CONCEPT

Alternative sediment handling Ghana

Results step 1 - Desk Research

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Alternative Sediment Handling in Ghana

INTRODUCTION

In the beginning of 2019, the Government of Ghana started to execute the feasibility study funded by a Development2Build (D2B) grant from the Government of the Netherlands. This feasibility study is to prepare a Performance Based Contract (PBC) for the deferred and routine maintenance dredging works in the Odaw River Basin combined with the re-use and environmentally-safe disposal of the dredged material as part of the Greater Accra Resilient Integrated Development (GARID) program funded by the World Bank. The overall objective of the feasibility study is to contribute to achieving a 1 in 10 years flood protection in the primary Odaw channel system.

The Feasibility Study (FS) is being undertaken by a consortium of IMDC, CDR, REBEL and ADK, with IMDC as the lead Consultants. The Environmental and Social Impact Assessment (ESIA) is being carried out by RHDHV (lead) and a local partner (SAL).

NETICS is currently also working on a project which is part of a funding program from RVO, called 'Circular Innovations in fast-growing cities in Africa'. Within this program, NETICS initiated the plan to renovate and improve the tertiary drainage system in Accra to improve Urban Resilience against flooding and diseases like malaria. During our visit to Accra (for the SBIR project) in the beginning of March 2020, we visited the Ministry of Works and Housing.

Alternative Sediment Handling in Ghana
REQUEST FOR EXPERTISE

THE SEDIMENT ENGINEERS

The GARID stakeholders are highly interested in the alternative and (elsewhere in the world) proven solutions for re-using the dredged material that were proposed by NETICS. Especially the production of Compressed Stabilized Earth Blocks (CSEB) made from dredged sediment instead of local available (fertile) soil to stabilize beach and soil or to be used for housing-structures. The second alternative the GARID stakeholders wants to be explored is the viability of using the treated sediments in geotextile (sand) bags to protect banks of other drainage basins, especially these in low income areas.

The overall objective of this additional study as described in this proposal is to assess more in detail the technical, financial and economic feasibility of alternative treatment and re-use options of dredged material of the Odaw River (for example CSEB and sand bags for protecting banks), with the overall goal to reduce the quantity of sediment for disposal.

Alternative Sediment Handling in Ghana
STEP 1 – DESK RESEARCH

Title:	Alternative sediment handling Ghana
Project number:	NP.2020.250
Your ref. number:	202004007
Date:	May 25, 2020

SCOPE OF WORK

Step 1	Desk research
Step 2	Program of requirements and stakeholder analysis
Step 3	Technical feasibility
Step 4	Financial feasibility
Step 5	Economic feasibility
Step 6	Financial overview

Alternative Sediment Handling in Ghana
STEP 1 – DESK RESEARCH

In this first step NETICS has collected and studied all the documents that were already available from the project, such as the Feasibility Study (FS), the Environmental and Social Impact Assessment (ESIA) and the SBIR Phase I feasibility study of NETICS. Additionally, a relevant literature study is carried out as answer to question 8 from the ToR: What additional information does the consultant need to answer the feasibility questions?

Step 1 – Desk Research
CONTENT

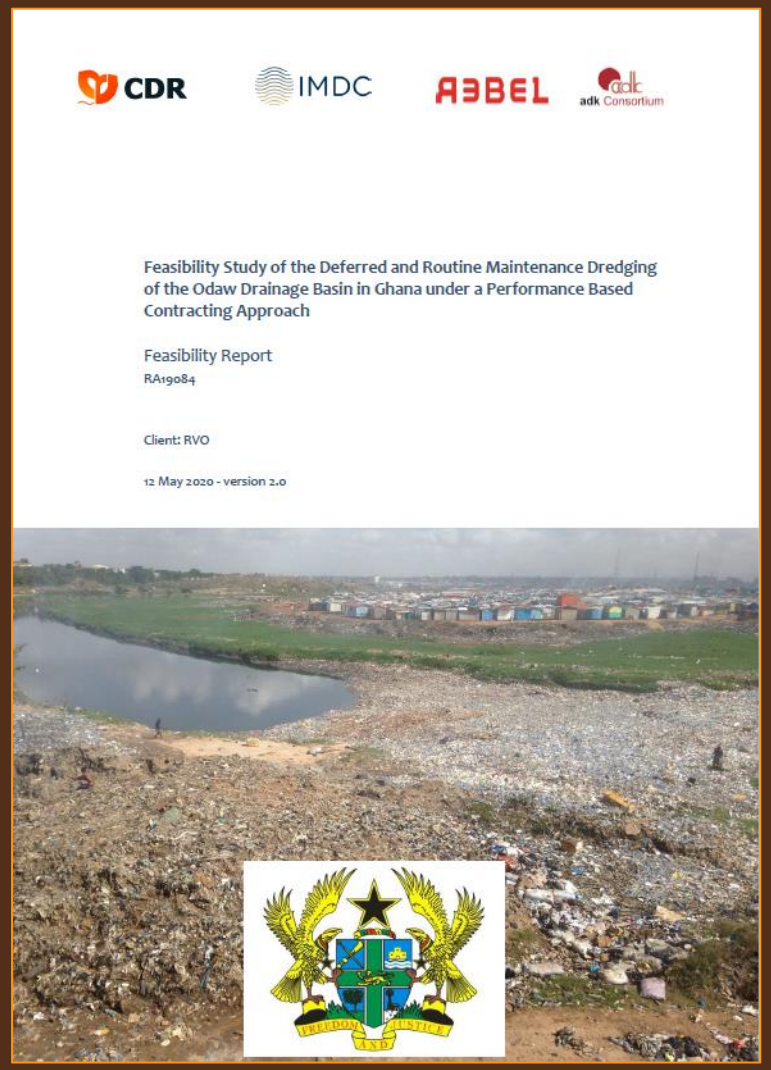
STEP 1 – DESK RESEARCH

1.1. Documents
PROVIDED DOCUMENTS

All provided documents that are available from the project are collected and studied and orginized in the database

DOCUMENT TYPE	DOCUMENT REFERENCE	ABBREVIATION	DOCUMENT DATE	DOCUMENT TITLE
Feasibility study	RA19084	FS	12 May 2020 – version 2.0	Feasibility Study of the Deferred and Routine Maintenance Dredging of the Odaw Drainage Basin in Ghana under a Performance Based Contracting Approach
Environmental and Social Impact Assessment (ESIA)	BG7296-RHD-ZZ-XX-RP-Z-0001	ESIA	30 October 2019 – Final/P01.01	Environmental and Social Impact Assessment Deferred and Routine Maintenance Dredging Odaw Drainage Basin
Sediment quality Odaw report	BG7296IBR01F01	SQOR	02 December 2019 – Final/P01.01	Sediment quality Odaw river in Ghana as part of the ESIA
Note / Memo results sediment sampling	BG7296WATNT1909301619	MEMO SED	7 October 2019	Results sediment sampling and chemical analysis Odaw Basin, Accra, Ghana.
Presentation ESIA	N/A	PRES ESIA	15 January 2020	Environmental and Social Impact Assessment – Main issues. Odaw dredging Accra.

1.2. Interpretation of the provided documents
FEASIBILITY STUDY



Interpretation feasibility report

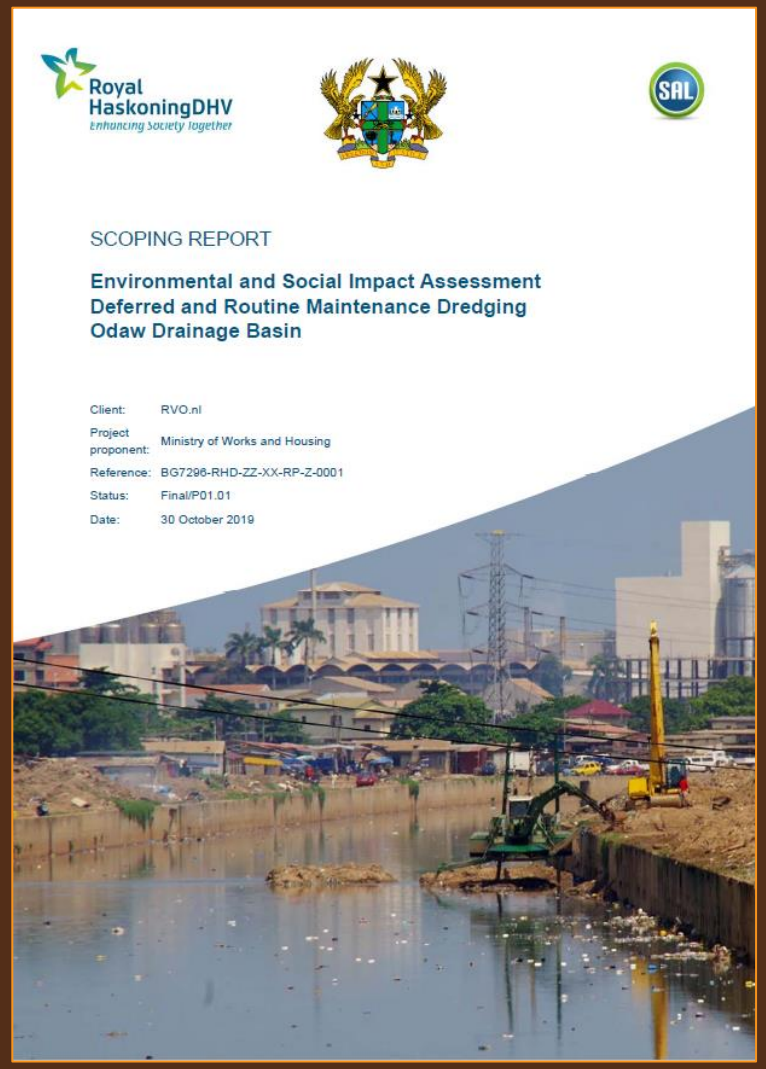
- Dredged material 25% gravel, 55% sand, 25% silt and clay
- €4.- to 7.- / m3 for deferred dredging of 655,000 m3
- €4.5 to 9.- / m3 for maintenance dredging of 44,000 to 165,000 m3
- Sampling campaigns for soil analyses
  - 2003 – KLERP (11 samples from boreholes / cores)
  - Dec 2018 – ESIA SAL (10 samples from boreholes / cores)
  - May 2019 – IMDC (20 samples dredged sediment on banks)
  - Aug 2019 – RHDHV SAL (30 samples from bottom drain)
- Contamination of mineral oil, reuse in industrial applications (NL standard)
- Reuse options: Construction aggregate, Capping, Geotextiles.
- Market offset analysis: Gravel - €20.- / m3; Sand - €9.- / m3
- ''Historically there has been little appetite for reusing the dredged material, as demonstrated in the newspaper from 1992''.

1.2. Interpretation of the provided documents
SEDIMENT SAMPLING AND RESULTS

In 2019, 30 samples have been taken by RHDHV and SAL from the Odaw drain for analysis for the ESIA. Their interpretation of the results resulted in the three conclusions. The conclusions and *our comments* are described below:

1. No dredged sediment should be reused without any treatment
2. All dredged material shall be treated with an extensive treatment process: Plastic removal, aeration, Washing of silt and clay and treatment of washing water → *By introducing more testing capacity in the process (before/after dredging) and matching sediment compositions and application requirements, not all material has to follow the full treatment process before reuse. For some sediment, only removing plastics can be sufficient.*
3. Sand and gravel can be reused in industrial circumstances as they may still contain (low) elevated levels of contamination. → *After full treatment, the sand can most probably be reused in all circumstances. In case of reusing the sediment on land or in a waterbody the following rule applies: the dredged material should be of the same class or cleaner than the receiving soil. If reused beneficial in large volumes (>5000 m3), there is even more possible. All according to Dutch Standards.*

1.2. Interpretation of the provided documents
ESIA



The Environmental and Social Impact Assessment Deferred and Routine Maintenance Dredging Odaw Drainage Basin by RHDHV.

Information for the alternative sediment handling options:

- Policies and legal frameworks for reusing sediment
- World Bank Safeguard Policy in relation to reusing sediments
- Stakeholders
- Target Water Quality Ranges Volume 6: Protection of Aquatic Ecosystems

1.3. Meetings with the primary stakeholders
OVERVIEW

COMPANY NAME	COMPANY CONTACTS	DATE	SUBJECT
Royal HaskoningDHV	Margriet Hartman & Luuk Brinkman	12 May 2020	Introduction & Sharing information about the ESIA and the guidelines for the reuse of sediment.
Netherlands Water Partnership (NWP) / HKV	Job Udo	12 May 2020 & 23 June 2020	Introduction & Sharing knowledge
IMDC	Jon Kemp & Nordine Saïdi Mazarou	15 May 2020 & 30 June 2020	Introduction & Discussiong about the reuse options stated in the FS and potential off-takers.
ADK Consortium	Horatio Pitcher & noel Gyamfi	9 June 2020	Introduction & Discusson on reuse options.
SAL	Emmanuel Acquah & Seth Larmie	8 June 2020	Introduction & Sharing knowledge on the sampling campains and the guidelines used for classification
Rebel & ID Consultancy BV	Johan Gauderis & Dick Konijn	10 June 2020	Performance Based Contract and stimulating sediment reuse

1.3. Meetings with the primary stakeholders
KEY FINDINGS FOR REUSE OPTIONS

THE SEDIMENT ENGINEERS

Key finding 1: The sediment has been tested according to the Dutch Standards for reuse on land. For a complete overview the sediment should also be tested with the **Dutch Standards for reuse in waterbodies.** It is not always logical to just take the Dutch standards. Also other international standards might be a better fit for the land characteristics of Ghana. Another (in Accra well known) international sediment quality guidelines is for example the **Australian Standards**.

Key finding 2: The World Bank is currently starting with the West Africa Coastal Areas (WACA) Management Program – *https://www.wacaprogram.org/*. The sediment can be reused for **coastal protection** near Accra.

Key finding 3: If **incentives for reuse** are not included, a contractor will most probably not do it. Reuse can be stimulated by including ENVI scores, a bonus for savings on transport costs to disposal sites or a 'staffel' with a higher incentive if reused closer to the dredging site.

Key finding 4: The dredged material is mainly sandy. Sieving for **getting rid of the plastics** alone would already give a huge benefit for reuse.

Key finding 5: A **demonstration of the treatment equipment** can convince contractors that they can clean the sediment on an economic feasible way. Otherwise a contractor will probably hesitate to invest in this treatment equipment.

Key finding 6: It should also be clear for the contractor what is considered as 'clean' sediment. **Values for 'clean' or 'contaminated' should be included in the contract** and how the contractor will be checked. Or instead of values, an approval (by the Environmental Protection Agency) for the treating method of the sediment.

1.4. Literature study
SUBJECTS

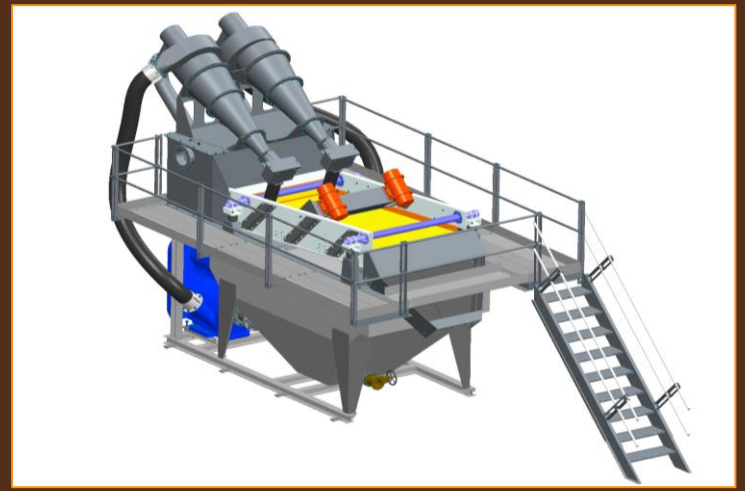
Based on the provided documents and key findings, addional information is gathered **(ToR-8)** about the following subjects:

- Sediment treatment options
- Marine applications
- Local legislation for sediment reuse
- Local practice for sediment reuse
- Local standards for reuse options
- Contaminations in soils
- Sandcrete blocks in Accra
- CSEB in Accra
- Rammed Earth in Accra
- Challenges in Ghana

1.4. Literature study
Treatment options & Marine application

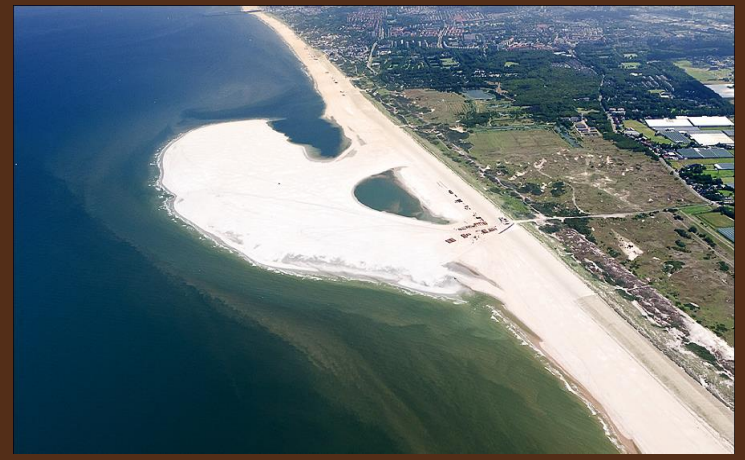
Sediment treatment options

- Hydrocyclones for sieving on particle size (figure on the right)
- Solid waste separation techniques
- Processing plant setup



Marine applications

- Reuse as 'zandmotor'
- Reuse as solid shore protection in geotextile tubes
- Reuse as dune or as offshore breakwater



1.4. Literature study
Local legislation (by the NETICS representative)

Research question: What legislation is used in Ghana for the reuse of dredged sediments in Ghana?

There is currently no specific legislation on reuse of dredged materials except general guidelines on environmental issues available in other environmental policy documents which have been reviewed by RoyalHaskoningDHV and SAL consult. The policy framework and institutional set up described are accurate.

In the case of reuse of dredged materials from the Odaw, the Ghanian Environmental Protection Agency (EPA) guideline on hazardous substances established under Environmental Protection Agency Act (source: I), 1994 and the Hazardous and Electronic Waste Control and Management Bill, 2016 –Act 917 (source: II) might kick in. The Hazardous Chemical Committee consisting of members from the Council for Scientific and Industrial Research, the crops service department of the ministry of food and agriculture, the Ghana Standards Authority amongst others might need to sit and evaluate the (industrial) use of the sediments. Other regulatory authorities that might check the process of dredging and use of the sediments would be the Hydrological Services Department, Maritime Authority and Water Resouces Commision. A review of the National Environmental Sanitation Strategy and Action Plan (NESSAP) (source: III) and other shows that traditionally the orientation of the policy document and others are towards the disposal of dredged material or desilted materials from drains. The NESSAP tags it as cleansing of drains.

I. *Environmental Protection Agency Act, 1994.*
https://www.lexadin.nl/wlg/legis/nofr/oeur/arch/gha/490.pdf

II. *Hazardous and Electronic Waste Control and Management Bill, 2016 –Act 917*
http://www.epa.gov.gh/epa/sites/default/files/downloads/publications/Hazardous%20and%20Electronic%20Waste%20Control%20and%20Mgt%20Act%20917.pdf

III. *National Environmental Sanitation Strategy and Action Plan (NESSAP)*
https://www.ircwash.org/resources/national-environmental-sanitation-strategy-and-action-plan-nessap-materials-transition

1.4. Literature study
Local practice (by the NETICS representative)

THE SEDIMENT ENGINEERS

Research question: What are the rules in practice in relation to reusing sediments / soils?

Soils containing Chromium, Lead, Mercury, PCBs, etc. are **commonly classified as contaminated sediment** by the Environmental Protection Agency (EPA) → Contaminated sediment fall under **Hazardous waste** → **Proper disposal** (in landfill sites) should be assured and mixing with other soils is not allowed.

When producing **building/construction materials** from these sediments it should undergone **minimum cleaning and treatment**. Building materials will have to conform to the **Ghana Standards Authority (GSA) specifications**. The Civil Department of the GSA could test the sediment before it is used to manufacture construction materials if needed.

The Ghana Standard for several building materials are:

- **Sandcrete blocks**: GS 189:2000 Building and General Construction – Guide to Quality Sandcrete Block Manufacturing
- **Sandcrete blocks**: GS 297-1:2010 Building and Construction Materials – Specification for Blocks Part 1: Precast Sandcrete Blocks.
- **Concrete Pipe Culverts**: BS 5911-3:2010
- **Concrete kerb units**: BS EN 1340:2003

If the construction materials are to be used for **road construction**, then the materials would have to be tested further at the Ghana Highway Authority Lab.

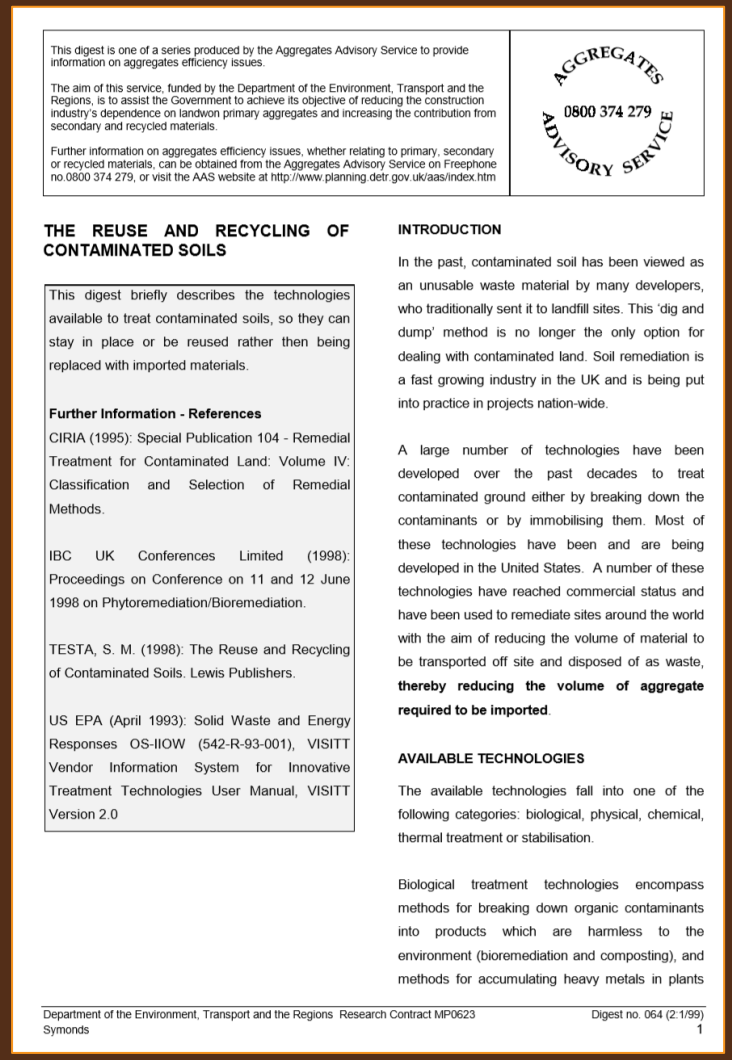
1.4. Literature study
Contaminations

THE SEDIMENT ENGINEERS

Treatment of Contaminations in Soil

- Proven technologies to treat contaminated soils: biological, physical, chemical, thermal treatment or stabilisation
- With physical treatment (soil washing)
- Article "THE REUSE AND RECYCLING OF CONTAMINATED SOILS" (Symonds, Department of the Environment, Transport and the Regions, Digest No.064)

The contamination is concentrated in the particles with higher surface area, i.e. the fine material. The soil washing separates the coarse material from the contaminated fines, scrubs them and prepares them for reuse.



This digest is one of a series produced by the Aggregates Advisory Service to provide information on aggregates efficiency issues.

The aim of this service, funded by the Department of the Environment, Transport and the Regions, is to assist the Government to achieve its objective of reducing the construction industry's dependence on landwon primary aggregates and increasing the contribution from secondary and recycled materials.

Further information on aggregates efficiency issues, whether relating to primary, secondary or recycled materials, can be obtained from the Aggregates Advisory Service on Freephone no.0800 374 279, or visit the AAS website at http://www.planning.detr.gov.uk/aas/index.htm

AGGREGATES 0800 374 279 ADVISORY SERVICE

THE REUSE AND RECYCLING OF CONTAMINATED SOILS

This digest briefly describes the technologies available to treat contaminated soils, so they can stay in place or be reused rather then being replaced with imported materials.

Further Information - References

CIRIA (1995): Special Publication 104 - Remedial Treatment for Contaminated Land: Volume IV: Classification and Selection of Remedial Methods.

IBC UK Conferences Limited (1998): Proceedings on Conference on 11 and 12 June 1998 on Phytoremediation/Bioremediation.

TESTA, S. M. (1998): The Reuse and Recycling of Contaminated Soils. Lewis Publishers.

US EPA (April 1993): Solid Waste and Energy Responses OS-IIOW (542-R-93-001), VISITT Vendor Information System for Innovative Treatment Technologies User Manual, VISITT Version 2.0

INTRODUCTION

In the past, contaminated soil has been viewed as an unusable waste material by many developers, who traditionally sent it to landfill sites. This 'dig and dump' method is no longer the only option for dealing with contaminated land. Soil remediation is a fast growing industry in the UK and is being put into practice in projects nation-wide.

A large number of technologies have been developed over the past decades to treat contaminated ground either by breaking down the contaminants or by immobilising them. Most of these technologies have been and are being developed in the United States. A number of these technologies have reached commercial status and have been used to remediate sites around the world with the aim of reducing the volume of material to be transported off site and disposed of as waste, **thereby reducing the volume of aggregate required to be imported**.

AVAILABLE TECHNOLOGIES

The available technologies fall into one of the following categories: biological, physical, chemical, thermal treatment or stabilisation.

Biological treatment technologies encompass methods for breaking down organic contaminants into products which are harmless to the environment (bioremediation and composting), and methods for accumulating heavy metals in plants

1.4. Literature study
Application Sandcrete blocks

4" Hollow Block

The blocks are available in a standard sizes of 390mm x 195mm x 100mm.

4" Solid Block

The blocks are available in a standard sizes of 390mm x 200mm x 100mm.

5" Hollow Block

The blocks are available in a standard sizes of 400mm x 200mm x 125mm.

5" Solid Block

The blocks are available in a standard sizes of 400mm x 195mm x 125mm.

6" Solid Block

The blocks are available in a standard sizes of 400mm x 195mm x 150mm.

6" Hollow Block

The blocks are available in a standard sizes of 400mm x 195mm x 150mm.

PRODUCTS

- Building Blocks (Solid)

  Sizes:
  - 400mm x 200mm x 125mm (aka 5 inches)
  - 400mm x 200mm x 150mm (aka 6 inches)

- Building Blocks (Hollow)

  Sizes:
  - 400mm x 200mm x 125mm (aka 5 inches)
  - 400mm x 200mm x 150mm (aka 6 inches)

- Pavement Blocks (rectangular shaped)
- Pavement Blocks (rhombus-shaped)

PRICES

SIZE (INCHES)	DIMENSIONS (MM)	PRICE (NO TNT)
5" SOLID	400 x 200 x 125	2.85
5" HOLLOW	400 x 200 x 125	2.80
6" SOLID	400 x 200 x 150	3.01
6" HOLLOW	400 x 200 x 150	2.9

1.4. Literature study
Application Sandcrete blocks

THE SEDIMENT ENGINEERS

PRODUCTION PROCESS

(a) Material Selection

BESTE block is made from 3 kinds of raw materials; Ordinary Portland Cement, Quarry dust and Clean Water. The soundness of the blocks depends very much on the quality of the raw material used. The following raw materials are carefully selected in order to achieve the required quality of products:

- Ordinary Portland cement (as approved by Ghana Standard Authority)
- Quarry dust
- Clean water i.e. free from organic matter, leaves roots, foreign chemicals etc.

A series of tests are conducted on the raw materials before passed for usage in BESTE Block production.

(b) Measurement

The strength of the block depends also on the proportion of raw materials. Cement to quarry dust ratio for solid blocks is 1:6 (for hollow blocks the ratio is about 1.5.5).

(c) Block Making

The required proportion of raw material is made, mixed thoroughly and loaded into a mould. 30seconds is allowed for settling and compaction of mixture.

(d) Packing

Blocks are packed unto a pallet and allowed to cure for minimum 2 weeks with 6 hour interval watering daily.

(e) Quality Assurance

Blocks produced per batch are selected at random and tested for compressive strength and water permeability in an approved lab. Only after passing these tests is the batch passed for storage.

Aslan Dervis International Company Limited was established in 2013 in Kasoa, Ghana with **10.000 pieces Blocks** manufacturing capacity daily. We are manufacturing A Class blocks for developing Ghana.

www.accrablock.com

1.4. Literature study
Application CSEB or Rammed Earth

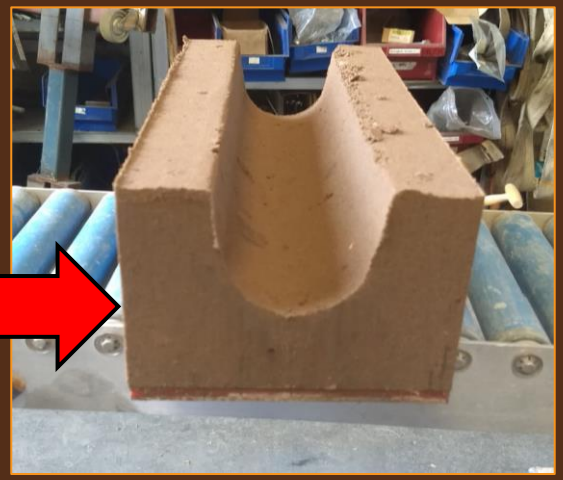
THE SEDIMENT ENGINEERS

Compressed Stabilised Earth Blocks (CSEB)

- No producers present in Accra
- Not known to contractors (checked with Devpod, Vonnyborq, Oskam v/f)
- Possible with sediment from Odaw (pictures next slide)

NETICS CSEB from SBIR program

- Samples from Odaw and upstream
- Demonstration block CSEB produced
- Drain shape



1.4. Literature study
Application CSEB or Rammed Earth

THE SEDIMENT ENGINEERS

Rammed Earth for buildings

- Present in Accra
- Company: Hive Earth

The **housing deficit** in Ghana currently stands at 1.7 million homes, and that number continues to grow. Due to the low cost of building with earth, Hive Earth manages to build a one-bedroom house for only $5,000 USD. According to the company, this can solve the housing crisis not only in Ghana but also throughout the African continent. https://www.archdaily.com/914736/colors-of-the-earth-the-incredible-designs-of-rammed-earth-walls-in-ghana

Article "Building Houses with Locally Available Materials in Ghana: Benefits and Challenges" (H. Danso, 2013)

Benefits: The study found promotion of cultural heritage, abundance of material in the locality, provision of **cool room temperature** and availability and **affordability** of local building materials as the major benefits of houses built with locally available materials in Ghana.

Challenges: Requirement of increased labour work and easily wearing or erosion of the materials, **low strength** and **frequent maintenance** were found to be the major problems associated with houses built with locally available materials in Ghana.

1.4. Literature study
Challenges in Ghana

THE SEDIMENT ENGINEERS

TOP 5 ENVIRONMENTAL PROBLEMS IN GHANA ACCORDING TO NESSAP

Nature of concern	Causes	Effects	Indicators
1. Land degradation	Traditional farming methods Bush fires Clearing of watersheds Sand and stone winning Harvesting of firewood	Loss of top soil Loss of biodiversity Loss of medicinal plants Siltation of rivers Salination of soil	Area affected by erosion Area affected by salinisation Area of land contamination Area of water logging
2. Coastal erosion	Rising sea level Sand wining on beaches Harbour construction	Erosion of coast Loss of spawning ground	% land loss to erosion No of sand wining sites on beach
3. Pollution of water bodies	Mining activities Indiscriminate waste disposal Farming along river banks Indiscriminate defecation	Damage to aquatic life Poor water quality Toxic water sources	Increase BOD in rivers % loss in aquatic life % faecal coliform in rivers Use of agricultural pesticide
4. Deforestation	Timber exploitation Fuel wood extraction Shifting cultivation Bushfires	Loss of biodiversity Drying of streams Soil erosion	% loss of fauna, flora % loss of forest land/year Number of bushfire/year Annual Allowable Cut
5. Poor Waste management	Human activities Mining activities Industrial activities Agricultural activities	Increased soil toxicity Poor water quality Visual intrusion Increase in diseases Emerging diseases	Volume of types of waste No of waste treatment plants

According to NESSAP, the top 2 problems in Ghana are **land degradation** (loss of top soil) due to sand- and soil mining and **coastal erosion** due to sand winning on beaches.

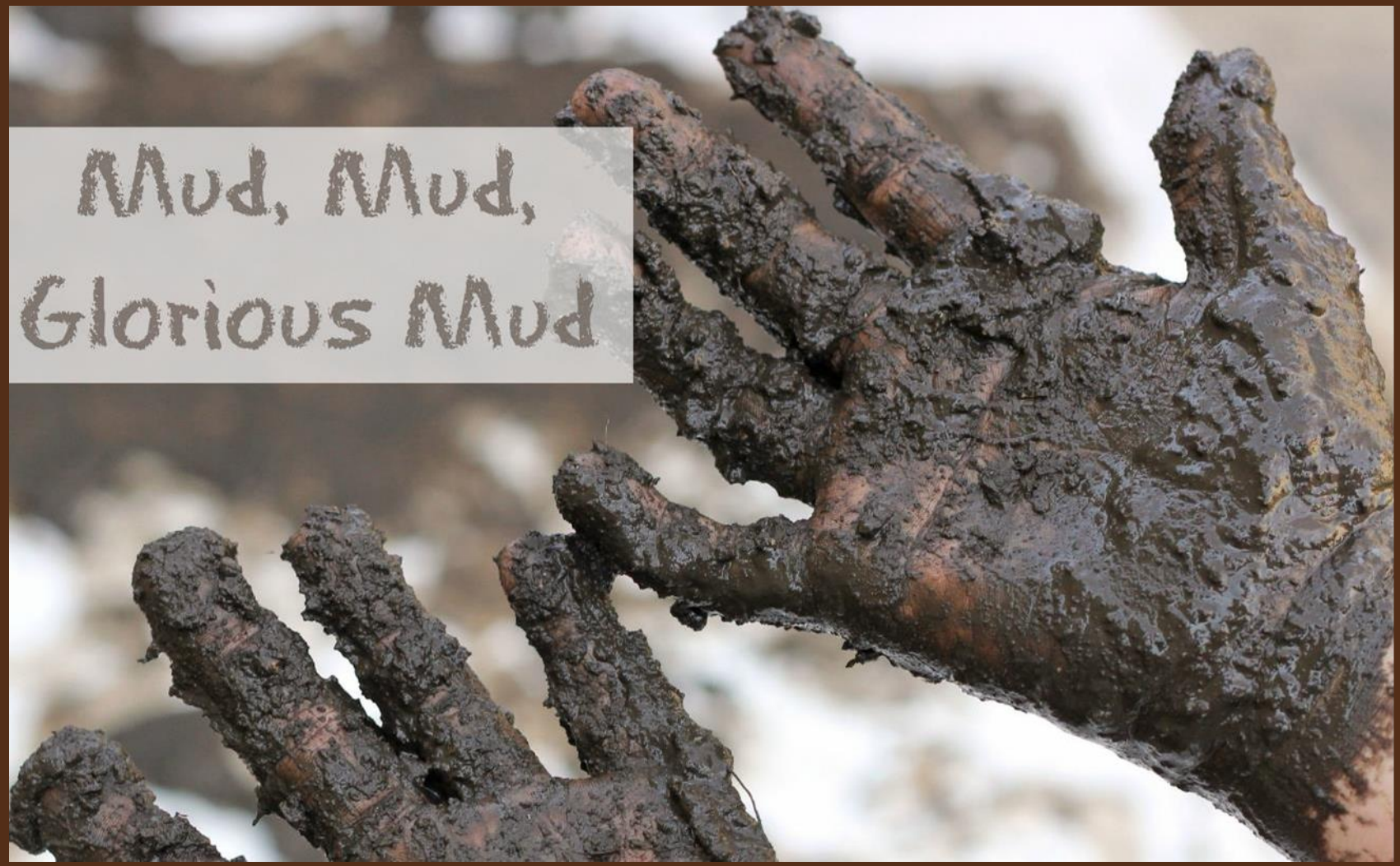
Source: National Environmental Sanitation Strategy and Action Plan (NESSAP)

https://www.ircwash.org/resources/national-environmental-sanitation-strategy-and-action-plan-nessap-materials-transition

1.5. Next steps
FOCUS FOR NEXT STEPS OF THIS STUDY

In the next steps for the reuse options the focus will be on:

- Testing of the sediment
- Sediment treatment options (together with Royal IHC)
- Stimulating sediment reuse in the contract
- PR: Changing the perspective of Odaw sediment → Sell as river sand
- Reuse option: Sand / Construction aggregate (Sandcrete blocks)
- Reuse option: CSEB & Rammed earth
- Reuse option: Geotextile tubes or reclamation for coastal protection



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