Report

Biofil Toilet Evaluation

Rohingya Refugee Camp, Cox's Bazar, Bangladesh

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OXFAM

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Chapter-1 : Background

1.1 Context

Since August of 2017, extreme violence in Rakhine State of Myanmar has driven an estimated 646,000 people from the Rohingya community across the border into the Cox's Bazar District of Bangladesh. The new arrivals have joined some 212,500 Rohingya in Cox's Bazar, who had fled in earlier waves of displacement. Bangladesh government has provided shelter to the Displaced Rohingya Population (DRP) in camps located in Ukhia and Teknaf Upazilas of Cox's Bazar. Access to safe drinking water and hygienic sanitation facilities is a priority for DRP population. A number of organizations including the Department of Public Health Engineering (DPHE), UN organizations (UNHCR, IOM, Unicef), I/NGOs, and development partners are working in the camps for providing water supply, sanitation and hygiene facilities. A number of sanitation technologies including pit-based latrines (single- and twin-pit), Biofil toilets, toilets with septic tanks and soakage pits have been installed in these camps. The containments of these toilets (i.e. pits or septic tanks) need to be desludged periodically to keep the toilets operational.

Unlike regular pit-based toilets, Biofil toilets have a digester in the pit; the digester consists of a porous bed (made in the form of a perforated concrete slab) that supports, on top of it, tiger worms placed on a bed of coconut fiber and straw. Fecal matter is collected on the digester bed, and the free liquid is drained through the porous bed of the digester. On top of the digester, the fecal solids are converted into vermicompost by the tiger worms. This process slows down the build-up of fecal matter in the digester. As a result, the pit/digester of a properly functional Biofil toilet should take a longer time to get filled (compared to a regular pit of similar volume), and the desludging frequency becomes longer. This is considered to be a major advantage of Biofil toilets.

A total of 2,176 Biofil toilets have been installed in different Rohingya camps in both Ukhia and Teknaf, by a number of organizations (e.g. Oxfam, ACF). Biofil toilets have also been installed in the host communities at household level in these Upazilas of Cox's Bazar. It is important to assess performance of Biofil toilets in both Rohingya camps and host communities, in order to understand their relative advantages/ disadvantages over regular pit-based latrines. Oxfam requested ITN-BUET to conduct a comprehensive review of Biofil toilet in emergency situation in Rohingya camps at Cox's Bazar. In response to request, ITN-BUET carried out a study to evaluate the performance of Biofil toilets in Rohingya camps at Cox's Bazar. The evaluation covered the assessment of performance of both Biofil toilet and regular pit-toilets, both in camps and host community.

1.2 Objectives

The objectives of the assessment were:

- To review the appropriateness and effectiveness of Biofil latrines constructed by various actors in the Rohingya camps considering different factors including geophysical and social context.
- To communicate monitoring data (collected and analyzed) which would inform the success and challenges of the Biofil toilets in Cox's Bazar sanitation response, including information from other WASH sector partners who have constructed Biofil toilet.
- To recommend next steps for the WASH Sector and Oxfam in Cox's Bazar regarding Biofil toilets.

1.3 Scope

The present study involved literature review on Biofil toilets, questionnaire survey (conducted by field enumerators employed by Oxfam), field observation of 26 toilet units (20 Biofil and 6 pit-toilets), interview with the key informants (KIIs), and focus group discussions (FGDs) with the users of the toilets and emptier group.

The questionnaire survey covered 323 Biofil toilets in selected camps and host communities in Ukhia and Teknaf. The KIIs were conducted with key officials of DPHE, UNHCR, UNICEF, Inter Coordination Sectoral Group (ICSG)-WASH, Oxfam & ACF. The FGDs were conducted with participants from toilet users, general camp people, and representative of desludging/pit emptier group. Detail field observation of selected toilets were carried out twice during the course of this study. A total of 26 toilets were assessed including 20 Biofil toilets and 6 regular twin-pit toilets; the toilets were selected in consultation with Oxfam. The field observation primarily focused on two key elements related to the performance of a Biofil toilet:

1) Ability of a Biofil digester to drain free liquid (accumulation of liquid on top of the digester would kill the tiger worms or would force them out of the digester); and
2) Reduction of fecal matter accumulation (by tiger worm) in the digester (compared to a regular toilet pit).

Chapter-2 : Methodology

2.1 Introduction

This Chapter presents the methodology followed in this study for evaluation of Biofil toilets in Rohingya camps in Cox's Bazar. As mentioned earlier, the methodology involved literature review, questionnaire survey, detail field survey of selected Biofil and pit toilets, analysis of field data/information, Focus Group Discussion (FGD), and Key Informant Interviews (KIIs). This Chapter briefly describes the activities carried out as a part of this study. Finally, it presents the criteria for evaluation of Biofil toilets.

2.2 Literature review

For conducting assessment of Biofil toilet at Rohingya camps in Cox's Bazar, several documents were reviewed. These included REACH published follow-up assessment report on Water, Sanitation and Hygiene (WASH) at household level for Monsoon Season of 2019, design details of household and community level Biofil toilets made by "Biofil.com" (the sole supplier of Biofil toilet in Bangladesh), Oxfam report on Biofil toilets at Teknaf, the report on evaluation of sanitation technologies under SanMark-CITY project of ICCO Cooperation, iDE and DSK (ITN-BUET, 2015), and the report on evaluation of Biofil toilet by UPM (UPM, 2019).

2.3 Questionnaire Survey

Approximately 2,200 Biofil toilets have been installed by Oxfam and ACF in Teknaf and Ukhia Upazilas. As a part of this study, a questionnaire survey covering a portion of this toilets; the survey was carried out under the leadership of Oxfam. For ensuring representative sample size, a total of 323 Biofil toilets were covered in the questionnaire survey, with 95% confidence level and 5% margin of error.

The Oxfam Cox's Bazar MEAL (Monitoring, Evaluation and Learning) team carried out the questionnaire survey for Biofil toilets at both Teknaf and Ukhia Upazilas using a software based survey tool/platform "https://www.surveycto.com/". The questionnaire used in survey tool/platform was developed jointly by Oxfam and ITN-BUET. The questionnaire contained questions on location of toilets, usage of toilets, type and functionality of Biofil toilet including information related to digester, tiger warm, sludge digestion, desludging, cleansing of toilet, etc. Appendix A presents the questionnaire used in the questionnaire survey. A total of 323 toilets were surveyed, 213 toilets in Teknaf Upazila and 110 toilets in Ukhia Upazila. In Teknaf, survey was conducted at Nayapara Camp 26 and 27, Unchiprang Camp 22 and host community nearby Unchiprang Camp 22, mostly in Whykong Union. In Ukhia, the survey was conducted at Balukhali Camp 10,12 and 19, Kutupalong Camp 4 and 8 and host community nearby Kutupalong Camp 4 and 8, mostly in Jaliapalong Union. The distribution of toilets

covered under the questionnaire survey at different Camps and host community both in Teknaf and Ukhia Upazilas is given in Table 1.1.

Table 1.1: Distribution of Biofil toilets covered in the questionnaire survey in Rohingya camps in Teknaf and Ukhia Upazilas

Location	Camp no./Union	Upazila	No. of toilets surveyed
Nayapara	Camp 26 and 27	Teknaf	46
Unchiprang	Camp 22		125
Host in Unchiprang	Whykong		42
Balukali	Camp 10, 12 and 19	Ukhia	53
Kutupalong	Camp 4 and 8		35
Host in kutupalong	Jaliapalong		22
		Total	**323**

2.4 Detail Assessment of Biofil Toilet

ITN-BUET conducted in-depth assessment for 26 toilets, including 20 Biofil toilets and 6 pit latrines. Table 2.2 shows the locations of these toilets. The selection of toilets for detail assessment was finalized in consultation with Oxfam. Of the selected toilets, 17 are located in Teknaf Upazila and 9 in Ukhia Upazila. Among the 17 toilets in Teknaf, 13 were Biofil toilets and 4 were pit latrines. Of the 9 toilets in Ukhia, 7 were Biofil toilets and 2 pit latrines.

Table 2.2: Locations of the toilets selected for detail assessment

Location	Camp no./Union	Upazila	No. of toilets assessed
Nayapara	Camp 26 and 27	Teknaf	11
Host in Unchiprang	Whykong		6
Balukali	Camp 12 and 19	Ukhia	7
Kutupalong	Camp 7		2
		Total	**26**

For detail assessment of toilets, two visits were made by the study team to Ukhia and Teknaf, during which each of the 26 selected toilets were individually surveyed for collection of detail information. The schedule of field visits was as follows:

Field visit – 1: 24 – 28 November, 2019
Field visit – 2: 21 – 26 December, 2019

Collection of Data/Information:

During each field visit to the toilet sites, data and information on each toilet was collected from the toilet users in a "data collection form", specifically designed for this purpose.

The “form” covered the basic information related to the toilet design, user and usage (including water use, tissue), conditions/ cleanliness within and surrounding the toilets, smell within outside toilets, cleaning practices (e.g. use of bleach, etc.), desludging practices, desludging frequency, etc. Appendix B presents the “data collection form” used for collection of basic information during each field visit to the toilets.

At each toilet site, first verbal consent was taken from the user community, in the presence of Oxfam officials, to carry out survey at the toilet site. ITN-BUET research team with the help of Oxfam engineers and field staff conducted the field survey; Oxfam field staff supported the survey team with translation since the DRP do not speak either Bengali or English. Photographs 2.1 to 2.6 shows a number of toilet sites surveyed by the ITN-BUET study team.

Photograph 2.1: Oxfam constructed 48” dia Biofil toil*et at Camp-27, Teknaf Nayapara C*amp (ID: Taknaf-Camp 27-SL7-ID-104)

Photograph 2.2: NGO-Forum constructed 48" dia Twin pit pour flush latrine at Camp-26, Teknaf Nayapara Camp [ID: Teknaf-Camp26(A)-SL10 –ID-42]

Photograph 2.3: Oxfam constructed 48" dia Biofil toilet at Camp-27, Teknaf Nayapara Camp [ID: Teknaf-Camp27(B)-SL4-ID-69]

Photograph 2.4: Oxfam constructed 36” dia Biofil toilet at host community adjacent to Camp-22, Teknaf Whykong Camp [ID: Teknaf-Camp22(Host)-SL1-HH-ID-1120]

Photograph 2.5: BRAC constructed 2.5" dia alternative twin pit pour flush toilet at host community adjacent to Camp-22, Teknaf Whykong Camp (ID: Teknaf-Camp22 (Host)-SL6-HH-ID-1052) [(a): inside condition of alternative twin pit toilet, (b) backside view (c) used pit, & (d) pit not currently in rest]

Photograph 2.6: Oxfam constructed Biofil toilet at Camp-12, Ukhia Balukhali Camp [ID: Ukhia-Camp12(B-4)-SL4]

During survey, users were asked about use of water, toilet issues; they were also asked about the cleaning practices, including use of aggressive chemicals for cleaning which would directly impact the survival and functioning of tiger warm inside the Biofil toilet. Users were also asked about the desludging practices and methodology, as well as their general impression and comments about the toilet.

Detail Observation of Toilets:

Apart from survey, ITN-BUET team observed the toilets in detail, including inside and outside condition of toilets, its superstructure and substructure. During each field visit, the inside condition of digester of each Biofil toilet was observed by removing the top slab of toilet with the help of labor engaged by Oxfam. ITN-BUET research team closely observed the sludge accumulation, digestion condition of fecal sludge and presence/ absence of vermi-compost, presence of filter media (coconut fiber), tiger warm, water logging/accumulation, etc. Depth of fecal sludge inside the digester as well as effective depth of digester below the Sato-pan (used in the toilets) bottom were estimated with the help of a stick that was inserted into the accumulated sludge. For each toilet, the observations made during the first field visit in November 2019 were recorded; these were then compared with observations made during the second visit made in December 2019. Photographs 2.7 to 2.12 show digesters of some of the Biofil toilets surveyed in this study.

Photograph 2.7: Inside condition of digester of a Biofil toilet at Camp-27, Teknaf Nayapara Camp [ID: Teknaf-Camp 27(B)-SL4-ID-69]

Photograph 2.8: Inside condition of digester of a Biofil toilet at Camp-27, Teknaf Nayapara Camp [ID: Teknaf-Camp 27(B)-SL2-ID-47]

Photograph 2.9: Inside condition of digester of a Biofil toilet at Camp-27, Teknaf Nayapara Camp [ID: Teknaf-Camp 27(B)-SL3-ID-59]

Photograph 2.10: Inside condition of digester of a Biofil toilet at Camp-26, Teknaf Nayapara camp [ID: Teknaf-Camp 26(C)-SL6-ID-147]

Photograph 2.11: Inside condition of digester of a Biofil toilet at Camp-26, Teknaf Nayapara Camp [ID: Teknaf-Camp 26(C)-SL5-ID-189]

Photograph 2.12: Inside condition of digester of a Biofil toilet at host community near Unchiprang Camp-22, Teknaf [ID: Teknaf-Camp 22(Host)-SL1-HH-ID-1120]

During field observation, effort was made to assess the functionality of the digester, porous slab and tiger warm. Effort was made to identify the presence/ absence of tiger worm in the digester of Biofil toilets (Photograph 2.13). Proper drainage of free water from the digester is very important for functioning of a Biofil toilet. Effort was therefore made to visually observe the liquid/effluent draining out of the digester. This was however not possible because the bottom part of the toilet pit (underneath the porous slab) is used as soakage pit, and it was not possible to remove the porous slab to take a look at the bottom of the pit. Effort was also made to assess the infiltration capacity or permeability of soil based on experience of local people and Oxfam staff; however, it was difficult to assess infiltration capacity based on information provided by the respondents.

Photograph 2.13: Inside condition of digester of a Biofil toilet at Camp-27, Teknaf Nayapara Camp (ID: Teknaf-Camp 27(B)-SL4-ID-69) where Tiger worms were detected in the digester

2.5 Key Informant Interview (KII)

Key Informants (KIs) were selected primarily from the organizations that are working currently on water, sanitation and hygiene in Rohingya camps in different capacities. The list of key informants was finalized in consultation with Oxfam. Table 2.3 shows the list of key informants interviewed as a part of this study. In these interviews, the key informants were asked about different aspects of Biofil toilets, including their perception about advantages and disadvantages of Biofil toilets, compared to regular pit latrines. Photographs 2.14 were taken during some of the key informant interviews.

Table 2.3: Participants of KIIs

Key Informant Interviewed	Designation	Organization
Mr. Laurence West	WASH Officer	UNHCR, Cox's Bazar
Mr. Mohammad Ashfaqur Rahman	WASH Officer	UNICEF, Cox's Bazar
Mr. Ritthick Chowdhury	Executive Engineer	DPHE, Cox's Bazar
Mr. Md. Asif Arafat	Sector Coordinator-WASH	Inter Sector Coordination Group, Cox's Bazar
Mr. Zulfiquar Ali Haider	HSP – OXFAM Global Humanitarian Team	Rohingya Response Programme, Cox's Bazar
Mr. Loriaman Alex	WASH Coordinator Emergency Program	ACF, Cox's Bazar

Photograph 2.14: Key Informants Interview with: (a) Mr. Laurence West, (b) Mr. Mohammad Ashfaqur Rahman, (c) Mr. Ritthick Chowdhury & Mr. Md. Asif Arafat, and (d) Mr. Loriaman Alex]

2.6 Focus Group Discussion (FGD)

A total of four FGDs were conducted with the users of toilets, camp inhabitants and desludging operators. During the FGDs, local translators engaged by Oxfam were present to facilitate communication between the Rohingya participants of the FGDs and the study team. Prior to each FGD, verbal consent was taken from the participants for carrying out the FGD, in the presence of Oxfam officials. In the FGDs, discussion was held with the participants about different aspects of toilets, including advantages and disadvantages of toilets from user perspective, operation and maintenance of toilets; desludging operators who participated in the FGDs provided their perspective on different aspects of desludging operation, including methodology employed for desludging and health and safety issues. Table 2.4 shows the details of the FGDs. Photographs 2.15 were taken during the FGDs conducted during this study.

Table 2.4: Details of FGDs conducted in this study

FGD No.	FGD location	Upazila	Participants			Type of participants
			Male	Female	Total	
1	Camp-26, Block-A, Sub-block-10	Teknaf	15	5	20	Toilet users
2	Camp-26, Block-C	Teknaf	8	0	8	Desludging operator
3	Host of Camp-22 (Ward No-3, Village: Roiykong, Union: Whykong)	Teknaf	2	4	6	Toilet users
4	Camp-19, Block-C, Sub-block-8, Oxfam shade	Ukhia	9	5	14	Toilet users

Photograph 2.15: Focus Group Discussion conducted with the DRP at Camp 26 in Teknaf [(a) & (b)] and Camp-19 in Ukhiya [(c) & (d)]

2.7 Criterial for Evaluation of Biofil Toilet

A Biofil toilet has a "digester" (set in the toilet pit) that is the "heart" of the toilet system; the digester significantly reduces accumulation of fecal matter by the action of tiger worms present in the digester. Therefore, from the perspective of "technology evaluation", it is important to assess whether Biofil toilets are able to reduce accumulation of fecal matter in the digester/pit, in addition to their ability to fulfill the general requirement of a "hygienic latrine".

User-acceptance is also vital for the successful functioning of a toilet. For example, a perfectly "functional" (from technology perspective) toilet may not be well-accepted by users because of strict operation and maintenance requirements. While "technical performance" of a toilet would affect user-acceptance, user-behavior (especially with regard to O&M) may also affect technical performance.

Therefore, the criteria for evaluation of the Biofil toilets have been broadly divided into two categories:

(a) Functionality (Technical Performance), and
(b) Feedback from Users and Other Stakeholders.

Functionality (Technical Performance)

With regard to functionality or technical performance of a Biofil toilet, two questions are of prime importance:

(1) Whether the toilet is "hygienic"?
(2) Whether the toilet reduces accumulation of fecal matter? [In other words "performance of the digester" in reducing accumulation of fecal matter]

Fulfilling Criteria of a Hygienic Latrine

The three "criteria" of a "hygienic latrine" (according to the Bangladesh National Sanitation Strategy 2005) and the intended purpose of each are summarized in Table 2.5.

Table 2.5: Criteria for a "hygienic latrine"

Criteria	Intended "Purpose"	Comment
Confinement of feces	So that fecal matter and wastewater from toilet does not come out into open environment, thereby polluting environment and endangering public health	In conventional pit/ pour-flush latrine, fecal matter accumulates in a pit, and the liquid infiltrates into the subsurface.
Sealing of passage between squat hole and pit	Prevents insects/disease vectors from entering/exiting toilet pit; also prevents odor.	In pit/ pour-flush latrine, this is achieved through the use of a water-seal pan or a "sato-pan".
Provision for venting of foul gas generated within pit	To reduce/eliminate offensive odor within/ surrounding the toilet	In conventional pit/ pour-flush latrine, this is achieved through installation of a vent pipe in the toilet pit.

The ability of a Biofil or pit latrine in fulfilling these three criteria has been assessed through evaluation of:

(a) Designs of the toilets (e.g., presence of vent pipe, type of seal in the toilet pan),
(b) Presence of offensive smell within/surrounding toilets (through field visits and survey among users),
(c) Environmental condition of toilet-surrounding environment (through field visits and survey among users).

Performance of the Digester of Toilets

In a Biofil toilet, fecal matter, urine, (anal) cleansing water and cleaning water drop over a "filter". The filter retains the fecal matter and drains the free liquid. The fecal matter retained on the filter is digested by "tiger worms", slowing down its build up. Over time, this process also produces vermicompost. Thus, two issues are vital for effective performance of a Biofil digester:

(1) Ability of the "filter" to drain the liquid: If the filter is unable to drain the liquid properly, water will accumulate above the filter, submerging/killing the tiger worms. The performance of the filter of a Biofil toilet was assessed through visual observation of the filter by removing the top slab of the toilet.

(2) Ability of Tiger worms to reduce accumulation of fecal matter in the digester: The accumulation of fecal matter at the top of the filter bed of a Biofil toilet was assessed through visual observation of fecal matter build-up in the digester during two field visits. In addition, some quick calculations were made to compare actual accumulation (observed) with accumulation that would have resulted if the toilets functioned as traditional pit/pour-flush toilets.

Effort was made to identify presence or absence of tiger worms in Biofil toilet digester (by removing the top slab and using a stick). The desludging practice and its effect on tiger worms in the digester was carefully assessed.

For all toilets, possible effects of the intensity of toilet use (i.e. number of users per toilet), and O&M (e.g., use of cleaning agents) on performance of the digester was assessed based on information gathered from survey of users.

Feedback from Users and Other Stakeholders

User feedback gathered in the "data collection form" during field surveys, information gathered during field visits at the toilet sites and in FGDs were used to assess user-acceptance of Biofil toilet.

Chapter-3 : Results and Discussion

3.1 Introduction

This Chapter presents an evaluation of Biofil toilets installed at the Rohingya camps in Ukhia and Teknaf Upazilas of Cox's Bazar. The evaluation has been made based on a questionnaire survey covering 323 Biofil toilets, and detail assessment of 26 toilets that included 20 Biofil toilets and 6 regular twin-pit toilets. At first this Chapter presents (in Section 3.2) an overview of the Biofil toilet, as well as regular twin pit toilet. This is followed by the evaluation of Biofil toilets at Rohingya camps. The evaluation has been made based on the criteria discussed in Chapter 2 (Section 2.7). At first, a detail evaluation of Biofil toilets is presented (in Section 3.3) based on data and information gathered through two field visits, during which 26 toilets were thoroughly surveyed. Information gathered through interviews, KIIs and FGDs were also utilized in this evaluation. Then an evaluation of Biofil toilets based on questionnaire survey of 323 Biofil toilets is presented (in Section 3.4). A summary of the evaluation is presented in Section 3.5.

3.2 Description of Toilet Technology

3.2.1 Biofil Toilets

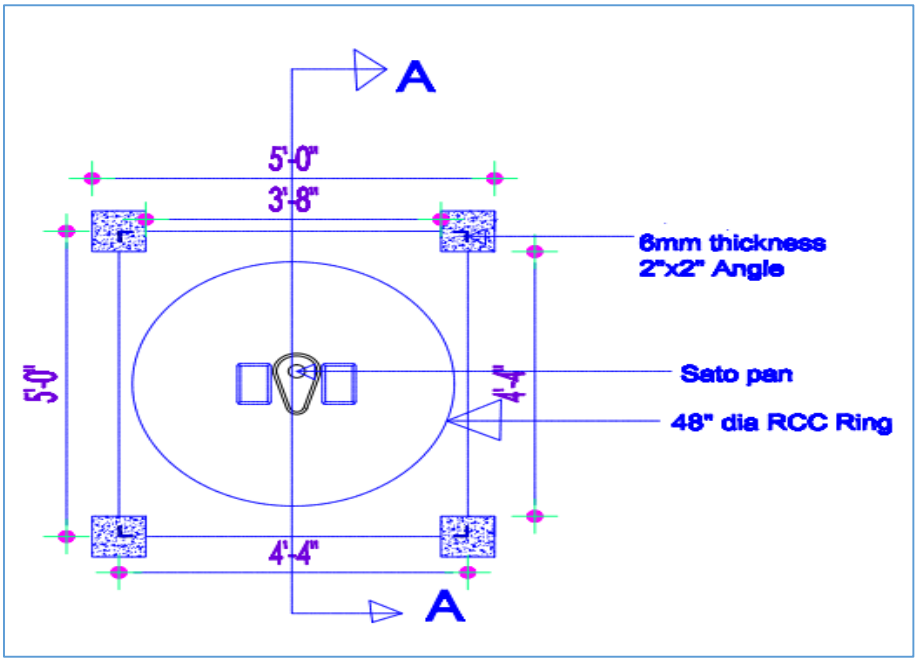
On the basis of design, the Biofil toilets evaluated in this study could be divided into three different types as follows:

(1) Type-1: 4' diameter direct pit Biofil toilet
(2) Type-2: 3' diameter direct pit Biofil toilet
(3) Type-3: 4' diameter alternate twin-pit Community Biofil toilet with 4 cubicles

Type-1: 4' Diameter Direct Pit Biofil Toilet

Among the 20 Biofil toilets evaluated in this study, 12 are Type-1 (4' diameter direct pit) Biofil toilets. Nine of these 12 toilets are located in Camp 26 and Camp 27 in Teknaf, two are located in Camp 19 in Ukhia and one is located in Camp 12 in Ukhia. Table 3.1 shows the locations of these toilets.

Figure 3.1 shows plan and sectional view of a Type-1 Biofil toilet. The floor area of the toilet is about 5' x 5'. The roof is inclined with 7' clear height. Sato-pans have been used in all Biofil toilets. A 4-inch diameter vent pipe has been used for venting of foul gas from the pit (shown in the Figure 3.2). The bottom of the vent pipe is inserted into the pit at a depth of one foot or less.



Plan View

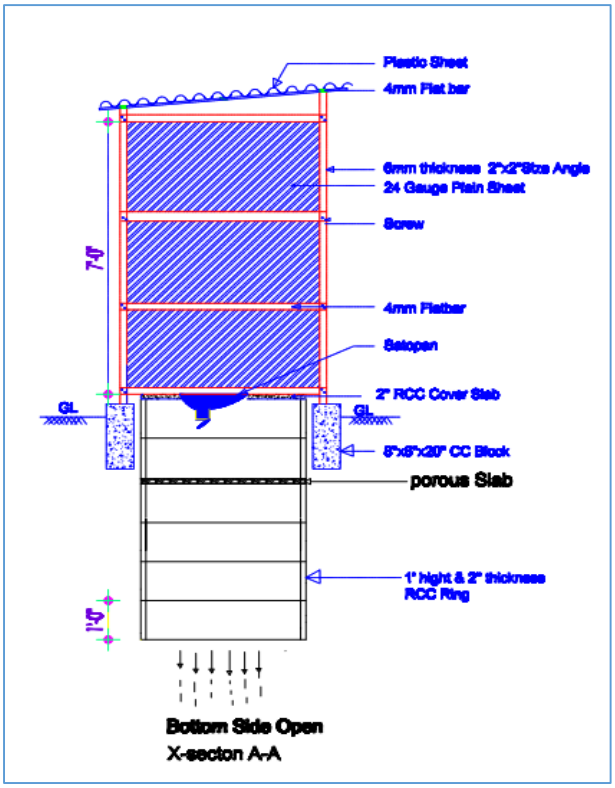


Figure 3.1: Plan and sectional view of Type-1 Biofil toilet

As shown in Figure 3.1, the pit of the Biofil toilet is 4 feet in diameter and 6 feet in depth. It is made up of either 6 rings of 1-foot depth, or 12 rings of 0.5-foot depth. According to the design drawings received from the toilet supplier (Figure 3.1), the digester of the toilet is set on a porous slab (about 1.5 inch in depth as shown in Figure 3.3), which is placed at a depth of about 2 ft. from the top surface. Thus the total depth of the digester is about 2 feet. However, since the bottom of the Sato pan occupies some depth of the first ring (see Figure

3.1), the effective depth of the digester is little over one foot/ring. The portion of the pit below the digester porous slab (about 4 ft in depth) is used as a soakage pit for drainage of water that is drained through the porous slab.

Figure 3.2: Positioning of vent pipe and porous slab for Type-1 Biofil toilet; photograph taken during desludging operation

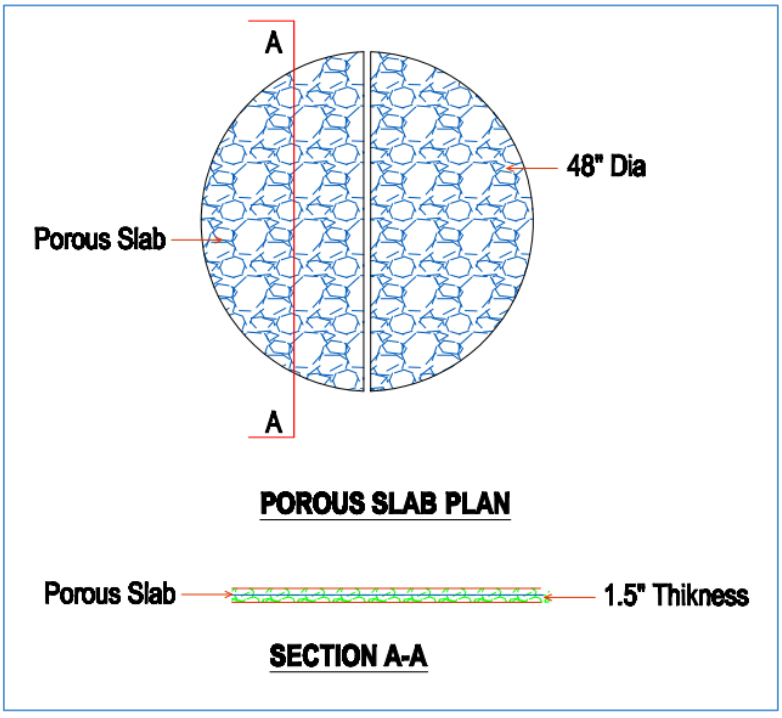


Figure 3.3: Plan and section of porous slab on which the digester of Biofil toilet is set

It was found that although in the design drawings of the toilets, the porous slab is located 2 feet below the top surface, in reality the porous slab has been placed 2.5 ft below top surface

for all the Type-1 toilets surveyed. This resulted in an increase of digester depth to little over 2 ft, while reduced the depth (and hence surface area) of the soakage area by one ft.

Table 3.1: Locations and IDs of Type-1 Biofil toilets

Sl. No.	Location	Toilet ID
1	Teknaf-Camp 26 (A)	Teknaf-Camp 26(A)-SL8-ID-Nil
2	Teknaf-Camp 27	Taknaf-Camp 27-SL7-ID-104
3	Teknaf-Camp 26(C)	Teknaf-Camp 26 (C)-SL6-ID-147
4	Teknaf-Camp 26(C)	Teknaf-Camp 26(C)- SL5-ID-189
5	Teknaf-Camp 27(B)	Teknaf-Camp 27(B)-SL2-ID-47
6	Teknaf-Camp 27(B)	Teknaf-Camp 27(B)-SL1-ID-55
7	Teknaf-Camp 27(B)	Teknaf-Camp 27(B)SL3-ID-59
8	Teknaf-Camp 27(B)	Teknaf-Camp 27(B)-SL4-ID-69
9	Teknaf-Camp 27(B)	Teknaf-Camp 27(B)-SL11-ID-48
10	Ukhia-Camp 12-Block (B-4)	Ukhia-Camp 12(B-4)-SL4
11	Ukhia-Camp 19-Block (C-14)	Ukhia-Camp 19(C-14)-SL1
12	Ukhia-Camp 19-Block (C-12)	Ukhia-Camp 19(C-12)-SL2

Type-2: 3' Diameter Direct Pit Biofil Toilet

Among the 20 Biofil toilets evaluated in this study, 5 are Type-2 (3' diameter direct pit) Biofil toilets. Two of these 5 toilets are located in Camp 22 in Teknaf, one is located in Camp 12 in Ukhia, and two are located in "host community" located close to Camp 22.
Table **3.2** shows the locations of these toilets.

Figure 3.5 shows plan and sectional view of a Type-2 Biofil toilet. The floor area of the toilet is about 3'-6" x 3'-6". The roof is inclined with clear height of 5'-9" at front side and about 5'-3" at back side. Sato-pans have been used in all Biofil toilets. A 3-inch diameter vent pipe has been used for venting of foul gas from the pit (not shown in the figure). It was found that the bottom of the vent pipe has been inserted into the pit at a depth of about one foot or less. This appears to be causing a major problem; sludge continues to build-up in the digester with time and eventually reaches the bottom level of the vent pipe and clogs it. When this happens, the vent pipe is taken out from the pit.

Table 3.2: Locations and IDs of Type-2 Biofil toilets

Sl. No.	Location	Toilet ID
1	Ukhia-Camp 12-Block (A)	Ukhia-Camp 12(A)-SL6
2	Teknaf-Camp 22(Host)	Teknaf-Camp 22(Host)-SL1-HH-ID-1120
3	Teknaf-Camp 22(Host)	Teknaf-Camp 22(Host)-SL2-HH-ID-676
4	Teknaf-Camp 22(Host)	Teknaf-Camp 22(Host)-SL4-HH-ID-972
5	Teknaf-Camp 22(Host)	Teknaf-Camp 22(Host)-SL3-HH-ID-1038

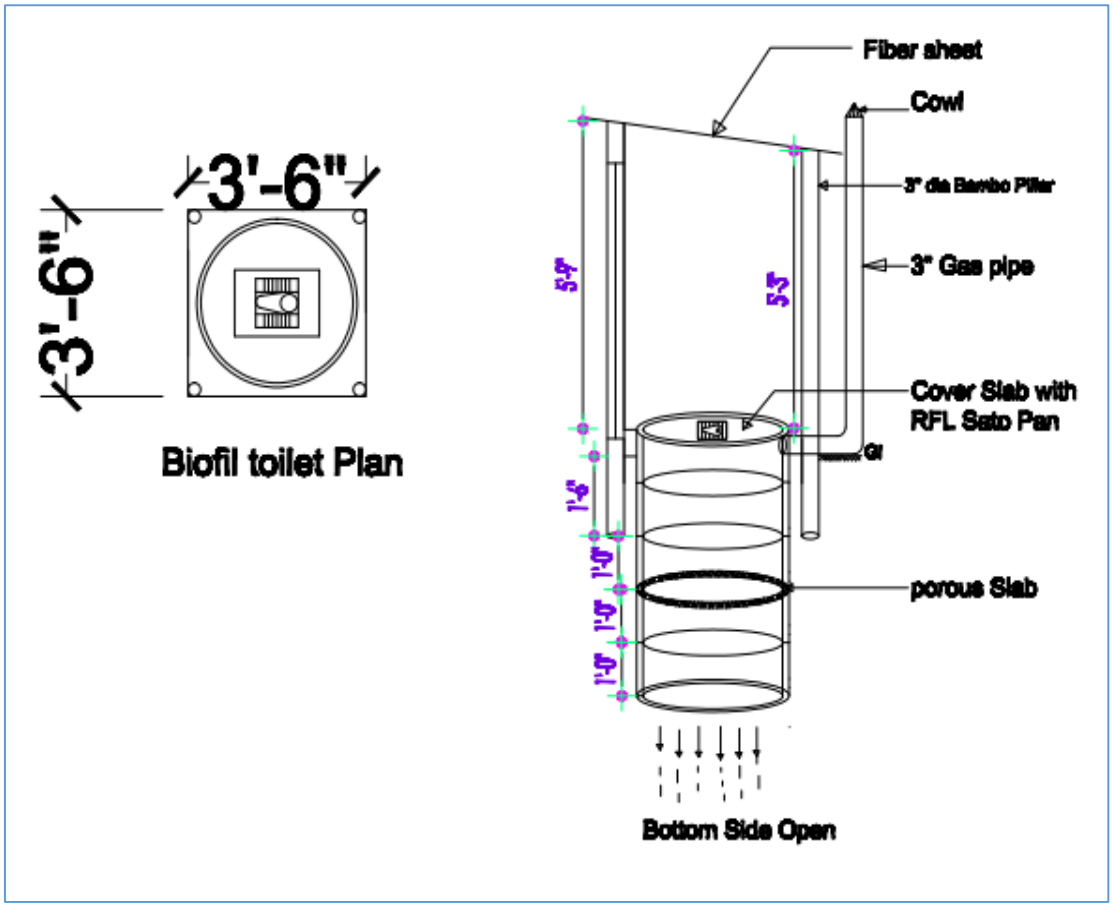


Figure 3.4: Plan and sectional view of Type-2 Biofil toilet

As shown in Figure 3.4, the pit of the Biofil toilet is 3 feet in diameter and 5 feet in depth. It is made up of 5 rings of 1-foot depth. According to the design drawings received from the toilet supplier (Figure 3.4), the digester of the toilet is set on a porous slab (about 1.5 inch in depth, as shown in Figure 3.3), which is placed at a depth of about 3 ft from the top surface. Thus the total depth of the digester is about 3 feet. However, considering the depth occupied by Sato pan, the effective depth of the digester becomes little two one foot/ring. The portion of the pit below the digester porous slab (about 2 ft in depth) is used as a soakage pit for drainage of water that is drained through the porous slab.

Figure 3.5: Positioning of vent pipe for Type-2 Biofil toilet (a) & Sludge in digester builds-up to clog the vent pipe (b)

It was found that although in the design drawings of these toilets, the porous slab is located 3 feet below the top surface, in reality the porous slab has been placed 2 ft below top surface for all the Type-2 toilets surveyed. This resulted in a decrease of digester depth to little over 1 ft, while increased the depth (and hence surface area) of the soakage area by one ft.

Type-3: 4' Diameter Alternate Twin-pit Community Biofil Toilet with 4 Cubicles

Three community Biofil toilets were surveyed as a part of this study. These toilets consist of alternate twin pits, connected to four toilet cubicles. All three Type-3 Biofil toilets surveyed are located in Ukhia, two in Camp 7 and one in Camp 12. Table 3.3 shows the locations of these toilets.

Table 3.3: Locations and IDs of Type-3 Biofil toilets

Sl. No.	Location	Toilet ID
1	Ukhia-Camp12-Block (B)	Ukhia-Camp12(B)-SL-Biofilcom
2	Ukhia-Camp7-Block (A)	Ukhia-Camp7(A)-ACF-LTK-05
3	Ukhia-Camp7-Block (A)	Ukhia-Camp7(A)-ACF-LTK-002

Figure 3.6 shows plan and sectional view of a Type-3 Biofil toilet. The floor area each cubicle of the toilet is about 3' x 4'-6". The roof is inclined with clear height of 6'-3" at front side and about 6' at back side. Sato-pans have been used in all Biofil toilets. A 4-inch diameter vent pipe has been used in each pit for venting of foul gas from the pit. The bottom of the vent pipe has been inserted into the pit at a depth of about one foot or more. There is also an inspection pit (IP) which is used as a junction for diverting fecal matter into a particular pit.

The total depth of each pit is 4.5 ft, made up of nine 4-feet diameter and 0.5-foot deep concrete rings. According to the design drawings received from the toilet supplier (Fig. 3.4), the digester of the toilet is set on a porous slab (about 1.5 inch in depth, as shown in Fig. 3.3), which is placed at a depth of about 3 ft from the top surface. The depth of the soakage area below the digester is about 1.5 ft in depth. The inlet pipe from the inspection pit enters the pit at the level of the second ring from the top [see Figure 3.6 and Figure 3.7 (b)].

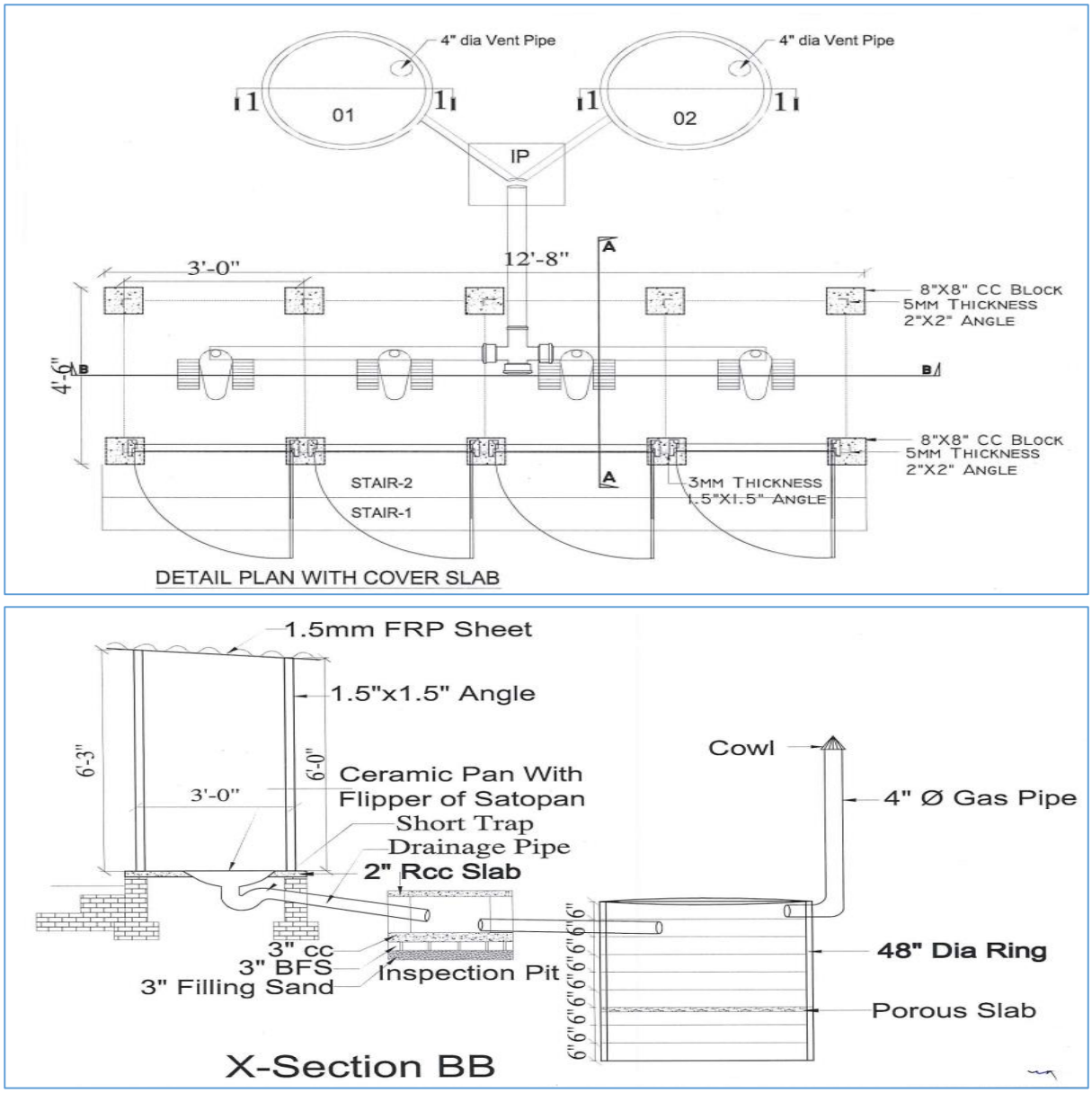


Figure 3.6: Plan and sectional view of Type-3 Biofil toilet

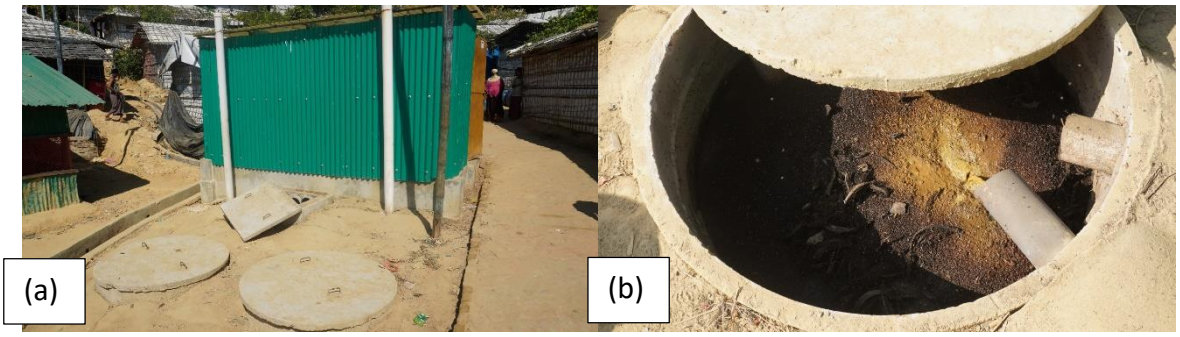


Figure 3.7: Community Biofil Toilet with 4 Cubicles at Ukhiya Camp-12 [(a) back end of toilet, (b) inside condition of digester]

3.2.2 Regular Twin-Pit Toilets

Six regular alternate twin pit toilets were surveyed in this study. Among these, two are located in Camp 26 in Teknaf, two are located in host community near Camp 22 in Teknaf, one is located in Camp 19 in Ukhia and one is located in Camp 12 in Ukhia. Table 3.4 shows the locations of these toilets.

Table 3.4: Locations and IDs of regular alternate twin-pit toilets

Sl. No.	Location	Toilet ID
1	Teknaf-Camp26(A)	Teknaf-Camp26(A)-SL9-ID-40
2	Teknaf-Camp26(A)	Teknaf-Camp26(A)-SL10-ID-42
3	Teknaf-Camp22(Host)-Roikkhong Dakkhin para	Teknaf-Camp22(Host)-SL5-HH-ID-1050
4	Teknaf-Camp22(Host)-Roikkhong Dakkhin para	Teknaf-Camp22(Host)-SL6-HH-ID-1052
5	Ukhia-Camp 19	Ukhia-Camp 19-Block (C-11)-SL3
6	Ukhia-Camp 12	Ukhia-Camp 12-Block (B-5)-SL5

Floor area of these toilets is about 5’ x 5’ for each chamber. Superstructure is mostly made of CGI sheet, wood and bamboo. For the two toilets in Camp 26, the pits are made up of 4-feet diameter concrete rings, with a total depth of about 10 feet. While for the remaining toilets, pits are made of 2.5 feet diameter concrete rings with a total depth of about 6 feet (as shown in Figure 3.8).

Figure 3.8: Inside view of alternative twin-pit latrines with 2.5 ft diameter concrete rings (a); [(b) operational pit, (c) pit in rest]

3.3 Detail Evaluation of Biofil Toilet

As explained in Chapter 2, the performance of Biofil toilets have been assessed based on two major criteria: (a) Functionality (technical performance), and (b) User and stakeholder feedback. The functionality of Biofil toilets has been assessed with respect to two parameters/questions: (1) whether the toilet is "hygienic?", and (2) performance of digesters of Biofil toilets. For comparison, performance of regular twin-pit toilets has also been assessed. This Section presents a detail evaluation of Biofil toilets.

3.3.1 Functionality (Technical Performance)

Fulfilling Criteria of a Hygienic Latrine:

Table 3.5 shows the basic features (e.g. year of construction, number of user, water use, etc.) of the toilets that were surveyed in detail in this study. All Biofil toilets fulfil the first criterion of a "hygienic" latrine, that is, confinement of fecal matter (as explained in Section 2.7). The fecal matter remains confined within the pit/digester of the toilet (before desludging), and the free liquid drained into the subsurface.

The second criterion is the presence of a water seal or other form of barrier (e.g. Sato pan) between squat hole and pit/digester to prevent movement of disease vector and to prevent

odor. Among the 20 Biofil toilets surveyed, 19 were found to have the “barrier” in the form of Sato pan, fulfilling the second criterion. Sato pan of one Type-2 toilet in Teknaf host community [ID: Teknaf-Camp22(Host)-SL4-HH-ID-972] was found to be broken; foul smell was also detected during field visit to this toilet site.

The third criterion is the presence of vent pipe for venting of foul gas from the pit/digester. Among the Biofil toilets surveyed, all except one [ID: Teknaf-Camp22(Host)-SL1-HH-ID-1120] had vent pipes. The vent pipe for this unit is being used as pipe to discharge fecal sludge from digester to nearby (as shown in Figure 3.9). During field visit, foul smell was detected in this toilet (see Table 3.5).

Figure 3.9: Biofil toilet in the host community of Camp-22, Teknaf [ID: Teknaf-Camp22 (Host)-SL1], failed to fulfil the criterion of presence of vent pipe

Table 3.5: basic features of Biofil toilets assessed by ITN-BUET

Sl. No.	Location	Toilet Type	Toilet ID	Commencement	Total number of users	Estimate water use (L/day)	Smell inside toilet	Presence of flies inside toilet	Confinement of faces within digester
1	Teknaf	Type-1 (Biofil-48 inch dia)	Teknaf-Camp26(A)-SL8-ID-Nil	March-April 2019	40	450	Slight smell	Some flies present	Yes
2	Teknaf		Taknaf-Camp27-SL7-ID-104	May-18	24	300	No	No fly	Yes
3	Teknaf		Teknaf-camp26 (C)-SL6-ID-147	May-18	9	126	No	No fly	Yes
4	Teknaf		Teknaf-camp26(C)- SL5-ID-189	May-18	24	48	Slight smell	Some flies present	Yes
5	Teknaf		Teknaf-camp27(B)-SL2-ID-47	April-May 2018	15	75	No	No fly	Yes
6	Teknaf		Teknaf-Camp27(B)-SL1-ID-55	April-May 2018	12	108	No	No fly	Yes
7	Teknaf		Teknaf-Camp27(B)SL3-ID-59	April-May 2018	15	135	No	No fly	Yes
8	Teknaf		Teknaf-Camp27(B)-SL4-ID-69	Nov-Dec 2018	17	102	No	No fly	Yes
9	Teknaf		Teknaf-Camp27(B)-SL11-ID-48	Nov-Dec 2018	17	170	No	No fly	Yes
10	Ukhiya		Ukhia-Camp12(B-4)-SL4	Aug, 2018	18	122	Slight smell	No fly	Yes
11	Ukhiya		Ukhia-Camp19(C-14)-SL1	Aug, 2018	14	63	No	No fly	Yes
12	Ukhiya		Ukhia-Camp19(C-12)-SL2	Aug, 2018	20	68	Slight smell	No fly	Yes
13	Ukhiya	Type-2 (Biofil-36 inch dia)	Ukhia-Camp12(A)-SL6	Jan-18	15	34	Slight smell	No fly	Yes
14	Teknaf		Teknaf-Camp22(Host)-SL1-HH-ID-1120	Dec-17	11	93	Slight smell	Some flies present	No
15	Teknaf		Teknaf-Camp22(Host)-SL2-HH-ID-676	Dec-17	15	120.0	Slight smell	Some flies present	No
16	Teknaf		Teknaf-Camp22(Host)-SL3-HH-ID-1038	Mar-18	5	11	Slight smell	No fly	No
17	Teknaf		Teknaf-Camp22(Host)-SL4-HH-ID-972	End of 2018	5	38	Slight smell	Some flies present	Yes
18	Ukhiya	Type-3 (community Biofil-4 cubic)	Ukhia-Camp12(B)-SL-Biofilcom	May-19	80	900	Slight smell	No fly	Yes
19	Ukhiya		Ukhia-Camp7(A)-ACF-LTK-05	Nov, 2019	250	4375	Slight smell	No fly	Yes
20	Ukhiya		Ukhia-Camp7(A)-ACF-LTK-002	Nov, 2019	60	600	Slight smell	No fly	Yes

As discussed in Section 3.2, the Type-2 toilets have a small digester volume, with effective depth of the digester just little over 1 foot. As discussed earlier, as sludge continues to build-up in the digester with time, it eventually reaches the bottom level of the vent pipe and clogs it. For a digester with an effective depth of little over 1 foot, this could happen fairly quickly (especially if tiger worms are absent in the digester). When this happens, the users take out the vent pipe from the pit. This (i.e. positioning of vent pipe and shallow depth of digester) appears to be a flaw in the design of these toilets.

All 6 regular twin-pit toilets fulfilled the first criterion (i.e. "confinement") of a hygienic latrine. Four toilets had Sato pan, and one had a water seal pan. Water seal of one toilet in Teknaf host community [ID: Teknaf-Camp22(Host)-SL6-HH-ID-1052] was not clearly visible. All six regular twin pit toilets surveyed had vent pipes.

Performance of the Digester of Biofil Toilet:
The performance of the digester of Biofil toilets was assessed in terms of two parameters: (1) Ability of digester filter to drain liquid, and (2) Reduction of fecal matter accumulation by Tiger worms.

Ability of Digester to Drain Liquid:
Table 3.6 presents some of the important observations about the digester, including presence of stagnant water, presence/absence of Tiger worms, desludging related information, possible flooding of digester, etc. As discussed earlier, if the filter is unable to drain liquid properly, water will accumulate above the filter, submerging/killing the tiger worms. Among the 12 Type-1 Biofil toilets surveyed, two toilets [with ID: Teknaf-Camp 26(A)-SL8-ID-Nil; and ID: Taknaf-Camp 27-SL7-ID-104] had accumulated water on top of the digester (see Figure 3.10). The digesters of another two toilets [with ID: Teknaf-Camp 27 (B)SL3-ID-59, and ID: Ukhia-Camp 19 (C-12)-SL2] were found to be very wet (suggesting poor drainage of liquid). The remaining 8 digesters appeared to be well-drained. Few examples of good condition of digester for Type-1 [(a) ID: Teknaf-Camp27(B)-SL4-ID-69; (b) ID: Ukhia-Camp19(C-14)-SL1] is shown in Figure 3.11.

Figure 3.10: Accumulation of water on top of digester for Type-1 [(a) ID: Teknaf-Camp 26(A)-SL8-ID-Nil; (b) ID: Taknaf-Camp 27-SL7-ID-104]

Figure 3.11: Good condition of digester for Type-1 [(a) ID: Teknaf-Camp27(B)-SL4-ID-69; (b) ID: Ukhia-Camp19(C-14)-SL1]

Among the five Type-2 toilets surveyed, 2 had accumulated water on top of the digester; contents of digesters of another two toilets were very wet suggesting poor drainage (see Table 3.6), while only one digester appeared to be well-drained. Of the three community Biofil toilets (Type-3) surveyed, digester of one had very wet contents, suggesting poor drainage.

Thus, among the 20 Biofil toilets surveyed, accumulation of liquid or poor drainage was observed in 7 toilets (as shown in Table 3.6). The digesters of these toilets are unlikely to support survival of Tiger worms. As a result, these toilets would not provide the main advantage of a Biofil toilet, which is slower accumulation of fecal matter and production of vermi-compost.

Assuming that the filter design is more or less uniform for all Biofil toilets, there are a number of reasons that could be attributed for poor drainage of liquid through the digester. These include:

(a) Poor infiltration of liquid through the bottom chamber of the pit due to low permeability of soil,
(b) High groundwater level and/or flooding,
(c) Higher user number, resulting in higher water use,
(d) Lower retention capacity of the chamber serving as soakage pit of the toilet, and
(e) Lower surface area of the digester, resulting in lower filtration capacity

Table 3.6: Table: Important observations about the digester of Biofil toilet

Sl. No.	Toilet Type	Location	Toilet ID	Commencement	Does Tiger worm exist inside digester?		Water logging inside the digester		Stagnant water mainly		Bleach, phenyl, harpic used in the toilet	Desludging done before	Was bed set again, after desludging
					1st visit	2nd visit	1st visit	2nd visit	1st visit	2nd visit			
1	Type-1 (Biofil-48 inch dia)	Teknaf	Teknaf-Camp26(A)-SL8-ID-Nil	April 2019	don't appear	don't appear	Yes	Yes	liquid	liquid	No	Yes	No
2		Teknaf	Taknaf-Camp27-SL7-ID-104	May-18	don't appear	don't appear	Yes	Yes	FS & Liquid	FS & liquid	No	Yes	No
3		Teknaf	Teknaf-camp26 (C)-SL6-ID-147	May-18	don't appear	don't appear	No	No	No	No	No	Yes	No
4		Teknaf	Teknaf-camp26(C)- SL5-ID-189	May-18	don't appear	don't appear	No	No	No	mostly moist	No	Yes	No
5		Teknaf	Teknaf-camp27(B)-SL2-ID-47	April-May 2018	don't appear	don't appear	No	No	No	mostly moist	No	No	N/R
6		Teknaf	Teknaf-Camp27(B)-SL1-ID-55	April-May 2018	don't appear	don't appear	No	No	No	mostly moist	No	No	N/R
7		Teknaf	Teknaf-Camp27(B)SL3-ID-59	April-May 2018	don't appear	don't appear	No	No	No	mostly moist	No	No	N/R
8		Teknaf	Teknaf-Camp27(B)-SL4-ID-69	Nov-Dec 2018	over filter media	over filter media	No	No	No	No	No	Yes, but	N/R
9		Teknaf	Teknaf-Camp27(B)-SL11-ID-48	Nov-Dec 2018	over filter media	don't appear	No	No	No	mostly moist	No	No	N/R
10		Ukhiya	Ukhia-Camp12(B-4)-SL4	Aug, 2018	don't appear	don't appear	No	No	No	mostly moist	Yes	No	N/R
11		Ukhiya	Ukhia-Camp19(C-14)-SL1	Aug, 2018	over filter media	over filter media	No	No	No	No	No	Yes, but	N/R
12		Ukhiya	Ukhia-Camp19(C-12)-SL2	Aug,2018	don't appear	don't appear	No	No	moist	moist	No	Yes	Yes
13	Type-2 (Biofil-36 inch dia)	Ukhiya	Ukhia-Camp12(A)-SL6	Jan-18	don't appear	don't appear	No	Yes	No	Half-Half	No	Yes	Yes
14		Teknaf	Teknaf-Camp22(Host)-SL1-HH-ID-1120	Dec-17	don't appear	don't appear	Yes	Yes	FS, Half-half	FS, Half-half	Yes	Yes	No
15		Teknaf	Teknaf-Camp22(Host)-SL2-HH-ID-676	Dec-17	don't appear	don't appear	Yes	Yes	FS, liquid	FS, liquid	Yes	Yes	No
16		Teknaf	Teknaf-Camp22(Host)-SL3-HH-ID-1038	Mar-18	don't appear	over filter media	No	No	No	No	No	No	N/R
17		Teknaf	Teknaf-Camp22(Host)-SL4-HH-ID-972	End of 2018	don't appear	don't appear	Yes	Yes	moist	FS and liquid	Yes	No	N/R
18	Type-3 (community Biofil-4 cubic)	Ukhiya	Ukhia-Camp12(B)-SL-Biofilcom	May-19	don't appear	don't appear	Yes	Yes	FS, Half-half	Half-Half	No	No	N/R
19		Ukhiya	Ukhia-Camp7(A)-ACF-LTK-05	Nov ,2019	don't appear	don't appear	No	Yes	No	FS	No	No	N/R
20		Ukhiya	Ukhia-Camp7(A)-ACF-LTK-002	Nov ,2019	don't appear	don't appear	Yes	Yes	FS, liquid	FS and liquid	No	No	N/R

Poor infiltration capacity of soil would restrict drainage of liquid into the subsurface. During field visit, it was not possible to gather useful information about the infiltration capacity of soil in the camp areas. However, it appears that Biofil toilets located in low lying areas are more prone to waterlogging (in the digester) than those located in higher elevation. For example, significant accumulation of liquid was observed (in November-December 2019) in the digester of one Type-1 toilet in Teknaf [ID: Teknaf-Camp 26(A)-SL8-ID-Nil] located in a low lying area (see Figure 3.10). The situation is likely to get worse during the wet season, when there would be significant precipitation and groundwater table would rise. Flooding could result in inundation of the pit/digester. Users of two Biofil toilets (one in Ukhia and one in Teknaf) reported risk of flooding during the wet season/monsoon. It should be noted that the survey was conducted during dry season (November-December), which is not the critical time for flooding or high water table.

Higher user and higher water use is likely to put additional pressure on the infiltration of liquid. Analysis of available data and information collected from the field (see Table 3.5 and Table 3.6) suggest that the number of user of a toilet has a significant impact on the drainage of liquid through the digester. Among the 12 Type-1 Biofil toilets, 2 had water accumulation on top of the digester; the average number of users of these two toilets [with ID: Teknaf-Camp 26(A)-SL8-ID-Nil; and ID: Taknaf-Camp 27-SL7-ID-104] is 26. Another Biofil toilet [with ID: Ukhia-Camp 19 (C-12)-SL2] had very wet contents in the digester, suggesting poor infiltration; the average number of users of these two toilets was about 18. The average number of users of the remaining 8 Type-1 toilets with no visible accumulation of liquid in the digesters was about 16. Similarly, among the 5 Type-2 Biofil toilets, two with accumulation of liquid have an average user of 13; two with wet digester contents have average user of 10, and the one with well-drained digester content has 5 users. However, this reasoning could not be extended to the community Biofil toilets (Type-3); despite having large number of users (as reported by the user community), there was no visible accumulation of liquid in the digesters of these toilets.

Available drainage area and detention volume of soakage pit (at the bottom of digester) can also affect drainage of liquid. For Type-1 Biofil toilets, the soakage pit has a diameter of 4 ft and depth 3 ft. This provides a maximum drainage area of about 37.7 ft^2 (about 3.5 m^2) and maximum detention volume of 37.7 ft^3 (about 1.07 m^3). Long-term infiltration capacity of soil varies from about 10 L/m^2.day for compacted silty loam or clay soil to about 30 L/m^2.day for sandy loam soil. This means that the volume of liquid a Type-1 Biofil toilet would be able to drain would range from about 35 L/day to 105 L/day. According to data collected during field survey/interview, daily water use for Type-1 Biofil toilets range from 63 to 450 L/day. In fact, the estimated water use for the two Type-1 toilets which had water accumulation on top of the digester [with ID: Teknaf-Camp 26(A)-SL8-ID-Nil; and ID: Taknaf-Camp 27-SL7-ID-104] are 450 L/day and 300 L/day (two highest values for this type of toilet). Thus, it appears that **poor infiltration (and hence accumulation of water on digester) is closely related to water use**.

Thus, if number of user and/or water use increases, the infiltration capacity of soil could be exceeded; if that happens liquid would begin to enter and accumulate in the Biofil digester.

For Type-2 Biofil toilets, the situation is even worse. It has a soakage pit with a diameter of 3 ft and depth 3 ft. This corresponds to a maximum drainage area of about 28.3 ft^2 (about 2.6 m^2) and maximum detention volume of 21.2 ft^3 (about 0.6 m^3). Thus, drainage capacity would most likely be in the range of 26 L/day to 78 L/day. This could be easily exceeded if number of user and/or water use increases. In fact, the estimated water use for the two Type-2 toilets which had water accumulation on top of the digester [with ID: Teknaf-Camp22(Host)-SL1-HH-ID-1120; ID: Teknaf-Camp 22(Host)-SL2-HH-ID-676] are 92.8 L/day and 120 L/day, the two highest values for this type of toilets. This further reinforces the observation that accumulation of water on digester is strongly related to higher water use.

Higher volume of soakage pit could facilitate infiltration by storing a portion of liquid. Volume of soakage pit, particularly of Type-2 Biofil toilets, is quite small. Depending on the subsurface condition of the toilet site (soil layer, groundwater level), toilet design, and number of user and water use, all the above factors could contribute to poor infiltration of liquid from a Biofil toilet pit.

Higher surface area (i.e. diameter) of digester would provide higher infiltration area of the porous slab through which free water would infiltrate, thus facilitating drainage/infiltration of liquid. From this perspective, Type-1 Biofil toilets built with 4 feet diameter rings are better, compared to Type-1 Biofil toilets built with 3 feet dia concrete rings.

It should be noted that despite very high number users (60 to 250) and high water use (estimated to vary from 600 L to 4,375 L per day), significant accumulation of water was not detected in the digesters of three community Biofil toilets (i.e. Type-3) evaluated in this study. Accumulation of fecal matter over the digester of these toilets was also not very significant (considering the number of user and length of time), despite the fact that no Tiger worm was detected in the digesters of these toilets. Among the three Type-3 toilets surveyed, two began operation in November 2019, the same month the first field visit was conducted; the third Type-3 toilet has been reported to be in operation for about 7 months. Efforts should be made to double check the user number and water use of these toilets. These toilets could be revisited later for reevaluation.

<u>Reduction of Fecal Matter Accumulation by Tiger Worm:</u>

The principal feature of a Biofil toilet is the presence of Tiger worms in the digester and reduction of volume of accumulated sludge through the action of the worms. Effort was therefore made to identify the presence of tiger worms in the toilet digester. This was done by removing the top cover slab (with pan) and poking and lifting portions of the accumulated sludge with a piece of stick. Among the 20 Biofil toilets evaluated, presence of tiger worm was

detected in four Biofil toilets (during first or second or both field visits). Tiger worms were detected in three in Type-1 toilets, two in Teknaf [ID: Teknaf-Camp 27(B)-SL4-ID-69, and ID: Teknaf-Camp27(B)-SL11-ID-48] and one in Ukhia [ID: Ukhia-Camp 19(C-14)-SL1]. Tiger worms were also detected in one Type-2 toilet in [ID: Teknaf-Camp 22 (Host)-SL3-HH-ID-1038] (see Figure 3.12); in fact, this was the only Type-2 toilet with well-drained digester content. It should be noted that these four toilets (with Tiger worm in the digester) did not have accumulation of water on top of the digester, and the contents of the digesters appeared to be well-drained. The number of users of these three Type-1 toilets are 17, 17 and 14, and that of the Type-2 toilet was 5.

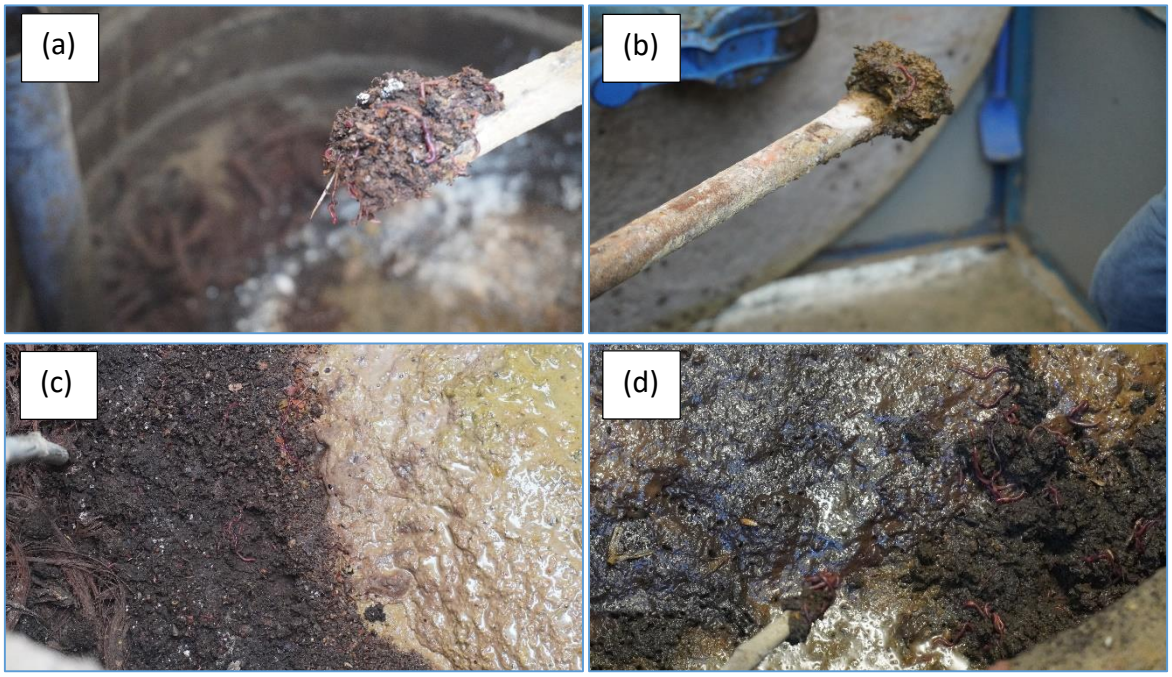


Figure 3.12: Tiger worms were detected in four toilets out of 20 [IDs: (a) Teknaf-Camp 27(B)-SL4-ID-69, (b) Teknaf-Camp27(B)-SL11-ID-48, (c) Ukhia-Camp 19(C-14)-SL1 & (d) Teknaf-Camp 22 (Host)-SL3]

Use of aggressive chemical in cleaning of toilets could adversely affect Tiger worm in the digester. Users of the four toilets where Tiger warms were found [ID: Teknaf-Camp 27(B)-SL4-ID-69; ID: Teknaf-Camp 27(B)-SL11-ID-48; ID: Ukhia-Camp 19(C-14)-SL1; ID: Teknaf-Camp 22(Host)-SL4-HH-ID-972] reported that they do not use any aggressive chemical for cleaning of toilets. On the other hand, at least three toilets have been found [ID: Ukhia-Camp 12(B-4)-SL4; ID: Teknaf-Camp 22(Host)-SL1-HH-ID-1120; ID: Teknaf-Camp 22(Host)-SL2-HH-ID-676] with relatively small number of users and well-drained digester contents, but with no Tiger worm; users of these three toilets reported using aggressive chemicals for toilet cleaning. This suggests that use of aggressive chemicals could adversely affect Tiger worm population in the digester.

Based on data/information collected during field visits and discussion with toilet users and other stakeholders, three major reasons were identified for the absence or death of Tiger worms in majority of Biofil toilets. These are:

(a) Accumulation of liquid in the digester (due to poor drainage of liquid that could be attributed to a number of factors including higher water use);
(b) Removal of entire digester content including Tiger worms during desludging of the digesters (and not resetting the digester with Tiger worms).
(c) Use of aggressive cleaning agents for cleaning toilets (that are harmful for Tiger worms)

As discussed above, 7 out of 20 Biofil toilets surveyed were found to have free liquid in the digester or very wet digester content that are not suitable for survival of Tiger worms. No Tiger worm was detected in these toilet digesters. The situation could get even worse during wet season when groundwater level would be higher and there would be risk of flooding of the low lying areas.

The other major reason for the absence of Tiger worms in the digesters appears to be the desludging method commonly practiced in the Rohingya camps. Among the 12 Type-1 Biofil toilets surveyed, 11 reported desludging prior to the field visit in November-December 2019; among 5 Type-2 toilets, three reported prior desludging; the 3 community toilets (Type-3) were constructed recently and were never desludged. Among the 14 Biofil toilets that were desludged/emptied, ten were apparently desludged by completely removing the contents of the digester and without resetting the digester with Tiger worms. Tiger worm was not detected in any of these ten toilets. In two Type-1 Biofil toilets, it was reported that desludging was done by emptying the top layer of fecal sludge, and efforts were made to keep a portion of the sludge with Tiger worms in the digester. Tiger worms were detected in both these toilets [with ID: Teknaf-Camp 27(B)-SL4-ID-69 and ID: Ukhia-Camp 19(C-14)-SL1]. In fact, estimated volume of accumulated sludge in these two toilet digesters (0.09 and 0.18 m^3, respectively) are much lower (by a factor of about 1.3 to 4) than the estimated accumulation in a regular pit, which was calculated using the following formula:

$$V = C. P. N$$

where, V = volume of fecal matter in m^3
C = fecal matter accumulation rate; (typical value 0.04 m^3/person/yr for a pour flush toilets)
P = Number of toilet user, and
N = period of operation (in year)

This appears to suggest that these two toilets with active Tiger worms in the digester are functioning as “Biofil toilets”. It was reported that the digester of two other toilets [ID: Ukhia-Camp19(C-12)-SL2, and ID: Ukhia-Camp12(A)-SL6] were reset with Tiger worms after desludging. However, no tiger worm was found in the digester of these two toilets. This is not

surprising because, as discussed earlier, both these digesters had very wet contents suggesting poor drainage of liquid. It should be noted that two other toilet digesters where Tiger worms were detected were never desludged before. Thus, it is clear that wrong or inappropriate desludging practice could prevent desired functioning of a Biofil toilet (by removing the tiger worm population from the digester).

Performance of Regular Twin-pit Toilets:

In a typical "alternate twin-pit toilet", the pits are used alternately, one at a time. When one pit becomes full, the fecal matter is diverted to the other pit. The contents of the filled pit are covered with soil and kept in this condition, preferably for at least 1.5 to 2 years for the contents to become safe for manual handling. The contents could then be removed manually (by users); this practice would eliminate the need for desludging the pits.

However, the twin-pit latrines at the Rohingya camps are not being used this way. After the filling of one pit, the second pit is being used. But the contents of the filled pit are being desludged (without keeping it at rest by covering with soil). The reason behind this is most likely the short life of one pit (less than 1.5 years, primarily because of large number of users); if the contents of a pit cannot be kept at rest for at least 1.5 years, the contents will not be safe for manual emptying (by users). Thus, it is better/safer to desludge the filled pits.

3.3.2 Feedback from Users and Other Stakeholders

Feedback Received from Users during Field Survey:

General Acceptance of Biofil Toilet:

The first challenge for the introduction of Biofil toilets was to make the technology, which involves use of worms (tiger worms), acceptable to the users. The implementers successfully overcame this challenge, and the user families accepted the concept of the technology with enthusiasm. Most users interviewed reported that they did not face any difficulty in using worm-based Biofil toilet and most users opined that the Biofil toilet is better than other toilets because of low or no smell inside; however, few users in the host community near Unchiprang Camp 22 in Teknaf, [Teknaf-Camp 22(Host)-SL1-HH-ID-1120] said that they are no longer interested to use their Biofil toilet, because it is filled-up with sludge, is non-functional (though they are still using it) and bad smell comes out of it.

Operation and Maintenance:

The user families also accepted the somewhat strict operation and maintenance requirements of the toilet, particularly with regard to cleaning of the toilet without using any chemical agents (e.g., Harpic, bleaching powder). Information gathered during field visits (through "checklist", physical survey and discussion with users) suggest that by and large the users were following this and other operation and maintenance instructions (not using too much water, dropping no materials inside digester which is harmful for warm etc.).

The number of a Biofil toilet users varied from 15 to 20 which is close to the limit (i.e., 15) suggested by the technology provider, with few exceptions in the host community near Unchiprang Camp 22 in Teknaf. Users reported using toilet 1 to 2 times for defecation and 2 to 3 times for urination. They reported average water use is about 3-4 liters per use, which is not very high. Thus, performance of the toilet digesters does not appear to have been adversely affected by user behavior (e.g., excessive use, use of chemical cleaning agents), except few units in Teknaf [Teknaf-Camp 26(A)-SL8-ID-Nil & Taknaf-Camp 27-SL7-ID-104]. During field visit most of the toilets were found clean, except 1-2 units in host community near Unchiprang Camp 22 [Teknaf-Camp 22(Host)-SL1-HH-ID-1120].

Feedback Received from the FGDs:

Participants in FGD informed that the number of users for Biofil toilets ranges from 15 to 30 with an average of about 20. The participants are aware of other toilet technologies being used in the camp. Before using Oxfam constructed Biofil latrines, they were using other types of latrines including NGO Forum pit latrine, Army latrines, etc. Most of the participants opined that the toilet use frequency is 1-2 per person per day and for single toilet use, 1-2 pot water is required; which means 2-4 litre of water is used per person per toilet use. Though most of participants opined that they get required water, female FGD participants from Camp-11, Ukhiya informed that they are suffering from low availability of water.

In FGD, most toilet users reported that they follow the instructions given to them for Biofil toilet use. They also informed that community based volunteer (CBV) team of Oxfam has oriented the Biofil toilet users on toilet use instructions, which include, no dropping of cigarettes, no use of soap or chemical for cleaning Biofil toilet or Sato pan, less water use, and many more. Most of the participants reported that they do not drop any soil or tissue inside the digester of toilet. They keep it in a bucket outside the toilet and is disposed by digging soil.

Mixed responses were received from the participants regarding the non-functionality of Biofil toilet due to filling-up toilet. Majority of the FGD participants in Ukhiya responded that their toilets became non-functional at least once. On the other hand, FGD participants from Teknaf reported that most of their toilets are functional, except few. FGD participants commented that the possible reasons behind the non-functionality of Biofil toilets were (i) more number of users, (ii) filling-up of digester with water due to poor draining of effluent from soakage pit underneath the digester, (iii) entering of rainwater into digester through outside or through rat-holes, etc. Once the toilet becomes non-functional, users inform the nearby camp office of Oxfam to desludge and traditional method is used to desludge the toilet. In most cases, the emptied sludge from Biofil toilet is disposed in a hole made by digging earth.

FGD participants informed that compared other toilets, Biofil is better; because Biofil toilets gives longer desludging period, comfortable to use due to wider space inside toilet, no bad smell, clean environment of toilet due to controlled/lower number of users, less space/surface area required due to placement of digester underneath the toilet superstructure, and good quality of superstructure. The challenging issues for Biofil are death of Tiger worm die or clogging of porous slab; if these happen then the toilet digester gets filled very quickly. Also desludging is more labor-intensive compared to regular toilets.

Feedback Received from Key Informant Interviews (KIIs):
During KIIs, effort was made to get responses from the key informants on the following questions: (a) Why do you choose Biofil? (b) Why not single pit latrine/alternative twin pit? (c) Is it costly or less costly than regular toilet? (d) What benefits you considered for Biofil? (e) What feedback you are getting on Biofil toilet? The responses received are summarized below:

Oxfam choose Biofil toilet for Rohinga camp because of very good feedback (in terms of longer desludging period) from piloting in Unchiprang Camp-22 at initial stage of influx of Rohinga population in 2017. Based on this feedback Oxfam installed Biofil toilet in the Rohinga camp, and Unicef, UNHCR provided financial supported to Oxfam. The other technologies were suffering from desludging issues seriously at that time.

There are two types of cost involved with the toilets in Rohinga camp including capital cost for installation of toilets and operational cost to keep the toilets functional and usable. The operational cost includes cost for desludging of toilets and also cost for re-setting of filter bed again for Biofil toilet. The capital cost for installation of an alternative twin-pit latrine is higher than Biofil toilet (i.e., BDT 65,000 for twin-pit latrine and BDT 55,000 for Biofil toilet), but the cost for desludging is relatively lower than Biofil (i.e., BDT 800 for twin-pit latrine and BDT 2,600 for Biofil toilet). Because, desludging of Biofil toilet also involves re-setting of filter bed. Though the frequency of desludging regular toilet is higher than Biofil toilet on an average, but it should be noted that the number of users of a regular toilet if often much higher (sometimes 5-10 times) than a Biofil toilet.

Very low or no desludging requirement and competitive cost of Biofil toilet (as claimed by the sole supplier Biofilcom, Bangladesh) were the main consideration for choosing Biofil toilet at Rohinga camps.

Initially, it was thought that Biofil toilet would not require any desludging for at least for 2-3 years, and very minimum sludge accumulation will take place because tiger warm will consume and reduce sludge volume. But, in reality, it was noticed that Biofil toiles also require desludging; though the frequency of desludging for Biofil is relatively less.

Unicef informed that they have received feedback from Oxfam Teknaf office that Biofil toilets are also suffering from the issue of desludging. But UNHCR did not receive any report on performance of Biofil toilet. It was gathered that for Biofil toilets in Teknaf, the toilet digesters were not reset with Tiger worms after desludging, because there was an issue regarding supply of worm, which could not be obtained without support of Biofilcom, Bangladesh. At present, mechanical desludging is not being done for Biofil toilets. It was reported that during rainy session, worms comes out from a few Boifil toilets. Oxfam informed that after resetting worm and filter media was done for some Biofil toilets, but those did not function well after resetting.

DPHE opined that, Biofil is a good on-site treatment technology for FS. In the camp, DPHE will also construct Biofil toilet under upcoming World Bank assisted DPHE project. But, they emphasized the consideration of water table and restricted number of users for Biofil toilet.

UNHCR opined that so far feedback they have received for Biofil toilet is not up to the desired level, so a network based desludging and transportation system need to be planned at Rohinga Camp.

3.4 Evaluation of Biofil Toilet based on Questionnaire Survey

The questionnaire survey was conducted in 323 toilet locations both in camps, and host community of Ukhia and Teknaf. 259 toilets were surveyed in camp locations in Ukhia and Teknaf and remaining 64 toilets in host community adjacent to the camps. Among the 259 toilets in camps, 125 toilets were surveyed at Unchiprang Camp-22.

Among these 323 Biofil toilets, 93% toilets are direct drop, and 7% are off-set. Among the 323 toilets, 92% were found to have digesters/pits of circular shape and remaining 8% toilets have rectangular digesters/pits. The depth of pit for all the surveyed Biofil toilets were reported to be 6 feet. For putting barrier between squat hole and pan, both Sato and water seal pans have been used; 34% Biofil toilets covered in the questionnaire survey have water seal pan, while 66% have Sato pan. For venting of foul gas from the digester, 4 inch dia PVC vent pipes have been used. For cleansing and flushing purpose, water used varied from 1.5 to 3 L per toilet use. About 26% users reported using 1.5 L per toilet use, about 65% reported using 2L, and the remaining 9% 2.5-3L per toilet use. For cleansing purpose, people use both tissue (10%) and soil (24%) before using water. For cleaning toilet and pans, 11% respondents replied that they use chemicals, mostly in Teknaf.

Surveyor asked respondents regarding operational condition of their toilets, and 308 toilets were reported to be in operational condition, while 15 were non-functional; most non-functional toilets (13 out of 15) were in Ukhia. Most of the toilets are shared with other families. Out of 323 toilets, 247 toilets are used by 1-3 families, 70 toilets used by 4-6 families,

and remaining 6 toilets are used by more than 6 families. Biofil toilets were constructed between 2017-2019, majority in 2018, as shown in Table 3.7.

Table 3.7: Distribution of surveyed Biofil toilets according to year of construction

Location	Camps/Union	Number of Biofil Toilets Constructed		
		2017	2018	2019
Teknaf	Nayapara (camp-26&27)	4	35	7
	Unchiprang (camp-22)	24	44	57
	Whykong (host adjacent to Camp-22)	14	18	10
Ukhiya	Balukhali (camp 10,12,19)	3	48	2
	Kutupalong (camp-4& 8W)	9	25	1
	Jaliapalong (Host in Kutupalong)	7	15	0
Total		**61**	**185**	**77**

Out of 323 toilets surveyed, 225 were desludged at least once before the survey; almost 99% toilets in Unchiprang Camp-22 required desludging. 55% of the toilets were desludged one month before this survey, 14% were desludged two months before, 10% three months before, 15% 6 months, and remaining 7% were desludged more than 6 months before the survey. Out of 225 toilets desludged, 27% toilets were desludged once, 65% required desludging more than three times; 51% toilets from Unchiprang were desludged more than 3 times (see Table 3.8). This suggests considerably high-frequency desludging for Biofil toilets in Unchiprang, considering that most toilets were installed during 2018 and 2019.

Table 3.8: Information on deslulging of surveyed Biofil toilets

Location	Camps/Union	Number of Times Desludged			
		1 time	2 times	3 times	> 3 times
Teknaf	Nayapara (Camp-26&27)	2(1%)	1(0%)	2(1%)	25(11%)
	Unchiprang (Camp-22)	4 (2%)	3 (1%)	3 (1%)	114 (51%)
	Whykong (host adjacent to camp-22)	6(3%)	0(0%)	1(0%)	1(0%)
Ukhiya	Balukhali (Camp 10,12,19)	25(11%)	2(1%)	1(0%)	2(1%)
	Kutupalong (Camp-4& 8W)	19(8%)	2(1%)	1(0%)	4(2%)
	Jaliapalong (Host in Kutupalong)	5(2%)	1(0%)	0(0%)	1(0%)
Total		**61 (27%)**	**9(4%)**	**8(4%)**	**147(65%)**

The methods followed for desludging Biofil toilets were mostly manual by desludging crew. After desludging, for 38% Biofil toilets beds were reset again with Tiger warms and coconut fibers. Very few of the Biofil toilets that were evaluated in detail reported resetting of digester

after desludging. This is a cause of concern. Table 3.9 shows responses of toilet users on some questions regarding toilet condition.

Table 3.9: Responses of Biofil toilet users on toilet condition

Sl. No.	Question	Yes (%)	No (%)
1.	Is the pan clean?	66	34
2.	Is there any smell in and around the latrine?	35	65
3.	Are there lots of flies in and around the biofil latrine?	23	77
4.	Does tiger worm come out of the digester?	11	89

3.5 Summary

The major findings from the evaluation of Biofil toilets presented above are as follows:

(1) Most Biofil toilets (as well as regular pit latrines) satisfy the criteria of a "hygienic latrine". A few Biofil toilets however failed to satisfy one criterion on venting of foul gas, because the users had to remove to vent pipe that was clogged (at the bottom) with accumulated sludge. This issue/problem could be addressed with design modification.

(2) Most Biofil toilets are not functioning as desired because of the absence of Tiger worms in the Toilet digester. Three major reasons for the absence of Tiger worms in the digester are: (a) poor drainage of liquid and accumulation of liquid in the digester; (b) inappropriate desludging practice that involves removing the entire content of the digester and not resetting the digester with Tiger worm after desludging; and (c) use of aggressive chemicals for toilet cleaning.

(3) High number of user and high water use appear to be a major reason for poor drainage of liquid and accumulation of liquid in the digester. Other reasons include high groundwater table, and inadequate sizing of the soakage zone of Biofil toilets.

(4) A properly functional Biofil toilets would be able to reduce accumulation of fecal matter significantly, as was observed for at least two Type-1 Biofil toilets evaluated in this study. Relatively small number of user, proper desludging practice, and proper maintenance appear to be key factors for proper functioning of a Biofil toilet.

(5) A Biofil digester devoid of Tiger worms would function like a regular pit. Since Biofil digesters usually have smaller volumes than regular pits, these would then require even more frequent desludging.

(6) The Type-3 community Biofil toilets evaluated in this study have been commissioned very recently. These toilets could be revisited later for reevaluation.

(7) Desludging of Biofil toilets is costly, because ideally this involves resetting the digester. Desludging of toilets is often done by the emptying personnel targeting all toilets in a particular region/area, without considering the actual desludging requirement.

Premature desludging of a Biofil digester would negate the most significant advantage of a Biofil toilet (which is less frequent desludging), and making the O&M even costlier.

(8) Due to the presence of well-drained fecal matter, Biofil digesters cannot be desludged effectively with pumps (which are commonly used for desludging of regular pit latrines). Since manual desludging is practiced for Biofil toilets, health and safety issues need to be addressed properly during desludging operation.

(9) Regular twin pit toilets appear to be functioning well. However, unlike normal alternate twin pit toilets, the contents of filled pit of these toilets are being desludged (instead of keeping these at rest for at least 1.5 years). Quicker filling of pits is forcing this practice.

Chapter-4 : Conclusions and Recommendations

4.1 Introduction

Access to safe drinking water and hygienic sanitation facilities is a priority for DRP population. A number of sanitation technologies including pit-based latrines (single- and twin-pit), Biofil toilets, toilets with septic tanks and soakage pits have been installed in these camps. The containments of these toilets (i.e. pits or septic tanks) need to be desludged periodically to keep the toilets operational. Unlike regular pit-based toilets, Biofil toilets have a digester consisting of a porous bed that supports Tiger worms. Fecal matter is collected on the digester bed, and the free liquid is drained through the porous bed of the digester. The Tiger worms converts the fecal solids into vermicompost and thus slows down the build-up of fecal matter in the digester. As a result, the pit/digester of a properly functional Biofil toilet should take a longer time to get filled, requiring less frequent desludging. Significant number of Biofil toilets have been installed in different Rohingya camps in Cox's Bazar. It is important to assess performance of Biofil toilets, in order to understand their relative advantages/ disadvantages.

This study presents an evaluation of the performance of Biofil toilets. The evaluation has been made based on detail assessment of 26 Biofil toilets and pit latrines; questionnaire survey of users of 323 Biofil toilets, interview of toilet users, KIIs and FGDs. This Chapter presents the major conclusions of the study and recommendations based on the findings of the study.

4.2 Conclusions

Major conclusions from the present study are as follows:

(1) While most of the Biofil toilets that were evaluated in detail in this study are not functioning as desired, it was also found that a properly functional Biofil toilet could significantly reduce accumulation of fecal matter and thus significantly reduce desludging requirement.

(2) There are a number of challenges for proper functioning of a Biofil toilet. A Biofil toilet will perform well if the Tiger worm population in the digester survive and are able to carry out their functions. This is likely to happen if the following conditions are met: (a) A properly designed Biofil toilet is installed in an area that is not prone to flooding or has a high water table; (2) The number of users of the toilet is relatively small, resulting in lower water use (a number less than 15 could be considered a good number for Type-1 toilet); (3) The digester is carefully desludged when needed, by ensuring that Tiger worm population remains in the digester after desludging or resetting the digester with Tiger worms after desludging; (4) Following precautions in using Biofil toilets (e.g. not using aggressive chemical for cleaning toilet that could harm the Tiger worms).

(3) Accumulation of fecal matter in the shallow digester (particularly in Type-2 design) located at the top portion of the pit of a Biofil toilet often clogs the bottom of the vent pipe. The design/placement of vent pipes and digester of Biofil toilets needs to be revisited.
(4) All toilets including Biofil toilets should be desludged only when needed; proper health and safety guidelines should be followed while manually desludging Biofil toilets.
(5) Unlike a typical "alternate twin pit toilet" (for which desludging of raw fecal sludge is not needed), the twin-pit toilets in Camps require desludging because of quick filling up of pits.

4.3 Recommendations

The following recommendations are made based on the findings of the present study:

(1) Successful operation of a Biofil toilet is challenging. A properly designed Biofil toilet could be considered only for suitable areas (e.g., areas not prone to flooding or not having high water table), after ensuring desired number of users, ensuing proper operation and maintenance, and ensuring proper desludging when needed & resetting of digester after desludging.
(2) The personnel involved in desludging of Biofil toilets should be properly trained, particularly on health and safety and resetting of digester. This is particularly important because desludging of Biofil toilets require careful considerations regarding: (a) when to desludge, (b) desludging methodology and resetting of digester, and (c) health and safety issues.
(3) A number of design issues of Biofil toilets need to be revisited. These include positioning of vent pipe, volume/surface area and depth of digester, and infiltration area of soakage zone. [Very shallow depth of digester located at the top of the pit (in Type-2 design) is causing problem with the venting system; low surface area filter and infiltration area, and detention volume of soakage zone is creating difficulties with proper infiltration of liquid].
(4) Higher number of users and hence high volume of water use is a concern for any Biofil toilet. Hence, the community Biofil toilets (Type-3) should be revisited for further evaluation. It should be noted that the community Biofil toilets (Type-3) have offset pits that typically require even higher volumes of water for flushing feces into the offset pit from the toilet pan.

References

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Appendix-A: Questionnaire used in the Questionnaire Survey

Biofil latrine - Evaluation questioner	
Name of Person collecting data	input
Date	input
Section 1: Location	
Camp	input
Host community	input
Section 2: Type and functionality of Biofil latrine	
Type of Biofil latrine	Offset - pit Drop- pit Other
Shape of digester	**Circular** **Rectangular/Square**
Dimension of digester	**Dia (if circular)**
Depth of digester from the bottom of pan (for direct pit) or inlet pipe (for offset pit)	**(in inch or feet)**
Type of pan used in the latrine	**Water Seal** **Other** **(note)**
Vent pipe used in the latrine?	**Yes** **No**
How much water (total for cleansing and flushing) is typically used for every use of the toilet?	
Is toilet tissue used for cleansing (that goes into the digester)?	**Yes/No**
Is soil used for anal cleansing?	**Yes/No**
Are any chemicals (e.g., bleaching power, harpic or similar liquid) used for cleaning of toilet?	**Yes/No**
Follow up question (If response to the above question is Yes)	
Material and diameter of vent pipe	**Material (e.g., PVC)** **Diameter (inch)**
Functionality of Biofil latrine	functional Not functional
Section 3: Number of Users and use	

How many families use the Biofil latrine as their primary toilet	input
Family size - latrine users	
Family Number -1	input
Family Number -2	input
Family Number -3	input
Family Number -4	input
Family Number -5	input
	Year/
When was the Biofil latrine constructed	**Month**
Has it been **disludged?**	Yes/No/No information
(Follow up question)	
Do you remember when it was last time disludged ?	Time
(Follow up question)	
How many times the biofil latrine was disludged from the beginning of operation?	1,2,3
Questions about method of desludging:	
Was the digester desludged with pump?	**Yes/No**
Was the digester desludged manually?	**Yes/No**
Was the digester bed set again, e.g., with tiger worms, filter material (e.g., straw/coconut fibre) after deludging?	**Yes/No**
Was the performance of the digester different after desludging? (e.g., poor performance, smell, etc. after desludging?)	
Section 4: Structured observation in the structure of Biofil latrine	Yes/No
Is the **pan** clean	
Is their any smell in and around the latrine	Yes/No
(Follow up)	
If yes, what does smell of	Bleach
Are there lots of flies in and around the biofil latrine	Yes/No
Does tiger worm come out of the digester?	Yes/No
Section 5: Structured observation of the Biofil latrine	
Does the tank/ digestor smell	Yes
	No
(Follow up)	
If yes, what does smell of	Bleach
	Urine
	Poo
	Other: detail
Does any flies come out?	Yes
	No

Is there ants around the latrine and digestor	Yes No
Is there a sign of rats presence around the digestor	Yes No
Estimate the depth of the poo/liquid	___ inch
Is free water (accumulation of water) visible on top of the digester?	**Yes/No**
Is it mainly poo or liquid	Poo Liquid Half Half
How is the Poo distributed	Flat across the surface Cone like
If there is a soakage pit for disposal of liquid from the digester, matter/solids?	**Yes/No**
If "yes", type of liquid coming into the soakage pit?	**Clear** **Mixed with fecal sludge**
What percentage of the surface of the system is covered by fresh poo	input
Enter NGO, if known	Oxfam NGO Forum Solidarities International BRAC MSF BDRC ICRC Other (specify) Unknown
Take a photo GPS location	**Toilet superstructure** **Toilet pan** **Biofil digester (top view)**

Appendix-B: data collection form

Study on Biofil Latrines Evaluation

Date of Commencement:		Name of Household Head:	
Date of Visit:		Name of Interviewee:	
Type of Toilet:	☐ Direct pit ☐ Pour flush pit ☐ Biofil	Type of Biofil latrine: ☐ Direct pit ☐ Off-set	
Shape of Digester/Pit:	☐ Circular ☐ Rectangular ☐ Square	Total no. of users:	Male ☐ Female ☐ Children ☐
Dimention of toilet:			Disable person ☐ Total ☐
Toilet ID:		No. of family:	
Location:		Flooding during rainy season?	☐ Yes ☐ No

Checklist

1	Size of pan:	**Material of pan:** ☐ Ciramic	☐ Plastic	
2	Type of pan used	☐ Water seal ☐ Sato ☐ Without water seal ☐ Others		
3	Water seal used	☐ Yes ☐ No		
4	Toilet-use frequency (per person per day)	☐ 1 ☐ 2 ☐ 3 ☐ 4		
5	Condition of the toilet surrounding (outside)	☐ Clean	☐ Not so clean	☐ Dirty
6	Condition inside the toilet	☐ Clean	☐ Not so clean	☐ Dirty
7	Presence of fly surrounding the toilet	☐ No Fly	☐ Some fly present	☐ Abunden
8	No. of pot (water) for every single toilet use	☐ 1 ☐ 2	☐ 3 ☐ 4	☐ Other ☐
9	Smell inside the toilet	☐ No	☐ Slight smell	☐ Acute
10	Smell outside the chamber/toilet	☐ No smell	☐ Slight smell	☐ Acute
11	Confinement of Fecal matter within digester	☐ Yes	☐ No	
12	Tissue, soil for cleansing, sanitary napkins, cigarette butts drops inside digester	☐ Yes	☐ No	
13	Visible crack/leakage in digester	☐ Yes	☐ No	
14	Any bleach, phenyl, harpic use in the toilet?	☐ Yes	☐ No	
15	Is effluent from digester drains?	☐ Yes ☐ No	**Where?** ☐ Soakage pit ☐ Environment	
16(a)	Presence of soakage pit	☐ **Yes**	☐ **No**	**If "Yes"**
16(b)	Color of effluent from soakage pit	☐ Clean ☐ Mixed with FS	☐ Turbid	☐ Blackish/ Brownish
17	Does Tiger worm exists inside digester?	☐ Coming out	☐ Over filter media	☐ Don't appear
18	Visual observation inside the digester	☐ Fresh FS	☐ Mostly Blackened	☐ Fresh and blackened
19(a)	Water logging inside the digester	☐ Yes	☐ No	**If "Yes"**
19(b)	Stagnant water mainly	☐ FS	☐ Liquid ☐ Half-Half	☐ Other
20	Accumulation of FS over filter inside digester	☐ Less	☐ Slightly higher	☐ Higher ☐ Rapid
21	Distribution of FS inside digester	☐ Flat across surface	☐ Below the drop	☐ Around digester edge
22	Filter material inside digester made of:	☐ Straw	☐ Coconut fiber	☐ Other
23(a)	Desludging done before:	☐ Yes	☐ No	**If "Yes"**
23(b)	Date of last desludging:		**Method:**	☐ Manual ☐ Using pump
24	Was bed set again, after desludging	☐ Yes ☐ No		
25	Performace of digester after desludging	☐ Water logged ☐ Bad smell ☐ Warm left/die		☐ Functioning

User feedback

UFT1	Any difficulties using the toilet?	☐ Yes	☐ No
UFT2	If "Yes", please mention the reasons		

* Approximate capacity of 1 pot = ☐ litre

Note: