MINISTRY OF LOCAL GOVERNMENT AND RURAL DEVELOPMENT

REPUBLIC OF GHANA

GREATER ACCRA REGIONAL COORDINATING COUNCIL

Local Service Delivery and Governance Programme (LSDGP)

ENVIRONMENTAL SANITATION SUB-COMPONENT

FINAL DETAILED DESIGN REPORT FOR SMALL TOWNS ENVIRONMENTAL SANITATION IMPROVEMENTS, AKPLABANYA-

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1.0 INRODUCTION

1.1 Background

The Government of Ghana has received a Grant from the Government of Denmark through the Danish International Development Assistance (DANIDA) towards the cost of the Environmental Sanitation Subcomponent of the Local Service Delivery and Governance Program (LSDGP).

The programme seeks to provide Environmental Sanitation Infrastructure in selected Small Towns in the Central, Greater Accra, Eastern and Volta Regions and also strengthen institutions at the District Assembly and Community levels in operation and maintenance of sanitary facilities.

In line with this, the Greater Accra Regional Coordinating Council contracted WasteCare Associates (Consulting firm) to carry out environmental sanitation studies, for Obom, Akplabanya, and Kordiabe in the Ga South, Dangme East and Dangme West Districts respectively. The study covered amongst others, the following environmental sanitation components:

- Storm-water drainage and sullage conveyance;
- Excreta management;
- Watershed management;
- Solid waste management;
- Environmental burdens and public health.

The key outputs of the first phase of assignment were **town environmental sanitation development plans** (TESDPs), financing packages defined for sub-projects and preliminary engineering designs of proposed facilities for improving the environmental sanitation situation in the three communities.

However, under the LSDGP, there is funding for implementation of the recommendations made based on the studies carried out, in only one of the three communities in which the studies were conducted. Consequently, the Greater Accra Regional Coordinating Council selected Akplabanya to benefit from the second phase of the assignment which entails preparation of detailed engineering designs, assistance in tendering, construction supervision and post construction activities.

1.2 Scope of Services

The scope of services for the second phase of the consultancy assignment is in two parts:

The first **Part** involves:

(i) Carrying out verifications and final validation studies in Akplabanya
(ii) Preparation of detailed engineering designs and cost estimates,
(iii)Preparation of tender documents,
(iv)Evaluation of tenders.

The second **Part** involves:

(i) Preparation of contract documents,
(ii) Supervision of construction works,
(iii) Preparation of monthly progress reports,
(iv) Preparation of Facilities Management Plans (FMPs),
(v) Preparation of practical completion report,
(vi) Preparation of As-built drawings and As-built costs,
(vii) Preparation of final completion report

1.3 Stages of the Consultancy Assignment

Assignment for the remaining duration of the project will be carried out in accordance with the stages of activities outlined below:

STAGE 1: PRE-CONSTRUCTION AND DETAIL DESIGN STUDIES.

Activity 1: General project management & quality assurance, reviews and reporting
Activity 2: Verifications, validation studies and final field consultations on approved interventions in Akplabanya
Activity 3: Detailed architectural and engineering drawings of proposed sanitation interventions
Activity 4: Preparation of draft and final versions of tender documents and engineering estimates
Activity 5: Technical assistance in tendering and bidding process

STAGE 2: CONSTRUCTION SUPERVISION

Activity 6: Construction Supervision

STAGE 3: POST- CONSTRUCTION

Activity 7: Post Construction Services and Defects Liability Management
Activity 8: Preparation of Facilities Management Plans (FMPs)
Activity 9: Training and Implementation of FMPs
Activity 10: Support to Procurement of Logistics, Equipments and Machinery

1.4 Brief Description of Akplabanya

1.4.1 Location

Akplabanya is located in the Dangme East District of Greater Accra Region, Ghana. Geographical coordinates are Latitude 5º45´ south to 6º00´ north of the Equator and Longitude 0º20´ west to 0º35´ east of the Greenwich Meridian. The community is accessed by the Tema-Aflao main asphalt road, 11 kilometres south of Sege.

1.4.2 Socio-economic Profile

Akplabanya is a fishing community with four residential settlements all joined together. The community's built up area is along the shore. Due to persistent sea erosion new areas are springing-up further inland and away from the shore towards the northern sections of the community.

The population of the area has grown steadily. The current growth rate is around 3.4 percent and community's current population is estimated as 5741 comprising 2726 males (48.9%) and 3015 females (51.1%).

Economic activities in the area include fish mongering, dressmaking, hairdressing, food vendoring (kenkey/banku/fufu) petty trading, etc. The area has no health post. There are about 4 churches, 1 complex basic school (Akplabanya Basic School)

1.5 A Recap of Proposed Service Improvement Programme

1.5.1 Drainage and Sullage (grey-water) Conveyance Improvement Scheme

There is currently no drainage system in Akplabanya. We proposed to provide 400m length of drain in sanitary site which should be linked to a suitable outfall.

For improving sullage disposal, 380 households were selected and approved to benefit from properly designed and constructed soakage pit with concrete covers.

The proposed interventions for package 1 included;

- 200m length of outfall drain whose location will be determined by Consultants final validation studies
- Provision of 75 households in Akplabanya with properly designed and constructed soakage pit with concrete covers

1.5.2 Excreta Management (faecal liquid waste) Improvement Programme

The comprehensive Town Environmental Sanitation Plan outlined the following as interventions for improving liquid waste management covering homes, institutions and public facilities.

A. Home Latrine Promotion Programme:

Under this programme, it was proposed to encourage, raise awareness and intensify marketing of household latrine construction to home-owners through trained latrine artisans. It was also proposed that district Environmental Health Office will be used in achieving awareness raising and hygiene education and ultimately applying Community-Led Total Sanitation (CLTS) strategies to achieve a sustainable HLPP in Akplabanya.

Training for two (2) artisans in latrine construction and marketing to home owners was also proposed.

B. School Sanitation and Hygiene Education (SSHE):

Our (SSHE) centered on the provision of improved facilities in selected schools and based on the assessment of SHEP effectiveness, the provision of teaching and learning materials as part of re-orientation training for SHEP facilitators.

Under package 1 of the interventions, training of two (2) selected SHEP facilitators in Schools Hygiene Promotion Programme was proposed.

C. Public and Neighbourhood Facilities Improvement Programme:

Under this programme we recommended replacement of existing but dilapidated facilities and instituting efficient management for the selected facilities.

Details was to start with the replacement of three (3) dilapidated 10- Seater KVIP toilets with 1 No.- 20 seater WC toilet with ground septic tanks in addition to the new 12-seater WC currently not in use.

We also proposed an appropriate O&M strategy which is the establishment of private management franchises, as already existing for the management of the new 12-seater WC facility.

The construction of one (1) new 10-seater WC toilet facility for the primary and JHS school in Akplabanya was proposed as to augment the existing 12 seater KVIP.

1.5.3 Solid Waste Management Improvement Programme

The audit and assessment studies revealed that secondary storage facilities are not available in Akplabanya. To prevent indiscriminate littering and the widespread dumping provision of communal storage facilities was recommended.

The detailed plan is to evacuate refuse from open dump sites and identify appropriate sites for the provision of 3-fenced, gated and paved sanitary sites with toll booths at three strategic locations in the community.

Ancillary facilities to be provided are 3-15m^3 communal refuse bins mounted on 3 concrete skips/ refuse holding bays.

Site improvement will be carried out at each of these sites including restoration of wetland pits. The schools will also be provided with litter bins. Financial constraints will allow for

The low-lying nature of Akplabanya and its proximity to the sea will render on-site solutions like composting and dedicated disposal site difficult unless raising the ground or platforms are resorted. The potential for installing buy-back centres at strategic locations within the district to serve coastal communities including Akplabanya and nearby towns (e.g. Sege) to feed artisanal thin-film plastic processing plants will be explored.

Upon extensive discussions with District officers, key among them was the District Chief Executive; a site was identified at Todze for the location of the facility. The site is easily accessible by vehicles, water and electric connections are close by, hence making it a suitable site for the location of the facility.

The provision of artisanal buy-back centres and processing plants, compost plants and the promotion of household-latrines all have potential for creating jobs for the youth, especially for females who make up a larger proportion of the youth (20-45 yrs) in rural communities. This is in line with government's goal of improving sustainable employment opportunities for the youth.

1.5.4 Improvement of Wetland Management

The Akplaba lagoon basin and areas around it as well as the beach have been filled with garbage and human excreta. The effect of implementing the various programmes above will be to improve the ecological property of the wetlands.

1.5.5 Programme for Institutional and Management Support

The delivery of the various components of the Town Environmental Sanitation Development Plan and their management depends on improving the capacity of the front-line institutions responsible for the services. As a matter of strategy although financing of the various components may come from different sources, each of these sources will contribute to the implementation of a single, comprehensive and integrated capacity development programme anchored around the District Environmental Health Management Department (including DWST) of DEDA and the Area Council covering Akplabanya.

The immediate support will be to strengthen and improve the EHMD in DEDA including provision of equipment and refurbishment of offices and the provision of targeted training to its staff.

1.6 Preliminary Design Recommendations for Sanitation Improvement in Akplabanya

Improvement Intervention	Total	Package 1	Package 2	Package 3
1. Drainage and Sullage Improvement				
Drain in sanitary sites and linked to suitable outfall or soakaway (m-length) U-450 concrete	400	200	200	
Deep chambers made with block-work , plastered and pit filled with stones and covered with concrete covers -1mx 1m x 1m(No.)	380	75	125	180
2. Excreta (Liquid Waste) Management				
Home Latrine Promotion				
Community- Led Total Sanitation Programme	-			
Artisan Training and Support to Sanitation Marketing (No.)	5	2	2	1
School Sanitation and Hygiene Educ.				
Provision of TLMs for hygiene promotion	-			
Training of SHEP Facilitators (No.)	5	2	2	1
Public Facilities Programme				
20 seater WC toilets with septic tanks (1 No., 114.4m2 per toilet)	2	1	1	
10 seater WC toilets with septic tanks (1No., 57.2m2 per toilet)	1	1		
3. Solid Waste Management				
Develop improved collection programme for households (No. of Houses) provision of litter bins (50 L)	753	200	253	300
Provide sanitary sites with ancillary facilities (communal containers -15m^3, toll booths and refuse holding bays) (No.)	3	2	1	
Establishment of buy- back centre and artisanal processing plant for thin film and rubber.	2	1	1	
Provision of litter bins to institutions (120 L)	3	3		
4. Improvement of Wetland Management				
Evacuate refuse and Plant trees (No. of sites)				
Component 5: Management Support				
Provision of Office equipment to DEHMD-DEDA				
Technical Assistance - including project(s) preparation				
Training: CLTS, latrine promotion & construction, environmental management and planning and costing for DESSAP				

1.7 Structure of Draft Detailed Design Report

The Consultant provided, as required by the Client ten (10) copies of the detailed design reports for review and approval. This report final report has therefore incorporated all agreed comments and suggestions by client and other stakeholders.

The report has 7 chapters. Chapter 1 of the report gives mainly the background to the project implementation. The second chapter presents issues raised at validation meetings held with the key person from the district assembly and community. Detailed engineering analysis for the various interventions is discussed in Chapter 3. In the fourth chapter potential sources of construction materials is presented. Summary of recommended interventions and estimated cost are presented in Chapters 5 and 6 respectively. The seventh chapter present content of the Tender document.

2.0 VERIFICATIONS AND VALIDATIONS ANALYSIS

2.1 General

A team from WasteCare visited Akplabanya to verify and validate the recommended scope of interventions to be carried out under the project in Akplabanya.

The objectives of the visit include;

- Identifying befitting a location for the construction of 200m drain in the community;
- Identifying a suitable location for the construction of the proposed buy-back centre;
- Confirmation of the site for construction of a public sanitary site for the community with facilities such as 20-seater WC toilet, refuse skip pads, drainage, toll booth and fencing;
- Confirmation of the site for the construction of a 10 seater WC toilet for one of the schools in the community.

A second meeting was held at the assembly hall of the district assembly to take on board all comments after the presentation of the draft reports.

2.2 Outcome of Meetings

The WasteCare team was accompanied by Mr. Divine Kpoh (Environmental Health Officer), Honourable Amos Dotse (Assemblyman) and some elders from the Akplabanya chief's palace for the final validation studies.

2.2.1 Site for new school toilet facility

A new location was identified for the siting of the school toilet facility. According to the community representatives the school is relocating to this newly proposed site.

2.2.2 Finalization on location of Public Sanitary Site

The site meant for the 20 seater WC toilet facility for the community is been encroached upon and advancing towards the cemetery and an adjoining land which belongs to an individual in the community.

Another concern is the two dilapidated community latrines located within the site which poses additional cost burden on the project (i.e. cost of evacuation of raw sewage in the dilapidated toilets and demolition to make way for construction of new facilities).

The community has on this note identified a "virgin" land where the new public sanitary site should be located.

2.2.3 Selection of Site for Buy-Back Centre

With regards to the selection of the best site for the buy-back centre, after a meeting with the District Chief Executive, it was agreed that, the buy-back centre be located at a dumpsite between Kone and

Baadzoohe due to its easy access, relative closeness to the main road and the availability of land. An initial visit was made to the proposed site and initial measurements taken. Again due to perceived challenges with acquistion of land a site located at Todze was proposed.

2.2.1 Location of 200m drain in the community

On the issue of the location of the 200m length drain, the community identified Sanglatey as critical location for siting of the drain (see plates 1 & 2). This is to drain stagnant water which breeds mosquitoes and produce foul smell. Upon further engineering analysis, it came out that Akplabanya needs an extensive drainage network system. Hence the idea of the construction of the a 200m length drain is not appropriate.

2.3 Other Technical Validations

2.3.1 Layout Map of Akplabanya

The base map of the community used during environmental studies (phase 1) was reviewed for use under this phase.

The general development plan/layout of the area has not changed much apart from the few new residential and other infrastructural developments spring-up northwards of community due sea erosion at areas southwards and close to the coast.

2.3.2 Site Drainage Design Validations

Erosion is a potential threat to durability of foundations of buildings/civil works in any environment which is without good drainage and sound erosion control measures. In this regard the condition, presence or absence of adequate drainage facilities and erosion control measures have been investigated at the various project sites.

Validations also entailed the collection of the following drainage management data for improvement of the drainage conditions at the various project sites:

- Presence/absence of drains for collection of sullage and surface runoff
- Where drains are available, the types, sizes and physical conditions
- Evidence of erosion of site grounds (description of extent of site erosion is backed by photographs indicating presence of rills or gullies)
- Measure of site slopes and direction and area of sanitary catchment to be able to calculate runoff and size the type of drains required to adequately deal with the most intense runoff

This data helped in the development of a detailed drainage improvement scheme for the project sites.

2.3.3 Water Supply Reliability

The water supply situation and reliability profile of Akplabanya has not changed from what it used to be.

We have reviewed AS-BUILT Drawings of the 3-Districts Small Towns' water supply project obtained from the CWSA covering Akplabanya and carried out external water connections to the

project sites linking 100mm and 50mm uPVC distribution water mains close to the proposed sites based on the reviewed drawings.

2.3.4 Accessibility Situation

Good access to sanitary site for collection and transport of refuse and decomposed excreta to their final disposal sites are therefore very crucial to the selection of an appropriate sanitary site.

The following validation studies have been carried out to assess the presence or absence and condition of motorable accesses to the project sanitary sites:

- Presence/absence of access roads linking the site to any neighbouring main street(s)
- Where present type of road and road surface condition (i.e. presence/absence of pot holes, presence of road camber for effective drainage or absence of camber)
- Presence or absence of road side ditches/drains
- Length and width of access road to the nearest neighbouring main street

2.3.7 Geotechnical Analysis

Geotechnical tests carried out in the field and at the laboratory provided the necessary data for

- Confirmation of ground water table levels and
- Design of foundations of new toilets and attached ground mounted holding tanks

In-Situ field tests that were carried out are the dynamic cone penetration (DCP) and soil percolation (SP) tests. DCP test provided results on average range of water table levels in Apklabanya and in-situ strength or CBR of existing grounds of the selected project sites

The following are the specific design information obtained from the two field tests:

- The cone penetration test provided in-situ CBR values of the project sites. In-situ CBR values are index properties of sites grounds bearing capacities.

- 1.5m x 1.5m pits sunk into the project sites grounds to depths ranging from 0 to 3m helped in making visual assessment of the type of soils at various depths of the sites sub stratum (i.e. (0-1)m, (1-2)m and (2-3)m).

Soil samples obtained from field trial pits were sent to the laboratory for analysis. The laboratory tests were sieve analysis and Atterberg's limit. These tests provided results that enabled the Consultant to properly classify the soils.

In-situ CBR values obtained from our field geotechnical studies ranged between 21% and 65%.
Figures obtained are all above the minimum threshold of 7% recommended. This shows that natural grounds of the three sanitary sites are stable enough to receive facilities that will be erected on them without appreciable settlement or structural failure in foundation.

3.0 DETAILED ENGINEERING ANALYSIS AND RESULTS

3.1 Review of Existing Designs

WasteCare has studied in great detail designs/working drawings and costs of similar rural/urban environmental sanitation improvement projects such as the **UN-Habitat urban sanitation sub-projects, the World Bank/IDA urban environmental sanitation projects, phases i & ii etc**., implemented in similar low income settlements with similar socio-economic and cultural backgrounds as Akplabanya.

The following important aspects of the old designs have been identified, reviewed, considered and incorporated into new designs based on lesson learnt.

- Non robust components such as Plastic WC suites with low level cisterns found in most of the earlier designs gets easily damaged due to inability to withstand high patronage and robust use. Plastic suites have been replaced with more robust components such as ceramic WC squat suites with high level cisterns firmly and robustly fixed unto privy room walls.

- Earlier designs also had small privy rooms which could not accommodate small waste paper baskets therefore the privy rooms become filled with lots of litter. Some of the litter found their way into suites and squat holes blocking them and reducing effective functioning of the toilets. The improvement modality requires an increase of the privy room size. The recommended minimum dimension of privy room is (850mm x 1500mm). This minimum requirement will accommodate small waste baskets and prevent littering of rooms and eventual clogging of the toilets.

3.2 Justification for Proposed Toilet Designs in Akplabanya

Our site investigations revealed that Akplabanya is located within a high water table zone with average depth of water table in the range of (0.6m – 1.2m) beneath existing ground level in most places.

It is therefore very difficult to achieve construction of underground septic tank for sewage treatment. The best design option is ground holding tank internationally accepted for wetlands, marshy terrains and areas with high ground water table level. Similar existing constructions studies are the Malaam junction WC public toilet facility and other Household toilets around that area.

Our recommended toilet design is the toilet facility mounted on top of reinforced concrete holding tank with drain field sewage purification system.

3.3 Design Standards/Criteria

3.3.1 Criteria for Siting Public Toilets

(Wang, 1995 and Shanghai 1996) recommends the following standards for siting public toilets. These standards have been adopted by the Consultant

- Average walking distance to the toilet from the farthest point **must not exceed 500m**
- Site must be completely accessible **by any cesspit emptier**

- Site must have adequate security facilities such as internal and external lighting and fencing and must be place in a clear open space to reduce subject of crime (i.e. vandalism and sexual harassment
- Site must be readily "legible" so that it can easily be found and accessed without confusion or fear
- Good signposting must be provided for easy direction and identification of the site
- Toilet compound must be clearly paved to ensure aesthetic and clean environment around it

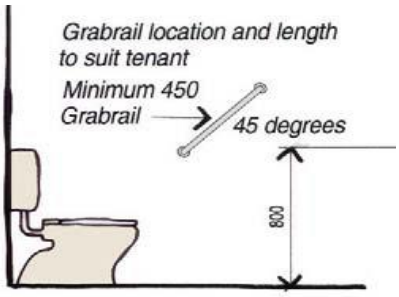
3.3.2 Criteria for Architectural Design of Public Toilets

Architectural design of toilet met the following international design criteria:

- Provision of adequate spaces between adjacent facilities for free movements. Space between any two adjacent or opposite facilities must not be less than **3.0m,** (Neufert, 1994)
- Provision of honey combed and design block on external walls of toilets to serve as windows for adequate ventilation and daylight effect in toilets. Unit window area is should not be less than (**1.5m x 0.6m or 0.9m2**), (Neufert, 1994)
- Provision of adequate number and sizes of entrance and privy rooms doors to ease mass evacuation, minimum door size is (**0.7m x 2.0m**), (Neufert, 1994)
- Provision of segregated entrances for males and females to allow full privy and non mixing of opposite sex, (Wang, 1995; Shangai, 1996)
- Provision of external ramp facility to ease access into toilets by the physically challenged, **ramp widths of not less than 1.5m**, (AS1328, Part 1)
- Provision of toilet privy rooms/cubicles with adequate floor areas of **(minimum 0.9m x 1.7m for all types of people excluding disables**) and (**minimum 1.5m x 1.7m for disables**), (Goldsnith, 2001), (BS 6465, Part 1; BS 8300 Part M)
- Provision of toilet room corridors with adequate widths (i.e. not less than the **1.5m**), (Neufert, 1994)
- Inclusion of store rooms with adequate floor storage space (i.e. not less than **2.25m^2**), (Neufert, 1994)
- Provision of external toll booths as office space for toilet caretakers, floor space not less than **2.25m^2**, (Neufert, 1994)
- Inclusion of provision special privy rooms to cater for the physically changed, (AS 1328, Part 1)
- Number of privy rooms required was calculated based on the following standards of (AS1328, Part 1), (BS6465, Part 1) and (CummingHam and Norton 1983-BTA, 2001)

    a) At least 1 cubicle per 550 women and females children
    b) At least 1 cubicle per 550 men and male children
    c) At least 1 urinal per 550 men
    d) At least 2 disables cubicles for community population of 10,000

- Relevant population for estimation of total number of cubicles required in a public toilet = Design population + 20% for commuters, tourists and visitors (Shiohiko, 2003)
- Slope of exterior paths and ramps to toilets must not exceed 1:20
- Two (2) exits must be provided in toilets whose daily usage exceeds 200 persons



- Fix grab-rails in front and inside disable cubicles (AS 1328, part 1)

- Grab rails shall be a minimum 450mm long, constructed from 32mm outside diameter stainless steel, with concealed fixings or white powder coated rippled finished aluminium with powder coated screws. (Typically lengths are 450mm, 600mm and 900mm)

- Fix grab-rails to walls with No. 12 (5.5mm diameter) galvanised steel screws with two screws per fixing point. The screws should penetrate 30mm into the base timber/wall plug.

- Use a timber wall plate when the studs are not in the locations where the grab rail fixing is required. Fix the wall plate to the studs with No. 12 (5.5mm diameter) screws with minimum two screws per crossing. The screws should penetrate 30mm into the studs.

3.3.3 Criteria for Provision of Sanitary Wares

The following for installation of sanitary wares in public toilet cubicles has been provided in accordance with the internationally accepted standard (AS1428, Part 1) which meet desirables for disables:

- WC pans should be located 800mm from the front of the pan to the rear wall
- Raised toilet pans, with a rim 460mm above the finished or tiled floor level for disable cubicles. Otherwise an ordinary toilet pan with a rim 400mm above floor level is acceptable.
- The centre of the pan should preferably be located 450mm from the sidewall.
- Toilet roll holders shall be located a maximum of 700mm above the finished or tiled floor level and within 330mm from the front of the pan.
- WC cisterns shall be located at a maximum of 1000mm to the top from the finished or tiled floor level.
- All WCs cisterns must hung and robustly fitted against the cubicle rear wall, volumetric capacity **must not exceed 9 litres**
- All plumbing fixtures connecting the WC suites must be concealed for easy maintenance and to deter vandalism
- WC suites must be fitted back to back with common pipe ducts in between
- Minimum size of wash hand basis should be **500mm length x 400mm width or 0.2m^2**
- Minimum spacing between any two (2) wash hand basins should be **800mm**
- Minimum space between center of the basin and any end wall should be **500mm**
- Minimum room dimension for hand-washing area with one wash hand basin should be **1800mm length x 1000mm width or 1.8m^2**
- Water pressure and tap/wash basin will be positioned such that water will not splash unto user's body during activation
- Where there are **2 or more basins**, one will be installed at child's height

3.3.4 Criteria for Provision of Good Finishes

Materials used for walls, floors and ceiling finishes must be durable and resistant to vandalism and neglect. The following good examples of internal and external finishes have been adopted:

- Floors of the toilet rooms must be tiled with non slip ceramic tiles.
- Selected non slip tiles for floors must be durable and relatively easy to clean and maintain
- Minimum size of floor tiles must be 200mm x 200mm
- Internal walls of toilets must be ceramic wall tiled
- Minimum size of wall tiles must be 150mm x 150mm

Materials for ceiling works must be selected from the following and choice must be based on availability on the local market, cheaper cost and ease of maintenance:

- Mineral fibre board or fibrous plaster board,
- ½ " plywood boards
- Aluminium panels or strips

We have opted for the use of ½ inch plywood boards due to availability and cost in the local market. All ceilings will be painted white to brighten the toilet rooms, create the interest and pleasant environment.

3.3.5 Criteria for Provision of Internal and External Lighting

The following lighting design standards have been adopted:

- Energy saving bulbs will be used
- The minimum general lighting level is 300 luminaries
- Warm-colour lighting will be used in the general lighting scheme because it creates better ambience in the toilets, which in turn encourages more care and responsibility from the users
- Adequate number of windows with a good spread around the building will be incorporated to:
- Provide maximum daylight effect and help create a softer and friendlier environment

3.4 Architectural Design of Public Toilet

Design comprised the following:

- Calculation of total number of cubicles and type of toilet in the selected public sanitary site
- Preparation of functional design of the public toilet and estimation of total floor area. Details of functional design will entail design of functional spaces for privy rooms, disable cubicle, toilet corridors, hand-washing, store and janitor etc. using the design guidelines proposed in 3.3 above.

3.4.1 Calculation of Relevant Population

Item	Value/Figure	Remarks
1. Present population (P_o)	5741	Population of Akplabanya at completion project 2012
2. Growth rate (r), %	3.4	Average growth rate over the inter-census periods
3. Design life (N), years	10	Accommodation of community's population growth up-to 10 years
4. Design population (P_N)	8020	Population growth formula is $P_N = P_O (1+r)^N$
5. Relevant population (R_P)	9624	Relevant population is $R_P = 1.2 \times P_N$, (Shiohiko, 2003)

The relevant population is **9624**. This will be used in the Table below for calculating the required number of cubicles or privy rooms.

3.4.2 Calculation of Total Number of Cubicles

Total number of privy rooms and selection of type of toilet were done based on design standards of AS1328, Part 1), (BS6465, Part 1) and (CummingHam and Norton 1983-BTA, 2001) in bullet point 11 of item 3.3.2 above

Item	Value/Figure	Remarks
1. Relevant population (R_p)	9624	Population of Akplabanya, 10 years after 2012, (i.e. end of year 2022)
2. Percentage of males (m), %	48.9	Percentage distribution, males in Akplabanya
3. Percentage of females (f), %	51.1	Percentage distribution, females in Akplabanya
4. Number of males (N_m)	4706	Number of males is $N_m = 0.489 \times R_p$
5. Number of females (N_f)	4918	Number of females is $N_m = 0.511 \times R_p$
6. Number of male cubicles (M_c)	8.6	Number of male cubicles (M_c) = 4706/550, see item 3.3.2 pt 11
7. Number of female cubicles (M_f)	8.9	Number of female cubicles (M_f) = 4918/550, see item 3.3.2 pt 11
8. Sub-total number of cubicles	17.5	Say 18 cubicles in all for both sexes, nine (9) in each section
9. Allowance for disables	2	At least 2 disable cubicles for community population of 10,000
10. Total number required	19.5	Say 20 cubicles, 9 plus 1 disable cubicle in each section for both sexes
11. Type of toilet	20-seater	Provide 20 seater WC public toilet in Akplabanya

Type of public toilet required in Akplabanya is **20-seater water closet (WC)**.

3.4.3 Functional Design and Total Floor Area Calculation

Based on item 3.3.2 guidelines and the above calculations the following architectural design components/functional areas have been provided:

- Eighteen (18) normal cubicles for able males, females, male and female children, nine (9) in each section and 2 cubicles for disable males and females, one in each section, minimum floor areas are:
    a) Normal cubicles-1.20m^2
    b) Disable cubicles-2.25m^2

- 2-store rooms for storage of toilet cleaning materials (i.e. brooms, mobs, buckets, gloves, nose masks, disinfectants etc.), one store is in each section, minimum floor space of each store room is 2.25m^2, ditto minimum for janitor

- Hand-washing area to ensure and enhance personal hygiene conditions, minimum floor space 1.8m^2
- Entrance lobby for segregation purposes
- Internal corridors for maneuverability and internal movement, minimum width 1.5m^2
- Ramps to aid disables with easy access into toilets, minimum width 1.5m
- Grab-rails at front and inside disable toilets in accordance (AS1328, Part 1)
- Cubicles door widths of not less than 0.85m clear space

The following adequate functional design provisions have been recommended for the 20-seater WC public toilet. See table below

Item	Description	Unit Provision	Minimum Criteria	Total	Remarks
1	Normal cubicles (18no.)	1.53m^2	1.20m^2	27.54m^2	Adequate
2	Disables cubicles (2no.)	2.93m^2	2.25m^2	5.86m^2	Adequate
3	Internal corridors (2no.)	1.5m	2.0m	11.55m^2	Adequate
4	Hand-washing Area (2no.)	3.67m^2	1.80m^2	7.34m^2	Adequate
5	Entrance lobby (2no.)	4.37m^2	N/A	8.74m^2	
6	Internal lobby (2no.)	4.30m2	N/A	8.60m^2	
7	Janitors (2no.)	2.68m^2	2.25m^2	5.34m^2	Adequate
8	Store room (2no.)	2.25m^2	2.25m^2	4.50m^2	Minimum Provision

The conclusion is that our **functional design is satisfactory**.

Total floor area is **74.94m^2**; this excludes areas taken up by internal partition walls and floor areas for steps and external ramps provisions.

3.5 Architectural Design of School Toilet

Design comprised the following:

- Calculation of total number of cubicles and type of toilet in the beneficiary school
- Preparation of functional design of the school toilet and estimation of total floor area. Details of functional design will entail design of functional spaces for privy rooms, disable cubicle, toilet corridors, hand-washing, store and janitor etc. using the design guidelines proposed in 3.3 above.

3.5.1 Calculation of Design Population

Item	Value/Figure	Remarks
1. Present population (P_o)	1306	Population of students and staff of school by project completion
2. Annual enrollment rate (r), %	3.4	Assume same as population growth rate of 3.4%, no data case
3. Design life (N), years	10	Accommodation of school population growth up-to 10 years
4. Design population (P_N)	1824	Population growth formula is $P_N = P_O (1+r)^N$

Here the design population is used instead of the relevant population because hardly will the design number of users change significantly owing to effect of tourists, commuters and visitors. Therefore 1824 will be used in the Table below for calculating the required number of cubicles or privy rooms.

3.5.2 Calculation of Total Number of Cubicles

Total number of privy rooms and selection of type of toilet were done based on design standards of (Asano, 2003) and (BS6465, Part 1). (Asano, 2003) recommends provision of 1 WC suites complete with all other ancillaries for **every 220 pupils** (non-gendered).

Item	Value/Figure	Remarks
5. Design population (D_p)	1824	Design population of beneficiary school
6. Number of cubicles (N_c)	8.3	Number of male cubicles (N_c) = 1824/220, say 8 for both sexes
7. Allowance for disables	2	Provide 2 disable cubicles for both sexes, one in each section
8. Total number required	10.3	Say 10 cubicles, 4 plus 1 disable cubicle in each section for both sexes
9. Type of toilet	10-seater	Provide 10-seater WC public toilet in beneficiary school

The type of school toilet recommended in the beneficiary school in Akplabanya is **10-seater water closet (WC)**.

3.5.3 Functional Design and Total Floor Area Calculation

Based on item 3.3.2 guidelines and the above calculations the following architectural design components/functional areas have been provided:

- A total of eight (8) cubicles for able students and staff and 2 cubicles for disable students and staff, minimum floor areas are:
  a) Normal cubicles-1.20m^2
  b) Disable cubicles-2.25m^2
- Store room for storage of cleaning materials (i.e. brooms, mobs, buckets, gloves, nose masks, disinfectants etc.), minimum floor area 2.25m^2, ditto minimum for janitor
- Hand-washing area to ensure and enhance personal hygiene conditions, minimum floor space 1.8m^2
- Entrance lobby for segregation purposes
- Internal corridors for maneuverability and internal movement, minimum width 1.5m^2
- Ramps to aid disables with easy access into toilets, minimum width 1.5m
- Grab-rails at front and inside disable toilets in accordance (AS1328, Part 1)
- Cubicles door widths of not less than 0.85m clear space

The following adequate functional design provisions have been recommended for the 10-seater WC public toilet. See table below. (Kobby and Selasi you need to fill and calculate the total floor area in based on 10-seater design provided by Francis, minimum critia will not change)

Item	Description	Unit Provision	Minimum Criteria	Total	Remarks
1	Normal cubicles (8no.)	1.53m^2	1.20m^2	12.24m^2	Adequate
2	Teacher's cubicles (2no.)	2.38m^2	2.25m^2	4.76m^2	Adequate
3	Internal corridors (2no.)	5.4m^2	2.0m^2	10.80m^2	Adequate
4	Hand-washing Area (2no.)	2.04m^2	1.80m^2	4.08m^2	Adequate
5	Entrance lobby (2no.)	2.60m^2	N/A	5.20m^2	
6	Urinal (2no.)	4.30m2	N/A	8.60m^2	

The conclusion is that our **functional design is satisfactory**.

Total floor area is 45.64 m^2; this excludes areas taken up by internal partition walls and floor areas for steps and external ramps provisions.

3.6 Architectural Design of Buy-Back Centre

3.6.1 General

A multi-recycling buy-back centre is a simple industrial facility used for collection, re-use, and recycling of plastic shopping bags and other recyclable materials that are discarded in the waste stream. The facility makes provision for the collection of recyclables plastics from environmentally sensitive areas, including rural areas, hotspots, taxi ranks, tourist areas and high density, low socio-economic urban areas.
The centre is a business model planned and established for the buying in, sorting and resale of various plastics materials.

Strategic Objectives:

Strategic objectives of establishing the buy-back center as part of the total sanitation improvement scheme for this project is to achieve the following:

Create an accessible business avenue that will create informal/formal jobs opportunities for rural people through collection and recovery of plastic bags and other recyclable plastic materials
To use the created business opportunity to address the problem of indiscriminate and rampant littering of plastic bags and other recyclable plastics from the waste stream thereby ensuring a clean environment

Economic and Social Benefits:

- Creation of formal and informal job opportunities for local entrepreneurs and rural people
- Abatement of indiscriminate and rampant littering of plastic bags and other plastics in and around communities
- Reduction of environmental pollution and insanitary conditions and effects of non functional local drainage structures
- Reduction of landfill costs and
- General assurance of clean and sustainable environment.

Priorities and Requirements:

Identify the local market to sell recyclables
Determine the purchase price for sorted plastics materials and other financial requirements that will ensure profitability
Ensure security through provisions of fencing, gates and security officers
Initial capital and/or funding is required to start-up business
Assets required are the centre building with office space and toilet and bath and local plastic shredding and plastic pellets production machines and plastics storage shed

The above mentioned priorities and requirements will be provided through project support funding of the civil works aspect of the intervention relying on close assistance and collaboration of the DA and beneficiary community. We will also train and assist the DA to procure a befitting private entrepreneur/operator to operate and maintain the facility and established business prudently on behalf of the DA and community.

Technical Assistance/Support Services:

WasteCare will support in the following operational activities to make the entire programme successful and sustainable:

- Assist DA in supervising construction of all building facilities and external works of the buy-back centre
- Assist DA in preparing private management contract and procuring private operator for effective and sustainable operation and maintenance of the buy-back centre
- Assist DA in promoting community awareness about the centre
- Assist DA and beneficiary community in identifying and registering collectors for the centre's routing collection activity
- Assist in education & training support for local collectors

3.6.2 Recommended Facilities

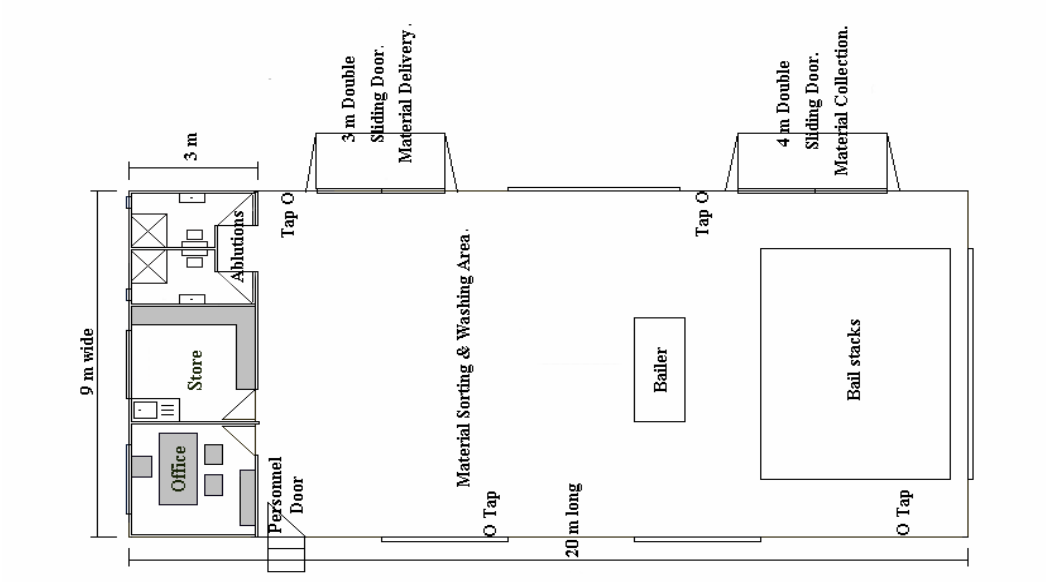
Design followed same general steps for architectural design of light industrial buildings most of which have earlier on been discussed. Our design buy-back center consists of the following architectural components:

- A single storey masonry building with industrial concrete floor, office space location, toilets and ablution facilities (working area comprised two sections; first section is the plastics shredding area and second area is the pellets production area)

- Other ancillaries are wooden shed for storage/stockpile of plastics, chain-link fencing with concrete gate columns and metal gate, local shredding and pellet production machine (electric power driven) and electronic weighing scales

3.6.3 Functional Design and Total Floor Area Calculation

The diagram below provides a schematic design of WasteCare's the buy-back center. Our actual design provision in the standard drawings does not include bail stacks and bailer.



The various functional areas/space allocations and architectural descriptions are as follows:
Main Building dimensions

L = 20 metre (outer)

W = 9 metre (outer)
H = 3.5 m side wall height

Office plan dimensions: -approx. 3 m x 3 m
Store plan dimensions: -approx. 3 m x 3 m
Ablutions (male & female): -approx. 1,5 m x 3 m (each)

Walls
- Office, store, ablutions: - solid 6" sandcrete blocks in foundations and similar 5" blocks in superstructure
- Main operational area: - solid 6" sandcrete blocks in foundation area and similar 5" blocks in superstructure from floor to 1.20m above industrial floor slab continued with 5" design/honey combed blocks to lintel

Doors
- Main operational area, industrial steel door with upward lift/sliding (2no.): - W: 3 m; H: 3.5 m
- Office, store, ablution doors (5no.): - standard (750-850mm width) x 2050mm height panelled doors.

Windows
- Number and size of windows are in accordance with National Building Regulations.
- All opening windows to be equipped with burglar bars spaced narrow and embedded in frames with attached louver frame pairs and louver blades.

Roof
- 30^{o} hardwood trussed pitch roof.
- 0.6 mm gauged long span coloured imported roofing sheets.

Store and kitchenette
- Heavy-duty steel shelves (500 mm wide) spaced at 400 mm intervals.
- 1200 mm steel kitchen unit with single basin and warm / cold water mixer tap.

The Table below provides the summary of functional space allocations of facilities recommended

Item	Description	Unit Provision	Minimum Criteria	Total	Remarks
1	Main working area	$180m^2$	$150m^2$	$180m^2$	Adequate
2	Office	$9.0m^2$	$6.0m^2$	$9.0m^2$	Adequate
3	Store and kitchenette	$9.0m^2$	$4.5m^2$	$9.0m^2$	Adequate
4	Ablutions (male and female)-2no.	$4.5m^2$	$2.25m^2$	$9.0m^2$	Adequate

The conclusion is that our **functional design is satisfactory**. Total floor area is **$207m^2$**; this excludes areas taken up by internal partition walls and floor areas for steps and drainage.

3.7 Design of Holding Tanks of W/C toilets

3.7.1 Design Parameters

Capacity of holding tanks for new toilets will be calculated in the same manner as the approach for septic tanks. The approach requires calculation of the tank volume followed by sizing. The following design inputs or parameters are required:

- Average per capital flow (Q)/day which by design is the same as the flushing plus hand-washing volume of 10 litres
- Selected period for desludging (N) in years, design recommends a desludge period N of less than 5 years, say N = 1
- If N < 5 years, then per capita sludge accumulation rate r, is 0.03 m^3/yr
- Selected ambient temperature of coldest month (T) is 25^0C
- Selected septic tank free board is 0.3m

3.7.2 Calculation of Holding Tank Volumes and Dimensions

We employed Mara, D. Duncan (1994) approach for design of our septic tanks because the approach is very practical and simple. The approach defines four functional/operational zones as follows:
Scum formation and storage which occurs as the first layer or zone in the tank

- Sedimentation process in the layer beneath the scum zone also known as the 2^{nd} zone of operation
- Sludge digestion zone which is 3^{rd} zone and beneath the sedimentation zone and
- The last and final zone is the digested sludge storage zone

Each zone defines a specific space or volume of the tank to accommodate its formation.

Scum Accumulation:

Empirically scum accumulates at approximately (30-40) percent the rate at which digested sludge is stored at the base of the tank. If V_{sl} is the volume of sludge stored at the base of the tank the volume of scum, V_{sc} is determined as:

$V_{sc} = 0.4 \times V_{sl}$ in m^3 –---- eqn 1.0

Sedimentation:

The sedimentation activity is determined by the time required to allow for effective sedimentation of settleable solids, T_h is determine by the rational formula below:

$T_h = 1.5 – 0.3\log (PQ)$ in days ----- eqn 2.0

P is the Design Loading

Q is the per capital waste flow rate in l/day. Good designs require a T_h value < 0.2 day. If calculated Th is > 0.2 day, choose $T_h = 0.1$ to ensure good design.

The tank volume for sedimentation in Zone 2 in litres is given by:

$Vh = 10^{-3} \times (P \times Q \times T_h)$ ----- eqn 3.0

SLUDGE DIGESTION:

The time needed for anaerobic digestion of the settled solids (t_d in days) varies with the ambient temperature (T ^{0}C) in the tank and related according to the equation:

$t_d = 30 \times (1.035)^{T-35}$ in days ---- 4.0

The volume of fresh/digested sludge produced at the end of completion of anaerobic digestion in t_d days is:

$V_d = 0.5 \times 10\text{-}3 \times P \times t_d$ in m^3 ---- 5.0

Sludge Storage:

The volume of produced sludge stored in the sludge storage zone depends on the rate of sludge digestion (r, m^3 per person/yr) and the interval between successful desludging operations (N in years)
For N < 5 years r = $0.03m^3$/person per year
For N > 5 years r = $0.025m^3$/person per year
The sludge storage volume is given by:

$V_{sl} = r \times P \times N$ in m^3 ---- 6.0

Overall Design Capacity:

The effective volume of the tank V_{eff} should accommodate the volume scum produced, volume sewage undergoing sedimentation, volume of fresh/digested sludge and volume of stored sludge.

$V_{eff} = V_{sc} + V_h + V_d + V_{sl}$ in m^3 ---- 7.0

INPUT DATA:

Design Input Data	**Public Sanitary Site**	**Akplabanya Basic School**
Design Loading, P (same as one year of design population = Dp÷10)	962.4	182.4
Per Capita Waste Flow, Q_f / (litres)	10	10
Ambient Temperatures, T^0C	25	25
De-sludge Frequency, N / (yr)	1	1
Per Capita Sludge Accumulation Rate, r (m3/yr)	0.03	0.03

Calculation of Holding Tank Volume, 20-Seater Public Toilet

Item	**Value/Figure**	**Remarks**
1. Design loading (P)	962.4	This is the average annual population = (9624÷10)
2. Flushing volume (Q_f) in litres	10.0	WC cistern capacity of 9 litres plus 1 litre for hand-washing
3. Effective settling time (T_h)	0.305	$T_h = 1.5 - 0.3\log(PQ)$ in days ----- eqn 2.0, $T_h < 0.2$ day, O.K
4. Tank volume for sedimentation (V_h)	2.94	$V_h = 10^{-3} \times (P \times Q \times T_h)$ in m^3----- eqn 3.0
5. Time for anaerobic digestion (t_d)	21.3	$t_d = 30 \times (1.035)^{T-35}$ in days ---- eqn 4.0
6. Volume for fresh sludge (V_d)	10.23	$V_d = 0.5 \times 10^{-3} \times P \times t_d$ in m^3 ---- eqn 5.0
7. Sludge storage volume (V_{sl})	28.87	$V_{sl} = r \times P \times N$ in m^3 ---- eqn 6.0
8. Scum accumulation volume (V_{sc})	11.55	$V_{sc} = 0.4 \times V_{sl}$ in m^3 –---- eqn 1.0
9. Holding Tank Capacity (V_{eff}),	53.59	$V_{eff} = V_{sc} + V_h + V_d + V_{sl}$ in m^3 ---- eqn7.0

Effective volume of public toilet holding tank is **53.6m^3**. This excludes free board.

Sizing or Calculation of Length, Width and Depth of Holding Tank of Public Toilet

- For plug flow length of tank L ≥ 3 times the width, W, say L = 3W

- Effective depth d of tank is normally between 1.0m and 2.0m maximum, say d = 1.2m
- Effective volume V_{eff} of the tank = L x W x d = 3W x W x 1.2
- Minimum width W = √(53.6÷3.6) = 3.86m, minimum length L = 11.57m

Calculation of Holding Tank Volume, 10-Seater School Toilet

Item	Value/Figure	Remarks
1. Design loading (P)	182.4	This is the average annual population = (9624÷10)
2. Flushing volume (Q_f) in litres	10.0	WC cistern capacity of 9 litres plus 1 litre for hand-washing
3. Effective settling time (T_h)	0.522	$T_h = 1.5 – 0.3\log (PQ)$ in days ----- eqn 2.0,
4. Tank volume for sedimentation (V_h)	0.95	$V_h = 10^{-3}$ x (P x Q x T_h) in m^3----- eqn 3.0
5. Time for anaerobic digestion (t_d)	21.3	$t_d = 30 \times (1.035)^{T-35}$ in days ---- eqn 4.0
6. Volume for fresh sludge (V_d)	1.94	$V_d = 0.5 \times 10^{-3}$ x P x t_d in m^3 ---- eqn 5.0
7. Sludge storage volume (V_{sl})	5.47	V_{sl} = r x P x N in m^3 ---- eqn 6.0
8. Scum accumulation volume (V_{sc})	2.19	$V_{sc} = 0.4 \times V_{sl}$ in m^3 –--- eqn 1.0
9. Holding Tank Capacity (V_{eff}),	10.55	$V_{eff} = V_{sc} + V_h + V_d + V_{sl}$ in m^3 ---- eqn7.0

Effective volume of public toilet holding tank is **10.6m^3**. This excludes free board.

Sizing or Calculation of Length, Width and Depth of Holding Tank of School Toilet

- For plug flow length of tank L ≥ 3 times the width, W, say L = 3W
- Effective depth d of tank is normally between 1.0m and 2.0m maximum, say d = 1.2m
- Effective volume V_{eff} of the tank = L x W x d = 3W x W x 1.2
- Minimum width W = √(10.6÷3.6) = 1.72m, minimum length L = 5.16m

3.7.3 Design Results

Dimensions	Public Toilet Holding Tank	School Toilet Holding Tank
Recommended length, L (m)	10.90	5.50
Recommended width, W (m)	5.85	2.00
Effective depth, d (m)	1.25	1.20
Free board, FB (m)	0.30	0.30
Total depth , D (m)	1.55	1.50

- Design effective volume of public toilet holding tank = **53.6m^3**
- Recommended effective volume of public toilet holding tank = **79.7m^3**
- Design effective volume of school toilet holding tank = **10.3m^3**
- Recommended effective volume of school toilet holding tank = **13.2m^3**

3.8 Design of W/C Septic Tank for Buyback Centre

3.8.1 Calculations

The concept, standards and methods of design will not change as shown below. The following design inputs or parameters are required:

INPUT DATA:

Design Input Data	**Public Sanitary Site**
Design Loading, P (same as relevant population is workers, customers and visitors)	23
Per Capita Waste Flow, Q_f / (litres)	10
Ambient Temperatures, T^0C	25
De-sludge Frequency, N / (yr)	1
Per Capita Sludge Accumulation Rate, r (m3/yr)	0.03

Breakdown of relevant population is as follows:

- Industrial line employees (12No. and same as case at the site near the Zongo central mosque),
- Administration staff, a total of seven (7) comprising manager, accounts clerk, secretary, driver, security-man and cleaners (2no.)
- Sub-total = (12+7) = 19
- Add 20% of sub-total to cater for customers and visitors, say 4

Calculation of Septic Tank Volume, Buy-back Center

Item	**Value/Figure**	**Remarks**
1. Design loading (P)	23	See breakdown of relevant population
2. Flushing volume (Q_f) in litres	10.0	WC cistern capacity of 9 litres plus 1 litre for hand-washing
3. Effective settling time (T_h)	0.79	$T_h = 1.5 – 0.3\log (PQ)$ in days ----- eqn 2.0,
4. Tank volume for sedimentation (V_h)	0.18	$V_h = 10^{-3}$ x (P x Q x T_h) in m^3----- eqn 3.0
5. Time for anaerobic digestion (t_d)	21.3	$t_d = 30 \times (1.035)^{T-35}$ in days ---- eqn 4.0
6. Volume for fresh sludge (V_d)	0.25	$V_d = 0.5 \times 10^{-3}$ x P x t_d in m^3 ---- eqn 5.0
7. Sludge storage volume (V_{sl})	0.69	V_{sl} = r x P x N in m^3 ---- eqn 6.0
8. Scum accumulation volume (V_{sc})	0.28	$V_{sc} = 0.4 \times V_{sl}$ in m^3 –---- eqn 1.0
9. Holding Tank Capacity (V_{eff}),	1.40	$V_{eff} = V_{sc} + V_h + V_d + V_{sl}$ in m^3 ---- eqn7.0

Effective volume of public toilet holding tank is **1.40m^3**. This excludes free board.

Sizing or Calculation of Length, Width and Depth of Septic Tank

- For plug flow length of tank L ≥ 3 times the width, W, say L = 3W
- Effective depth d of tank is normally between 1.0m and 2.0m maximum, say d = 1.2m
- Effective volume V_{eff} of the tank = L x W x d = 3W x W x 1.2
- Minimum width W = √(1.4÷3.6) = 0.62m, minimum length L = 1.87m

3.8.2 Design Results

Dimensions	**Septic Tank**
Recommended length, L (m)	3.00
Recommended width, W (m)	1.00
Effective depth, d (m)	1.20
Free board, FB (m)	0.30
Total depth , D (m)	1.50
Length of 1st compartment, L_1	2.00
Length of 2nd compartment, L_2	1.00

- Design effective volume of septic tank = **1.40m^3**

- Recommended effective volume of septic tank = **3.6m^3**

3.9 Design of Solid Waste Holding Bays (SWHBs)

3.9.1 Justification and Design Method

Field studies revealed that there is the urgent need to improve the poor refuse management in Akplabanya. Existing poor conditions provide ample justification for refuse management improvements.

The non expensive technical solution recommended is provision of communal refuse containers to be placed at the proposed sanitary sites. Provided skip pads/ waste holding bays will protect skip bins from direct contact with ground thereby preventing produced leachate and water from corroding base of skip containers and eventually damaging it.

The refuse holding bay recommended will provide an adequate container sitting space of 70m^2 big enough to conveniently accommodate 2no. 15m^3 skip containers.
Data on measured density, frequency of collection and design population obtained from the field were applied in the calculation of floor space, wall height and other functional provisions of the skip pads.

3.9.2 Design Results

The designed solid waste holding bay has the following functional units:

- A 49m^2 reinforced concrete floor space with dimensions 7.23m length x 7.2m width bid enough to house up 2-15m^3 skip bins with adequate working space around and in between the bins
- A 18m^2 reinforced concrete ramp placed in front of the concrete floor to provide smooth climbing provisions for roll off refuse trucks
- A back and side block walls provision of height 1.5m. The block walls serves as surround protection for containers against vandalism
- A centrally placed floor U-drain of dimension 300mm width x 200 mm depth for collection of rainwater and leachate from the floor into a soakaway system placed at the back of the structure.

3.10 Design of Sanitary Sites Drainage

3.10.1 General

The public sanitary site will be entirely paved and adequately drained make the surroundings of toilet and refuse holding bay facilities very clean and slightly. The stabilized and paved surroundings will also offer a decent driving surface for refuse collection vehicles and cesspit emptier. Drainage is required to ensure erosion free surroundings.

3.10.2 Calculation of Runoff flows

The runoff flow produced at the site was calculated by the rational formula defined belowas:

$$Q = 0.0278CIA \ (m^3/s) \text{ --------- eqn (1.0)}$$

Q is the runoff discharge at the sanitary site m^3/s

C is the runoff co-efficient. C is a factor dependant on the degree of imperviousness/hardness of the surface of the drainage area or catchment. Higher C values depict higher imperviousness of drainage

surface and vice-versa. A C value of 0.96 was selected because the entire site will be paved with a hard surface cover.

I in (mm/hr) is the maximum rainfall intensity for a predetermined occurrence period and time of concentration. I was calculated based on the duration of the most intense rain and return period/frequency of occurrence.

The duration of occurrence of the most intense rain t was calculated as the sum of the time of concentration t_c and the time of flow t_f..

$$t = t_c + t_f \text{ -------- eqn (2.0)}$$

The time of concentration was determined by the Lloyd Davies formula defined below:

$$t_c = \frac{58.5 \times L}{A^{0.1} \times S^{0.2}} \text{ ------- eqn (3.0)}$$

L is the mainstream length in (Km) in this case the total length of travel of a raindrop from the remotest point of the catchment into the proposed drain; S is the slope of mainstream (dimensionless) and A = the catchment area (Km^2). The time of flow is calculated more easily by the empirical formula that ensures self cleansing velocity of 0.7m/s in the storm drain over its design life.

$$t_f = \frac{L}{0.7} \text{ ------- eqn (4.0)}$$

L is the length of channel (m), 0.7m/s is the minimum velocity required in the drain to maintain self cleansing. A is the catchment area. In this case the area of the sanitary site in (Km^2). See Table C9 in Annex C for the runoff calculation.

DRAINAGE DESIGN DATA:

Figures on return periods, runoff co-efficients and Manning's coefficients were extracted from GHA road and drainage design manual produced by (J.V. AUGUSTT, 1991) and used for the drainage design analysis.

- Sanitary site catchment area, A is 2200m^2 or 0.22Ha.
- The mainstream length, L is 240m or 0.24Km
- Average slope is 25m/Km

3.10.3 Calculation of Required Size of Drain

The Consultant in furtherance to the determination of the runoff calculated the dimensions of interceptor drain required to collect and discharge the estimated runoff from the area. The Manning's equation defined below was used:

$Q = 1/n \times A \times R^{2/3} \times S^{1/2}$ (m^3/s)
A = x-sectional area of the selected drainage channel (m^2)
R = hydraulic mean depth (m)
S = Slope of the invert of the channel
n = roughness co-efficient dependant on the type drainage channel (i.e. whether concrete, earth, stone pitched etc.)

3.10.4 Design Results

Design calculations indicated the need 200m length of interceptor or collector U-drain (i.e. cross sectional area 450mm width x 450mm deep) linked to 50m length of similar U-drain (cross-sectional area 600mm width x 600mm deep) at the public sanitary site. The total length of the collector and outfall U-drains required along the periphery of public sanitary site is 240m.

3.11 Site Fencing

The habit massive and continual encroachment on lands towards inland sections of Akplabanya due effects of sea erosion provides ample justification for fencing of the proposed sanitary site. The recommended type of fencing is block wall. Block-wall fencing has been selected because it is more robust and durable than chain-link fencing of the same length.

To ensure good ventilation and quick escape of fowl gases from the sanitary sites, 0.45m of the top section of full wall height should be constructed with fancy/design blocks with honey combs. R.C columns spaced at 3.0m intervals is provided to structurally hold the entire length of wall in place. The recommended length of block wall fence is **380m**.

3.12 Plumbing Works Design

The Consultant's mechanical/plumbing installation design conforms to the national regulations and codes for designing building plumbing works. All materials proposed in our plumbing design layouts also conformed to the relevant British Standards (i.e. BS2781, Parts 1 and 2).

- 19mm or 3/4" of uPVC pipes and fittings will be used for connection of water from the existing mains into toilets and bay-back centre facilities
- 25mm or 1" draw off taps and stop valves are the recommended water services stop corks.

3.13 Design of Internal and External lighting

The Consultant's electrical designs conformed to E.C.G regulations/codes for building electrical works. The following are electrical services provisions have been recommended:

- Cabling for control devices external to switchboards will be 1.5mm^2 cross-section
- Cabling for lighting will be 1.5mm^2 cross-section
- Cabling for general power will be 2.5mm^2 cross-section

The type electrical cabling will be X-linked polyethylene XLPE insulated single wire armored type with PVC over sheath. Our outdoor lighting services have been designed to provide adequate illumination of toilets external areas and luminaries have been placed at adequate heights on the superstructure and evenly spread. Recommended voltage rating for lighting services is 240V AC, 50Hz frequency.

3.14 Paving of Sanitary Sites

The Consultant has provided paving as an essential design to stabilize and secure sanitary site grounds from effects of erosion including enhancing the following site drainage requirements.
Paving will augment the total drainage solution by providing a solid impervious cover over the entire sanitary sites thereby eliminating stagnation of rainwater and messiness of sites after rainfall.

- Paved sanitary sites are easy to sweep and maintain.

In view of budgetary constraints, only the public sanitary site will be paved. The total area of paving recommended is **2200m^2**. The type of paving recommended is hard surface concrete blocks paving.

3.15 Structural Design of Facilities

BS 8110 structural design approach backed with STRUCALC 8.0 computer analysis were used in the preparation of structural detailing/bending schedules of reinforced concrete column bases, foundation and superstructure columns, suspended slabs, beams and lintels of toilets and buy-back buildings superstructure

The same approach was used for preparation of structural detailing/bending schedules of water retaining/sewage holding and septic tank structures comprising bases of tanks, walls, columns and bases and tank top suspended slabs. Our working/standard drawings packaged attached to the submitted draft tender documents presents details of bending schedules of all facilities recommended.

3.16 Site Layouts, Block-Plans and Standard Drawings

- Refer to attached detailed design drawings for location maps and existing and proposed Block Plans of the Project Interventions
- Refer to attached draft detailed design drawings for standard design drawings of recommended interventions

4.0 SOURCES OF CONSTRUCTION MATERIALS

Technical specifications of the tender documents submitted is explicit on type and quality of materials desirable for all aspects of the works including directives on proper workmanship. It is therefore very essential and crucial to determine and recommend sources where these materials can be obtained or purchased at reasonable costs.

Available sources of required construction materials do not only have a significant bearing on overall cost of the project but also on project completion time, quality and durability of the completed works.

The Consultant has on this note recommended the use of the following materials that are common/easy to obtain in the open market and have other advantages such as robust, durable, of relatively cheaper prices and easy to work with.

- Cement for concrete works may be purchased from the factory of Ghacem in Tema or from large quantities distributors in the open markets in Tema, Adafoah/Sege taking into consideration price differential at the factory compared with the depots and transportation cost.

- Quarry dust and chippings for concrete works will be purchased from quarries/sand pits around Sege, Adafoa, Tema or on the Afienya – Akosombo road.

- Sandcrete blocks will upon convenience and approval of request from the project manager or based on cost be produced on-site or purchase from block factories close to the project sites.

- Reinforcement in slabs, beams, columns and column bases etc. shall be purchased from the factories in Tema/depots in Sege, Adafoah or Accra or at any suitable open market close in the project site depending on quality and cost.

- Timber for roof members shall be purchased from the timber markets in Sege, Adafoah and Tema or any approved location close to the site.

- Aluminium roofing sheets may be purchased from the factory in Tema or open markets near Tema.

- Tiles for walls and floor finishes shall be purchased from the open markets in Tema or Accra.

- uPVC or PE pipes required for plumbing and electrical works shall be purchased from pipes and plastics, INTERPLAST, DURAPLAST factories or depots near Tema.

5.0 SUMMARIZED LIST OF RECOMMENDED INTERVENTIONS

Table 5-1 below presents a summary of interventions recommended for implementation in Akplabanya and the other project sites covered under the project.

Detailed/standard drawings of the below listed interventions are attached to this draft detailed design report in Annexes A and B including location maps and layouts.

Table 5-1: Summarized List of Recommended Interventions for Improvement of Sanitary Sites

Item	Construction Site	Recommended Interventions
1	Akplase, Akplabanya Community	• Construction of new 1no. 20-seater W/C toilet of total floor areas **74.94m^2** joined to a **79.2m^3** capacity ground reinforced concrete holding tank that carries the public toilet superstructure 1.50m above the existing ground level in a selected public sanitary site. • Construction of **380m** block fence wall at the public sanitary site. • Installation of **two (2)** overhead water polytank, type **Rambo 400, 4000 litres capacity** mounted on the roof suspended slabs in the male and female section of the public toilet respectively • Construction of concrete blocks compound paving at the public sanitary site, Paved surface area **2200m^2** • Construction of **190m** of concrete interceptor drain (U450) linked to **50m** of concrete outfall drain (U600) at the public sanitary site. Total length of drains is **240m**. • Construction of solid waste holding bay (SWHB) of floor area **70m^2** at the public sanitary site. • Construction of toll booth facility, total floor area **7.29m^2** at the public sanitary site.
2	Close to site for GETFund school project, Akplabanya Community	• Construction of new 1no. 10-seater W/C school toilet. Total floor areas 45**.64m^2**. • Construction of a ground holding tank for school toilet facility. The holding septic tank capacity is **13.2m^3**. • Installation of **one (1)** overhead water polytank, **Rambo 200, 2000 litre capacity** mounted on the roof suspended slab of the school toilet

Item	Construction Site	Recommended Interventions
3	Buy Back Centre	# Total area of buy-back centre = **207m^2** # Total length of fencing and drainage measures is N/A site has not been selected # Buy-back center septic tank volume is **1.40m^3**

6.0 APPROXIMATE COST OF PROPOSED INTERVENTIONS AND LOTING

6.1 Cost of Recommended Interventions

The first Table below provides breakdown of the approximate cost of proposed intervention in the public sanitary site in Akplabanya

Cost Item	Cost/Item in GH Cedis
20-Seater W/C Toilet on Sewage Holding Tank	**114,184.05**
Toll Booth	**5,049.90**
Refuse Holding Bay & Skip Containers	**22,336.35**
Block Fence Wall and Gate	**21,354.40**
External Works	**29,065.00**
Sub-Total	**191,989.70**

The cost of works in the public sanitary site is **GH Cedis 191,989.70**.

This second Table below provides the approximate cost of proposed interventions in the school site in Akplabanya and buy-back center

Cost Item	Cost/Item in GH Cedis
10-Seater W/C Toilet and Sewage Holding Tank	**62,187.20**
Plastic Recycling Buy-Back Center	**84,768.55**
Buy-Back Centre Equipment	**64,500.00**
Block Fence Wall, Gate and External Works	**28,039.20**
Sub-Total	**239,494.95**

The cost of works in the public sanitary site is **GH Cedis 239,494.95**. Total cost of all interventions is **GH Cedis 431,484.65**

6.2 Loting

We propose to divide the entire project scope of works into two (2) lots as follows:

- LOT 1 will comprise of the list of intervention in the first Table above and cost of works in Lot 1 is **GH Cedis 191,989.70**.

- LOT 2 will consist of list of intervention in the second Table and the cost of works in Lot 2 is **GH Cedis 239,494.95**

We recommend bidding to be opened to eligible bidders who have registered with the Ministry of works and housing and have certificates with financial class D2/K2 and above. Bidding should be made flexible such that bidders may bid for more than one lot but should be allowed to submit one bid per lot.

7.0 TENDER DOCUMENTS

7.1 Tender Documents

The entire project which comprises three (3) lots will be packaged separately. Each lot will have its own tender document. Tender information in any of the three tender documents will be the same and will consist of:

- The Tender which has five sections – Sections (1-5)
- Technical Specification – Section 6
- Un-priced Bills of Quantities – Section 7
- Working Drawings – Section 8 and
- Sample Forms of Securities – Section 9

Details of the various main sections of the Tender Documents are as follows:

1.7.1 The Tender

The tender is made up of the following:

- Invitation for Bids, IFB (Section 1)
- Instruction to Bidders, ITB (Section 2)
- Form of Bid and Qualification Information (Section 3)
- Conditions of Contract (Section 4) and
- Contract Data (Section 5)

1.7.2 Technical Specification

The technical specification consists of description of works, materials, equipment and methods of works under the following:

- General provisions
- Earthworks
- Concrete works
- Brickwork and Blockwork
- Roofing
- Carpentry and Joinery
- Ironmongery
- Plumbing and Electrical Installations
- Electrical Installations
- Plasterwork, Floor, Wall and Ceiling Finishes
- Cleaning
- Glazing
- Painting and Decoration and
- Roads, Drains and Paved Ways
- Sewer, Septic Tanks and Water Mains

1.7.3 Bills of Quantities (BOQs)

Bills of Quantities in the Tender documents are un-priced meaning unit rate columns are without their unit costs.

Un-priced bills of quantities (BOQs) have been prepared to give sufficient information on the quantities of works to be performed to enable bids to be priced by all competing bidders on equal basis. The prepared bills of quantities shall also be used as a guide in measuring works for payment periodically as construction progresses.

1.7.4 Working Drawings

Working drawings consists of set of detailed designs/working drawings of recommended interventions in each lot and each set has been presented in the tender documents.

1.7.5 Sample Forms of Securities

These are attached forms containing formats of contract agreement, performance bond and advance payments required to be filled by the eligible contractor who wins the bid. They are also key components of the contract documents.

8.0 CONCLUSION

Our field studies indeed revealed a precarious state of environmental sanitation situation in Akplabanya and hence need for improvements.

The list of sanitation improvement interventions recommended by our estimation are most cost effective methods for restoring decency in the sanitation profile of Akplabanya including the new innovation of buy-back center introduced to deal with the menace and difficulty of dealing plastic waste disposal which have engulf most rural and urban settlements of Ghana and also being a nightmare for authorities of MMDAs in Ghana.

We also gathered from site observations/interactions that beneficiaries are aware of the existing sanitation problems and have brought their problems to the attention of the DANGME-EAST DISTRICT ASSEMBLY and Local Authorities for prompt solutions most of which the assembly is unable to solve due to financial constraints.

This project therefore offers a perfect and timely opportunity for financial support towards improvement of sanitation in Akplabanya. Beneficiaries are happy and very grateful to the AMA, MLGRD through its local DA, the Goverment and the international funding partner for this project and are therefore lending their full support to see to the implementation and success of the project.

The Consultant has recommended succinct designs listed in the Tables in Chapter 6.0 to completely deal with the major current sanitation problems confronting Akplabanya and all designs recommended are totally in line with the needs and concerns of beneficiaries. WASTECARE Associates has the strong conviction that implementation of the project will alleviate the poor profile and management of sanitation in the Akplabanya community.

The total project cost covering all interventions have been estimated as **GH Cedis 431,484.65.**

It is our hope that funds will be made available to see to all the recommended list of interventions which are so dear to the hearts of the Akplabanya people and Dangme East District Assembly.