CONCEPT

THE SEDIMENT ENGINEERS

Alternative sediment handling Ghana

Results step 3 to 5 – Feasibility

www.buildingwithnature.com

Alternative Sediment Handling in Ghana
FEASIBILITY

Title:	Alternative sediment handling Ghana
Project number:	NP.2020.250
Your ref. number:	202004007
Date:	July 1, 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 3 to 5

TECHNICAL FEASIBILITY

In the technical feasibility study the details of the implementation of the CSEB and geotextile tube technology within the GARID project boundaries were assessed. It provides a detailed description on the materials to be used, the for Accra deployable treatment / process scenarios including suitable applications, the corresponding execution methods (with adjustments if necessary), spatial impact, process rates, process quantities, capacity and time durations.

FINANCIAL FEASIBILITY

The scenarios are used as input / framework for the financial feasibility study. In this study the costs and benefits of the different treatment / processing scenarios (only in comparison to the building element itself) have been assessed. Market prices are investigated for required materials and (local) processing equipment. This step also describes the differences between the costs and benefits of the different scenarios and where financial viability gaps are expected.

ECONOMIC FEASIBILITY

The economic analysis assesses the market for building elements. The potential off-takers and firms, potential business partners and other companies will be questioned to obtain the answers for the economic feasible research questions. It will give information about the demand for the building elements and what off-takers are willing to pay for the products. But also, it will give insight in the companies who want to be involved as producer / processer / seller / buyer / user / transporter of the building elements and what investments they are willing to do.

Alternative Sediment Handling in Ghana
TECHNICAL FEASIBILITY QUESTIONS

THE SEDIMENT ENGINEERS

Technical feasibility research questions

- What type of sediment handling, treatment and/or processing is needed to produce what potential off-takers in Ghana need? In addition, do building processes/techniques need to be adjusted to fit the offered products and is this feasible in Ghana/Accra? (ToR-Q2)
- What space and land requirements are needed to handle/process the sediments for the different reuse alternatives identified (for example CSEB)? (ToR-Q3)
- What is the timeframe to set up a processing system and to process the different scenarios? For example, is such a system set up in a few weeks and thereafter, how long will it take to produce construction materials like blocks/bricks? (ToR-Q7)
- What quantities (m^3 or %) are expected to be processed in relation to the total dredged material on annual basis, based on quality of sediment, speed of processing, capacity, location, etc.? (ToR-Q9)

Alternative Sediment Handling in Ghana
FINANCIAL / ECONOMIC FEASIBILITY QUESTIONS

THE SEDIMENT ENGINEERS

Financial feasibility research questions

- What are the costs of the sediment handling, treatment and/or processing steps, and where are financial viability gaps expected? (ToR-Q4)
- What is the difference between costs and benefits of the different treatment and processing scenarios of the material? (ToR-Q6)

Economic feasibility research questions

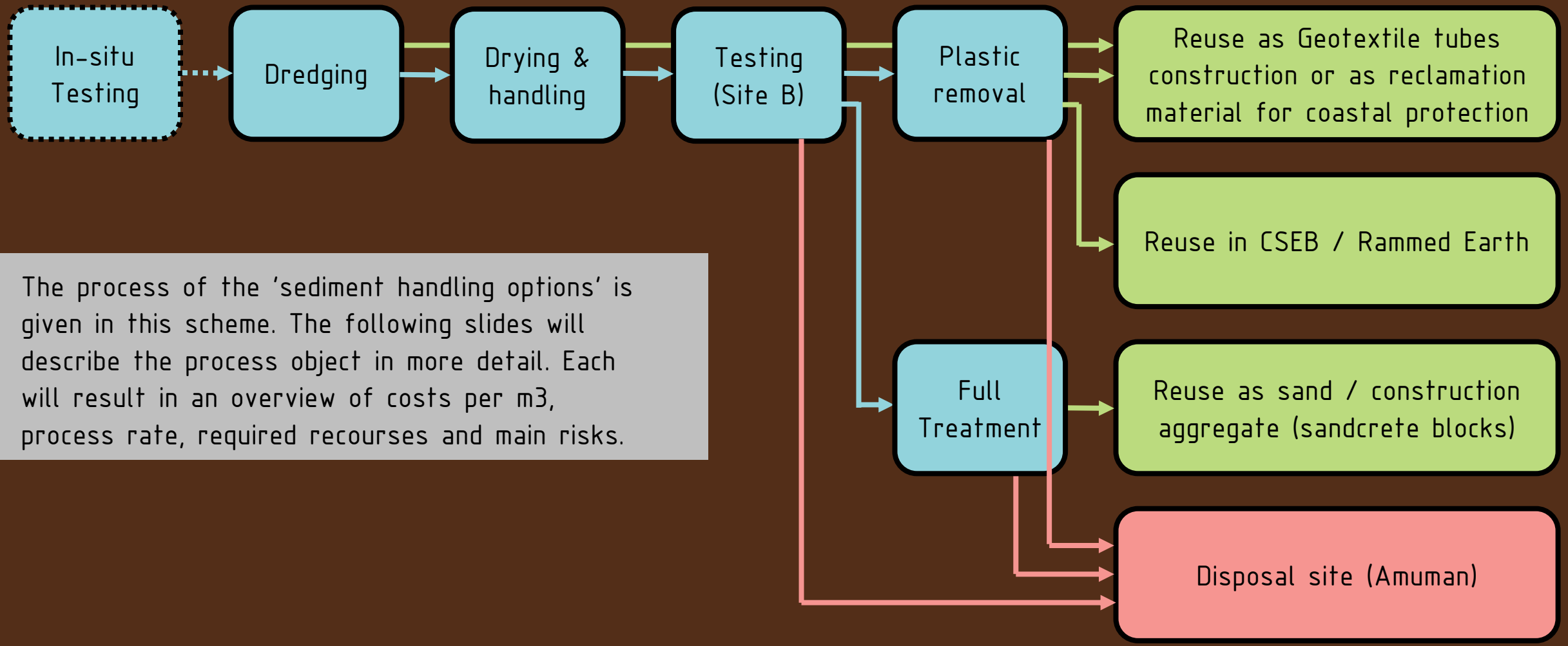
- What are the interests and business case for potential off-takers in Ghana/Accra? For example, buy, treat raw material like sand, clay, gravel and/or sell products build from these raw materials like bricks, sand bags or building blocks? (ToR-Q1)
- What investment is required and are people/firms willing to pay? (ToR-Q5)
- Is there a list of (approached/interested) potential business partners/companies to set up the supply chain to process, sell, buy, use, transport the material and products? If not, please describe what steps to take to get this. (ToR-Q10)
- What will be the break even point or pay back time of the investment should this approach be adopted? (ToR-Q11)

Steps 3 to 5 - Feasibility
CONTENT

THE SEDIMENT ENGINEERS

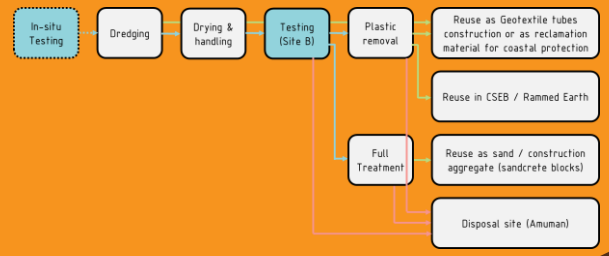
STEP 3	TECHNICAL FEASIBILITY
STEP 4	FINANCIAL FEASIBILITY
STEP 5	ECONOMIC FEASIBILITY

3.1. Process and costs
PROCESS



The process of the 'sediment handling options' is given in this scheme. The following slides will describe the process object in more detail. Each will result in an overview of costs per m3, process rate, required recourses and main risks.

3.1. Process and costs
(IN SITU) TESTING



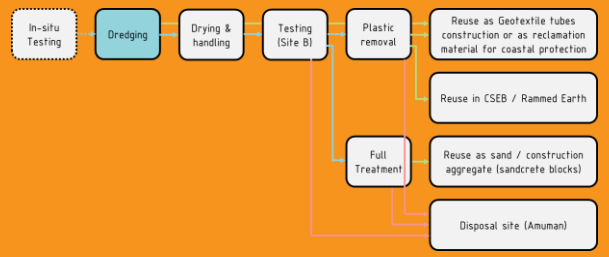
THE SEDIMENT ENGINEERS

Testing large quantities of sediment

- Testing the dredged material on land at site B after dredging could be done according the Dutch method for testing large quantities of sediment. 'Lots' of maximum 10,000 tons (around 6000m3) are tested at once. Based on the tests, a lot will receive a certain classification.
- The costs for testing a lot in the Netherlands is €1200.–. This includes 1 lot inspection, a report and advise (2x analyses of 50 mixed samples) in which actual testing 2x €250.– for standard analyses (7x heavy metals, Mineral Oil, PAC's, PCB's)
- Testing large quanties of sediment in the Netherlands is €0.20 / m3
- Testing could be done at National Laboratories in Ghana
- There is a request for quotation via SAL consultants for the testing costs in Ghana as well as process rates

(In situ) testing		
Cost per m3	Netherlands	€0.20 / m3
	Ghana	(*request for quotation SAL consultants*)
Process rate	*Requested*	
Required resources	Testing laboratory	
Main risks	Time for getting a formal approval from the EPA on the testing process and time before result are back after testing a lot.	

3.1. Process and costs
DREDGING

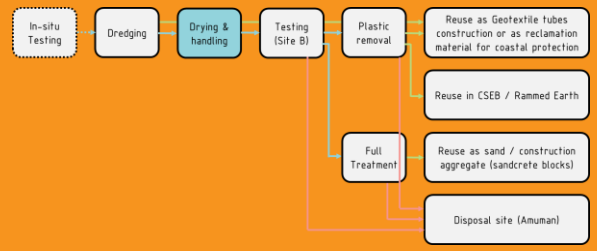


THE SEDIMENT ENGINEERS

Dredging costs, process rates and resources are given in the feasibility study by IMDC and are summarized in the following table:

Dredging				
Cost per m3	Deferred	Wet	CSD	€7.5 / m3
			Excavator + Pontoon	€7.5 / m3
		Dry	Excavator	€4.0 / m3
	Maintenance	Wet	CSD	€9.0 / m3
			Excavator + Pontoon	€8.5 / m3
		Dry	Excavator	€4.50 / m3
Process rate	Deffered dredging		655.000 m3 / year	
	Maintenance dredging		45.000 to 165.000 m3 / year	
Required resources	Dredging vessels and/or excavator (with pontoon)			
Main risks	Variation in the amount of sediment in maintenance dredging, the variation in the sediment quality and tha assumption of off-takers that all Odaw sediment is heavily contaminated.			

3.1. Process and costs
DRYING & HANDLING

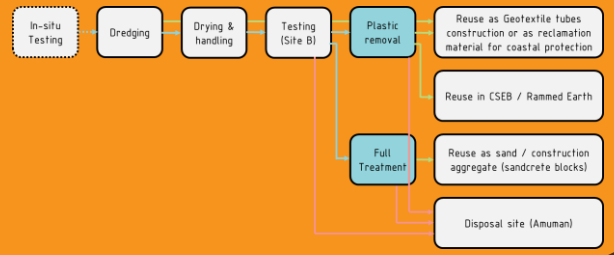


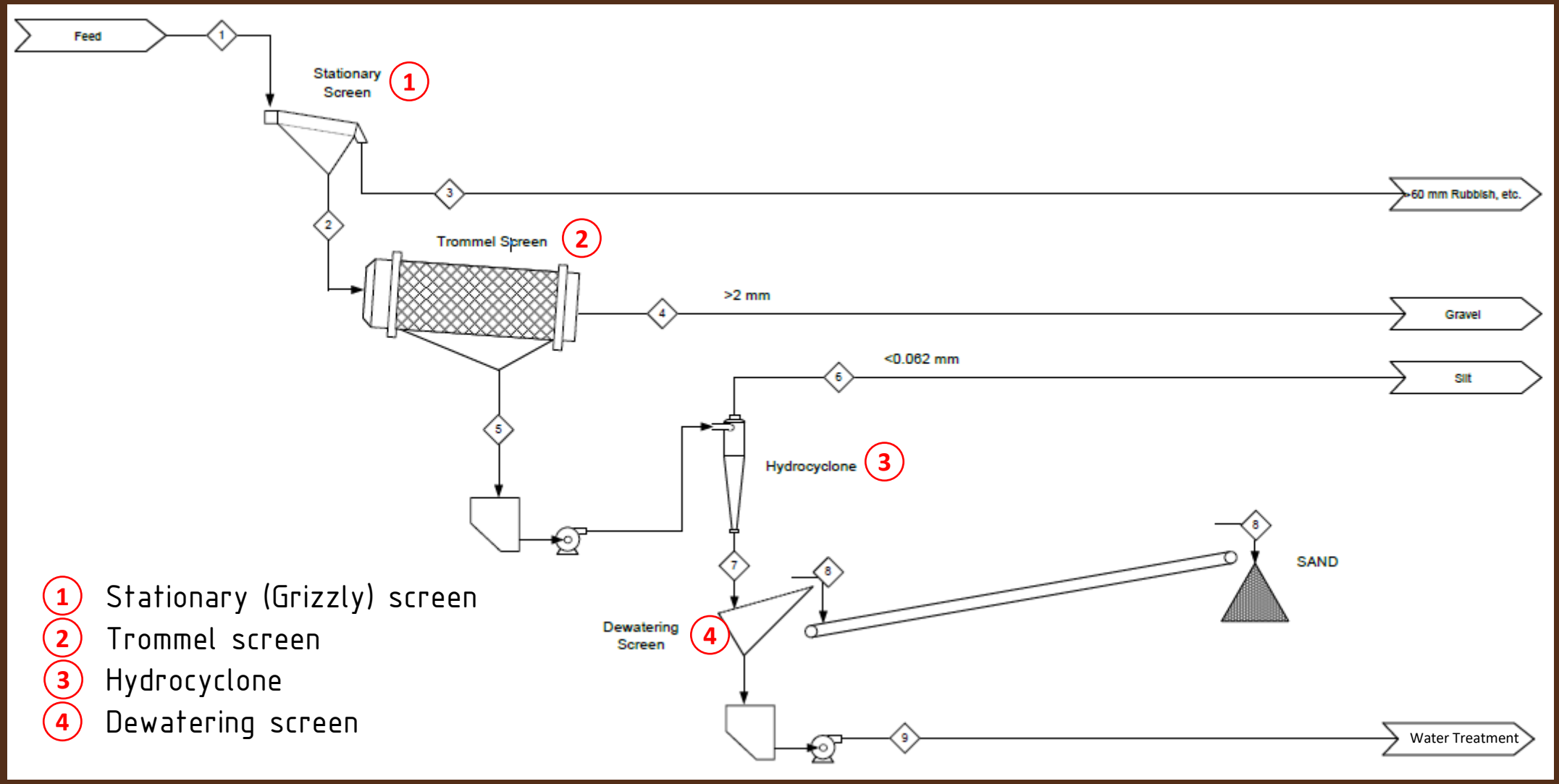
THE SEDIMENT ENGINEERS

Due to ESIA requirements wet sediment cannot be transported directly and so it will need to dry. Drying and airing will also assist in the degradation of the contamination (mineral oils) which increases the amount for reuse (source: ESIA).

Drying & Handling		
Cost per m3	Loading of dried material and small crane	€5.0 / m3
Process rate	4 to 6 days	when 20 % of the particles are smaller than 0.075 mm.
	1 to 1.5 months	when 40 % of the particles are smaller than 0.075 mm.
Required resources	Small crane	
Main risks	Limited storage space at the handling site – site B (approximately 450,000 m3)	

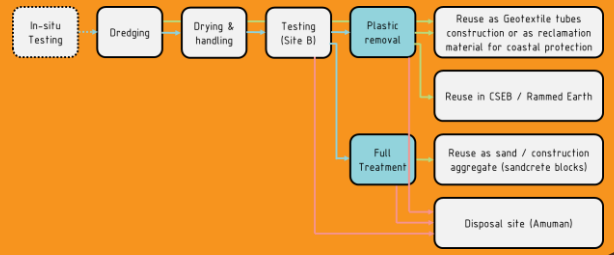
3.1. Process and costs
TREATMENT



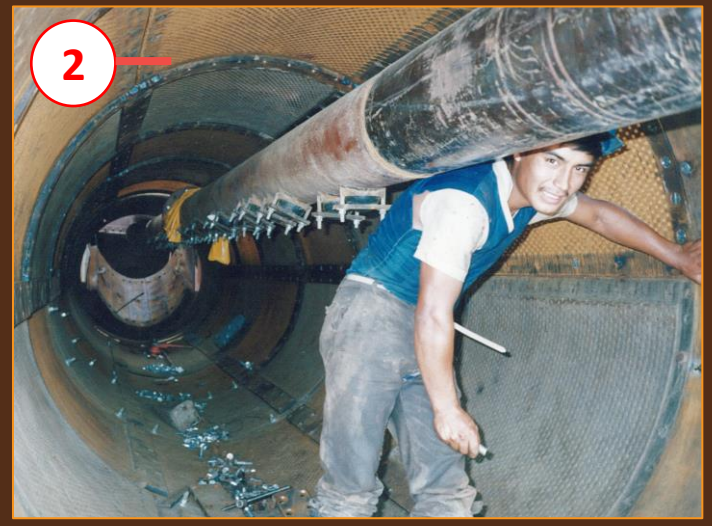


1. Stationary (Grizzly) screen
2. Trommel screen
3. Hydrocyclone
4. Dewatering screen

3.1. Process and costs
TREATMENT

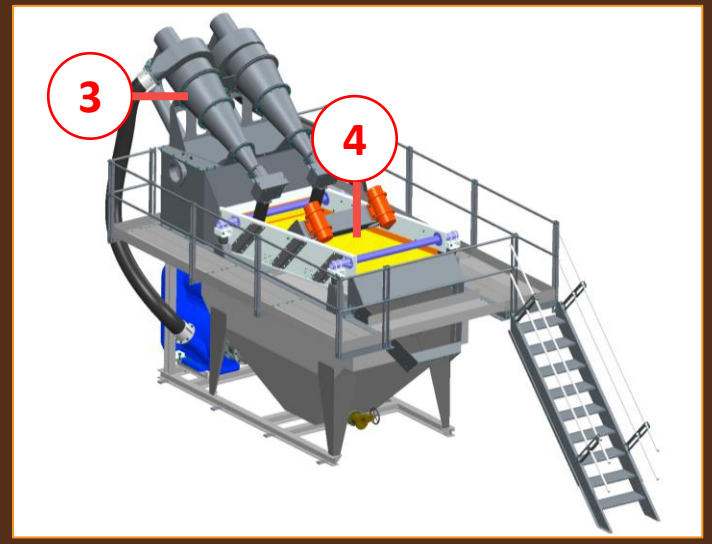


THE SEDIMENT ENGINEERS

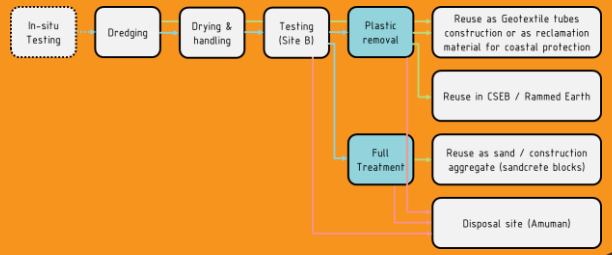


Examples by IHC

1. Grizzly screen
2. Trommel
3. Hydrocyclone
4. Dewatering screen



3.1. Process and costs
TREATMENT

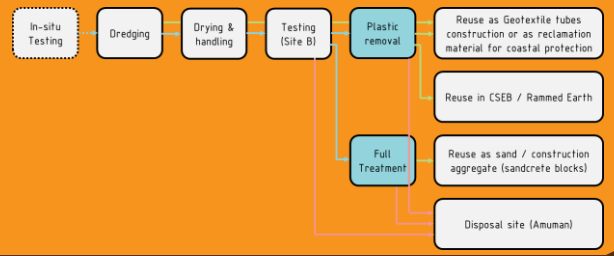


THE SEDIMENT ENGINEERS

	Cost	remarks
Costs plant	€980,000	Including FAT testing, on-site start-up, commissioning
transport	€50,000	Containerised setup of equipment
Profit and risk 30%	€309,000	
OPEX	€1-2 per ton	Operational cost 1-2 euro per ton = €1.6-3.2/m3
Excavator on site	€150,000	CAT 320 GC excavator in Accra
	€150,000	Operational cost 6 years
Wheel loader on site	€250,000	CAT 950 GC
	€150,000	Operational cost 6 years
total	€2,039,000	

- Capacity of the treatment plant: 190 T / hour ≈ 120 m3/hour
- Normal capacity (8 hrs / day, 5 days/week, 45 weeks/year, 90% availability) = 173,000 m3 / year
- High capacity (16 hrs / day, 6 days/week, 50 weeks/year, 90% availability) = 528,000 m3 / year
- Total investment costs are 1,430,000 for the plant including excavator and wheelloader

3.1. Process and costs
TREATMENT



THE SEDIMENT ENGINEERS

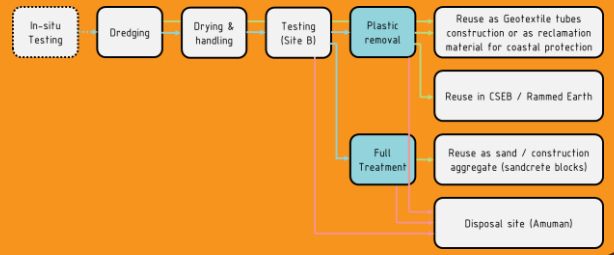
	m3/year (80%)	Tons/ year	Tons/ hour	Workload	Time	OPEX	Plant/year (6 years)	Cost	/m3
Deferred	524,000*	820,800	194	16 hr/day 6 days/week 50 weeks/year 0.9 availability	1 year deferred dredging	€2 /m3	340,000	1.39M	€2.65
Maintenance	36,000- 132,000*	57,600- 211,200	36- 130	8 hr/day 5 days/week 45 weeks/year 0.9 availability	5 years maintenance	€3,2 /m3	340,000	2.28M 3.81M	€14.64 €5.78

*Assumed that 20% of the sediment is clean enough for solid waste treatment only.

Treatment			
Cost per m3	Plastic removal*	Deffered	€2.- to €3.0 / m3
		Maintenance	€4.- to €8.- / m3
	Full treatment	Deffered	€2.50 to €4,50 / m3
		Maintenance	€6.- to €15.- / m3
Process rate	190 T / hour ≈ 120 m3/hour		
Required resources	Process plant, excavator and wheelloader		
Main risks	Limited storage space at the handling site (approximately 450,000 m3)		

*Plastic removal is estimated based on the full treatment costs

3.1. Process and costs
TREATMENT



THE SEDIMENT ENGINEERS

Comparison of prices Feasibility study with treatment prices Royal IHC

	Drying (€5/m³.)	Spreading and aeration (€12/m³.)	Removal of plastics (€10/m³.)	Mixing (€12/m³.)	Gr. Separation (€25/m³.)	Disposal fee (€4/m³.)	COST	BENEFIT (sand/gravel sales)	COST
Full re-use in construction (Sand/Gravel sales)	x	x	x		x		€52/m³	G. €20/m³ S. €9/m³	G. €32/m³ S. €43/m³

Only solid waste

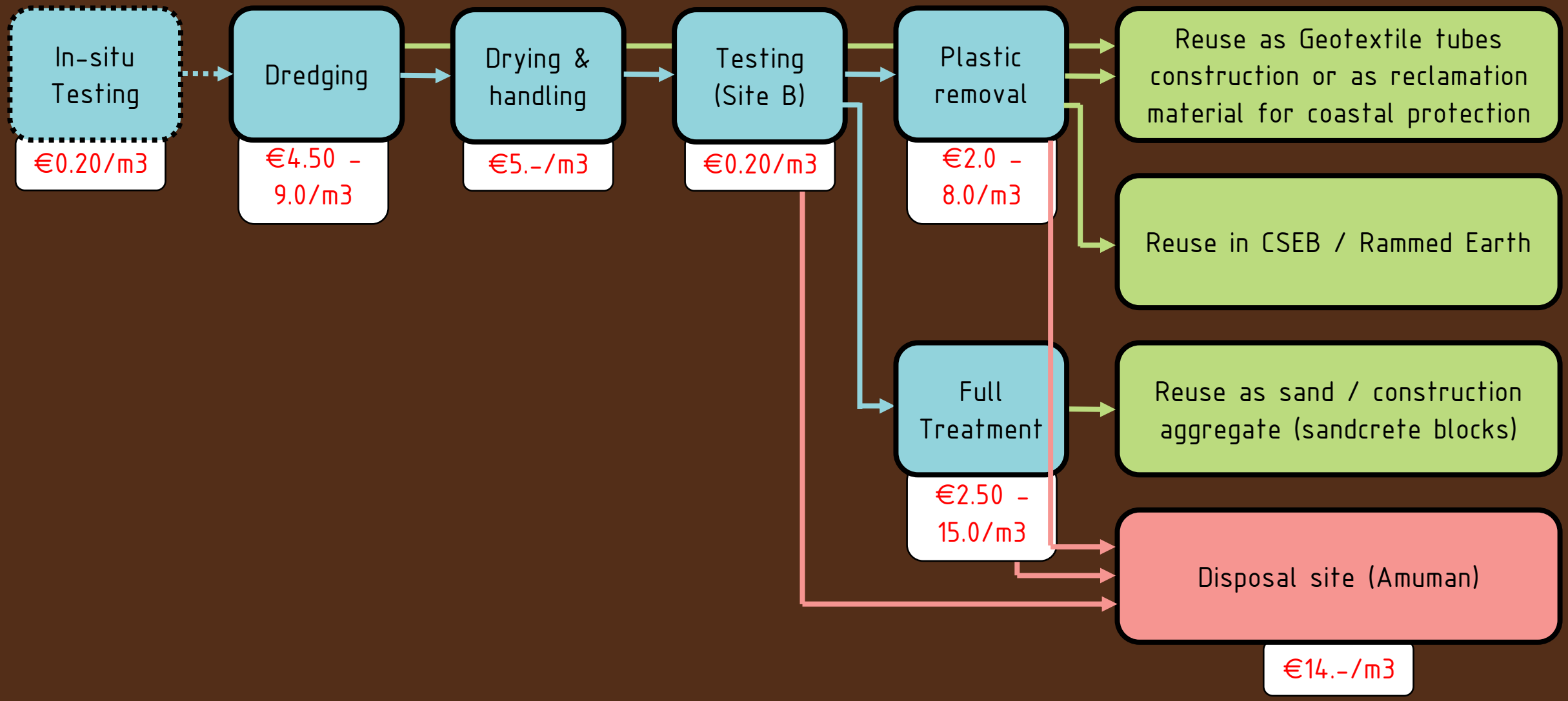
Full treatment

IHC

1. Grizzly screen
2. Trommel
3. Hydrocyclone
4. Dewatering screen

Treatment	Source: Feasibility study Costs per m3		Source: Royal IHC / IHC mining Costs per m3	
Only solid waste	€22.- / m3	Green	€2.- to €8.0 / m3	1 2
Full treatment	€47.- / m3	Yellow	€2.50 to €15.0 / m3	1 2 3 4

3.1. Process and costs
OVERVIEW

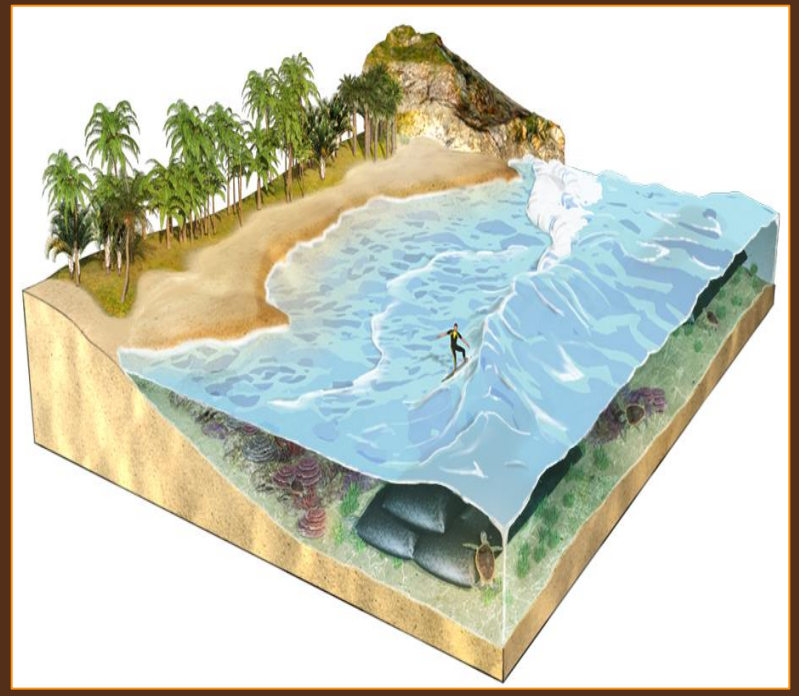


3.2. Market study
REUSE OPTIONS

THE SEDIMENT ENGINEERS

As **sand / construction aggregate** (for example for sandcrete blocks)

In **geotextile tubes** or as **reclamation material** for coastal protection



In **compressed stabilized earth blocks** (CSEB) or **rammed earth**

3.2. Market study
SANDCRETE BLOCKS

As **sand / construction aggregate**
(for example for sandcrete blocks)

3.2. Market study
SANDCRETE BLOCKS

Sandcrete blocks for residential use: Housing

At present, nearly 90% of buildings in Ghana are constructed with sandcrete blocks,i.e blocks made from sand, water and cement.

http://www.accrablock.com/
https://www.asanduff.com/asanduff-blocks-factory/
http://www.gravitashousing.com/

3.2. Market study
SANDCRETE BLOCKS

THE SEDIMENT ENGINEERS

Sandcrete blocks for industrial use: Kerbs, pavements, etc.

3.2. Market study
SANDCRETE BLOCKS

10 sandcrete block factories were interviewed by the local representative of NETICS in Ghana. 17 (prepared) questions were asked to the managers of the factories. The questions are shown on the right. The answers can be found in the Document database.

Interview being conducted at Haksea Ltd

No.	Question
1	Name of company
2	Location
3	Name of contact person
4	Contact number
5	How many blocks are produced approximately per year?
6	How much sand is required for these blocks (or estimate based on the number of truck trips)? And what is the sandprice?
7	Who are your customers (residentioal or industrial)? How many is bought?
8	What are the price they pay for a solid 5" and 6" sandcrete block?
9	What are the minimal (physical and chemical) requirements for the quality of the sediment? % sand/silt/clay, organics?
10	Where do you get your sand?
11	Can you take some sand samples from the sandcrete manufacturers
12	Are you familiar with Ghana Standard 189:2000 for Quality Sandcrete Block Manufacturing or the GS 297-1: 2010 for the Specifications for Blocks?
13	Has Ghana Standards Authority tested your products or materials before? Yearly or monthly or quarterly?
14	How are the blocks produced? Pressing, vibration, etc.?
15	How much of sand, cement and water are needed for the production of sandcrete blocks?
16	What are 'standard' sizes of a sandcrete block?
17	Does the sandcrete blocks manufacturer want to buy the Odaw sand if you can guarantee the quality via cleaning? And how much are they willing to pay per year for the cleaned Odaw sediment?

3.2. Market study
SANDCRETE BLOCKS

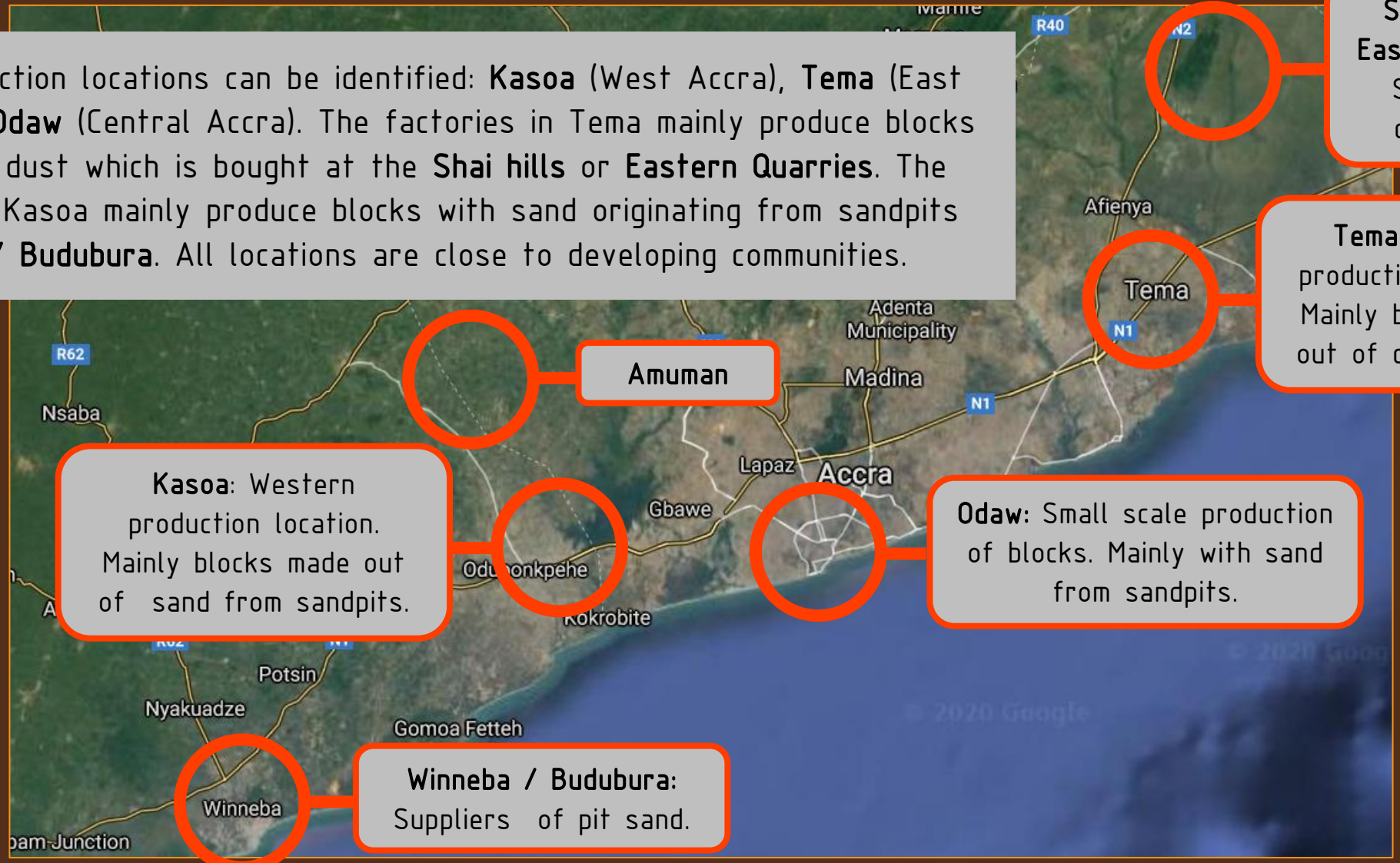
No	Name of company or individual	Location (Google coordinate)	Contact person	Mobile	No. of blocks per day	Estimated number of blocks per year
1	Anadol Company Ltd	Tema Industrial Area (5.6905667,-0.0086556)	Inal	0543431877	4,000.00	1,248,000
2	Bricks and Pipe Company Ltd	Tetegu, Ga South (5.5533111,-0.3148639)	Daniel Baron Sampah	0206022983	4,000.00	1,248,000
3	Jumana Company Ltd	Kalabule, Ga South (5.5445833,-0.3885583)	Kwame Adjei	0262317508	4,200.00	1,310,400
4	Yevubrown Concrete products	Lartebiokorshie (5.5499639,-0.2296639)	Prince Buaben	0549434100	200.00	62,400
5	Haksea	Tema Motorway (5.6561361,-0.0925722)	Alhassan	0203916457	4,000.00	1,248,000
6	Niras Ventures	Odawna (5.5345056,-0.2210028)	Samuel Ankwanor	0554731263	200.00	62,400
7	Ernest Asiamah	Brigade (5.5408444,-0.3954639)	Ernest Asiamah	0570422534	250.00	78,000
8	Richard Keni	Galilea (5.5385806,-0.4009083)	Richard Keni	0245154906	525.00	163,800
9	Emmanuel Sekyi	Amanfro Toptown (5.5521333,-0.4075472)	Emmanuel Sekyi	0555958630	600.00	187,200
10	Osman Masawdu	Ngleshie Amanfro (5.5402472,-0.4098306)	Osman Masawdu	0244150643	800.00	249,600

The factories can be categorized in two groups:
Small factories (+/- 100,000 blocks per year)
Large factories (+/- 1,300,000 blocks per year)

3.2. Market study
SANDCRETE BLOCKS

3.2. Market study
SANDCRETE BLOCKS

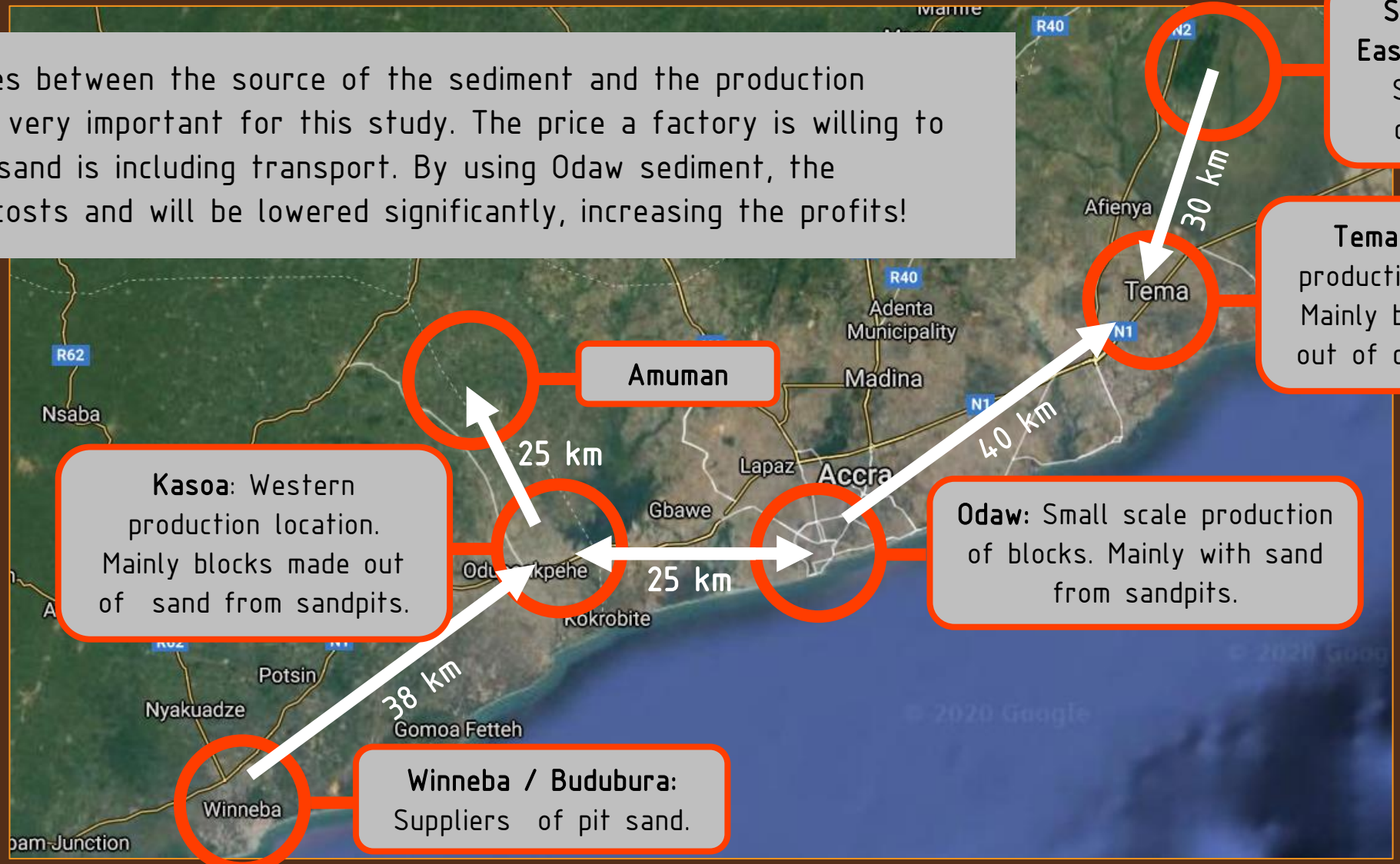
Three production locations can be identified: **Kasoa** (West Accra), **Tema** (East Accra) and **Odaw** (Central Accra). The factories in Tema mainly produce blocks with Quarry dust which is bought at the **Shai hills** or **Eastern Quarries**. The factories in Kasoa mainly produce blocks with sand originating from sandpits in **Winnaba / Bududura**. All locations are close to developing communities.



3.2. Market study
SANDCRETE BLOCKS

THE SEDIMENT ENGINEERS

The distances between the source of the sediment and the production location are very important for this study. The price a factory is willing to pay for its sand is including transport. By using Odaw sediment, the transports costs and will be lowered significantly, increasing the profits!



Shai hills and **Eastern Quarries:** Suppliers of quarry dust

Tema: Eastern production location. Mainly blocks made out of quarry dust.

Amuman

Kasoa: Western production location. Mainly blocks made out of sand from sandpits.

Odaw: Small scale production of blocks. Mainly with sand from sandpits.

Winneba / Bududura: Suppliers of pit sand.

3.2. Market study
SANDCRETE BLOCKS

Question	Answers based interviews with sandcrete block factories
How many blocks are produced approximately per year?	Small factories: Around 100,000 blocks per year Large factories: Around 1,300,000 blocks per year.
How much sand is required for the blocks?	1 m3 of sand: +/- 100 blocks Small factory requires 1,000 m3 of sediment per year Large factory requires 13,000 m3 of sediment per year.
Who are the customers?	Residential purposes (+/- 80%) Blocks Industrial purposes (+/- 20%) Kerbs, pavements, etc.
What are the minimal requirements for the quality of the sediment?	The factories have no strict minimal requirement for the quality of the sand. Not one factory had ever tested the sand from its source. Most of the sand samples had organics (roots, grass, etc.) in them.
Where do the factories get their sand?	The block factories in Kasoa (West Ghana) and Odaw mainly from sand pits. The block factories in Tema (East Accra) mainly used quarry dust. Some factories mix quarry dust with sand (50% / 50%).
Are the factories familiar with Ghana Standard 189:2000 for Quality Sandcrete Block Manufacturing or the GS 297-1: 2010 for the Specifications for Blocks?	50% knew about the standards. Larger factories would sometimes (if requested by the client) send samples to the lab or to the Ghana Standards board for testing and certification. Mainly for industrial customers.
Has Ghana Standards Authority tested your products or materials before? Yearly or monthly or quarterly?	None of the factories has had a visit from the Ghana Standards Authority. Checking lies with the Metropolitan, Municipal and District Assemblies (MMDAs).
Does the factory want to buy the Odaw sand if the quality can be guaranteed via cleaning? And how much are they willing to pay?	90% of factories would accept the sediments from the odaw drain if it is cheaper than the alternatives they buy and if quality is assured.

3.2. Market study
SANDCRETE BLOCKS

90% of the visited sandcrete block factories would accept the sediments from the odaw drain if it is cheaper than the alternatives they buy and if the quality of the sediment is assured.

Prices for sand are mainly influenced by the transport distance.

3.2. Market study
SANDCRETE

Question	
What is the sand price from sandpits?	GHs 25 to GHs 67 per cubic meter EUR 3.85 to EUR 10.26 per cubic meter
What is the quarry dust price?	GHs 47.2 to GHs 66 per cubic meter EUR 7.26 to EUR 10.2 Euro per cubic meter
What is the cement price?	GHs 38 to GHs 40 for a 50kg bag depending on the location where it is bought. Used cement: Diamond cement, Dangote cement, CIMAF and Ghacem Portland cement R 42.5
What is the price for water	GHs 11.12 per cubic meter for industrial consumers and a service charge of GHs 6 per month None of the site measured water volumes used.
What are the price they pay for a solid 5" and 6" sandcrete block?	5" blocks (450x200X125): GHs 2.20 to GHs 3.4 (EUR 0.34 to EUR 0.52) 6" blocks (450x200X150): GHs 2.50 to GHs 3.6 (EUR 0.38 to EUR 0.55).
How are the blocks produced? Pressing, vibration, etc.?	Most of the large scale block factories had machines made from turkey that were adapted to the use of quarry dust.
How much of sand, cement and water are needed for the production of sandcrete blocks?	*Excel sheet*
What are 'standard' sizes of a sandcrete block?	5" blocks (450x200X125) and 6" blocks (450x200X150) for residential purposes Kerbs and paving stones (?) for industrial purposes

3.2. Market study
SANDCRETE

THE SEDIMENT ENGINEERS

Selling price

- Sand (including transport): €4.- to €10.- / m3

Costs for Transport

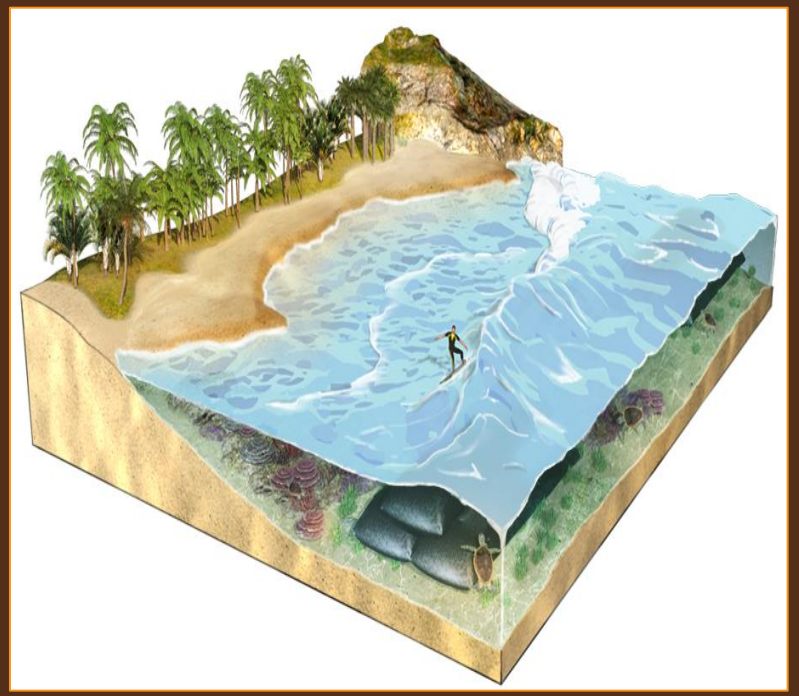
- Field study: €0.14 / km / m3
- To Odaw production location €0 / m3
- To Tema production location €5.60 / m3
- To Kasoa production location €3.50 / m3

Quantities

- Odaw production location: 30,000 m3 sand/ year
- Tema production location: 50,000 m3 sand / year
- Kasoa production location: 100,000 m3 sand / year

3.2. Market study
COASTAL PROTECTION

In **geotextile tubes** or as **reclamation material** for coastal protection



3.2. Market study
COASTAL PROTECTION

THE SEDIMENT ENGINEERS

Off-taker 1: Property owners along coastline

Project example in Ada Foah, Ghana. Private property protection (island) using geotextile tubes

- Shoreline protection of 270m
- ACE Geosynthetics design and engineering

Off-taker 2: Ghana government – WACA programme

Project example of coastal protection at Ada Foah. In this project geotextile tubes were not used but could have been (part of) the solution

- Severe erosion along coastline around Volta estuarian.
- 15km shoreline protection and stabilization (IMDC engineering & design)
- Client preferred standard solution with sand suppletion and goynes. Potential use of geotextile.

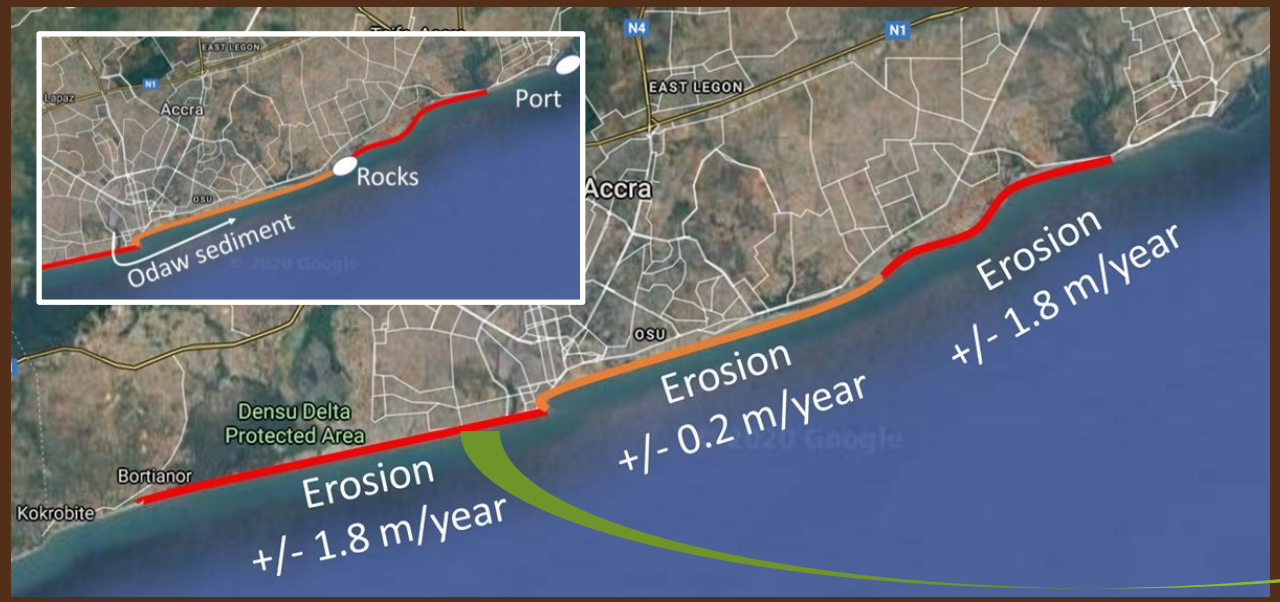
3.2. Market study
COASTAL PROTECTION

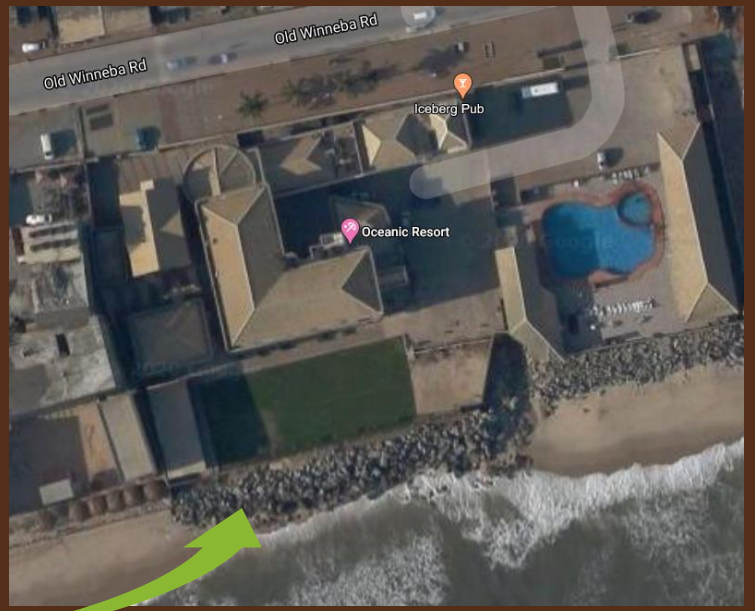
THE SEDIMENT ENGINEERS

Off-taker 3: Ministry of Works and Housing – private property owners along Accra coastline

The Accra coastline is eroding (K. Appeaning Addo, 2009). Significant portions of the coastal lands have been lost. The coastline has receded at an average rate of 1.13 meter per year.

- Erosion around Accra especially east and west, central part of Accra is less affected.
- Central part probably less affected because of Odaw sediment moving to east along the coastline.
- Example of coast erosion 500m west of Korle Lagoon at Oceanic Resort where local protection measures are taken.

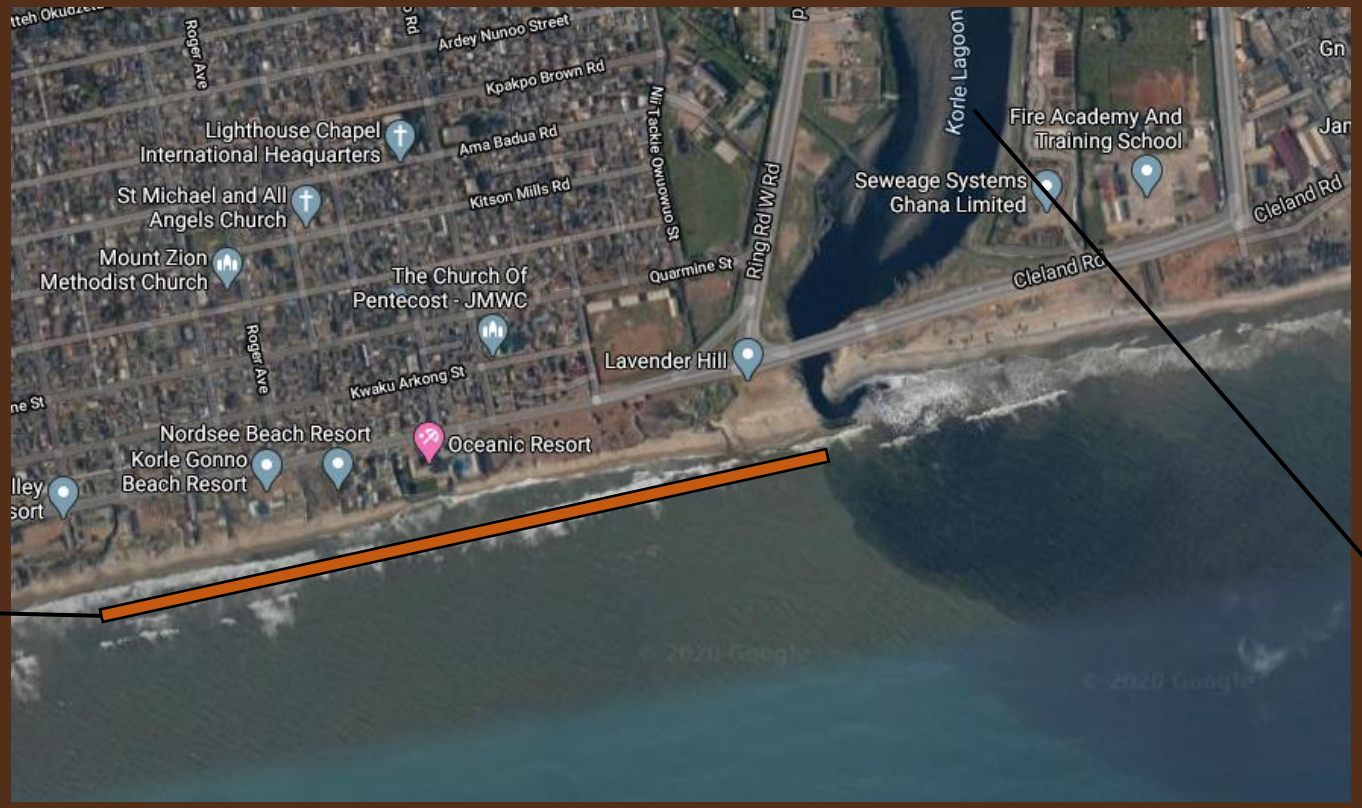




3.2. Market study
COASTAL PROTECTION

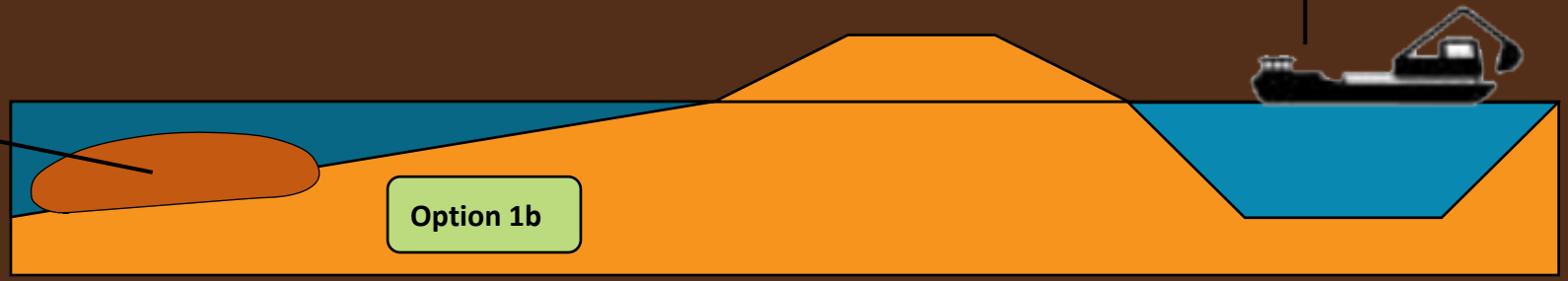
Option 1: Using geotextile tubes as offshore submerged breakwater

Submerged breakwater:
-geotextile tube
-option 1a: 3 tubes (circum 18m)
-option 1b: large tube (circum 34m)



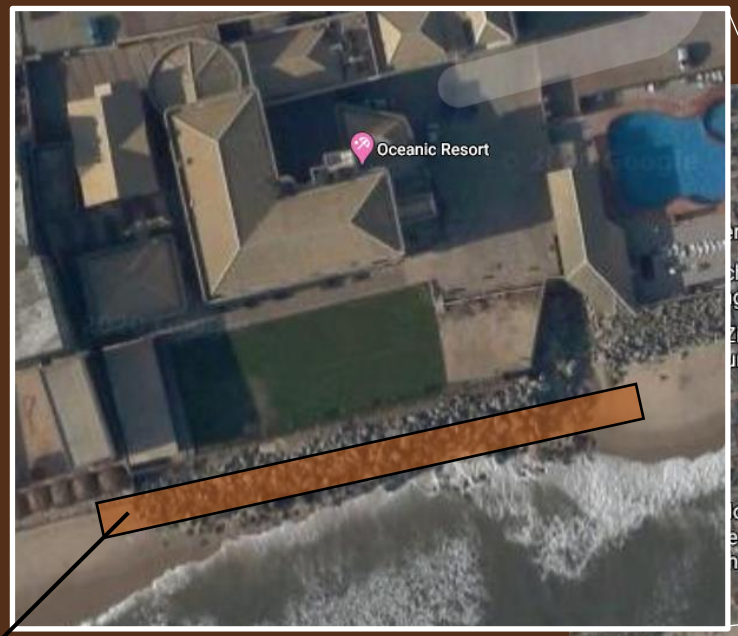
Compared to **traditional breakwaters** with riprap or concrete **geotextile tubes** can be up to 50% cheaper and up to 70% carbon emission can be reduced.

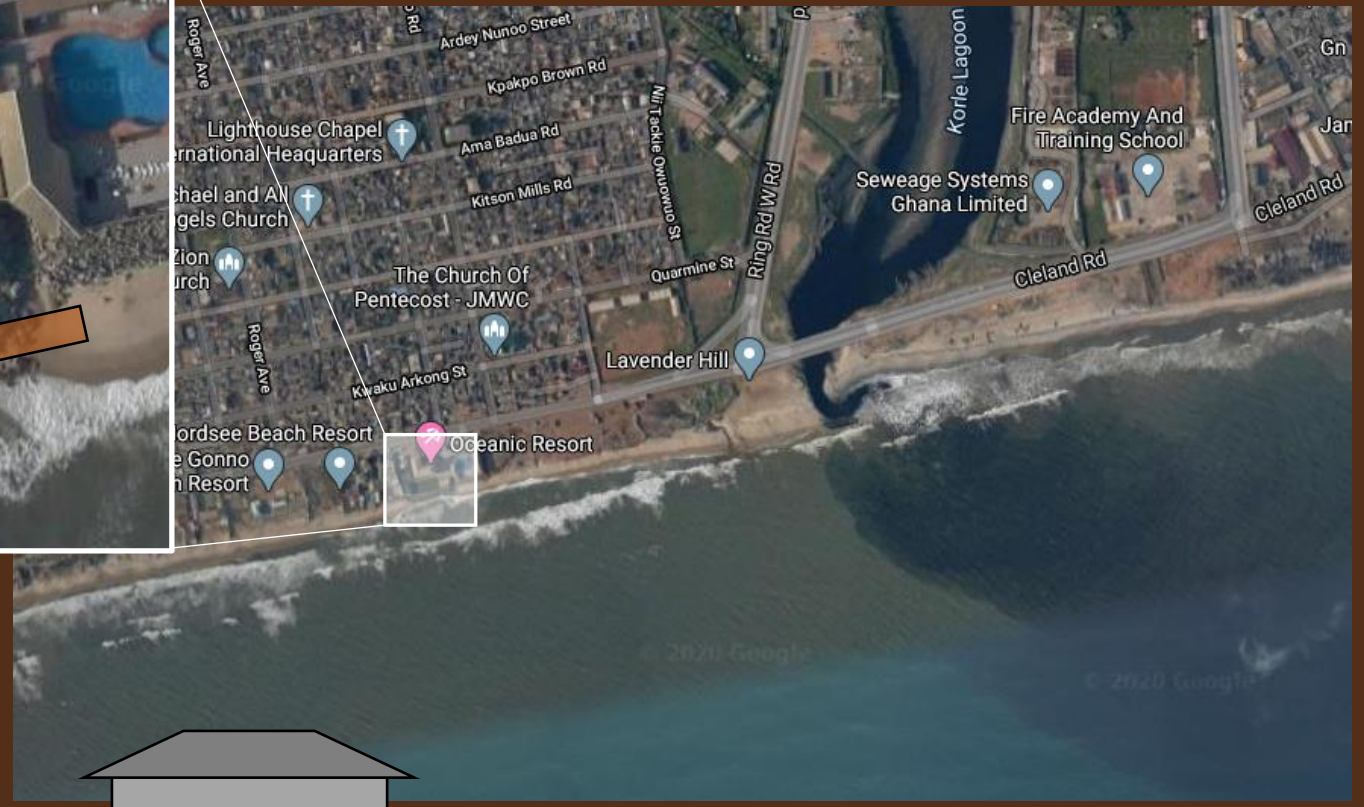
Dredging in Korle Lagoon, Accra
-transport to shore 500m
-transport from site B
-80% sand / 20% fines



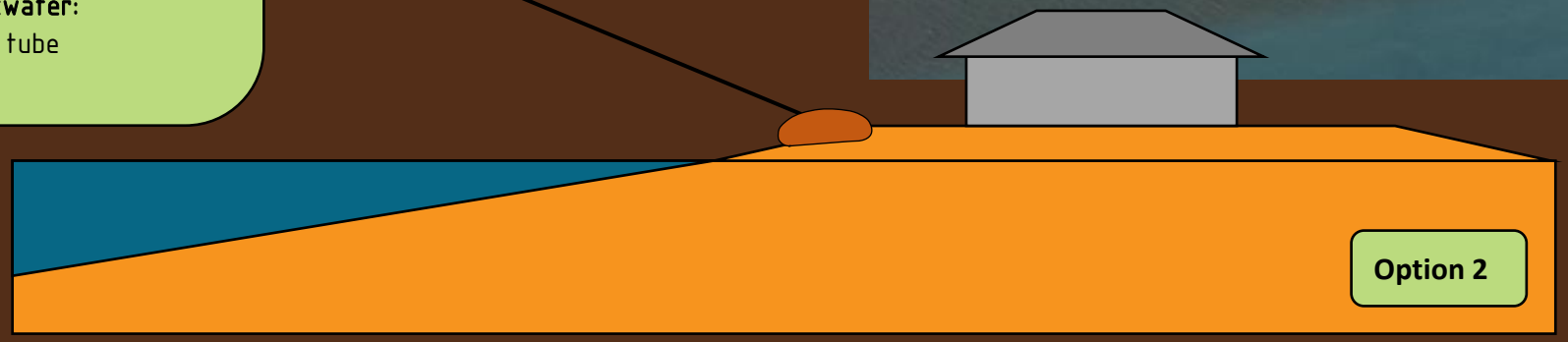
3.2. Market study
COASTAL PROTECTION

Option 2: Using geotextile tubes as small scale breakwater





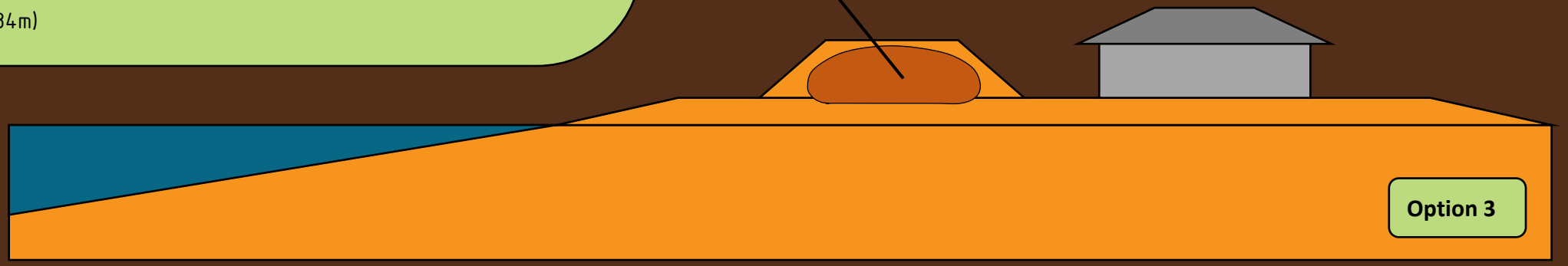
Small scale breakwater:
-small geotextile tube
-local use



3.2. Market study
COASTAL PROTECTION

Option 3: Using geotextile tubes as dune construction

Dune:
-dune with core of geotextile tube
-large tube (circumference 34m)



3.2. Market study
COASTAL PROTECTION

THE SEDIMENT ENGINEERS

Treatment & cost

- Colid waste and plastics removal
- Contaminated sediment can be used in geotextile tubes (industrial use)

Cost & quantities option 1b submerged breakwater & option 3 protection dune

- Cost €25.- per m3 sediment for big tube 34m circumference (ACE geosynthetics cost breakdown)
- reuse of 46m3 per m1 geotextile tube (height 4m, width 15m)
- approximately 20km Accra coast has substantial erosion = potentially 920,000 m3 reused in geotextile tubes

Est. cost for 1KM (Main Tube +Anchor tube+Scour Apron on the sea facing side) (USD)	1,476,500	1,818,500
Est. cost for 1KM (Main Tube without Anchor tubes or Scour Apron) (USD)	1,257,375	1,607,700
Average Cost from Experience of 1km Submerge Geotextile tube project in Taiwan (USD)	1,600,000 ~1,800,000	

Cost & quantities option 2 small breakwater

- Cost €48.- per m3 sediment for small construction 3x8.6m circum (ACE geosynthetics cost breakdown)
- reuse of 13m3 per m1 geotextile tube (height total construction 3m, width 9m)
- approximately 20km Accra coast has substantial erosion = potentially 260,000 m3 reused in small geotextile breakwater

Breakdown Cost Est. Provided to the client that got final Approval:
ACE Material (Tube+NW woven): $85,595
ACE Design / Installation assistance (15 days): $25,000 (Heavily Discounted rate to fit the client budget)
Installation/Filling of ACETube(4,298m3) with client supplied equipment and personnel: $18.70/m3 ($80,372.60)
Miscellaneous: Unknown
Est. Total: $190,967.60

3.2. Market study
COASTAL PROTECTION

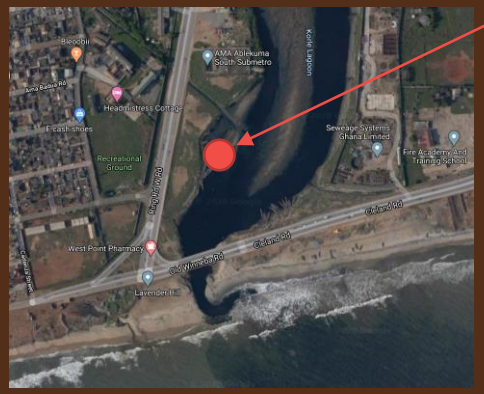
THE SEDIMENT ENGINEERS

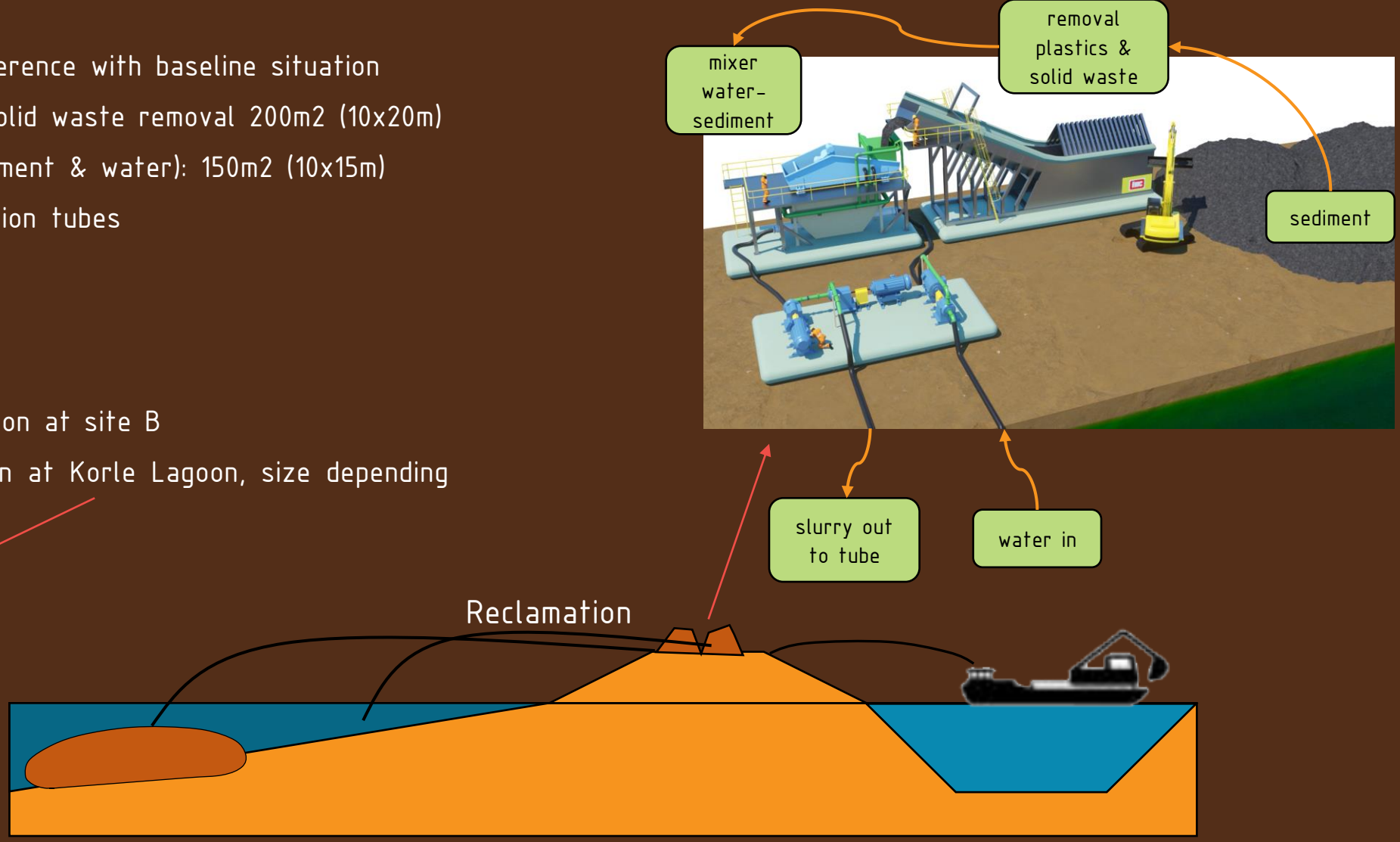
Space and land requirements:

- sediment storage: no difference with baseline situation
- treatment: plastics and solid waste removal 200m2 (10x20m)
- pump station sludge (sediment & water): 150m2 (10x15m)
- (floating) pipeline to location tubes
- booster pumps every km

Options

- 1. treatment & pump station at site B
- 2. small treatment station at Korle Lagoon, size depending on efficiency





3.2. Market study
COASTAL PROTECTION

Timeframe for design & production:

- procedure legislation in Ghana: (Hazardous Chemical Committee / Environmental Protection Agency / Water Resources Commission / Marine Authority) – 6 months?
- Alignment with WACA programme of the World Bank: (World Bank Overall coordinator & National Coordinator for WACA have been contacted) – 0 to 3 years?
- Modeling & design & engineering: 6 months?
- production and transport to Ghana containerized transport – 3 months?
- Construction speed 1.5 - 2 months/km

Do building process/techniques or procedures need to be adjusted?

- Technique not standard in Ghana, need for input from abroad for modeling, design and supervision on site.
- Procedure for permission of application of sediment in geotextile: Water Resources Commission has been contacted to discuss (Hazardous Chemical Committee / Environmental Protection Agency / Marine Authority).

3.2. Market study
COASTAL PROTECTION

THE SEDIMENT ENGINEERS

Selling price

- Coastal protection: €60.- / m3

Costs for construction

- Submerged breakwater / dune: €25.- / m3
- Small breakwater: €48.- / m3

Quantities

- Coastal protection: 200,000 m3 sediment / year

3.2. Market study
CSEB & RAMMED EARTH

In **compressed stabilized earth blocks** (CSEB) or **rammed earth**

3.2. Market study
CSEB & RAMMED EARTH

https://www.azuremagazine.com/article/rammed-earth-housing-ghana/
https://www.facebook.com/hiveearthconstruction/
https://www.sustainability-times.com/sustainable-business/ghanas-affordable-ecofriendly-rammed-earth-homes/

3.2. Market study
CSEB & RAMMED EARTH

THE SEDIMENT ENGINEERS

Selling prices

- CSEB: €0.40 / block, €40.- / m3
- Rammed earth: €60.- / m3

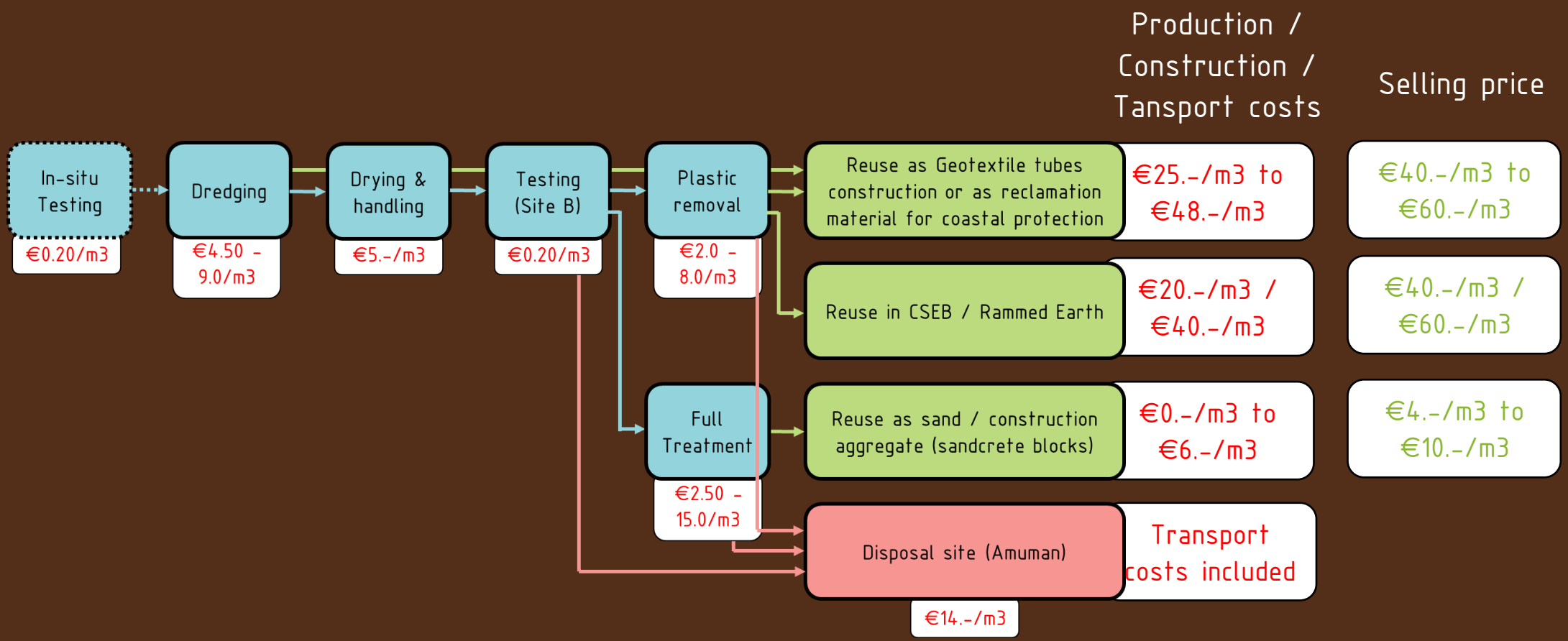
Costs for production

- CSEB: €0.20.- / block, €20.- / m3
- Rammed earth: €40.- / m3

Quantities

- CSEB: No market yet
- Rammed earth: 1,000 / year, but increasing

3.3. Cost benefit analysis
COST BENEFIT ANALYSIS

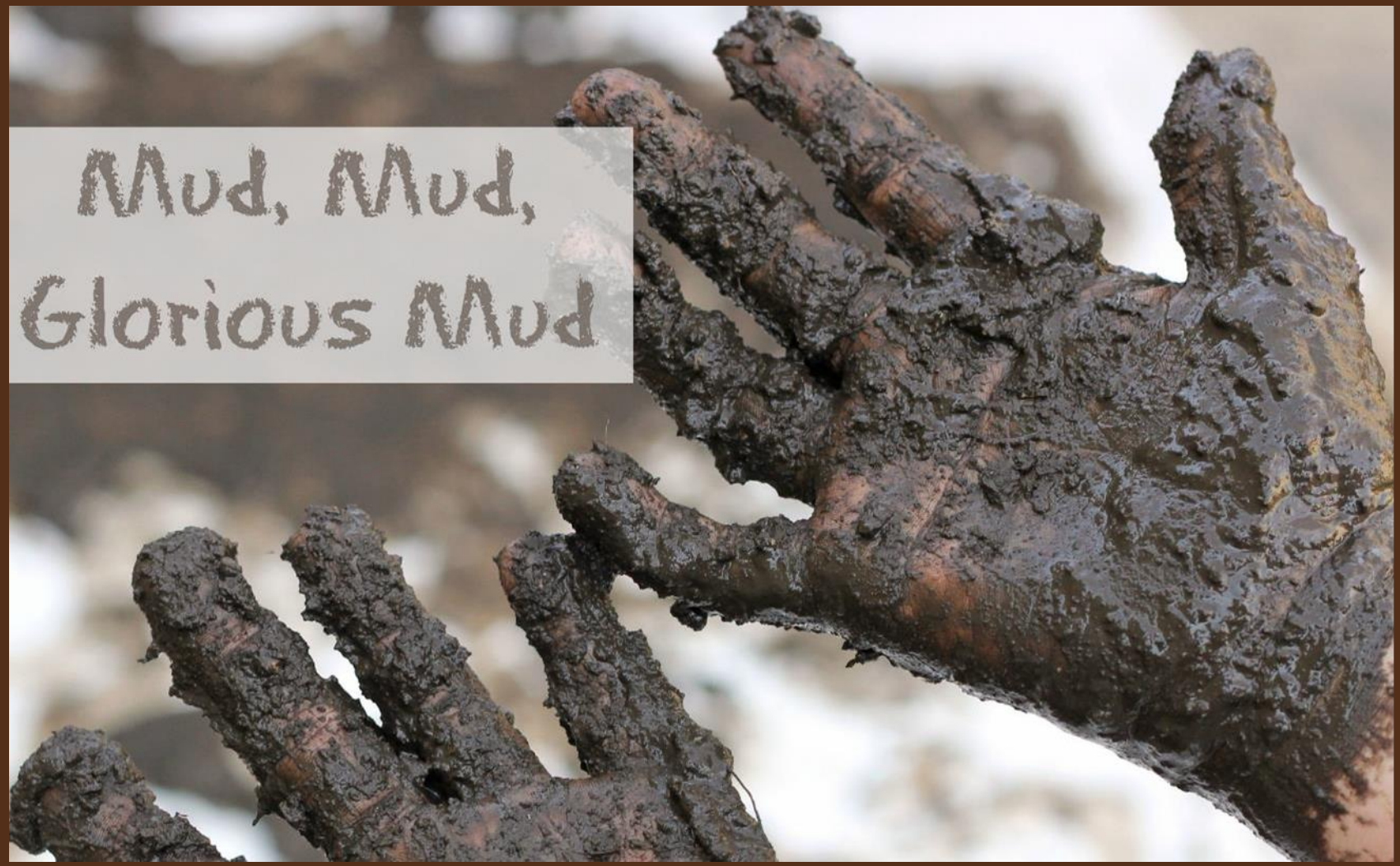


3.4. Quantities and Capacities
QUANTITIES and CAPACITIES

Dredging →	Drying & handling →	Testing (Site B) →	Treatment	Coastal	Sand	CSEB / RE
Yr 1: 655,000 m3	12,600 m3/week	12,600 m3/week	10,000 m3/week	0 m3/week	2,000 m3/week	200 m3/week
Yr 2-6: 100,000	2,000 m3/week	2,000 m3/week	4,300 m3/week	2,000 m3/week	3,000 m3/week	500 m3/week
	Site B max capacity: 450,000 m3 and 140,000 m2					

Quantities and capacities

- The expected off-take in the first year during the deferred dredging process is expected to be lower than the total dredged volume in the first year. This will result in a surplus of treated material at Site B. With the limited capacity of 450,000 m3 it is advised to have the deferred dredging being executed in two years time.
- It will take some time before the dredged sediment will be used for coastal protection, due to required time for a plan and budget (from the WB or Ministry). The offtake will probably start in the maintenance dredging period.
- The off-take of sediment for sandcrete blocks, CSEB and rammed earth are expected to increase over the years



NETICS B.V.
the sediment engineers

Edisonweg 10 (-300)
2952 AD Alblasserdam
The Netherlands

info@netics.nl
06-22960671