# STANDARD OPERATING PROECDURES

## Kutupalong faecal Sludge Treatment Plant FSTP-2

**"OPERATING A FAECAL SLUDGE TREATMENT PLANT & REACHING ITS DESIGNED CAPACITY , MEETING EFFLUENT DISCHARGE STANDARDS REQUIRE THE OPERATOR'S CLOSE ATTENTION AND UNDERSTANDING. SUCCESS DEPENDS ON TAKING GOOD CARE OF THE PLANTS AND BACTERIA'S, MAKING THEIR LIVING CONDITIONS A TOP PRIORITY."**

# Contents




Project Funded by

Treatment plant ( Module 2 and 3 ) operated by

Technical Support

**Brief:**

UNHCR/ OXFAM and MSF have completed the construction of the second large-scale fecal sludge treatment plant in 2021 which is serving Kutupalong North-East camps and adjacent host communities with the treatment capacity of a total 180m3/day.From 1st January ,2022 BRAC has taken over the operational responsibility from OXFAM in collaboration with UNHCR. UNHCR - OXFAM will continue with technical backstopping, KTP FSTP lab establishment , FSM training center and other concentrated FSM related activities throughout the year of 2022 and 2023 till June .

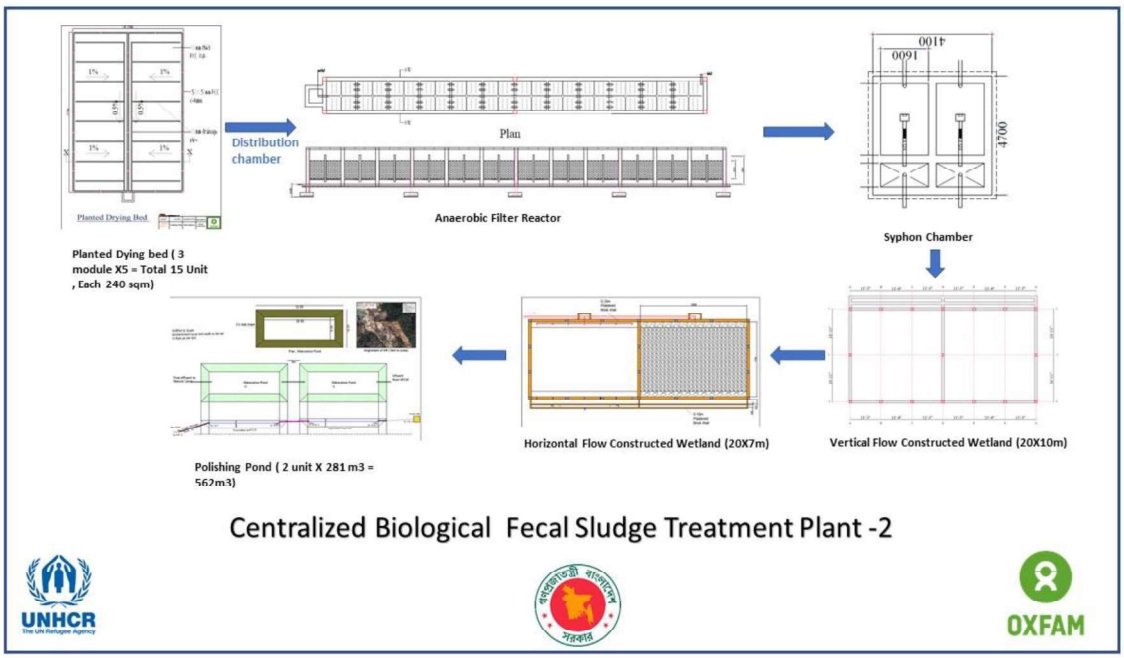
Around 140,000 Rohingya population live in Camp 1E, 1W, 2E, 2W and Kutupalong Registered camp who will be benefitted in addition to nearby Ukhiya Host community from this plant lessening the chance of getting public health disease and outbreaks.

**Brief of the plant**

| | |
|---|---|
| **Total Capacity** | **180 m3** |
| ***Area:*** | 4.6 Acre or 18,700 sqm |
| ***Construction and Operational modality:*** | Whole treatment plant is divided into three modules. Each module has 60 m3/day capacity and are identical in operational modality. MSF is constructing module 1 and OXFAM, module 2 and 3. |
| ***Coverage area:*** | Camp 1E, 1W, 2E, 2W, Kutupalong Registered camp and nearby host communities |
| ***Projected Population coverage:*** | 200,000 individuals<br>Largely depends on several factors such as; latrine containment, soil type, season, etc. |

**Objective of the document**

This document emphasizes the comprehensive operational process and crucial stages necessary to achieve successful operation. It also includes troubleshooting mechanisms. Additionally, we strongly urge operators to review the design and mass balance. Furthermore, examining previous field visit reports will provide a solid understanding of past system issues and their resolution during operation.


Planted Drying Bed
Distribution chamber
Plan
Anaerobic Filter Reactor
Syphon Chamber
Planted Dying bed ( 3 module X5 = Total 15 Unit , Each 240 sqm)
Horizontal Flow Constructed Wetland (20X7m)
Vertical Flow Constructed Wetland (20X10m)
Polishing Pond ( 2 unit X 281 m3 = 562m3)
Centralized Biological Fecal Sludge Treatment Plant -2
UNHCR
OXFAM

OXFAM

**OPERATORS MONITORING CHECKLIST ( Print in A3 )**

| Activity | Details | Daily | Weekly | Monthly | 3 month | 6 month |
|---|---|---|---|---|---|---|
| **Receiving and screening Chamber ( TBU)** | | | | | | |
| Loading to PDB's | This is the most crucial decision an operator has to take every day , follow the related section for recommendation , mostly two factor plants health and drainage capacity. | X | | | | |
| Record the FS loading onto Planted Drying Bed | Record the loading from flowmeter or Sludge tanks volume | X | | | | |
| **Planted Drying Beds** | | | | | | |
| Fill the monitoring sheet , Planted Drying Bed | - Record liquid and sludge height on PDB<br>- # of days required to drain the water and sludge cracked<br>- Take image every other day of each PDB from same angle. | X | | | | |
| Check filtration rate of each PDB | - Using bucket and timer at PDB outlet pipe , continue until PDBs become stable and complain around low infiltration is gone. | X | | | | |
| Plants Health | • Trim and cleaning dead leaves , fallen stems<br>• Check plants health, leaf color status<br>• Replantation inside PDB's as required<br>• Harvesting of plant leaves ( Packchung )<br>• Harvesting of plant leaves ( Canna Indica ) | | X | | | |
| Check liquid control pipes | Liquid control pipes is supposed to be always lower to be able to allow 100% drainage . But during startup time if plant shoots require water, this need to be upraised to 50mm down from sand surface. | | X | | | |
| Clean the collection chamber | It can accumulate scum layer due to slow passing liquid / stagnant often , this need to cleaned monthly. | | | X | | |
| Backwashing | **Twice in a year.** | | | | | X |
| **Anaerobic Filter Reactor** | | | | | | |
| AFR Inlet gate valve control , flow control | Max flow should be restricted to max 2,68 m3 /hr distributed over 8 hours , for one unit of AFR. This can be controlled with gatevalves | | X | | | |
| Check sludge level at bottom of AFR though desludging pipe | Inlet /Outlet pipeline cleaning for struvite formation . | | | | | X |
| Check for any physical damage , floating coco husk , or clogged chamber | Clean as necessary. | | | | | |
| Removal , Washing and replacement of coco husk | Time duration yet to be confirmed . Expected to be done after 3 to 4 years, but the decision will depend on physical structure of the cocohusk and removal efficiency. | | | | | |
| **Siphon chamber** | | | | | | |
| Check if Flout is flushing OK , Mosquito net is not damaged | **Fix as necessary .** | | X | | | |
| Cleaning of Siphon | Ushing water jet , clean the siphon box , clear out scum layer if ay from the chamber | | | X | | |
| **Vertical Flow Constructed Wetlands** | | | | | | |
| Plant health , leaves | See PDB section for plants health monitoring and operation. | | | X | | |
| Ensure for no clogged , overflowing unit , In case of any clogged event | Please see troubleshooting guide as below | X | | | | |
| **Horizontal Flow Constructed Wetlands** | | | | | | |
| Plant health , leaves | See PDB section for plants health monitoring and operation. | | | X | | |
| Ensure for no clogged , overflowing unit | | X | | | | |
| **Polishing Pond** | | | | | | |
| Cleaning of Algae and disposed safely | | X | | | | |
| **General backwashing of all inlet/outlet pipes ofPDB, AFR, Siphon ,VFCW ,HFCW** | Using Fresh water clean all inlet . outlet pipes with pumps , to avoid any possible struvite formation. | | | | | X |

## Daily Loading and Planted Drying Beds

### Sludge loading onto PDB's

One of the most crucial indicators that dictate the daily decision of loading into each PDB (Planted Drying Bed ) is vegetation health. The presence of healthy plants inside the PDB is vital for ensuring the smooth operation of other treatment units. Compromising the growth or health of plants can have detrimental effects on the entire treatment system, leading to issues such as clogging, low filtration rates, and the generation of odors and nuisances.

### Loading Combination 1 ( Batch Loading )

| | PDB2.1 | PDB2.2 | PDB2.3 | PDB2.4 | PDB2.5 | | PDB3.1 | PDB3.2 | PDB3.3 | PDB3.4 | PDB3.5 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sunday** | **60m3** | Rest | Rest | Rest | Rest | | **60m3** | Rest | Rest | Rest | Rest |
| **Monday** | Rest | **60m3** | Rest | Rest | Rest | | Rest | **60m3** | Rest | Rest | Rest |
| **Tuesday** | Rest | Rest | **60m3** | Rest | Rest | | Rest | Rest | **60m3** | Rest | Rest |
| **Wednesday** | Rest | Rest | Rest | **60m3** | Rest | | Rest | Rest | Rest | **60m3** | Rest |
| **Thursday** | Rest | Rest | Rest | Rest | **60m3** | | Rest | Rest | Rest | Rest | **60m3** |

**Option -2 , Parallel loading** , This is not suggested as idle . But since October,2022 trial was done to charge the PDB as shared loading ( Such as dividing 40m3 the load into 20m3 each ) . it was recommended to minimize the hydraulic loading into the plan and allowing drainage time . However it was noted that , loading quantity and frequency in the PDB was governed by supervisor decision and it was made based on particular PDB's plant growth and drainage efficiency. Most of the PDB got a resting period of 5 to 6 days. Further investigation is required on this approach .

**When the loading into certain Planted Drying Bed should be reduced or completed stopped ?**

**In below two conditions**

1. **If there is visible stagnant liquid in the PDB**

**STOP LOADING UNTIL THE LIQUID COMLETELY DRAINS OUT**

2. **If vegetation is less than 50% , and plants are getting yellowish and dying off frequently**

Macrophytes therefore play an essential role in the following ( Source - Ives Magloire Kengne and Elizabeth Tilley,Planted Drying bed )

- Stabilising the beds to prevent media erosion and clogging, and improving the drainage;
- increasing moisture loss (through evapotranspiration, in contrast to only evaporation in unplanted
- drying beds);
- Providing a surface area for microbial growth within the sludge layer;
- Transferring oxygen to the sludge layer (i.e. within the rhizosphere); and
- Absorbing heavy metals and nutrients.

3. **Replantation of Cannas and Packchung**

Keep the nursery for both type of plants ready and acclimatize them with diluted raw sludge. When any PDB will completely go out of plantation , plant the shoots as onto PDB starting with Low loading with a gradual increase.

**Harvesting of Packchung**[1]

When to Harvest ?

1. The plant reached its maximum height ( roughly 2 to 3m ) , Leaves are getting yellowish and falling naturally.
2. Regular harvesting – This idea I still to be explored – After certain height of each stem , cut them from each at certain interval.

From local knowledge , for agricultural purpose generally to cut the grass stems from the outset (at sand layer level ) or keeping few cm from bottom ( 6 to 10 cm from sand layer ) but as sludge layer will raise over time this method is not recommended for PDB's. rather operator should

[1] Please see the past visit reports from OXFAM to get further details.

trim and cut the sub branches from top portion of the plants. While harvesting from each main stem we can get more cutting. Always cut keeping two node in between . After that each stem to be kept under water / At moisture condition for 24 to 48 hrs to grow new leaves.

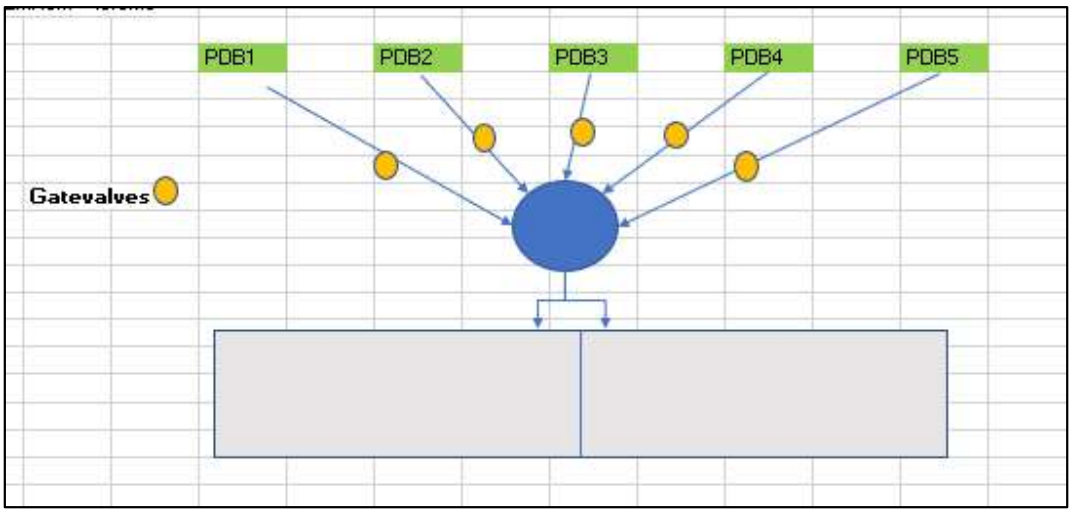
**Advantages and Disadvantages of Harvesting**

| Advantages | Disadvantages |
|---|---|
| 1. Create biological pressure onto plants to extract more liquid from sludge layer, resulting more cracks and opening.<br>2. Fallen dead leaves also add organic load into PDB.<br>3. Packchung has economic value for high nutrition as cow grass. | 1. When sludge layer will be thickened to 10 to 15 cm then walking over the sludge layer may clog the openings. ( Operator should be careful with this )<br>2. If new shoots are not growing again within week or two then sludge loading may need to be reduced. |

## Distribution Chamber

The equal flow to both AFR through the V notch of inlet pipe is critical. Frequent monitoring and necessary adjustment in the V notch height is recommended.

**Controlling the inflow of AFR**



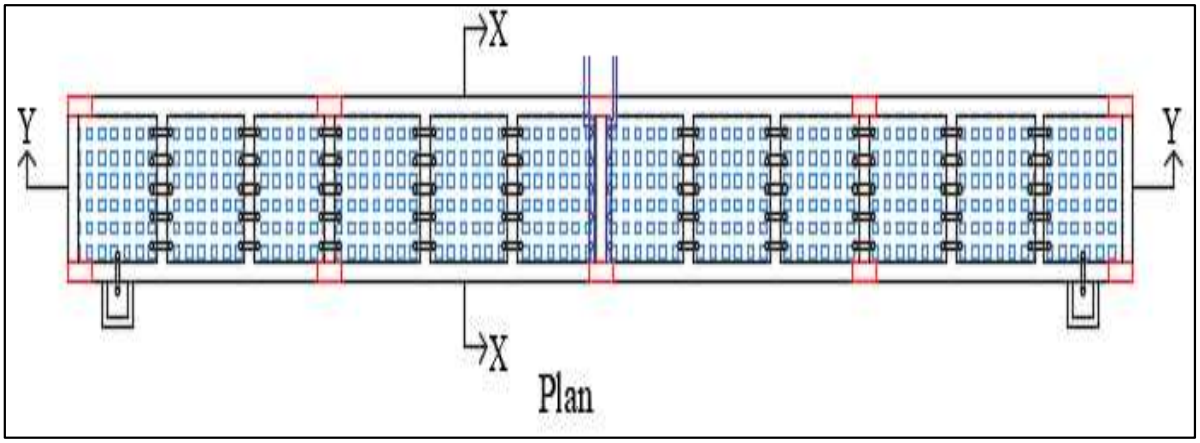

**Calculations**

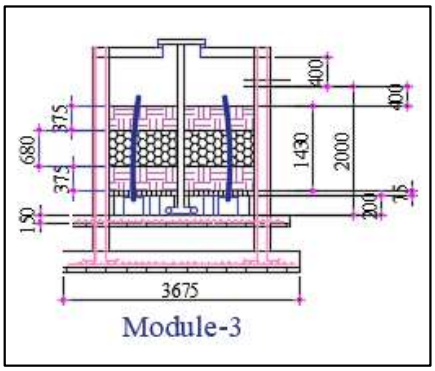
Design wastewater flow, Qd=21 m3/d
Flow Hours Tp, 8= hr
Peak flow QP = 2.625 m3/h
voids in filter mass = 80%

V= 0.82m/hr
A= 4 m2
V= Q/A
Q 2.624 m3/hr

**Anaerobic Filter Reactor (AFR) :**

There are two AFR in module-2 and 3. Each AFR has twelve chambers ( 2m X 2m Each ) and installed coco husk as a filter media. As built drawing and X-X section given below






**AFR cross section and pulling arrangement**

According to the experience of running another Upflow filter camp 4 x FSTP site , it is evident that Cocohusk bags creates upwards thrust when they are in dry condition and continues this nature for 6 to 8 months least. With time the cocohusk layer gets saturated and remain submerge under water. AFR all top slabs are pre-casted and very loosely plastered with the wall easy for operation and maintenance. During first startup ,overflowing liquid has been observed but while cochusk are wet , liquid level won't reach upto top slab. The reason for overtopping the liquid level above the outlet could be – a) The cocohusk layers are dry enough and liquid couldn't pass through next chambers properly causing an rise in liquid level upto top slab . b) The outlet pipe is clogged / displaced due to upward thrust of the cocohusk layer. ( Suggesting to monitor )

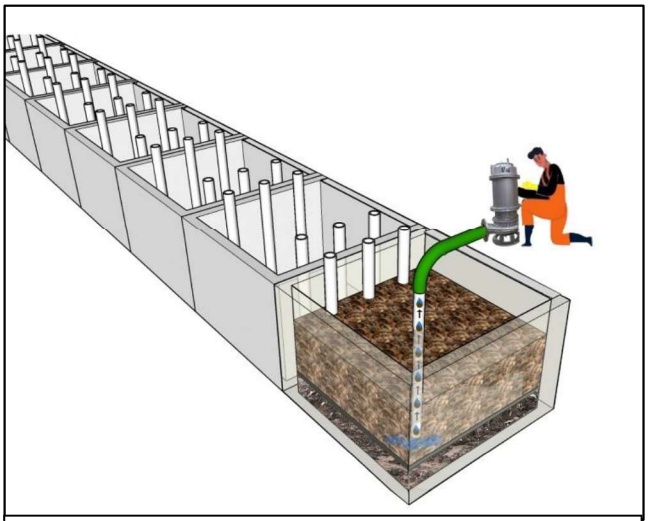


*Figure 1Checking and cleaning of deposited solid sludge / washed out biofilm layer from AFR bottom with help of desludging pump*

Either way we have to closely monitor this AFR for performance regarding removal efficiency. From practical experience most important is to be careful about velocity , media type and mesh size etc.

**For Successful AFR operation**

- Upflow velocity to be mentioned properly , so that bacteria cant be washed out
- Inlet organic loading doesn't get higher than expected
- All the cocohusk layers are submerged to liquid

If the effluent TSS is increasing at AFR outlet from monthly sampling

- Check if TSS is from sludge or washed out coco shuk
- Check the bottom sludge layer at each chamber
- Using a robin pump , desludge the AFR chambers and dispose the solid sludge into PDB.

## Siphon Chamber

Single flout siphon is installed in each chamber , which is designed to flush onto Vertical flow constructed wetland for ensuring equal distribution at each hole. To be remembered this is not a treatment unit rather a complimentary device to increase hydraulic pressure at outlet.

### Recommendation

In case of irregular siphon flush , its expected that there will stagnant water inside this chamber which can offer mosquito breeding ground. Suggested to cover the top part with mosquito net, mounted in plastic fence. Alternately very light wight / easily movable ferrocement slab can be placed in .
For analysis , Its important to record the time required to fill up the chamber and time required for one flush and volume per flush. Suggesting to record the data from installed flush counting device.

## Vertical Flow constructed wetland

### Suggestion –

- Regular watering of the plants for passing acclimatization phase.
- Only diluted effluent with no TS should be charged in VFCW.
- Suggested to install screener at VFCW final outlet to avoid clogging in future.

*Figure 2: VFCW*

Trouble Shooting guide for VFCW in case of clogging event

| | Possible Reason | Check | Actions |
|---|---|---|---|
| **Case -1** | If the hydraulic loading is higher than filtration capacity of the sand layer<br>The possible reason for higher loading can be –<br>Uncontrolled liquid flow from PDB> AFR> Siphon chamber and additionally rainwater . Or smaller area of sand than the required . | Check if the flow is now regulated before AFR or not ? As suggested in last yearly monitoring report .<br>How many flush one siphon does in a day? ( if possible hourly ) | If not please install GV or regulate the flow by outlet pipe.<br><br>For one unit try taking out the sand layer by 50%, reducing height of sand layer and restart the unit. This will reduce the filtration time for liquid but can effect the removal efficiency. ( To be monitored closely ) |
| **Case -2** | If the blockage is on top sand layer due<br>The dried fallen leaves over the sand layer , could have make impermeable organic layers at top . | Check if the fallen / dries leaves were been cleaned regularly or not?<br>What is the learning in Module -1, where canna indica is placed ?<br>Check if sludge layer has accumulated or not? | Clean the top sand layer, scoop out 1 " of sand layer at top surface , check permeability with bucket of water.<br>With the aeration pipe, closing the outlet pipe use pressurized waterjet . |
| **Case- 3** | The roots of Packchung has spread inside and over the sand and stone layer , additionally might have blocked the perforation of drainage pipe. | Summarize the learning BRAC had while inspection in one unit .<br>**Intermediate actions**<br>- Cut all the packchung from VFCW and make it unplanted and observe.<br>- If we can confirm than clogging is due to root , blocking the opening of Drainex Pipe. We may try just de attaching the Drainex pipe from outlet.<br><br>At last if none of recommendation above is not working we may go for this one -<br><br>Select any one unit of VFCW and do following<br>-Cut and clear the Packchung roots of one VFCW.<br>-Take out full sand layer , wash and clean<br>-Take our stone layer , wash and clean<br>-Replace the stone and sand layer inside the VFCW<br>-Place a layer of PE membrane over the drainage pipe to avoid future extension of root onto perforations.<br>-Plant canna indica instead of packchung , considering low penetration of shoots length. | |

## Horizontal Flow constructed wetland

*Figure 4; HFCW inlet*

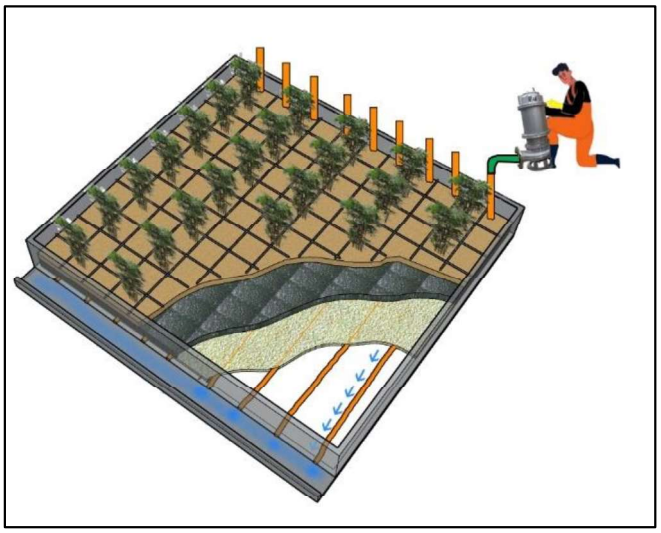


*Figure 3:P Backwashing/ cleaning of drainage pipes*

**Pinch Point for successful Operation**

- Both HFCW is ponded ie. Stone chips are saturated with water, so that plants can survive
- Only diluted effluent with no TS should be charged in HFCW.
- Suggested to install screener at HFCW final outlet to avoid clogging in future.

## Polishing Pond –

The two polishing pond placed in series is collecting effluent from HFCW of three module. The values of COD , TSS and Nitrate is increasing at this stage than the HFCW . Mostly three issues has been observed in PP

1. **Higher flowrate at inlet and possible shortcut of liquid**
    a. As described in PDB section increased flowrate in pond can push the liquid to end without having required retention time. Thus flow controller at PDB outlet is needed .
2. **High Algael growth**
    a. This eutrophic condition duw to high algae growth can be stimulated from any of the below reasons
        i. High nutrient ( N and P ) at inlet of MP 1

ii. As algae growth is increased it starts to reduce the DO in the pond making the pond anaerobic
iii. Dead algae increase the organic matter at PP and settle in the bottom .
iv. High algae growth blocks the sunlight and interferes with normal performance of PP to kill pathogens

The most effective options is to increase the removal efficiency of N and P at VFCW and HFCW to its maximum level.

### 3. Floating Geobag

For Geo bag layer floating issue refer to previous presentation shared in coordination meeting https://oxfam.box.com/s/x5gxseslqvjkqe7z3ntlg6b1tljkivot

***Annex –***

Strongly recommend Engineers and operators to read out the – Kutupalong Faecal Sludge Treatment Plant ( Performance Analysis for Module 2 and 3) Year 2022 shared by OXFAM ,

to have better understanding about the system and operation.

**Operators have the responsibility to ensure the safety of workers inside the Treatment Plant (TP) who are engaged in tasks such as repairs, washing, and other related works that involve direct contact with facial sludge. This involves providing appropriate Personal Protective Equipment (PPE) to each worker to mitigate potential health risks.**

Key safety PPE Items for sanitation workers engage inside the treatment plant

1. Face Mask
2. Safety Goggles
3. Hand Gloves
4. Full Body Apron
5. Safety Gumboot

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For any further queries please contact
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