allows for more efficient and rapid decomposition. The oxygen supply to the decomposing matter is increased through aeration and turning of the pile. Particle size of the decaying matter can also have an impact on porosity and therefore aeration of the pile. Small particle size has greater surface area per unit volume of organic matter, allowing for more surface area for the colonization of microbes. However, if particles are too small, porosity decreases and aeration within the pile is restricted. Therefore, porosity of tightly packed but mixed particle size allows for ideal airflow. This can be achieved by utilizing a diverse mix of organic matter of varying (small to medium) sizes.

Figure 1: Effect of porosity on pile aeration.



Source: Cooperband, 2002 .The Art of Composting: A Resource for Farmers and Compost Producers.

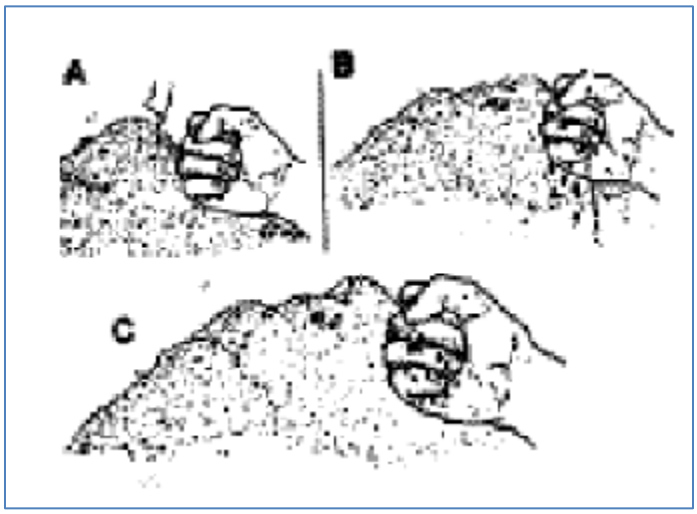
A lack of oxygen and proper aeration to the compost pile can result in anaerobic decomposition, which can result in the production of foul odors. Oxygen levels can be impacted when the moisture content of the pile is too high, or if the ratio of carbon-to-nitrogen-based materials (C:N) in the pile is not ideal. These conditions are described in greater detail below.

Carbon-to-Nitrogen Ratio: The supply of carbon in relation to the percentage of nitrogen is an important component in the type of feedstock utilized to produce compost. An ideal ratio of C:N ranges between 25 parts carbon to 1 part nitrogen, to 35 parts carbon to 1 part nitrogen. If the C:N ratio is too low (lower than 20:1), the surplus of nitrogen in the pile will be released into the environment as ammonia gas, resulting in odor troubles. Green materials generally represent nitrogen-heavy matter, whereas brown or woody materials tend to represent

material high in carbon content.[16] Therefore, the C:N ratio is informally also referred to as the "Greens-to-Browns ratio." Examples of "greens" include manures, grass clippings, vegetable wastes, and sewage sludge. "Browns" include dead or woody materials such as hay, sawdust, cardboard/paper, bark, dead leaves, and charcoal/ash.

Moisture Content: The ideal moisture content of the compost pile is between 45-60% by weight. If this content is reached, the material in the pile should feel moist to the touch when squeezed. The material should be moist enough to be held together, but not exude excess water.[17] A helpful reference used in determining ideal moisture levels is comparing a squeezed handful of material to a "wrung out sponge."[18] Moisture content is essential as low moisture will slow the decomposition process, and high moisture may result in anaerobic conditions and foul odors. Feedstock materials of varying moisture contents can be blended to achieve ideal moisture levels. The C:N ratio is again important in relation to moisture content, as materials high in nitrogen tend to contain more water. Therefore, if the moisture content of the pile is too high, carbonaceous materials can be added to reduce moisture levels. Likewise, nitrogenous organic materials or water can be added to the pile if it is too dry.

Figure 2: Testing of Moisture Content: Take a handful of compost and squeeze it in your fist. **A**: If no water is squeezed out, the compost is too dry; **B**: If many drops can be squeezed out, the compost is too wet; **C**: If few drops can be squeezed out, the moisture content is ideal



Source: Enayetullah, Iftekhar and Rothenberger, Silke, 2006.

[16] Cooperband, Leslie (2002). "The Art of Composting: A Resource for Farmers and Compost Producers." Center for Integrated Agricultural Systems, University of Wisconsin –Madison, Madison, WI.

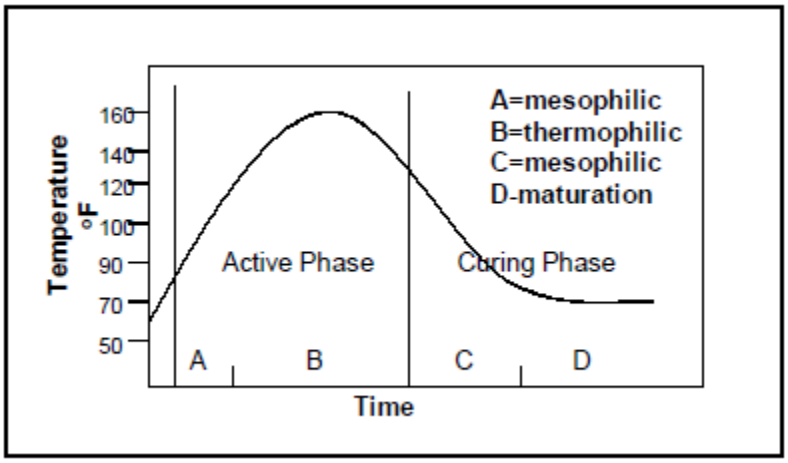
[17] Cooperband, Leslie (2002).

[18] New York City Department of Sanitation. Date published unknown. "New York City Composting Guide: What you need to know to start outdoor composting right now, right here in New York City." New York, NY.

Temperature and pH: Ideal temperature in the pile is also important in controlling the pace of decomposition, the proliferation of microbes, and the control of pathogens in the compost pile. In order to achieve "active" composting, the pile must obtain a "thermophilic phase" whereby temperatures are high enough to create an environment for thermophilic (literally "heat-loving") microorganisms to multiply. These temperatures also allow for the death of pathogens and weed seeds in the pile. This is especially important when utilizing animal or human waste in compost feedstock. Ideal pile temperatures range from 130°F to 140°F (54-60°C). During the thermophilic phase, oxygen replenishment via forced aeration or pile turning is essential.

The acidity or alkalinity (pH value) of the pile also affects the growth of microbes. Attention to pH value is especially important when utilizing human waste for feedstock, as this can result in compost of greater acidity. An ideal balance of human waste to organic matter must be achieved in order to avoid high acid levels in finished compost. Local farmers in Accra have expressed concern with using compost procured from human waste due to acid levels,[19] and therefore it is especially important to maintain proper pH levels in compost piles. The ideal pH for rapid and aerobic composting ranges from 6.5 to 8.0.

Figure 3: Temperature changes in an average compost pile



Source: Cooperband, 2002.

Odor Control: A number of conditions previously mentioned can impact odor control within the composting environment. Odor control is of particular importance to the viability of community-scale composting in the low-income neighborhoods in Accra. For one, the EPA has expressed odor problems as the primary concern with implementing local composting operations in Accra neighborhoods.[20] While optimal conditions within the pile can greatly

[19] Interview with Yaw Duah of NIMCOSS. CHF International. 10 June 2010.

[20] Housing for the Masses. *Workshop on Site Identification and Selection/Design Review: Community Mapping of Selected Sub-Metros for Land for the Design, Cost, and Establishment of Buy-Back Centers and Composting Plants.* CHF International. 10 June 2010.

reduce odor issues, a number of additional engineering controls can also reduce odors. For example, applying a top layer of "browns" (i.e. sawdust, ash, or charcoal) to a pile after new organic material had been added can lock in odors without affecting aeration.

In addition, the creation of a "buffer" zone between the compost facility and the surrounds also helps reduce odors. Planting of vegetation around the facility can help absorb and block odors from emanating into the surrounding environment.[21] Utilizing finished compost as fertilizer for the bordering vegetation can also help market the compost, meanwhile creating a pleasant and green atmosphere within these communities which characteristically tend to lack sufficient greenery.

Photograph 1: Photo of "buffer" plants in small-scale composting facility in Sri Lanka.

Source: Jayaratne, 2010

Curing and Sieving: Compost enters the *curing* phase when pile temperatures begin to gradually decline. During this period, the rate of oxygen consumption decreases to a level whereby turning of the pile is no longer necessary and compost can thus be stockpiled. The curing stage should not be neglected in its importance, as immature composts can result in lower quality finished material that can contain extreme pH values or high salt contents. Organic materials continue to decompose while curing, and the compost is converted to a biologically stable substance, known as *humus*. Stability refers to the state of decomposition activity—whereby the greater the stability of the pile, the lower the levels of active decomposition. Once the compost is finished and has transformed into a stable material, it can be sifted and packaged for sale.

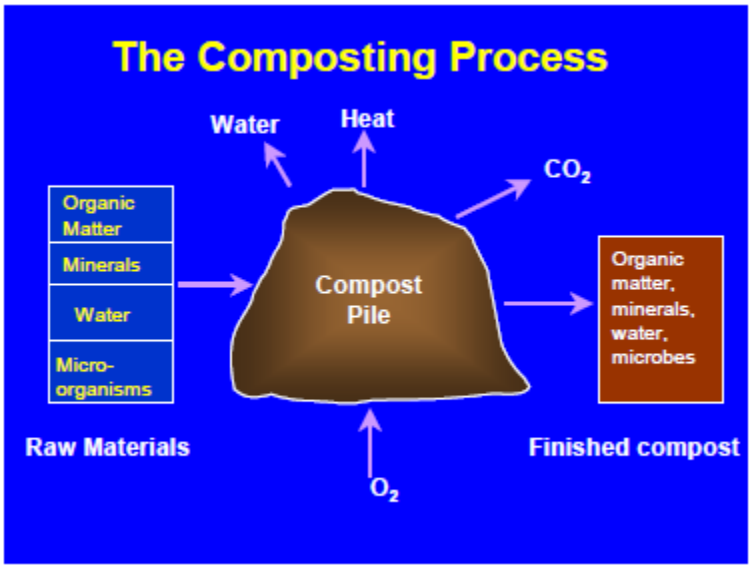
[21] Enayetullah, Iftekhar and Rothenberger, Silke (2006). "Decentralized Composting for Cities of Low- and Middle-Income Countries: A User's Manual."

Table 1: Optimal Conditions for Rapid, Aerobic Composting.

Condition	Acceptable	Ideal
C:N ratios of combined feedstocks	20:1 to 40:1	25-35:1
Moisture content	40-65%	45-60% by weight
Available oxygen concentration	>5%	>10% or more
Feedstock particle size	< 1 inch	Variable
Bulk density	1000 lbs./cu yd	1000 lbs./cu yd
pH	5.5-9.0	6.5-8.0
Temperature	110-150^{o} F (43-66^{o} C.)	130-140^{o} F (54-60^{o} C)

Source: Cooperband, 2002.

Figure 4: The Composting Process



Source: Cooperband, 2002.

It is important to bear in mind that there is no fixed time in which to produce finished compost, as curing time depends on composting methods used as well as management. It can take as little as three months or as long as one to two years for some piles to fully mature into finished compost. Therefore, in order to achieve high-quality compost, it is important to monitor compost during the final stages in order to ensure its stability prior to packaging.[22] Maturity or

[22] Cooperband, Leslie (2002).

stability of compost can be measured by temperature and oxygen levels at the center of the pile. If a lack of equipment and/or resources hinders the ability to monitor these parameters, there are number of simple tests that can be conducted to assess the stage of compost. For example, finished compost should not have a strong odor and its scent should be characterized by an "earthy" smell. One method of conducting a "smell" test is to place a small amount of compost in a sealable plastic (Ziploc) bag. After a number of days, the bag should be opened and its scent assessed. If there is still an odor of decay present in the material, the material is not yet fully matured. If the compost is odorless/has earthy scent, this indicates that the material has reached maturity and is ready to be harvested. [23] Maturity stage can also be assessed by visual examination. Changes in the color of compost can also be a good indication of its maturity as well as quality. Finished compost is generally represented by a dark brown/black color.[24] While a visual examination is not fully accurate as temperature/oxygen monitoring, it can at least provide a helpful approximation of the decomposition state of the material.

Photograph 2: Finished compost, dark brown/black in color.

Source: www.twoparticularacres.com , 2010.

[23] New York City Department of Sanitation.

[24] Mbuligew, S.E., et al. (2002). "Potential and Constraints of Composting Domestic Solid Waste in Developing Countries: Findings from a Pilot Study in Dar es Salaam, Tanzania." *Resources, Conservation, and Recycling*, 36:1, 45-59.

8.5 *Choosing a Composting Method*

There are several factors to consider when determining the type of compost system that would best suit a facility. The *most important criteria include*:

- **The average tonnage of waste per day to be composted**
- **The amount of land/space available**
- **Access to capital**
- **Planned use of finished compost** (i.e. will it be sold or stored for personal use?). This determination is necessary in order to establish facility requirements regarding maturation time and quality.

There are different space requirements for windrows, unenclosed large heaps of raw organic matter stacked in rows with aisles in between, versus employing enclosed bin or in-vessel systems, in a facility. Windrows generally require greater labor and space requirements. However, since windrow heaps are larger than most enclosed set-ups, thermophilic temperatures can be reached at a more rapid rate and decomposition is speedier. Therefore, time to maturation is shorter, which can be beneficial to those marketing their finished compost whom require higher yields within a shorter time period.

Photograph 3: Photo of composting facility utilizing static windrow piles.

Source: Cooperband, 2002.

Enclosed systems require less management and labor and a more efficient use of space, but require greater infrastructure and longer maturation times. However, engineering controls such as forced aeration, perforated aeration tubes, and perforations/openings in the vessel walls can help aid aeration to speed up decomposition processes. Manual turning is the most common means to aerate a compost pile at minimal cost. Enclosed systems also allow for better control over environmental factors (i.e. oxygen, moisture, and temperature levels).

Photograph 4: Box/enclosed composting system in Sri Lanka.

Source: Jayaratne, 2010

In addition, it is important to note that the EPA has outlined specific criteria regarding the creation of community-scale composting facilities within the Accra area. These criteria must be considered during the planning process in these communities. As mentioned previously, odor is the number one concern among EPA officials, as well as wind direction. As such, distance/space requirements from the planned facility to surrounding residences must be considered. The EPA requires the compost facility to be approximately 60 to 70 feet in distance from the nearest adjacent residence/building.[25] Therefore, when determining land availability and space requirements, these criteria must be incorporated in planning. Additional space requirements for waste sorting, sieving, and packaging also must be incorporated into planning. Climactic conditions and typical wind direction should be assessed in each community. The predominant wind direction in the Okaikoi South Sub-Metro (which includes Avenor) is from the west-southwest (WSW) to north-northeast (NNE).[26]

Other technical considerations include the installation of a sloped/graded pad for leachate collection, and a collection pit. If the installation of a graded concrete pad is not possible due to cost restraints, the slope/grading of a site location should be considered, as well as the depth of the water table. Composting on the open ground in areas where the water table is high or adjacent to surface water could result in the leaching of nitrates and other concentrated nutrients into the groundwater and/or nearby surface water.

[25] Housing for the Masses. *Workshop on Site Identification and Selection/Design Review: Community Mapping of Selected Sub-Metros for Land for the Design, Cost, and Establishment of Buy-Back Centers and Composting Plants.* CHF International. 10 June 2010.

[26] Okaikoi South Sub-Metro District Council (2009). "District Environmental Sanitation Strategy and Action Plan." *Accra Metropolitan Assembly (AMA).* Accra, Ghana.

Common Composting Methods: Windrow vs. Box/In-vessel System							
	Space Requirements	*Use of space*	*Labor*	*Infrastructure*	*Decomposition*	*Management*	*Odor*
Windrow	More space needed	Less efficient	Large labor requirements	Less infrastructure necessary	Shorter time period to maturation	Less controlled environment	More difficult to control odors
Box/In-vessel	Less space required	More efficient	Less labor required	More infrastructure necessary	Longer time period to maturation	More controlled environment	Easier to control odors

A mechanism for sieving finished compost should also be considered, especially if the compost will be sold on the market. Wooden-frame sieves with wire mesh can easily be constructed at low cost. Mesh sizes should be determined based on utilization of the finished compost. For example, a mesh size of 10 to 20 millimeters would be acceptable for sieving compost for use as plant fertilizer.[27] Compost residue from the sieving process can be returned to the compost pile for further decomposition.

8.6 Christian Village Case Study

A case study on community-based composting in low-income communities was conducted in the Christian Village neighborhood of the Greater Accra area. The project was implemented in 1998 and continued for approximately seven years. Given the similar objectives of this study with the YES project, and its location within Accra, lessons learned in this case study can help inform future composting intervention projects.

Description of Study Location: Christian Village is a low-income high-density neighborhood in the Greater Accra, with a population of approximately 2,500 at the time of the study. The village spans about 20 hectares with 130 people per hectare (compared with the overall city density of 69.3 persons per hectare as of 2000). Similar to other low-income communities in Accra with minimal access to waste collection services, open burning and dumping are common strategies utilized to manage waste within the community. This village was selected for investigation as it represents a community with severe solid waste disposal problems, and also hosts a large population of residents engaged in urban agriculture.

[27] Strauss, Martin et. al (2003). "Co-composting of Faecal Sludge and Municipal Organic Waste: A Literature and State-of-Knowledge Review." *Swiss Federal Institute of Environmental Science& Technology (EAWAG) and Dept. of Water & Sanitation in Developing Countries (SANDEC).* Duebendorf, Switzerland & Accra, Ghana.

Pilot Project Procedures: This project consisted of two elements, a source-separation component, as well as a composting project component. Volunteers in the community visited participating households and demonstrated source separation. Households were responsible for hauling their own waste, both the compostables and general refuse. The drop off points for general refuse and organic waste were located in two separate locations. In addition to household participation, two large bins were placed in the local market for compostable waste only. A community member was in charge of promoting compliance and managing the bins.

The organic waste was composted outdoors utilizing a simple windrow aerobic composting technique. The heap was sprayed with cow dung and manually turned periodically. The heap was covered with a layer of topsoil in order to minimize odor and retail heat. It was determined from analysis of mature compost that the finished material was of very high quality.

Findings: In 2005, seven years after project implementation, various problems arose and the composting operations at the site were discontinued. Fortunately, as a result of the project, participating volunteers were able to utilize their skills and were hired by individual wealthy city residents for aid in household composting.

By the end of the project, approximately 70% of community residents were regularly separating their waste. However, the remaining population continued to mix their refuse and dump it together at the composting site. This was especially common in households where children were responsible for hauling refuse to the drop off sites. Since the refuse drop off site and the organic waste drop site were located in two different areas, children regularly disposed of both waste streams at one site to avoid the hassle of additional trips. This raises two important issues: compost site location and determining which household members assume various tasks in management of their waste.

Marketing and the utilization of produced compost was also problematic in this study. No market assessment was performed prior to the project. While compost appeared to be in high demand, farmers were only willing to offer low prices for compost given the availability of cheap alternatives. The sustainability of producing compost for the market is highly dependent on successful marketing, which was not conducted during this project.[28] This study reveals the importance of two key actions in order to facilitate the success of a composting project: conducting a market assessment prior to project implementation, and focusing on the creation of a viable market for compost. The ongoing market assessment and planned compost promotion activities under the YES project should confront issues related to the demand of compost among local farmers, real estate developers, and other potential consumers.

[28] Asomani-Boateng, Raymond (2007). "Closing the Loop: Community-Based Organic Solid Waste Recycling, Urban Gardening, and Land Use Planning in Ghana, West Africa." *Journal of Planning Education and Research.* 27: 132-145.

In addition, another large weakness to this study was related to participation. This case study demonstrates the importance of having a population of community members participating in door-to-door pick up of waste. Unless all community members are educated and enthusiastic about the project, relying on families (and most generally children) to haul their refuse to two distinct locations introduces difficulties to the project. Employing community youth to take on the role of door-to-door waste collection minimizes the hurdles of effective community participation. While greater support of the project by community members is important anyway, the initial success of the project will be essential in gaining community support in order to maintain the sustainability of the project. This study demonstrates that organizational considerations of waste pick-up (collection and routes, location of facility, transportation, etc.) should be a priority in community composting programs.

Overall, the issues of greatest concern to the sustainability of the composting project were mainly related to land acquisition issues, including availability of land and tenure to land. The ability to secure suitable land in convenient locations is an important factor in the success of a community composting project. Open space and agricultural land in Accra is extremely valuable and is quickly being converted for urban use. As mentioned above, close proximity of communities to composting sites is also an important consideration. Greater proximity of compost facilities to their communities not only enhances participation but also reduces costs (i.e. transportation costs), and increases operational efficiency. Heavy consideration of the siting of these facilities should therefore be a main priority under the YES project. Decisions regarding siting of these facilities should not only be considered for the initial implementation period of the project, but in a matter which promotes long-term and sustainable use.

9.0 CHF & NIMCOSS Pilot Composting Facility at Avenor

9.1 Description and Design

The land for the pilot project was secured from the Avenor Traditional Authorities and the facility is located in the community of Avenor, to the east of the nearby Odaw storm drain/canal that bisects the area. The facility is constructed of concrete with corrugated sheet metal roofing, and wire mesh windows to aid in aeration. It contains eight enclosed adjoining concrete compost chambers, situated on a concrete pad. The concrete pad is slightly graded (5 degree slope) for leachate drainage. Each of the chambers contains a draining unit and is connected to a 75mm drainage pipe which collects the leachate and drains it into a central collection point at one end of the concrete pad.[29] Each of the eight bins measure 1.5 meters in

[29] Nimba Community Support Services (NIMCOSS)(2009). *A Narrative Report on the Viability of Manual Composting in Avenor.* Accra, Ghana.

length, 1.3 meters in width, and 1 meter in height. Wire mesh coverings overlain with charcoal have been constructed for each of the eight bins for odor control.[30] There is approximately 1.5 to 2 meters of open space between the bins and the surrounding structural walls. Source separation of waste and sieving would be performed in this surrounding open space.

One of the bins was piloted for the creation of compost from local organic waste. As of June 2010, the bin was undergoing decomposition and was approximately 30% full of organic waste, as estimated by visual examination. NIMCOSS was able to procure this waste from the neighborhood market.

The subsequent community compost facilities have a distinct preliminary design plan than that of the pilot facility. The current design plan incorporates the use of larger chamber compost systems within a building structure measuring 40 feet by 60 feet (12.2 meters x 18.3 meters). The facility design includes three large enclosed composting boxes parallel to one another with five chambers each, and one additional box with two chambers. An area of the facility will be dedicated to the shredding, weighing, and sorting of waste. Sieving and packaging would be conducted in a separate interior space of the building structure. A toilet, urinal, and shower would each be located within the building for the convenience as well as health of the workers. Perforated piping would be inserted into the windrow heaps for increased aeration of the piles. At the moment, sites are being selected within the local communities for these facilities, based on a number of specific criteria as well as land availability.[31] See Appendix B for diagrams of proposed facility designs.

[30] NIMCOSS (2010). Volume of Compost House.

[31] Housing for the Masses. *Workshop on Site Identification and Selection/Design Review: Community Mapping of Selected Sub-Metros for Land for the Design, Cost, and Establishment of Buy-Back Centers and Composting Plants.* CHF International. 10 June 2010.

Photograph 5: Avenor Compost Facility, view of interior

Source: CHF International Ghana, 2010

9.2 Recent technical modifications

In June 2010, a number of technical modifications were completed at the pilot plant. In the original design, the concrete bins lacked doors to allow for the transfer/movement of compost from one bin to the following bin. As such, NIMCOSS decided that the construction of doors between the adjoining bins would aid in the transfer of material, thereby reducing the amount of labor necessary and facilitating in the increased efficiency of the facility. A total of six access-ways were constructed, four of which were constructed on the interior of the bins and allow for transfer between the bins. The remaining two doorways were constructed on the exterior of two bins, allowing for the ease of movement of finished compost out of the bins for sieving/packaging. The doors were assembled from mahogany wood and were engineered to move in an up/down direction.

The remaining modifications were conducted in order to increase pile aeration. Angled holes fitted with 12mm PVC piping were drilled into each of the concrete bins. The holes are angled downward into the bin in order to prevent material leakage out of the holes. Two rows with three holes each were introduced into the exposed side of each bin. The four corner bins had double this amount (6 holes for each exposed side). A total of 72 aeration holes were constructed.

Three aeration perforated pipes engineered out of 100 mm PVC piping were constructed for each bin. A series of holes were drilled in each pipe to facilitate airflow. Once the bins are filled

with organic material, the pipes will be manually fitted upright into the organic matter. Photos of the recent modifications are included in Appendix A.

After the modifications had been completed last month (June 2010), NIMCOSS was able to procure organic waste from a local restaurant. Since door-to-door collection of household waste under the YES project has not commenced, household waste has not been collected for use at the Avenor facility as of this date. In the upcoming weeks, refuse bins (2 per household) will be distributed among approximately 200 houses. At this time, household training in source separation will begin. Once training is in motion, refuse collection will follow and household waste should be available for use at the pilot facility.

9.3 Current Estimated Capacity

Based on a number of calculations, it has been estimated that the pilot facility can support a total of 7.8 tons of waste. As mentioned previously, each chamber measures 1.5 meters in length, 1.3 meters in width, and 1 meter in height for a total volume of 1.95 cubic meters (volume = length x width x height). Since there are eight chambers, this volume can be multiplied by 8, for a total volume of 15.6 cubic meters. Using a conversion of 1 ton equal to 2 cubic meters, the approximate capacity of the chambers equals 7.8 tons, or approximately 7,076 kilograms of waste ($15.6m^3 \div 2\ m^3 = 7.8$ tons).

In addition, the weight of mature compost is about 75% less than its original organic matter, known as a "shrinkage rate." If the shrinkage is considered, the tonnage of mature compost resulting from the capacity input would result in approximately 1.95 tons of finished compost (7.8 tons x 0.25). If the estimated maturation time of the compost is 2 months (60 days), it is expected that 1.95 tons of finished compost will be available to market every 2 months.

9.4 Possible future modifications

The new modifications to the pilot facility should facilitate better aeration, enabling faster maturation times, and more successful aerobic decomposition. This should in turn mitigate odor concerns, as well as reduce labor since the turning frequency of the piles may be minimized (although this will not fully replace the need for turning). The addition of doors should also minimize necessary labor required to transport the compost between the chambers as well as out of the chambers for final processing.

While it is difficult to assess potential technical problems in the future, there are a few considerations to bear in mind. The greatest areas of concern are space (for sorting, sieving, and packaging), as well as odor control. If the compost facility is working at full capacity, it is possible that additional area for sorting of waste may become an issue. Currently, the square

footage space of the chamber area is approximately 15.6 square meters, and the total area of the facility is approximately 45.6 meters (8m x 5.7m). Therefore, the available open work space is currently 30 meters (the difference of 45.6 and 15.6). However, this total area consists of a border surrounding the chamber and is only approximately 1-2 meters wide, which may become constrictive as a suitable workspace. It may become necessary in the future to procure an additional work area. The construction of a concrete pad with an overhead canopy at the entranceway would be a low-cost solution if the procurement of additional space becomes necessary.

As for odor control, it is difficult to anticipate whether or not this will become an issue. However, since this is an important criterion of the EPA, it would be wise to take necessary precautions in regards to odor prevention. As mentioned in Section 7.3, a "buffer zone" of vegetation can be planted around the compost facility to absorb odors. Overall however, odor control will depend highly on proper management. Therefore, proper training and strong management will play a key role in odor minimization. Management should be prudent about the application a top layer of charcoal or sawdust (or any other "brown" material) after the addition of raw organic matter to the active chambers.

If the facility begins to generate substantial profits and market demand for compost begins to exceed supply, increased mechanization of the plant may be required. The introduction of electricity for air blowers (to facilitate in aeration), the use of oxygen monitoring equipment, or more sophisticated sieving technology may be of use.

9.5 Costs

The Benefit-Cost Analysis: A critical component in determining the viability of a composting project is the creation and evaluation of a benefit-cost analysis (BCA). A BCA can help to determine financial risk involved in the composting project and should be performed with conservative cost calculations to properly account for this risk. The BCA should be conducted after the feasibility of the project has already been established. A proper BCA should include the following:

- Determination of a time frame for the project (i.e. number of years)
- Determining annual revenues
- Calculation of total project costs
- Calculation of annual net benefits
- Determining an appropriate *discount rate* (conversion of future cash flows to present values in order to account for lower numerical values of costs and benefits in the future).
- Calculate the financial *net present value,* or NPV (conversion of future costs and revenues to be received to a common base value)

- Calculation of the *benefit-cost ratio*, or BCR (comparison of total costs to total benefits)

The BCA is important in that it accounts for costs and benefits over the estimated full length of a project, rather than simply accounting for costs per annum. In addition, the generation of benefits/revenues may not occur in the initial stages of the project. Likewise, some costs may be spread over a number of years.

Composting rarely generates profits on its own, unless operating as a large-scale centralized facility. However, it is important to note that when viewed as a component of an integrated solid waste management program, economic benefits can be achieved on a larger scale. While actual monetary costs of composting include raw materials and infrastructure, production, marketing, and some environmental costs, benefits involve the market value of compost, savings from avoided disposal costs, and a number of positive environmental impacts within the community as well as for the greater municipal waste management system. As mentioned previously, some other benefits include reduced landfill space, reduced groundwater/soil contamination and methane gas emissions from landfill sites, enhanced recycling of other materials due to removal of organic matter from the waste stream, reduced air pollution from burning of waste, and less drainage clogging in communities due to reduced refuse dumping (resulting in reduced flooding, less standing water for mosquito proliferation, and improvements in public health). When calculating benefits in a BCA, all of these elements should be included and assigned a monetary value.

Accrued Costs of Avenor Facility: According to NIMCOSS, the upfront capital costs, including costs of initial construction of the composting facility amounted to $3,800 Ghc. The cost of recent modifications amounted to approximately 500 Ghc (or about $345 USD), for a total approximate cost of $4,300 Ghc. This cost includes all construction-related costs and does not include any operational costs. In addition, bins are currently in the process of being purchased for distribution to households, and costs of training/education among households will accrue additional costs.

Estimated Initial Costs of Planned Community Facilities: The estimated initial construction cost of the planned community facilities is approximately $10,000 USD.[32]

9.6 Management, Youth Involvement, and Operationalizing the Facility under the YES Project

There are a number of factors which need to be assessed in order to determine the most appropriate means to operationalize and manage the compost facility under the YES project. Some of these issues are listed as questions to consider in the sub-sections below. While these

[32] Meeting with Ishmael Adams, Director of *YES* Project, CHF, June 30 2010.

considerations are specific to Avenor, they must be assessed within other communities adopting similar waste management interventions. Communities vary in geography, layout, culture and/or religion, and hence and may benefit from adoption measures specific to each community.

9.6.1 Youth Collection

The frequency of collection, means of collection, appropriate distance to drop-off site, as well as the mode of collection and payment are currently being assessed under the YES project. Some of the questions to consider within this context are as follows:

- **Collection:**
  - *What time of day should waste be collected (Early morning, evening, or throughout the day)?*

Waste collection times should be dependent on typical waste disposal habits within the community. For instance, if most residents in Avenor generally dispose of their waste in the morning hours, waste collection by youth should occur at this time. However, collection in the evenings after sundown would be difficult given minimal lighting and difficult access routes in some community areas. Since some residents must walk far distances to drop off waste at community containers, it is less likely that these residents would chose to dispose of their waste in the evening hours.

  - *How many times should waste be collected per week (daily, bi-weekly, etc)?*

Frequency of collection should likewise depend on waste generation habits of the community. According to recent statistics, individuals in Accra generate on average 0.5 kilograms of waste per day.[33] In order to prevent a high accumulation of waste in the households (which may discourage residents from maintaining their waste until youth pick-up and encourage open dumping), waste collection should be frequent. Again, determining frequency would depend highly on waste collection generation habits; however, it is assumed for the majority of communities this would require, at minimum, bi-weekly waste collection.

[33] NIMCOSS (2009). *A Narrative Report on the Viability of Manual Composting in Avenor.*

- *What is the most efficient and effective means of transport to collect community waste (by foot, tricycle, or bolo-taxi)?*

Determining the best mode of waste collection within the community depends largely on the layout of the community and easy access to households. Certain zones of the community may be located near main roads and therefore bolo taxis would be the most effective means of transport to haul household waste. On the other hand, it would be unrealistic to assume vehicular access in to areas of the community where roads are narrow or unpaved. In these scenarios, collection by tricycles or on foot (with a wheelbarrow) may be necessary.

Collection routes/zones should be established in the community with access considerations in mind prior to project commencement. This way, the most efficient and appropriate mode of transport for collection within specific areas of the community can be determined.

- **Payment:**
  - *Should youth charge households a determined rate? If so, should the youth pay the skip to collect their unusable remaining waste after source separation?*

Households should be charged in accordance with the charge incurred for skip container drop off. In this manner, residents are paying the same cost for door-to-door service as they would be paying to travel to the skip container for drop-off. This way, residents are more likely to maintain their waste and wait for pickup, ensuring that community youth have a greater opportunity for payment of services.

If the household charge is too high, residents may be discouraged from dropping their waste with community youth and may resort to other forms of waste disposal (container drop-off, or dumping/burning).

After organics have been removed for composting, and plastics and metal/e-waste have been separated out, there may remain a small amount of waste that will still require disposal. Youth will need to be responsible about transporting this waste to a proper disposal site (likely to be a community skip container) and will have to pay a fee to the container operator. It is assumed this fee will be small, since a large majority of the collected waste will be recycled. It is important that youth are educated about the importance of proper waste disposal and are committed to properly disposing of any remaining unrecyclable waste.

- *Incentives versus disincentives:*

    - Should households that separate their waste be charged less? How much less? (incentivizing)
    - Should households be charged more if they do not source separate appropriately? If so, what is the standard for acceptable source separation? (disincentivizing)

While incentives and disincentives can be powerful tools for encouraging or discouraging behaviors, determining proper incentives/disincentives can be a complicated task. Generally, incentives tend to be more successful than disincentives. However, unless you are able to provide the incentive indefinitely or can ensure that behaviors will remain after the incentive is no longer provided, incentives may not be the best tool.

However, in this case, youth could suffer a reduction in revenue if they provided financial incentives (i.e. a discount) for source separation. Community youth would have a disincentive to encourage source separation if they provided discounts to households for this activity. On the other hand, household source separation reduces the subsequent workload of source separation among youth, labor which does not offer any additional revenue.

In this scenario, time consumed through youth source separation may be great enough to hinder the ability to collect household waste, and thus would reduce revenues anyway. It may also inhibit the ability of youth to resell recyclables in a time efficient manner, while also slowing generation of finished compost for sale. However, it is also possible that revenue lost from discounts to households would be greater than revenue lost from the time it would take youth to properly source separate. Keep in mind that it is likely youth will have to source separate either way, but of course household participation would reduce subsequent labor required to source separate at the facility.

Overall, these factors must be carefully weighed in order to determine if financial incentives to households would be beneficial to both households and employed youth.

- **Distance and Travel:**
    - *What should be the pick-up radius of collection for individual youth?*

The radius of collection for each youth should be dependent on the size and layout of the community (ease or difficulty of access), average household size and overall community population, and mode of transport by youth. For example, if assigned to an area with access difficulties, the collection radius may

be smaller, whereas the radius of pickup for a youth equipped with a vehicle and access to main roads would be larger.

- *Should youth be responsible for final disposal of waste that cannot be reused, recycled, or composted?*

As mentioned above, youth should be responsible for final disposal of waste collected that cannot be sold/recycled. As a waste management intervention, the YES project should ensure that all waste collected under the project is properly managed and appropriately disposed of by participating youth.

- *Should youth be responsible for hauling organic waste from the local markets to the compost facilities?*

The inclusion of waste from nearby community markets is ideal, as it would likely provide a better feedstock for higher-quality compost (since it contains mostly organic waste), and it would also reduce solid waste dumping in these areas.

However, hauling organic waste from local markets should depend on a number of criteria. For one, the location of the market is important in determining the ease of collection. If the market area is located within a collection radius and transport to the compost facility/drop-off site is possible, market waste inclusion should be considered. Also, since household waste should be prioritized under the YES project, the capacity of compost facilities to handle the addition of market waste is a major consideration.

In some cases where household waste separation remains a problem, market waste may be necessary in order to secure sustainable organic matter for composting. In this scenario, the provision of market waste should be coordinated and included in the community composting project.

9.6.2 Youth & Employment Opportunities

Community youth would be employment in the solid waste sector under the YES project, which would focus on door-to-door waste collection from community households. Employment would also be generated from the necessary labor of source separation, cleaning of recyclables for resale, and composting. Financial support to community youth will be provided via fees collected from households, as well as through the resale of recyclables, and the sale of finished compost. Additional income may also be available through carbon financing (see Section 8.6.3 below).

Each compost facility should also have designated youth managers, who will be in charge of each facility. Given the importance of proper management to the success of the facility in terms of maintaining a site and procuring high-quality and high-yield compost, a means of additional payment should be considered for the facility manager. Perhaps the manager can receive greater proceeds from the sale of compost once the plants are fully operationalized. However, in this case, initial financial incentives for apt management might also be necessary early on, since there may be a lag in the generation of profits from compost sales.

There is also an incentive among youth compost workers to properly maintain the plant, with a keen focus on feedstock, source separation, and securing waste inputs. Enhanced source separation contributes to a better feedstock, which in turn will generate superior quality compost. Higher-quality compost will ideally create a greater demand and can be sold for a higher cost compared to low-quality compost. In addition, higher-quality compost can be utilized by a wider range of consumers (including farmers, who require higher-quality compost for use in food production) in comparison to lower-quality compost, which may only be of use to landscapers and real-estate developers. This information should be emphasized during youth training.

9.6.3 Carbon Financing Considerations

Carbon financing is defined as the provision of financial resources provided to projects which are generating/will be generating green house gas emission reductions. Finances are provided in the form of the purchase of such emission reductions. In other words, under a carbon financing scheme, one party pays another party in exchange for a given quantity of greenhouse gas (GHG) emission reductions.

Since composting diverts waste from landfills, which are heavy sources of GHG's, especially methane gas emissions, composting programs can benefit from carbon credits under the Clean Development Mechanism as an additional source of income. The Clean Development Mechanism, or CDM, is a framework set up under the Kyoto Protocol whereby industrialized countries can achieve their GHG emissions reductions targets by investing in GHG emission reduction projects in developing countries.[34]

Under the YES project, compost facilities can register as CDM projects and may be able to recover initial investment costs through carbon credits. In addition, carbon credits

[34]Enayetullah, Iftekhar and Maqsood Sinha, A.H (2010). "Overview on Financing Solid Waste Management Through Carbon Financing." *Waste Concern.* Presentation. Regional Exposure Workshop on Pro-poor Sustainable Solid Waste Management for Secondary Cities and Small Towns. 22 February 2010. Dhaka, Bangladesh.

can serve as an additional form of income for participating youth in later stages of the project.

9.6.4 Additional Programs: Household Composting Promotion and Technology

An important element that will help determine the overall success of the YES project is the engagement of the community in proper household waste separation. Proper household source separation will increase the efficiency of community composting programs and recycling by reducing the amount of sorting time necessary by employed community youth.

Another means to engage the community as well as enable a reduction in household solid waste, is to promote household outdoor composting of organic waste. The capacity of the Avenor plant, as well as other planned facilities, are not large enough to handle all community waste (assuming 100% of community organic waste can be obtained for composting). Household composting could help minimize excess solid waste that cannot be handled in the compost plant. This would also help familiarize households with source separation and introduce community members to the process of transforming waste into a valuable commodity. This commodity can either be utilized for personal use for plants or a garden area at home, or for sale as an additional means of personal income. Furthermore, since overall household waste would be reduced by removing organic matter from the waste stream, household waste disposal costs would decrease. Since it is common for households in low-income communities to operate home-based enterprises, compost selling can be encouraged as a new type of home-based enterprise that can be put into practice.

The only problematic issue with household composting is the possibility of reducing the profit margin of the composting facilities if they are unable to secure sustainable organic waste inputs. This may also lessen the earnings of community youth who rely on waste collection and compost production for income. It would be wise to ensure proper sustainable inputs of organic waste at the compost facilities (discussed in more detail below) prior to any large-scale intervention of household composting efforts.

Choosing a Household Composting Method: There are a number of low-cost and low-technology options available for household composting. Choosing a suitable compost bin/option is often dependent on space, the amount of labor involved, the speed at which is preferred to produce mature compost, the feedstock, and cost considerations.

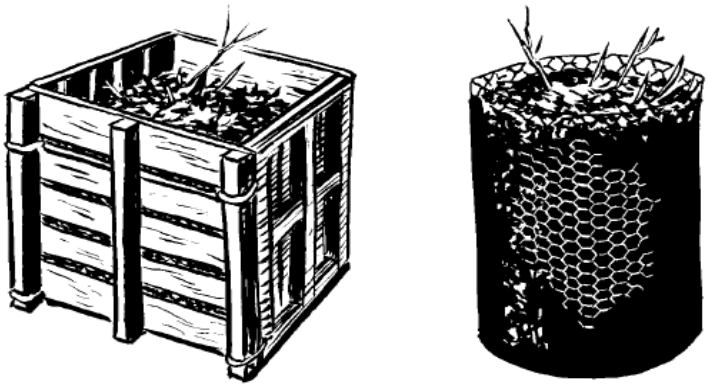
The lowest cost option is open-pit composting, whereby a hole is dug in a backyard area, and organic waste is simply placed in the hole. After each application of organic waste,

a layer of topsoil or charcoal ash is placed atop the matter. No turning is required in this scenario; however the procurement of mature compost might take longer periods of time than in a proper compost bin. In addition, open pit composting may attract vermin and are not rodent-proof.

The simplest household compost bin can be constructed from mesh material, whereby a large piece of mesh can be fashioned into a circular/cylindrical holding container. Household waste can simply be tossed into the area and covered with a layer of topsoil after the application of new material. However, since the mesh material is not very sturdy, the pile could not be turned and the decomposition process will be slow. Mesh containers are better suited for composting yard trimmings than household organic matter, as odor control may be problematic.

Enclosed bins are the best option for minimizing odors and preventing rodent access to your pile. These bins are also best suited for handling kitchen scrap waste. Enclosed containers can be constructed from wooden slats using inexpensive or recycled wood material. A lid can also be constructed from wood for odor control. Plastic or metal waste containers or drums can also be utilized, but holes must be drilled along the sides and bottom of the containers to aid in aeration and leachate outflow.

Figure 5: Two types of household composting bins.
Left: bin constructed from recycled wooden slats, *right*: bin constructed from mesh wire material.



Source: New York City Department of Sanitation, date unpublished.

Starting a Bin: To begin composting, a bin of choice should be filled with about one-third dry leaves or other "brown" materials (see Section 7.4). Other options to begin composting if leaves are unavailable include potting soil, shredded brown paper or newspaper, or hay. As these materials are added to the bin, water should be added to the pile. Enough water should be added to the pile so that the materials become damp. The materials should be mixed so that the moisture is spread evenly throughout the pile. If potting soil is utilized as a starter for the compost bin, it is not necessary to add water unless the soil is very dry.

Once the bin has been started, kitchen scraps and other organic matter can be added to the bin. As mentioned above, after each new addition of organic matter is added to the bin, a thin layer of "brown" material should be added on top of the waste. This aids in odor control and also minimizes the attraction of pests and flies to the pile. A simple rule of thumb for maintaining a good carbon: nitrogen balance for household piles is to have approximately two times as much "brown" material (carbon) in the pile as "greens" (nitrogen). It is common for charcoal to be utilized for cooking in many lower-income communities in Accra. Charcoal ash can be applied as "brown" material to compost piles. Locating brown materials for household composting should not be problematic due to the abundance of charcoal ash produced daily in these communities.

Items to avoid: Households may opt to avoid adding meat, fish, dairy scraps, or dead animals to their pile, as these materials tend to produce more foul odors compared to vegetable waste or grains. The addition of invasive weeds or weeds with seeds to household piles should also be discouraged, especially if households plan to sell their finished compost. Sand, rocks, and other non-compostables including plastic waste, metal, and glass should not be added to compost piles.

Managing Household Containers: It is recommended that households agree on an individual who will be in charge of managing the compost bin. This is especially important for compound houses which engage in collective composting in one central bin. Negligence of the bin can result in odor problems, and it can increase pest and rodent troubles. In community areas where housing is densely constructed, mismanagement can also become a burden on nearby residents.

The two most important factors in proper bin management include:

- Supervision over the items that are placed in the bin
- Monitoring of moisture and air levels (adding water when necessary and turning of the pile at least once a month). A good technique for turning the pile is utilizing a rake or shovel to move the items from the center to the outward edges of the pile, meanwhile moving the material on the edges toward the center of the pile. Another technique is "fluffing" the materials in the pile, allowing more space for air to infiltrate.

Supervision and monitoring will not only ensure faster and better-quality compost, but it will more importantly facilitate odor and pest control.

Maturity levels of the compost should also be observed in order to recognize when it is time to harvest the finished compost. For a household size bin, depending on how the bin in managed, this can be in as little as three months, or up to nine months. If finished compost is to be utilized for personal use within the household, it can be used

for a number of purposes. Finished compost can be mixed into flower or vegetable beds or spread directly onto grassy areas or vegetable gardens as a fertilizer. Coarser compost can be spread around the base of shrubs and trees. Compost can also be mixed with soil to improve soil conditions (increasing water retention of soil, decreasing erosion, etc.). However, it is important to ensure that the compost is fully mature prior to use, as immature compost can harm the growth of plants and vegetables.[35]

9.7 *Securing sustainable inputs of organic waste*

In order to determine sustainable inputs of organic waste, household waste generation in the community should be calculated and the percentage of total organic matter from this value should be then assessed. This value can be utilized to determine the acceptable size and capacity necessary for a community compost facility. However, regardless of the amount of organic waste generated in the community, this does not warrant a sustainable input of organic waste. In order to obtain sufficient waste inputs, the community should be engaged in household waste separation. In addition, the compost facility must be properly and effectively managed, and community youth must be diligently engaged in the transportation of organic matter to the facility on a daily basis.

As per NIMCOSS, waste generation in Avenor is estimated to be about 17,450 kilograms per day (or 17.45 tons). This value was determined by dividing the per capita waste generation in Accra (0.5 kg/day), by the present estimated population in Avenor, approximately 8,725.[36] According to the Waste Management Department of the AMA, organic waste constitutes approximately 65% of total generated waste in Accra. By this measure, the daily organic waste generated in Avenor is approximately 11.4 tons (17.5 tons x 0.65).

As determined above in Section 8.3, the current capacity of the Avenor compost facility is approximately 7.8 tons. Therefore, according to this calculation, sufficient organic waste is generated within the community to provide a sustainable input of organic waste to the facility.

However, as mentioned above, without community involvement and proper household waste separation, sourcing organic waste for the facility becomes an obstacle. Therefore, promotion, education, and training of household source separation are vital to community participation. This will determine the overall success in securing sufficient organic waste inputs for the facility.

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[35] New York City Department of Sanitation. Date published unknown. "New York City Composting Guide: What you need to know to start outdoor composting right now, right here in New York City." New York, NY.

[36] NIMCOSS (2009). *A Narrative Report on the Viability of Manual Composting in Avenor.* Accra, Ghana.

Community facility management is the second necessary element in ensuring adequate waste inputs. The facility must be suitably managed and youth must be competent in proper source separation in order to insure ample daily inputs of organic matter.

If securing household waste is problematic due to community participation, an additional option is obtaining organic waste from nearby markets. Avenor is located close to the central business district as well as market areas, and therefore obtaining market waste if necessary should be unproblematic. However, considerations of transporting market waste to the facility need to be assessed, as mentioned above in Section 8.6.1.

In order to maintain sustainable waste inputs, capacity requirements and compost facility designs in other communities should be determined based on daily community waste generation, total population size, and proximity to other sources of organic waste (i.e. market areas, farms).

9.8 *Potential Obstacles and Recommendations*

There are a number of potential complications that could impact the sustainability of the community compost operations at the Avenor site. Awareness of these possible obstacles is important in devising solutions or alternatives as necessary. Listed below are some concerns to be considered, some of which have been mentioned briefly in previous sections above.

9.8.1 Household Engagement and Cooperation in Source Separation

Household source separation is essential in order for composting to be a worthwhile operation. If the labor costs for source separation remain high, composting may not be valuable employment for youth. For example, if the time required to source separate outweighs the potential revenues gained by youth, they may be less willing to partake in employment in this sector, as the relationship between gained income and labor would become less appealing. Not only will labor for source separation induce a large time commitment, but it will consequently decrease the production of finished compost.

Therefore, household engagement is a vital component to the success of the composting facility under the YES project. Training and education of households should be a major focus of the project in order to sensitize households to the importance of source separation as a means to promote community development, youth employment, and community improvements in solid waste management. This also emphasizes the significance in determining proper incentives for community participation. The process of sensitizing and educating households on source separation should begin as early as

possible. Ideally, for future composting operations this process should begin prior to plant operationalization.

If source separation at the household level becomes problematic and has a negative impact on the efficiency of composting operations, additional household training and education should be emphasized. Incentives or disincentives currently in place should be reassessed and modified as necessary. The encouragement of household composting initiatives may help promote a better understanding of the benefits and process of composting. This understanding could help to encourage community support and engagement in source separation.

9.8.2 Sustainable Management of the Facility and Youth Engagement

There are two main activities which determine the sustainability of a for-profit composting operation: the production of compost, and its marketability. Assuming a steady input of organic matter, the greatest constraint on the first part of this equation—the generation of compost, relies on management. Inadequate attention to the biological process requirements of composting and lack of recordkeeping can greatly inhibit successful generation of high-quality compost.

Therefore, negligent management can impact the overall sustainability of composting operations. As mentioned above, given the importance of proper management, the assignment of facility managers is essential. Under the current project, managers have no additional provided incentive to supervise facilities. It is recommended that youth managers are offered additional incentives for their critical participation in these roles.

If production of compost becomes problematic due to inattentive management once the facility becomes operational, additional youth training and education may be required. A replacement manager or the addition of a management role within the facility should be considered.

9.8.3 Securing a Sustainable Market-base for the Sale of Compost

In order for the compost facility to become profitable, there must be a viable market for the sale of compost. In order to ensure this, good marketing programs and the optimization of the use of compost should be the basis of a successful for-profit compost project.

The first step in developing a market strategy is to assess all existing/potential markets for compost. As of this date, a market assessment is in development and YES has

identified a number of potential purchasers, including real estate developers, landscapers, small-scale vegetable farmers, and fertilizer industries.

A variety of factors can affect the marketability of finished compost, which should be considered in the market assessment. For instance, the availability and cost of other soil conditioners and chemical fertilizers, local agricultural practices, the reliability and quantity of compost production, compost quality (and how seasonal variation in the waste stream can impact quality), as well as any government policies (such as subsidies on chemical fertilizers, etc.).

Compost quality is especially important when determining a compost marketing strategy. While the high organic content in the municipal waste stream in Accra is ideal for composting, it also contains increasing quantities of plastics, metals, and other potentially hazardous materials which can contaminate finished compost. More efficient source separation prior to composting can aid in minimizing contamination of finished compost. Adequate source separation is additionally important, since high compost standards provide a valuable marketing tool. This is especially crucial for compost used for agricultural purposes.

Proper source separation is reliant on youth management as well as households, as mentioned above. Obstacles related to proper marketing, therefore, are also intimately tied to facility management and household engagement. Determining measures for effective source separation will hopefully provide solutions for a number of potential constraints. However, an in-depth market assessment and good marketing programs should also be focused upon.

10.0 Adoption of Community Composting in Other Sub-Metros of Accra

One of the purposes of the pilot facility in Avenor was to utilize its creation in order to determine is viability in other low-income communities in Accra. It is hoped that the project at Avenor can help inform the design and management of future small-scale community compost facilities. In addition, the successful operationalization of the Avenor plant can serve as a strong model for the promotion of composting programs in Accra, as well as an attractive option for solid waste management interventions in low-income communities in the area. More importantly, since source separation is a key element to community composting programs, household sensitization to environmental issues and the importance of waste handling may be a promising result of these efforts.

Since its establishment, the YES project has been further developed, and other communities have already embarked on preliminary design planning and siting of future compost facilities. The sub-metros of interest under the YES project include areas of Ayawaso Central, Ashiedu Keteke, and Ayawaso East. Some of the communities in these areas have already embarked on the initial design and planning phase for the compost plants. The planning designs were described briefly in Section 8.1 above, and will have an estimated plant capacity of approximately 14.71 tons, with a range of approximately 0.25 to 0.28

tons of organic waste to be composted daily. According to these calculations, it should take approximately 3-3.5 days to fill a single chamber (out of a total 17 chambers). Procedures for siting have been determined based on specific criteria as well as in accordance with EPA considerations. These criteria, as well as recommended criteria from outside sources, are discussed in further detail below.

10.1 *Siting criteria*

When determining the location of the facility within a community, a few specific considerations should be taken into account:

- Land availability and land tenure
- Proximity to waste generation sources, to ensure suitable service delivery while maintaining low transportation costs.
- Accessibility to households for waste collection and proximity to main roads for easy off-site final transport. These conditions should remain the same year-round.
- Easy access to a reliable water supply, and if possible to an electricity supply (although this is not essential)
- Composting sites should be located downwind of residential areas and should be located a specific distance from the nearest home (according to the EPA, the facility should be at a minimum of 70 feet from the nearest structure). Wind direction, especially in relationship to odor control, is prioritized as siting criteria by the EPA.[37]
- Locations characterized by densely-population residential areas should be avoided, as nearby residents may object to a neighboring compost plant. Although many of these communities are typically densely-populated, efforts should be made to acquire space in more open areas within these communities in order to avoid conflict with residents.
- Sites should not be located in flood-prone areas or at near wetland areas.
- There should be adequate land availability to account for the addition of a "buffer" zone (greenery, fencing, etc.).
- Ideally the composting site should be sited on slightly sloping land, or the soil around the area should be graded in order to avoid water logging and to facilitate proper drainage. [38]

[37] Housing for the Masses. *Workshop on Site Identification and Selection/Design Review: Community Mapping of Selected Sub-Metros for Land for the Design, Cost, and Establishment of Buy-Back Centers and Composting Plants.* CHF International. 10 June 2010.

[38] Enayetullah, Iftekhar and Rothenberger, Silke (2006). "Decentralized Composting for Cities of Low- and Middle-Income Countries: A User's Manual."

While there may be a number of other local or community-specific considerations, these are general concerns that should be regarded at the very least in the selection of facility sites.

10.2 *Obstacles and Possible solutions*

Many of the potential constraints to community composting within other areas are similar to those of Avenor, i.e. community involvement and household source separation, facility management and youth involvement, securing sustainable waste inputs and a market-base for compost, etc. However, there are some additional issues to be considered as well, as mentioned below:

10.2.1 Land Acquisition and Land Tenure

While land has been secured for the Avenor site, land ownership, tenure, and availability might become a serious constraint to the implementation as well as sustainability of future composting projects. The availability of suitable land in appropriate locations within the communities remains an important factor in the success of community composting projects. Siting of these facilities is clearly a vital consideration to their sustainable use, as they must be conveniently located and in proximity to a secure water source, meanwhile not becoming a nuisance to the community. Access to open land in Accra is becoming increasingly difficult due to rapid population growth and increasing population densities in both urban and peri-urban areas of the city. In addition, some of these low-income communities where facilities would be located are particularly densely populated and acquiring suitable land in these areas might be especially difficult. Densities of over 250 hectares per person have been recorded in low-income areas of Accra including Nima, New Town, and Jamestown, compared to population densities 17.5-40 hectares per person in higher income areas such as Airport Residential, North Ridge, and East Legon.[39]

Land tenure and ownership issues are also a major obstacle to securing space for compost sites. In order to conceptualize these difficulties, it is important to understand the history and politics of land ownership in Accra. Land ownership in the city can be categorized as public (state), private, and customary and access to land is maintained through formal and informal arrangements with these public, private, and customary land entities. Customary land ownership, recognized by the Republican Constitution of Ghana, is common in Accra and within many low-income neighborhood areas.

[39] WaterAid Ghana & United Nations Human Settlements Program (UN-HABITAT)(2009). *A Study on Land Tenure in Urban Areas Report.* Accra, Ghana.

Customary lands are generally held by families and clans, held in trust by the chief or head of family for the benefit of the group of ownership. Private ownership of customary land can be obtained via grant, sale, lease, gift, or marriage.

However, there are many overlapping and contradictory regulations in the legal framework for land ownership in Ghana, which complicates land transfers of public, private, and customary land. Over time this has resulted in the multiple sales of lands to private individuals by families and clans, numerous litigations, poor documentation of land transactions, and encroachment on public lands. Much of this situation is can be attributed to poor knowledge of land title acquisition and the bureaucratic nature of the process. Challenges with land tenure systems have resulted in delays with the implementation of many projects as well as increased costs in project implementation.[40]

Given this information, it is important that land acquisitions for composting sites are attained appropriately and all knowledge of prior land ownership is known. In addition, all possible land tenure concerns must be accounted for early on, in order to ensure sustainable land use for ongoing compost operations. While anticipating future dilemmas is challenging and may delay the project implementation in some areas, it is more important to be sure of proper land acquisition rather than succumb to land struggles later on, once capital investments have already been made.

10.2.2 Regulatory Requirements

The Environmental Protection Agency (EPA) in Accra maintains permitting requirements for composting operations that must be adhered to when establishing a composting facility. Regulatory legislation in Accra requires that an Environmental Impact Assessment (EIA) be conducted in order to operate a composting plant. According to the *EPA Environmental Assessment Regulations, 1999, Regulation (3) "Undertakings for which an Environmental Impact Assessment (EIA) is Mandatory*," Subpart *Section 15(b)* states that an EIA must be performed for waste treatment and solid waste of municipal solid waste including the "construction of compost plant,""construction of recovery recycling plant," or the "construction of waste depots." An Environmental Impact Assessment is defined by the EPA as *"the process for the orderly and systematic evaluation of a proposal including its alternatives and objectives and its effect on the environment including the mitigation and management of those effects; the process*

[40] WaterAid Ghana & United Nations Human Settlements Program (UN-HABITAT)(2009).

extends from the initial concept of the proposal through implementation to completion, and where appropriate, decommissioning."[41]

Upon submitting an application for an environmental permit requiring an EIA, the Agency may request the party to draft a preliminary environmental report. Once this has been reviewed and satisfied, the party may then proceed to conducting a scoping report to the EPA, which should include the scope or extent of the EIA which will be carried out by the applicant. The scoping report is then reviewed by the EPA. If accepted, the applicant may conduct an EIA as required and submit an environmental impact statement to the EPA (12 copies). The Agency will hold a public hearing in regards to the submitted statement and inform the applicant of their application status within 90 days of submission. Applicants will be subject to permitting fees; however the specific cost of permitting is not listed in the 1999 regulations. The EPA states that notifications in regards to current regulations are to be published in the Ghana *Gazette*, which may be a helpful resource for obtaining any information on updated regulatory guidelines.

If an environmental permit is granted, it is valid for 18 months from the date of issuance. The party must also submit an environmental management plan within 18 months of permit issuance, and every three years after the initial report. An annual report must also be submitted to the EPA. Failure to adhere to these requirements can result in a revocation of environmental permits.[42]

It is important that the community be aware of all regulatory requirements necessary for the establishment of a community composting facility, in order to avoid penalties and be in good standing with municipal bodies. It is recommended that a community member have frequent direct contact with an EPA affiliate in order to remain informed on all current and/or new environmental laws and permitting fees which may impact plant operations. The 1999 EPA document has been included in the Appendix of this report as a reference (See Appendix C).

[41] Accra Environmental Protection Agency (EPA)(1999). *Environmental Assessment Regulations, 1999: Arrangement of Regulations.* Regulation (3), Subpart 15(b). Published by Minister of the Environment. Ruling Docket. Date of Enforcement 24 June 1999, pp. 13.

[42] Accra Environmental Protection Agency (EPA)(1999). *Environmental Assessment Regulations, 1999: Arrangement of Regulations.* Published by Minister of the Environment. Ruling Docket. Date of Enforcement 24 June 1999.

10.2.3 Community Layouts and Future Land Development

Each community has a distinct geographic layout, which may affect access and influence the ease or difficulty of waste collection and the determined collection radius of individual youth. Some of these neighborhoods suffer from continuing land encroachment, which could result in the blockage of roads which are currently accessible at this point in time. This would not only hinder household collection routes, but could also impact transportation to the composting facility, an important consideration in facility siting (as mentioned above). Given these factors, specific community layouts and possible future land use changes (including any land use changes from planned/on-going intervention projects) should be appropriately considered as part of the site selection process.

11.0 Recommendations and Conclusions

Interventions in solid waste management in Accra are essential in facilitating much needed problem solving in water and sanitation. The YES project seeks to alleviate some of the challenges in solid waste management through the injection of new value chains within the sector, providing employment opportunities for community youth. The addition of the compost value chain is the focus of this report, specifically the establishment of community-level compost centers. This report has provided recommended guidelines and criteria for the successful operation of the pilot composting facility in Avenor. It also demonstrates the importance of composting as a solid waste management intervention, enabling waste minimization, increasing landfill capacity, and the enhancement of resource recovery; meanwhile promoting community engagement and employment opportunities for local youth. In order for composting operations under the YES project to be successful at Avenor and within other sub-metros/communities, a number of recommendations have been provided, based on the information gathered in this report.

Source separation & Community Engagement: This report has demonstrated that a number of problems must first be surmounted in order for the success of a composting project to be realized. The component of highest priority to this operation is *source separation*. Cooperation of households must be sought and promoted in regards to source separation. Households should be properly trained and communities must be sensitized about the importance of source separation in terms of the environmental health and sanitation improvements this will bring to their communities. Given the additional labor requirements of source separation, it is not sufficient to train households to separate wastes. Individuals must understand the value of these added efforts on an individual and community level, and must feel a social responsibility to his or her engagement in source separation efforts. This is an important component of community acceptance of the composting program, and therefore to the success of the program. Continuous sensitization on the benefits and requirements of solid waste

management as well as general health and environmental education within communities needs to be an integral element of solid waste management and composting efforts. This will also ease the labor requirements of employed youth in terms of time spent source separating wastes, and will likewise enable greater profit margins if youth are able to efficiently compost and resell reusable/recyclable items.

Youth should be trained in understanding the value of their work in terms of benefiting the community and the environment. Source separation is labor intensive and can be viewed as unpleasant. However, diligent source separation is key to higher quality compost. Therefore, youth must be dedicated to the process in order to ensure good management as well as sustainable and successful outcomes from the project.

If source separation cannot be adequately performed, this disrupts the success of the entire project. For instance, this narrows the market base for finished compost. Compost that is improperly source separated may include a higher content of heavy metal contamination. Heavy metal-contaminated compost should not be utilized in farming operations, as uptake of these contaminants can occur in agricultural products. It would be a health hazard and therefore irresponsible to market lower-quality and contaminated compost to local farmers and fertilizer companies. In the case that high-quality compost cannot be achieved due to limitations in source separation, it is recommended that the market base for finished compost should be limited to customers that are not involved in food production, such as real-estate developers and landscapers.

Investments in Facility Mechanization & Marketing: The market assessment for compost should continue, and viable markets should be sought and promoted in a timely manner. It is recommended that a market base for finished compost in Accra be determined prior to the full-scale implementation of the project in other communities, and prior to large capital investments.

Many different composting systems are available for consideration in this project. Since the YES project aims to employ as many youth as possible while still maintaining acceptable revenue generation per youth, highly mechanized compost facilities are not recommended at this time. Highly mechanized facilities not only require greater upfront capital costs, but this reduces the need for youth involvement, jeopardizing one of the key objectives of the YES project. Investments in high initial capital costs prior to an in-depth market assessment would also be a risky endeavor and may result in failures and loss of community support. However, there should remain a balance between labor requirements, youth employment, and acceptable revenue generation per youth based on the number of youth employed. If the work becomes too labor intensive with minimal opportunity for payment, greater mechanization needs to be considered in the planning process. Careful calculations should be made in order to determine the lowest amount of technology that can be utilized whilst still generating acceptable revenue per youth employed.

If the market for compost increases and greater outputs are required, greater mechanization can be considered at that time. Although the Avenor plant has already been constructed and other plants have

been designed, it is possible to add more mechanized technology at a later stage if it is deemed necessary. This would be a more prudent utilization of capital resources, meanwhile benefiting the largest number of youth.

Optimization & Integrated Interventions: Overall, composting systems generally require the optimization between transportation, land, labor, capital costs, feedstocks, and markets.[43] In order to successfully operationalize the Avenor facility as well as other community facilities, a necessary balance between these factors must be determined. It is also important to recognize that without community engagement, obtaining optimization of these factors would be difficult.

Composting is best incorporated as an integrated response to existing solid waste management systems, and is best utilized in cooperation with other efforts (i.e. recycling programs), especially since composting promotes more effective resource recovery. Better optimization can be achieved if composting is part of an integrated solid waste management strategy. In this case, appropriate processing technologies can be selected based on market opportunities, economic viability, and local community acceptance, in addition to the factors mentioned above. More cost effective and sustainable composting programs under the YES project can be achieved through integrated strategies, whereby revenues collected in other solid waste management areas can provide necessary support to composting efforts.

[43] Hoornweg, Daniel et. Al (1999). *Composting and its Applicability in Developing Countries.* Working Paper Series. Published for the Urban Development Division, The World Bank. Washington, D.C.

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APPENDICES

APPENDIX A: Photographs of Avenor Pilot Compost Facility

Photos of facility exterior

Signage posted on facility exterior

View of Odaw drain from facility

Facility roof structure

View of chambers after modifications (doors constructed)

View of Door to final chamber (for removal of finished compost)

View of addition of aeration holes (fitted with PVC piping)

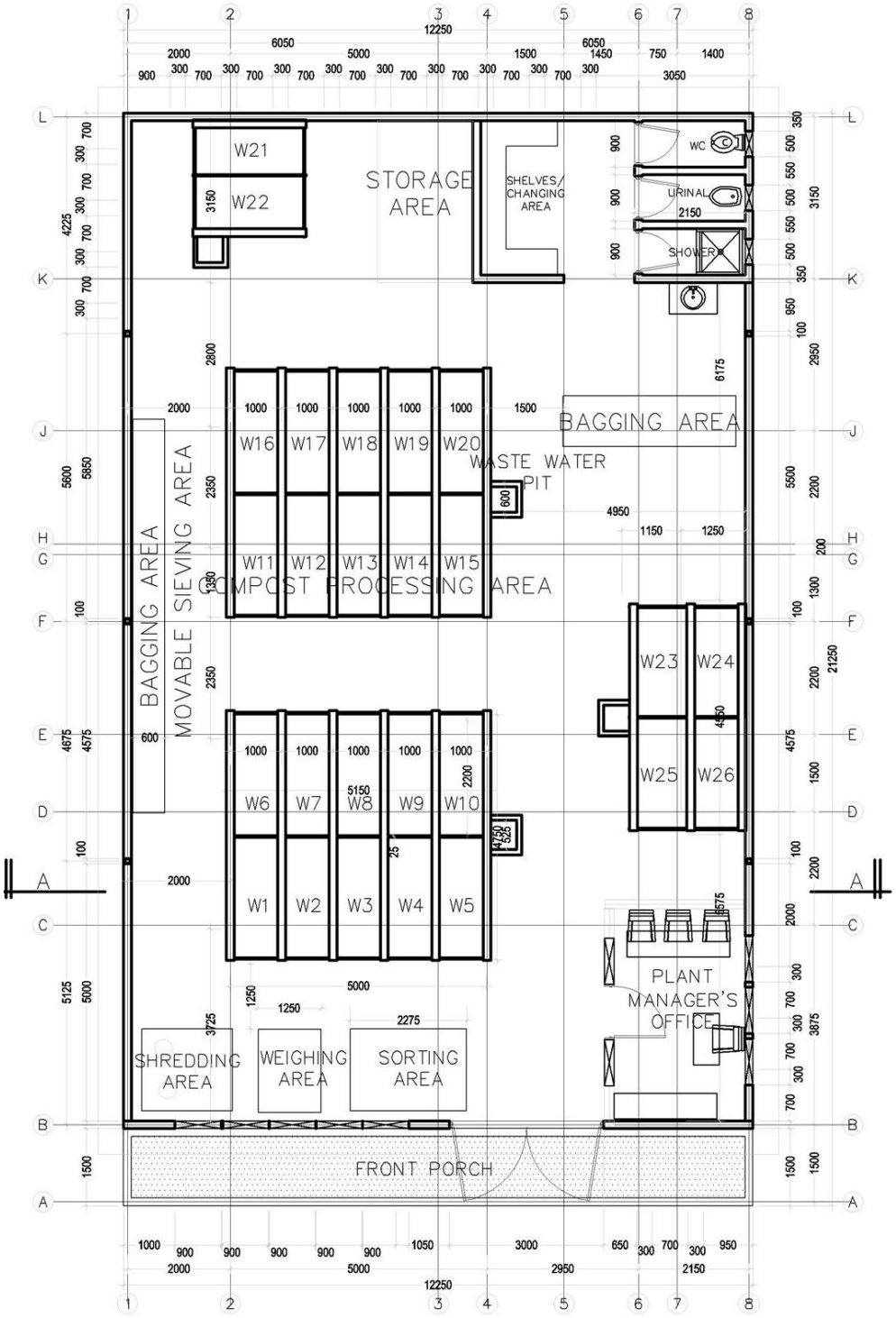
Aeration pipes to be inserted into composting organic matter

View of leachate collection pit

View of wire mesh coverings for odor control, also to be used for final sieving

View of drain in chamber (for leachate drainage).

APPENDIX B: Proposed Designs for Compost Facilities in Other Communities



GROUND FLOOR PLAN


COMPOST PROCESSING CENTER

APPENDIX C: EPA, Environmental Assessment Regulations, 1999

ENVIRONMENTAL ASSESSMENT REGULATIONS 1999

ARRANGEMENT OF REGULATIONs

PART I - ENVIRONMENTAL PERMIT

Regulation

PART II - PRELIMINARY ENVIRONMENTAL REPORT AND ENVIRONMENTAL IMPACT STATEMENT

ENVIRONMENTAL ASSESSMENT REGULATIONS, 1999

IN exercise of the powers conferred on the Minister responsible for the Environment under section 28 of the Environmental Protection Agency Act, 1994 (Act 490) and on the advice of the Environmental Protection Agency Board these Regulations are made this 18th day of February, 1999.

PART I - ENVIRONMENTAL PERMIT

Undertakings requiring registration and issue of environmental permit.

1. (1) No person shall commence any of the undertakings specified in Schedule 1 to these Regulations or any undertaking to which a matter in the Schedule relates, unless prior to the commencement, the undertaking has been registered by the Agency and an environmental permit has been issued by the Agency in respect of the undertaking.

2. No person shall commence activities in respect of any undertaking which in the opinion of the Agency has or is likely to have adverse effect on the environment or public health unless, prior to the commencement, the undertaking has been registered by the Agency in respect of the undertaking.

Existing undertakings

2. Where the Agency considers that any undertaking in existence on the date of the coming into force of the Regulations has or is likely to have adverse effect on the environment or public health, the Agency shall issue a written notice to the person responsible to seek registration and obtain an environmental permit in respect of the undertaking within such time as shall be specified in the notice.

Environmental impact assessment

3. No environmental permit shall be issued by the Agency for any of the undertakings mentioned in Schedule 2 to these Regulations unless there is submitted by the responsible person to the Agency, an environmental impact assessment in accordance with these Regulations in respect of the undertaking.

Application for environmental permit

4. (1) A person required under regulation 1 or 2 to register an undertaking and obtain an environmental permit shall submit to the Agency an application in such form as the Agency shall determine.

2. There shall be paid for the application such fee, as the Agency shall determine.

1. In addition to any information that an applicant is required to provide on application, the Agency may require an applicant to submit such other information on the undertaking as the Agency considers necessary for the initial assessment of the environmental impact of the undertaking.

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Initial assessment by screening of application

5. (1) The Agency shall on receipt of an application and any other relevant information required, as an initial assessment, screen the application taking into consideration

a. the location, size and likely output of the undertaking;

b. the technology intended to be used;

c. the concerns of the general public, if any, and in particular concerns of immediate residents if any;

d. land use; and

e. any other factors of relevance to the particular undertaking to which the application relates.

1. An applicant shall for the purpose of enabling the Agency determine the level of environmental assessment of his undertaking, prepare and submit to the Agency a report on the undertaking indicating in the report

a. the environmental, health and safety impact of the undertaking;

b. a clear commitment to avoid any adverse environmental effects which can be avoided on the implementation of the undertaking;

c. a clear commitment to address unavoidable environmental and health impacts and steps where necessary for their reduction; and

d. alternatives to the establishment of the undertaking.

Screening report

6. After the screening under regulation 5 the Agency shall issue a screening report on the application and shall state in the screening report whether the application

a. is approved; or

b. is objected to; or

c. requires submission of a preliminary environment report; or

d. requires the submission of an environmental impact statement.

Registration and issue of environment permit

7. (1) Where the Agency approves an application at the initial assessment, it shall register the undertaking, the subject of the application, and issue in respect of the undertaking an environmental permit.

1. Where the Agency on the initial assessment reports that it objects to the application the report shall constitute a non-acceptance of the application and the undertaking shall not be commenced or where it is in existence, be discontinued.

1. A determination by the Agency that, an application at the initial assessment, is approved, objected to, requires the submission of a preliminary environmental report or the submission of an environmental impact statement, shall be communicated to the applicant within 25 days from the date of the receipt of the application for an environmental permit.

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Fees for and publication of grant of environmental permit

8. (1) There shall be paid in respect of each environmental permit such fee as the Agency shall determine except that where for the purposes of granting the permit an environmental impact statement is required, the fee for the permit shall be 1 % of the development cost of the proposed undertaking.

2. The Agency shall publish in the Gazette and the mass media and in such form as the Agency shall determine notice of every environmental permit issued by it within 3 months of the date of issue of the permit.

PART II - PRELIMINARY ENVIRONMENTAL REPORT AND ENVIRONMENTAL IMPACT STATEMENT

Preliminary environment report

9. (1) Where the Agency upon consideration of an application decides that there is the need for a preliminary environmental assessment to be submitted in respect of the application, the Agency shall request the applicant to submit a preliminary environmental report on the proposed undertaking.

1. A preliminary environmental report submitted under subregulation (1) shall contain details other than information submitted with the original application for the environmental permit and shall state specifically the detailed effects of the proposed undertaking on the environment.

1. Where the Agency after consideration of a preliminary environmental report approves the report, it shall register the undertaking and issue in respect of the undertaking an environmental permit.

2. Where the Agency, upon receipt of a preliminary environmental report, is satisfied that a significant adverse environmental impact is likely to result from the activities of the undertaking the applicant shall be asked to submit an environmental impact statement on the undertaking in order that the environmental impact of the proposed undertaking can be assessed.

Environmental impact statement

10. (1) For the purpose of regulation 9(4) the applicant shall submit an environmental impact statement in respect of the proposed undertaking which shall be outlined in a scoping report to the Agency.

Scoping report

11. A scoping report shall set out the scope or extent of the environmental impact assessment to be carried out by the applicant, and shall include a draft terms of reference, which shall indicate the essential the essential issues to be addressed in the environmental impact statement.

Draft terms of reference

12. The draft terms of reference shall stipulate that the environmental impact statement on the proposed undertaking will deal with matters including the following -

a. a description of the undertaking;

b. an analysis of the need for the undertaking;

c. alternatives to the undertaking including alternative situations where the undertaking is not proceeded with;

d. matters on site selection including a statement of the reasons for the choice of the proposed site and whether any other alternative site was considered;

e. an identification of existing environmental conditions including social, economic and other aspects of major environmental concern;

f. information on potential, positive and negative impacts of the proposed undertaking from the environmental, social, economic and cultural aspect in relation to the different phases of development of the undertaking;

g. the potential impact on the health of people;

h. proposals to mitigate any potential negative socio-economic, cultural and public health impacts on the environment;

i. proposals to be developed to monitor predictable environmental impact and proposed mitigating measures;

j. contingency plans existing or to be evolved to address any unpredicted negative environmental impact and proposed mitigating measures;

k. consultation with members of the public likely to be affected by the operations of the undertaking;

1. maps, plans, tables, graphs, diagrams and other illustrative material that will assist with comprehension of the contents of the environmental impact statement;

m . a provisional environmental management plan;

n. proposals for payment of compensation for possible damage to land or property arising from the operation of the undertaking; and

o. an indication whether any area outside Ghana is likely to be affected by the activities of the undertaking.

Action on scoping report

13. (1) The Agency shall upon receipt of a scoping report examine it and inform the applicant within 25 days of the receipt of the report whether it is acceptable or not acceptable.

2. Where a scoping report is accepted by the Agency, it shall inform the applicant to submit an environmental impact statement based on the scoping report.

1. Where a scoping report is not acceptable by the Agency, the applicant shall be advised by the Agency to revise the report as appropriate and re-submit it if he so desires.

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Matters to be addressed in environmental statement

14. (1) In submitting an environmental impact statement pursuant to regulation 13(2), the applicant shall indicate in the document a clear assessment of the proposed undertaking on the environment based on the contents of the scoping report.

1. The environmental impact statement shall also address possible direct and indirect impact of the undertaking on the environment at the pre-construction, construction, operation, decommissioning and post-decommissioning phases including

a. concentrations of pollutants in environmental media including air water and land from mobile or fixed sources;

b. any direct ecological changes resulting from such pollutant concentrations as they relate to communities, habitats, flora and fauna;

c. alteration in ecological processes such as transfer of energy through food chains, decomposition and bio-accumulation which could affect any community, habitat or specie of flora or fauna;

d. ecological consequences of direct destruction of existing habitats from activities such as dumping of waste and vegetation clearance and fillings;

e. noise and vibration levels;

f odour;

g. vehicle traffic generation and potential for increase in road accidents;

h. changes in social, cultural and economic patterns relating to

i. decline in existing or potential use of valued resources arising from matters referred to in paragraphs (a) to (d) of this sub-regulation.

1. direct or indirect employment generation;

i. immigration and resultant demographic changes;

ii. provision of infrastructure such as roads, schools and health facilities;

iii. local economy;

iv. cultural changes including possible conflict arising from immigration and tourism; and

v. potential land use in the area of the proposed undertaking.

1. An environmental impact statement shall also include information on the possible health effect of the undertaking on persons within and around the vicinity of the proposed undertaking.

1. An environmental impact statement for mining and other extractive industry shall include reclamation plans.

Advertisement of scoping notice

15. (1) Where an applicant has been asked to submit an environmental impact statement it shall be the responsibility of the applicant to -

a give notice of the proposed undertaking to the relevant Ministries, government departments and organisations and the relevant Metropolitan, Municipal or District Assembly;

b. advertise in at least one national newspaper and a newspaper, of any circulating in the locality where the proposed undertaking is to be situated; and

c. make available for inspection by the general public in the locality of the proposed undertaking copies of the scoping report.

1. The Form in Schedule 3 of these Regulations shall be used for purpose of the advertisement required under sub regulation (1).

Considerations and review of environmental impact statement and publication of notices of environmental impact statement.

16. (1) The applicant shall submit 12 copies of the environmental impact statement to the Agency which shall review the environmental impact statement to the Agency which shall review the environmental impact statement.

1. The applicant shall also submit such copies of the environmental impact statement as the Agency shall direct to sector Ministries, government departments and organisations of relevance to the undertaking.

1. The Agency shall where it receives an environmental impact statement, publish for 21 days a notice which shall be in accordance with the form specified in Schedule 4, of the environmental impact statement in the mass media and also post at appropriate places such parts of the environmental impact statement as it considers necessary.

2. The cost of any notices of publication made under subregulation (3) shall be borne by the applicant.

3. The general public, relevant public agencies, organisations, NGOs, Metropolitan, Municipal and District Assemblies and local communities may make any comments, and suggestions on any matter on which notices are issued under this regulation.

Public hearing

17. (1) The Agency shall hold a public hearing in respect of an application where

a. upon a notice issued under regulation 16 there appears to be great adverse public reaction to the commencement of the proposed undertaking;

b. the undertaking will involve the dislocation, relocation or resettlement of communities; or

c. the Agency considers that the undertaking could have extensive and far reaching effect on the environment.

1. For the purpose of conducting a public hearing the Agency shall appoint a panel composed of not less than three persons and not more than five persons.

1. At least a third of the panel members shall be residents of the geographical area of the proposed undertaking and shall reflect representation of varying opinions, if any, on the subject of the hearing.

2. The chairman of the panel shall be appointed by the Agency from among the members but shall not be a resident of the locality of the proposed undertaking.

(5) The panel shall hear such persons and bodies that will make submissions to it; shall consider all submissions made to it and make its recommendations in writing to the Agency within a period of not less than 15 days from the date it starts hearing representations.

Review of environmental impact statement after public hearing

18. (1) A draft environmental impact statement shall be further reviewed by the Agency after receipt of recommendations following a public hearing.

1. Where after review, the draft environmental impact statement is found unacceptable by the Agency, the applicant shall be notified of this in writing and shall be required

a. to submit a revised environmental impact statement at a later date; or b. to conduct such further studies as the Agency considers necessary.

Finalisation of environmental impact statement and grant of environmental permit

19. Where an environmental impact statement is acceptable to the Agency this shall be communicated in writing to the applicant and the requisite environmental permits hall be issued to the applicant upon the submission of 8 hard cover copies of the approved environmental impact statement and a copy on floppy diskette.

Period for determination of an application

20. (1) Subject to the provisions of these Regulations an application for an environmental permit under these Regulations shall be finalized and communicated to the applicant by the Agency within a period of not more than 90 days from the date of receipt of the completed application form.

(2) Sub-regulation (1) does not apply -

a. to an application where public hearing is required to be held;

b. where only a preliminary environmental report is required by the Agency;

c. to the period taken to prepare and submit an environmental impact statement.

Validity of environmental permit

21. (1) Where an. environmental permit is granted to an applicant, the permit shall be valid for a period of 18 month effective from the date 'of the issue of the permit.

(2) Failure to commence operation of the undertaking within the 18 months as provided under sub-regulation (1) shall render the permit invalid after the period.

(3) Where an applicant whose permit becomes invalid under sub-regulation (2) requires a valid permit he shall resubmit an application to the Agency for approval to which the invalidated permit relates and provide reasons for the new application.

1. Upon consideration of an application under sub-regulation (3) the Agency may decide

a. that the assessment report already approved be used in respect of the re submitted application; or

a. that the assessment report be revised in such areas as the Agency shall direct.

Requirement for an environmental certificate

22. (1) Where an undertaking in respect of which a preliminary environmental report or an environmental impact statement is approved commences activities of the undertaking upon the issue of an environmental permit, the person responsible shall within 24 months of the date of the commencement of operations obtain an environmental certificate from the Agency.

1. An environmental certificate may be issued subject to such conditions as the Agency shall determine except that no such certificate shall be issued unless the person responsible has submitted to the agency evidence or confirmation of

(a) actual commencement of operations;

(b) acquisition of other permits and approvals where applicable;

(c) compliance with mitigation commitments indicated in the environmental impact statement or preliminary environmental report; and has submitted to the Agency its first annual environmental report as required under regulation 25.

(3) There shall be paid in respect of an environmental certificate such fee as the Agency shall determine.

Funds for reclamation

23. An undertaking in respect of which a reclamation plan is required shall be required to post reclamation bond based on approved work plan for reclamation.

Environmental management plan

24. (1) The person responsible for an undertaking in respect of which a preliminary environmental report or an environmental impact statement has been approved shall submit to the Agency an environmental management plan in respect of his operations within 18 months of commencement of operations and thereafter every 3 years.

(2) A person engaged in any of the undertakings mentioned in Schedule 1 which was in existence before the coming into force of these Regulations shall also submit an environmental management plan within 18 months from the coming into force of these Regulations and thereafter every 3 years.

(3) The environmental management plan shall be a document in such form as shall be determined by the Agency.

(4) The environmental management plan shall set out steps that are intended to be taken to manage any significant environmental impact that may result from the operation of the undertaking.

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PART III -MISCELLANEOUS PROVISIONS

Submission of annual environmental report

25. (1) A person granted an environmental permit under these Regulations shall submit an annual environmental report in respect of his undertaking after 12 months from the date of commencement of operations and after every 12 months thereafter to the Agency.

(2) The annual environmental report shall be in such form and contain such particulars as the Agency shall direct.

Suspension, cancellation or revocation of permit and certificates

26. (1) The Agency may suspend, cancel or revoke an environmental permit or certificate issued under these Regulations where the holder of the permit or certificate

a. fails to obtain any other authorisation required by law in relation to his undertaking before commencement of operations;

b. is in breach of any provision of these Regulations or any other enactment relating to environmental assessment;

c. fails to make any payments required under these Regulations on the due date

d. acts in breach of any of the conditions to which his permit or certificate is subject; or

e. fails to comply with mitigation commitments in his assessment report or environmentalmanagement plan.

(2) The Agency may also suspend an environmental permit or certificate in the event of occurrence of fundamental change~ in the environment due to natural causes before or during the implementation of the undertaking; and upon such change the environmental assessment report and the environmental management plan shall be revised on the basis of the new environmental condition.

Complaints by aggrieved persons.

27. (1) A person aggrieved by a decision or action of the Agency may submit a complaint in writing to the Minister.

(2) The complaint shall be submitted to the Minister within 30 days of the complainant becoming aware the decision or action to which the complaint relates.

1. The complaint shall

a. state the issues objected to;

b. have attached a copy of the decision objected to; and

c. have attached all documents relevant for considering and determining the complaint.

1. The Minister shall within 14 days of receipt of a complaint appoint a panel composed of

a. representative each of the following

i. the Ministry of the Environment not below the rank of a Director;

11. the Attorney-General's Department not below the rank of a Senior State Attorney;

iii. the Ministry with responsibility for the undertaking; and

a. two persons with specialization in the relevant field of the undertaking concerned.

1. The Minister shall refer the complaint to the panel, which shall give a fair hearing to all parties and determine the issue as it considers appropriate.

2. The panel after hearing all parties may

a. alter the decision of the Agency;

b. request the Agency to determine the application where applicable within a specified period;

c. give any other directives as it considers just.

1. A panel appointed under this regulation shall determine the matter and report to the Minister within 60 days from the date of reference of any matter by the Minister to it.

1. The proceedings of the panel shall be fully documented together with reasons for the panel's decision.

2. The panel shall cause copies of the decision and proceedings to be sent to

a. the Agency; and

b. the relevant Ministry.

Gazette publication

28. The Agency shall cause to be published in the Gazette notification of any codes of practice, standards, guidelines in connection

a. with matters provided for under these Regulations for the purpose of giving guidance; and

b. with matters relating to the protection, development and rehabilitation of the environment.

Offence and penalty

29. Any person who

a. commences an undertaking without an environmental permit issued in respect of the undertaking contrary to regulation (1);

b. fails to comply with directives of the Agency to register an undertaking and obtain an environmental permit contrary to regulations (2) or 2;

c. fails to conduct an environmental impact assessment in respect of an undertaking specified in Schedule 2 to these Regulations before commencement of the undertaking or as may be directed by the Agency contrary to regulation 3;

d. submits or provides the Agency with information required under any provision of these Regulations which he knows to be false;

e. fails to submit an annual environmental report as required under regulation 25; or

f. contravenes any provision of these Regulations.

commits an offence ENVIRONMENTAL ASSESSMENT REGULATIONS 1999

e. and is liable on summary conviction to a fine not exceeding 1/-2 million or imprisonment for a term not exceeding one year or to both and in the case of a continuing offence to a further fine not exceeding 1/-200,000 for each day the offence is continued.

Interpretation

30. (1) In these Regulations unless the context otherwise requires

"the Act" means the Environmental Protection Agency Act, 1994 (Act 490); **"adverse effect on the environment or public health"** means any change that an undertaking may cause to the environment and includes the effect of any change on health, socio-economic and cultural conditions;

"Agency" means the Environmental Protection Agency established by the Environmental Protection Agency Act, 1994 (Act 490).

"environmental assessment" means the process for the orderly and systematic identification, prediction and evaluation of

(a) the likely environmental, socio-economic, cultural and health effects of an undertaking; and

(b) the mitigation and management of those effects;

"environmental impact assessment" means the process for the orderly and systematic evaluation of a proposal including its alternatives and objectives and its effect on the environment including the mitigation and management of those effects; the process extends from the initial concept of the proposal through implementation to completion, and where appropriate, decommissioning;

"environmental impact" includes any direct or indirect, positive or negative change in the environment caused by man-made works or activity when such change affects life in general, biodiversity, the quality or a significant quantity of natural or environmental resources and their use, well being, health, personal safety, habits and customs, the cultural heritage or legitimate means of livelihood;

"environmental impact statement" means a document prepared by an applicant to present the case for the assessment of his proposal as part of the environmental impact assessment process;

"environmental permit" means an environmental authorisation to commence a proposed undertaking or continue with the undertaking, issued after registration of the undertaking or upon submission of a preliminary environmental report or environmental impact statement;

ENVIRONMENTAL ASSESSMENT REGULATIONS, 1999

"Minister" means the Minister responsible for the environment;

"Mitigation" means, in respect of a proposed or existing undertaking the elimination, reduction or control of the adverse environmental effects of the undertaking, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means;

"NGOs" means non-governmental organisations;

"occurrence of fundamental change in the environment" means the alteration of the environmental profile which was used as the basis of the environmental impact statement;

"person responsible" has the same meaning as provided for under the Act;

"**preliminary environmental report**" means a document containing detailed information other than information contained in the registration form especially detailing the effects which the undertaking would have on the environment as defined in the screening report;

"**scoping report**" means a report that summarizes the results of a scoping;

"**screen**" means the initial assessment of an application for an environmental permit, including a consideration of the factors set out in regulation 5 of these Regulations;

"**Screening report**" means a report that summarizes the results of a screening;

"**undertaking**" means any enterprise, activity scheme of development, construction, project, structure, building, work, investment, plan, programme and any modification, extension, abandonment, demolition, rehabilitation or decommissioning of such undertaking, the implementation of which may have a significant impact.

"**reclamation bond**" means performance bond, mining bond or rehabilitation bond or funds set aside in a reputable bank agreed upon by the Agency and the person responsible as a security deposit against default on reclamation or rehabilitation of disturbed land arising out of the undertaking.

"scoping" means an assessment that is carried out pursuant regulation 11 of these Regulations.

(2) For the purpose of these Regulations the areas specified in Schedule 5 are environmentally sensitive

ENVIRONMENTAL ASSESSMENT REGULATIONS, 1999

SCHEDULE 1 (Regulation 1(1)) **UNDERTAKINGS**

REQUIRING REGISTRATION AND ENVIRONMENT

PERMIT AGRICULTURAL AND RELATED SERVICE

I. AGRICULTURE

Community pastures

a. involving the clearing of land of greater than 40 hectares in area; or

b. involving the clearing of land located in an environmentally sensitive area.

Fruit and other vegetable farms

Management areas

(a) involving the clearing of land of greater than 40 hectares in area; or

(b) involving the clearing of land located in an environmentally sensitive area.

FISHING AND TRAPPING

Fishing

a. fish or shell fish farming in salt water, brackish water or fresh water, where the proposal includes the construction of shore-based facilities other than wharves;

b. permanent traps or weir fisheries, salt water.

Services incidental to fishing –

Fish or shellfish breeding and propagating services, or fish or shellfish hatchery services, where the proposal includes the construction of shore based facilities other than wharves.

3. LOGGING AND FORESTRY

Logging -

Management of forested land for the primary purpose of harvesting timber in a contract area.

4. FORESTRY SERVICES

Forestry services

a. application of pesticides;

b. introduction of exotic species of animals, plants or microbial agents.

ENVIRONMENTAL ASSESSMENT REGULATIONS, 1999 **MINING**

(INCLUDING MILLING), QUARRYING AND OIL WELLS

5. MINING

a. metal mines;

b. non-metal mines.

6. CRUDE OIL AND NATURAL GAS

a. crude oil or petroleum production facilities;

b. natural gas production facilities.

7. QUARRIES AND SAND PITS

Stone quarries

a. where the total area is greater than 10 hectares, or

b. where any portion is to be located within an environmentally portioned area.

Sand and gravel pits

a. where the total area is greater than 10 hectares, or

b. where any portion is to be located within an environmentally sensitive area.

MANUFACTURING

8. FOOD

Meat and poultry products

a. abattoirs;

b. meat, fat or oil processing facilities

c. poultry processing facilities.

Fish products

Flours, prepared cereal foods and feeds

Feed mills

9. BEVERAGES

a. distillery products;

b. brewery products;

c. wines

10. RUBBER PRODUCTS

a. tyres and tubes;

b. rubber hoses and beltings;

c. other rubber products

11. PLASTIC PRODUCTS

a. foamed and expanded plastic products;

b. plastic pipes and pipe fittings;

c. plastic films and sheetings;

d. other plastic products

12. LEATHER AND ALLIED PRODUCTS

13. PRIMARY TEXT

a. man-made fibres and filament yarns;

b. spun yarns and woven cloths;

c. broad knitted fabrics

14. TEXTILE PRODUCTS

a. natural fibres processing and felt products;

b. carpets, mats and rugs;

c. canvas and related products

d. other textile products.

15. WOOD

a. sawmill, planning mill and shingle mill products industries;

b. veneers and ply woods;

c. other wood products;

d. wood preservation facilities which use hazardous chemicals or similar chemical processes;

e. particle board or wafer board production.

16. PAPER AND ALLIED PRODUCTS

a. pulp and paper;

b. asphalt roofing;

c. other converted paper products.

17. PRIMARY METALS

18. FABRICATED METAL PRODUCTS

19. TRANSPORTATION EQUIPMENT

Leather and allied products

Leather

tanneries

Shipbuilding and repair Facilities engaged in building and repairing all types of ships above 4,000 tonnes displacement including marine production platforms for petroleum, natural gas or mineral resource extraction.

NON-METALLIC MINERAL PRODUCTS

20. REFINED PETROLEUM PRODUCTS

b. agricultural chemicals;

c. plastics and synthetic resins;

d. paints and varnishes.

e. Soaps and cleaning compounds;

f. Other chemical products.

22. OTHER MANUFACTURING

Scientific and Professional Equipment

a. photographic films and plates manufacturing;

b. floor tiles, linoleums and coated fabrics manufacturing;

c. other manufactured products.

23. CONSTRUCTION

Industrial construction (other than building)

a. construction of pipelines for the transmission of oil, natural gas and other related products from the source to the point of distribution, where

1. any portion of the pipeline is to be located at a distance greater than 500 meters from an existing right-of-way; or

Ii. any portion of the pipeline is to be located in an environmentally sensitive area;

b. diesel electric power generating plants having a capacity greater than 1 megawatt;

a. gas turbine electric power generating plants having a capacity greater than 1 megawatt;

b. nuclear electric power generating plants.

24. HIGHWAYS AND HEAVY CONSTRUCTION

a. roads

b. waterworks and sewage system

i. construction of trunk pipelines for transmission of water from the source to the point of distribution;

ii. construction of trunk sewer pipelines; Iii. construction of trunk sewer pipeline outfalls.

c. hydroelectric power plants and related structures

i. construction of dams and associated reservoirs;

ii. inter-or intra-basin water transfers;

Iii. construction of hydroelectric power developments.

25. UTILITIES

a. establishment of waste disposal sites;

b. establishment of facilities for the collection or disposal of hazardous waste materials.

WHOLESALE TRADE

26. PETROLEUM PRODUCTS

Petroleum products, wholesale Establishment of petroleum products storage facilities

27. OTHER PRODUCTS, WHOLESALE

Waste materials, wholesale

Establishment of facilities for purpose of assembling, breaking up, or sorting.

Wholesale trading of scrap, junk or waste material of any type.

28. SERVICES

Economics services administration

a. resource conservation and management programmes involving introductions of exotic species of animals or plants for any purpose;

b. resource conservation and management programs involving introductions of natives species of animals or plants into ears where those species do not occur at the time of the proposed introduction; .

c. designation of land for cottage development or other recreational development.

ACCOMMODATION, FOOD AND BEVERAGE SERVICES

29. ACCOMMODATION SERVICES

Establishment of recreation and vacation camps.

30. AMUSEMENT AND RECREATIONAL SERVICES

Commercial spectator sports

a. establishment of horse racetrack operations;

b. establishment of racetrack operations for motorized vehicles sports and recreation clubs and services;

c. establishment of facilities, including trails,

d. establishment of outdoor firearm ranges;

e. establishment of marina operations;

f. establishment of facilities, including trails, for motorized recreational vehicles;

g. other amusement and recreational services.

ENVIRONMENTAL ASSESSMENT REGULATIONS, 1999

SCHEDULE 2

(Regulation 3) UNDERTAKINGS FOR WHICH

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) IS

MANDATORY

a. land development for agriculture purposes not less than 40 hectares;

b: agricultural programmes necessitating the resettlement of 20 families or more.

2. AIRPORT

Construction of all airport or airstrips as well as the enlargement of existing airports airstrips.

3. DRAINAGE AND IRRIGATION

a. construction of dams and man-made lakes;

b. drainage of wetland;

c. irrigation schemes.

4. LAND RECLAMATION

a. coastal land reclamation;

b. dredging or bars, estuaries.

5. FISHERIES

a. construction of fishing harbors;

b. harbor expansion;

c. land based aquaculture undertaking.

6. FORESTRY

a. conversion of hill forest land to other land use;

b. logging or conversion of forest land to other land use within the catchment area of reservoirs used for water supply, irrigation or hydro-power generation or in areas adjacent to forest, wildlife reserves;

c. conversion of wetlands for industrial, housing or agricultural use.

7. HOUSING

a. human settlement development undertaking;

b. housing development.

8. INDUSTRY

a. chemical - where production capacity of each product or combined products is greater than 100 tonnes/day;

c. petrochemicals - all sizes or raw materials requirements of 100 tonns/day or greater;

d. c. non-ferrous-smelting

i. aluminum - all sizes;

ii. copper - all sizes;

iii. others -producing 50 tonns/day and above product;

a. Non-metallic -cement

lime - 10 tonns/day and above burnt lime rotary kiln or 50 tonns/day and above vertical kiln.

a. iron and steel;

b. shipyards;

c. pulp and paper.

9. INFRASTRUCTURE

a. construction of hospitals;

b. industrial estate development;

c. construction of roads and highways;

d. construction of new townships;

e. construction of railways.

10. PORTS

a. construction of ports;

b. port expansion involving an increase of 25 per cent or more in handling capacity per annum.

11. MINING

a. mining and processing of minerals in areas where the mining lease covers a total area in excess of 10 hectares;

b. quarries

Proposed quarrying of aggregate, limestone, silica, quartzite, sandstone, marble and decorative building stone within 3 kilometers radius of any existing village, residential, commercial or industrial areas, or any area earmarked for residential, commercial or industrial development;

c. sand dredging.

12. PETROLEUM

a. oil and gas fields development;

b. construction of off-shore and on-shore pipelines;

c. construction of oil and gas separation, processing, handling and storage facilities.

d. construction of oil refineries;

a. construction of product depots for the storage of petrol, gas or diesel which are located within 3 kilometers of any commercial, industrial or residential areas.

13. POWER GENERATION AND TRANSMISSION

a. construction of steam generated power stations;

b. dams and hydroelectric power schemes;

c. construction of combined cycle facilities in national parks;

d. construction of nuclear-fueled power stations;

e. erection of power transmission lines.

14. RESORT AND RECREATIONAL DEVELOPMENT

a. construction of coastal resort facilities of hotels with more than 40 rooms;

b. hill top resort or hotel development;

c. development of tourist or recreational facilities in national parks;

d. development of tourist or recreational facilities on islands waters.

15. WASTE TREATMENT AND DISPOSAL

a. toxic and hazardous waste

i. construction of incineration plant;

ii. construction of recovery plant (off-site)

iii. construction of wastewater treatment plant (off-site);

iv. construction of secure landfills facility;

v. construction of storage facility (off-site)

a. municipal solid waste

i. construction of incineration plant;

ii. construction of composing plant;

iii. construction of recovery recycling plant;

iv. construction of municipal solid waste landfill facility;

v. construction of waste depots.

a. municipal sewage

i.construction of wastewater treatment plant;

ii. construction of marine outfall;

iii. night soil treatment.

16. WATER SUPPLY

a. construction of dams impounding reservoirs;

b. groundwater development for industrial, agricultural or urban

17. ENVIRONMENTAL CONSERVATION AND MANAGEMENT

a. activity to remove "designated" status from an area designated for wildlife conservation and management;

ENVIRONMENTAL ASSESSMENT REGULATIONS, 1999

a. activities relating to

i. wildlife conservation and management;

ii. forest conservation and management;

iii. watershed conservation and management;

iv. commercial exploitation of fauna and flora

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SCHEDULE 3 (Regulation 15 (2» ENVIRONMENTAL

IMPACT ASSESSMENT (EIA) SCOPING NOTICE

(Name of company/organisation)

... proposed to establish a

. . . .. … at……in the ……

(Project Undertaking) (Location)

. .. . ., of the ……

Notice of the proposed……..is hereby served for public

Date:

ENVIRONMENTAL ASSESSMENT REGULATIONS, 1999

SCHEDULE 5 (Regulation 30 (2)) ENVIRONMENTALLY

SENSITIVE AREAS

1. All areas declared by law as national parks, watershed reserves, wildlife reserves and sanctuaries including sacred groves.

2. Areas with potential tourist value.

3. Areas which constitute the habitat of any endangered or threatened species of indigenous wildlife (flora and fauna).

4. Areas of unique historic, archaeological or scientific interests.

5. Areas which are traditionally occupied by cultural communities.

6. Areas prone to natural disasters (geological hazards, floods, rainstorms, earthquakes, landslides, volcanic activity etc.)

7. Areas prone to bushfires.

8. Hilly areas with critical slopes.

9. Areas classified as prime agricultural lands.

10. Recharge areas of aquifers.

11. Water bodies characterized by one or any combination of the following conditions

a. water tapped for domestic purposes;

b. water within the controlled and/or protected areas;

c. water which support wildlife and fishery activities.

12. Mangrove area~ characterised by one or any combination of the following conditions

a. areas with primary pristine and dense growth;

b. areas adjoining mouth of major river system;

c. areas near or adjacent to traditional fishing grounds;

d. areas which act as natural buffers against shore erosion, strong winds or storm floods.

CLETUS AVOKA

Minister Responsible for the

Environment

Date of *Gazette* notification: 26th February 1999.

Entry into force: 24th June, 1999