Rural FSM development in West Bengal

Steven Sugden, Water for People, June 2015

Introduction

The Parnter Partima test bed area provides a good location to research on-site FSM solutions in relatively rural low density housing areas found in West Bengal, but initial research has found that there is absolutely no possibility that anyone in this area would currently pay for waste to be transported to a treatment site (see separate study report). As the project agreement indicates, Water For People needs to explore a range of FSM transport and treatment options, and this has made it necessary to search for a location where such a service could be viable. This is proving to be harder than expected and this report outlines some of the key constraints in West Bengal and then uses this analysis to guide the way forward. This report is based on a rapid appraisal process involving visiting different types of areas and discussing existing practices with key informants.

At this stage the hypothesis needs further verification through household visits, semi structured interviews with the people who empty the pits and the testing of the physical characteristics of sludge within the pits using the Ball Penetrometer. It does, however, form the basis for the selection of the second test bed area.

The analysis is only applicable the area of West Bengal which have high water tables and prone to flooding during the monsoon. Its applicability outside such area is unknown.

Fecal sludge management

Septic tanks and leach pits need to be properly managed so as not to risk to public health, cause environmental contamination or risk operator safety during content removal. All off-site sanitation systems produce two type of waste product; effluent and sludge.

- Effluent is produced in the day to day operation of the septic tanks which theoretically are supposed to have a two day retention time. After this time the effluent should pass into a buried drain or soak away where it can infiltrate into the soil. The natural filtration qualities of the soil results in pathogen die-off and as all the system is buried, human contact is avoided. In West Bengal septic tank owners seem to prefer to see the effluent running out of their septic tanks as like to “see it is working”. Such effluent will have less suspended organic matter that raw effluent, but still have high levels of pathogens. Leach pits are inherently safer as the effluent permeates the soil directly from the pit and direct human contact is not possible. The amount of effluent produced depends on household water consumption with modern urban households with piped water producing far more than simple rural household without piped running water.

- Sludge resulting from the bacterial digestion of organic matter and settlement processes, slowly accumulates within the tanks or pits. It gradually builds up over the years and needs to be removed in bulk to keep the tank or pit functioning. The rate at which sludge accumulates is critical to developing an effective approach to FSM, but unfortunately not a great deal is known about accumulation rates and great variations have been reported. The pit characterization work with the Ball Penetrometer, outlined in the next section, aims at better quantifying and understanding fill up rates and to develop an indicator for pit / tank performance. In a well-managed FSM chain the sludge is removed from the tank with some form of mechanical device and transported to treatment plant for safe disposal. West Bengal rural towns usually lack any form of treatment plant or sludge transportation process making the traditionally accepted FSM chain highly unlikely.

Sludge Characteristic

The pit sludge characteristics work has been undertaken on 25 pits in Pathar Pratima. As the graph on the next page clearly shows, vast majority of the pit contents are below 500 Pa, with norm being around 250 Pa, and that the pit are filling up mainly with a thin watery sludge. The only thicker sludge i.e. above 1000 Pa, occurs at the bottom of the pit in a relatively thin layer. Sludge of 250 Pa is capable of being pumped by simple valve or vacuum based devices and as the pits are off-set, the sludge is not contaminated with large quantities of solid waste.

Removing thin sludge is a relatively quick and simple task and can be performed with a simple bucket tied on the end of a length of rope. Even centrifugal irrigation and diaphragm pumps will be effective. Some emptiers reported in the test bed area that they never climbed into the pit and always left any thicker sludge the pit.

A ‘full pit’ manifests itself through the inability of the flush water to drain from the bowl and usually only occurs in the wet season when water enters the pit from the soil surrounding the pit. West Bengal and Bihar have a soil with a high clay content and through which drainage is very slow. Once the soil becomes saturated; the pits act more like sealed tanks than leach pits.

The busy period for pit emptying is just after the end of the rains when the water table has receded. Households believe that emptying a pit during the rains will just result in the pit filling up with rain water, which would indicate that drainage from the pit is poor even when the water table is low.

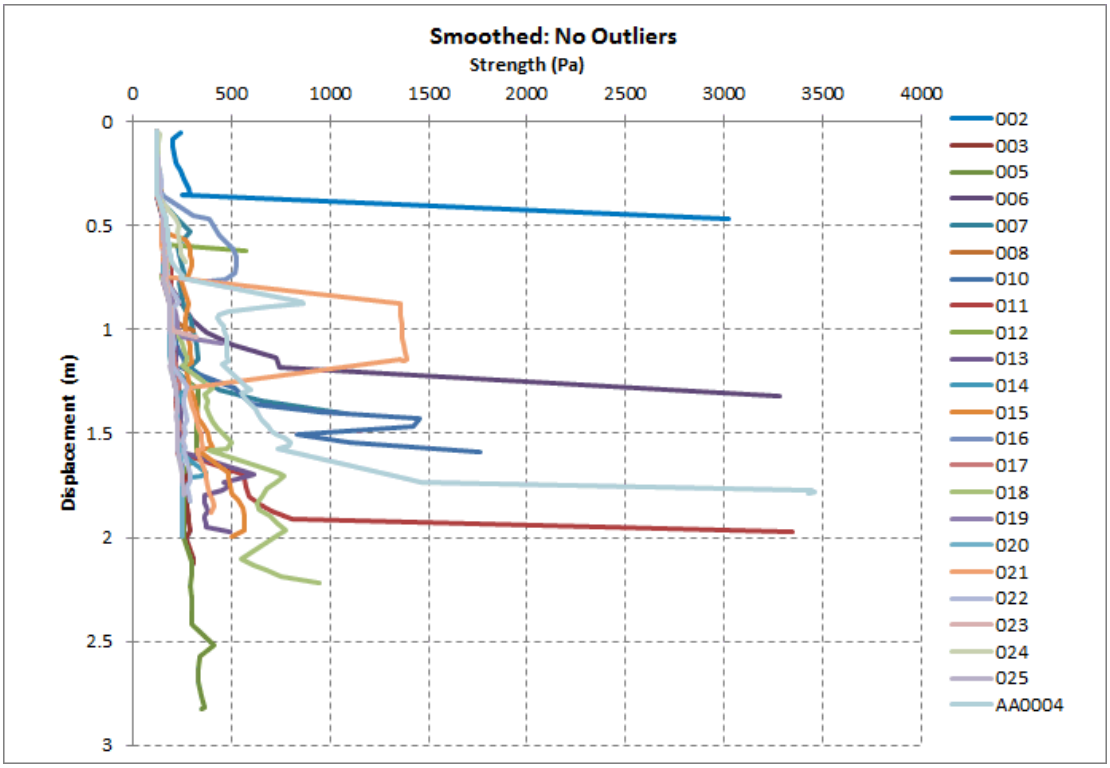


Fig 1 Sheer strength of 25 pits in Parnter Partima

Existing empting service providers in West Bengal

These can be divided into four categories

1. Self-emptiers, usually the male of the household using buckets. Remove only the thin sludge and dump on the nearest piece of land or pond.
2. Manual scavengers - although technically illegal, are still the most prevalent form of paid pit emptying process. In small towns or peri-urban area they promote their services by frequent early morning visits and will undertake the work immediately. It is not their only source of income and will search for any form of unskilled labour in the area to earn money. They empty with buckets and dump the waste on any nearby unoccupied ground, or in higher density areas where such a practice is impossible due to lack of land or the risk of a neighbour dispute, they will carry the waste a short distance to a more convenient and less controversial dumping location.
3. Private sector contractors using mechanical emptying devices. A few individuals offer mechanized emptying in rural areas, but not as their sole occupation. They usually use centrifugal irrigation pumps will limited capacity for thick sludge and dump in a nearby pit.
4. Municipal councils own or empanel (a form of regulation) companies with vacuum tankers to provide emptying service for residents of the municipality. Households pay for this service.

5. Private sector tanker operators exist in the larger cities where there seems to be a thriving and growing business opportunities. Such operators do not seem to exist outside the larger cities.
6. Municipal managed sewer networks and treatment plants. Only present in larger cities.

Household collection and the disposal of sludge and effluent

The following are the common household solutions

1. Leach pits, usually in rural areas where the volume and emptying frequency seems limited both by the depth of the pit and the water table and only rarely emptied in a safe manner.
2. Septic tank with connection to sewer network. These tanks operate like interceptor settling tank and the partially cleaned effluent drains off to the sewer. Such an arrangement results in long fill up rates and a thick sludge that has to be fluidized with water to enable it to be removed by a vacuum tanker.
3. Septic tank discharging to ditch, open drain or vacant plot. The ditch in such cases acts like a sewer and the sludge remaining in the tank has similar characteristics. In rural areas with single occupancy households the quantiles are relatively small and disbursed compared to the high density urban areas where space is limited, land expensive, and where there are large multi-occupancy dwellings each fitted with internal bathrooms and kitchens. Water usage in such household is high, yet the developers only provide relatively small 'septic tanks' and the sewage may have a retention time of less than a day before being discharged into the environment.
4. Septic tanks in high density areas. As medium density areas develop into high density areas, all the available empty plots into which the septic tanks once discharged are built upon and the ditches covered over and converted into pavements or parking space. This leaves the septic tank effluent nowhere to drain without causing annoyance and complaints from the neighbours.

Enforcement and regulation as a driver for change

"An analysis of Fecal Sludge Management: Emptying and Transportation Services in Africa and Asia" 2012 by Sangeeta Chowdhry and Doulaye Kone of the Bill and Melinda Gates Foundation concluded -

> "In India, separate regulation for fecal sludge does not exist in the surveyed cities although current laws do deal with diverse water, wastewater and sanitation services. Local governments are responsible for local sanitation regulations but in the absence of any policy or norms on fecal discharge or management, these local governments have no direct control in relation to fecal sludge management. The frequency of septic-tank emptying is left to the discretion of households and emptiers take care of disposal of sludge with no guidance or regulation

> enforcement. Septage management is not covered in a holistic manner beyond the prohibition of its discharge into water bodies.

In Patna, even the prohibition on discharging into water bodies is not enforced and seems to be unofficially accepted, possibly due to the lack of suitable dumping alternatives. When asked about his dumping practices, one tanker operator replied that he "Only ever dumped in fast flowing water as dumping in a pond was bad". He also complained that that there was shortage of good places to dump, but he was not concerned either about being fined or the environmental consequences of his actions.

> "Toilet, septic tank, and sewer design and maintenance are regulated through the 1983 National Building Code of India. The section on "Drainage and Sewerage" specifies the sizing and design of septic tanks, sewers, toilets and other sanitation devices. However, it is worth noting that these specifications may only be theoretical as there is no system in place to ensure that these standards are actually applied. Furthermore, guidelines for sludge management do not exist"

Sites where septic tanks discharge into ditches, empty into fields and empty into vacant building plots are common and can be easily found, even in what appears to be the more wealthy and newer developed areas of the city. In rural areas with a more disbursed population and harder to catch emptying events, the possibilities of any form of effective enforcement in the near future is remote.

'The prohibition of employment as manual scavengers and their rehabilitation act, 2013' made it illegal to employ Manual Scavengers, i.e. a person who directly handles fresh faces as part of their employment. This appears never to be enforced in West Bengal and the practice is openly carried out in most areas.

In summary, the FSM disposal practices are an example of the *tragedy of the commons* and driving towards any improvements in current FSM practices will be greatly hindered by local government laissez faire leadership and the inappropriate legislation. It also raises the question as to whether suitable technical solutions are available even if the local government were to be more proactive? There are no currently no affordable market ready solutions which the government could endorse / enforce to improve the public health situation. The knee-jerk reaction would be to build sewers and treatment plants, but even in places where these exist, the problem is not resolved.

Market Failure in FSM form a household perspective

Market based solutions only work if there is some element of dissatisfaction expressed by potential customers over their current practices. In West Bengal there seems to be limited amounts of dissatisfaction with regard to FSM, making the implementation of pure market based solutions extremely difficult.

Although fecal sludge management practices are extremely hazardous from a public or environmental health perspective, this does not appear to create any motivating force for change either within the general population or with individual householders. Dumping pit sludge on nearby land or allowing

effluent to seep into the neighboring field does not generate any cause for concern. It simply does not seem to be an issue. At best, when the problem is highlighted to householders they would respond by a side-ways movement of the head (the equivalent to a western shrug of the shoulders) and the acceptance of its inevitability.

If the better educated richer urban elite living in modern apartment blocks are not driven to action by the presence of open sewers next to their homes, the rural poorer educated rural poor are hardly likely to feel any form of pressure or be expected to change.

After accepting householder attitudes towards public health, environmental contamination and operator health, it is difficult to see any specific market failure from their perspective. In all the settings, from low to high density from rich to poorer households, the market would seem to be working reasonable efficiently. Take the following examples,

- When a rural household wants their pit or septic emptying, a person could be hired and the latrine put back in working order gain in around three days. It costs around Rps 800 which is not considered unreasonable. Poorer households can self-empty.
- Households in all areas use the open plots of land or open ditches outside their houses to drain the effluent from their tanks or pits. Nobody complains, everybody accepts and it a low cost method of solving what could be an expensive problem. It is more important to have a nice bathroom fed by a piped water supply than to limit its water use in order to have safe the environment.
- In a peri-urban areas or small town, manual emptiers wander the streets in the early morning once every four to five days promoting their pit emptying service. There is no need to search for a service provider, they come to the householder. If the householder has some neighbor issues or does not want the sludge near their home, they can pay a little extra for it to be taken away.
- The residents of blocks of flats with large septic tanks connected to the sewer or open ditch have to pay for a tanker to empty the tank once every 7 to 10 years. The tanker can be easily accessed through the municipality and are reasonable priced.

The main market failure starts to creep in as housing density increases and a growing scarcity of land on which to dump sludge and discharge effluent. When there is no more convenient land on which to discharge their effluent, households are immediate faced with the problem of rapid fill up rates, with the only solution being to hire a tanker. This may be as frequent as once a month and at around Rps1500 ($23) per trip, the cost can rapidly add up, particularly when they are removing 8 to 10 tanker (say $230) loads per dwelling. This is a lot of money, but when it is divided between the 20 households occupying the block it equates to $11.50 which somehow may seem more manageable. It is also hard to get the householders opinions as they work through committees and may not be directly involved with the decision making. The may regard it as a necessary and unavoidable cost of living in an apartment.

What may be considered to be a market / technical failure for the urban householder living in a block of flats is also the market maker for the owners of the vacuum tankers who make good money from

providing emptying services. Most of them are keen to expand their tanker fleet to capture more of this growing market.

Improving the efficiency of the business from an entrepreneur perspective

Another avenue through which to develop sanitation businesses is to improve the working practices, efficiency and the margins of the existing operators. Any new technology whose adoption is driven by purely by market forces has to achieve all three objectives and failing to achieve in any one will result in the technology not being adopted. It is unrealistic to expect an entrepreneur to buy a new emptying device which allows for a cleaner safer emptying operation if it is also more costly and slower. In his eyes, operator safety and public health are not a high priorities, and a new cleaner device may be regarded as essentially performing the same function as the existing technology.

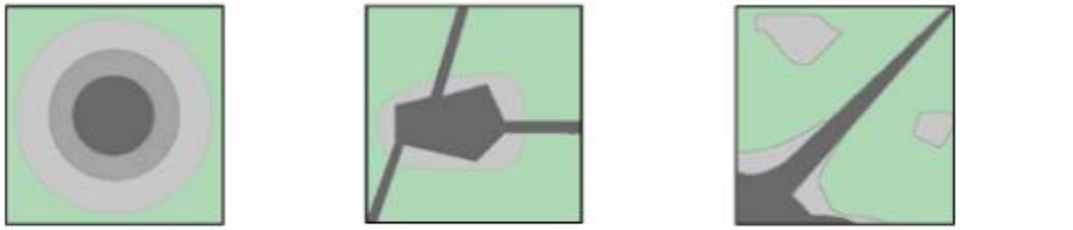
When looking as FSM technology development opportunities in West Bengal through the service provider lenses it is possible to surmise,

- Manual Scavengers. Have a very good business model with low capital cost, easy to transport, easy to maintain equipment. They have no sludge transport costs, their services are easy to access and although technically their practice is illegal, they are ignored by the authorities. The main value add they could gain from using better emptying equipment would be an elevation in their status, although they would find it hard to increase their fees unless the technology was adopted by everybody.

- Tanker operators. They currently pay no dumping fee and as long as there is easy access to a 'fast flowing water' dumping site, they have low transportation costs. The vacuum pumps they use are capable of removing the thin sludge found in most septic tanks. Additional treatment plants are unlikely to be successful if they are harder or more time consuming to access, or involved greater travelling distances, or require a dumping fee.

Forms of urban growth impacting on FSM practices

The following are the a diagrammatic representation of three different forms of urban growth,



a) Low Density Sprawl b) Ribbon Sprawl c) Leapfrog Development Sprawl

Source: CGIS at Towson University, 2010

Low Density Continuous Sprawl originally drove the settlement patterns and growth of lower density housing in the rural area of West Bengal, such as found in the test bed area of Pathar Pratima. This has resulted in a population density of around 520 people to 1km². Such growth lends itself to household based FSM solutions as opposed to the provision of expensive community-wide infrastructure.

Urban growth in West Bengal is heavily influenced by the level of the water table and the seasonal flooding. This has led to a mixture of Ribbon Sprawl and Leap Frog Development Sprawl which in turn has an impact on the way the households manage their excreta.

Main roads have to be built above the flood levels and this requires building of long embankments. When such an elevated road is close to a larger urban areas the land at each side of the road becomes attractive for housing and it is relatively simple for developers to extend the road embankment by adding earth or hardcore to the site so as to create an elevated platform on which to build a new house. This form of urban growth results in ribbons of single plot housing stretching on either side of the main roads, and open fields and a flood prone land to the rear (and usually the side) of each house. This arrangement is ideal for installing a septic tank where the outflow of the tank drains on to the open land and also allows Municipality owned tankers have easy access to the septic tank when they need emptying. There are no narrow long lanes to negotiate.

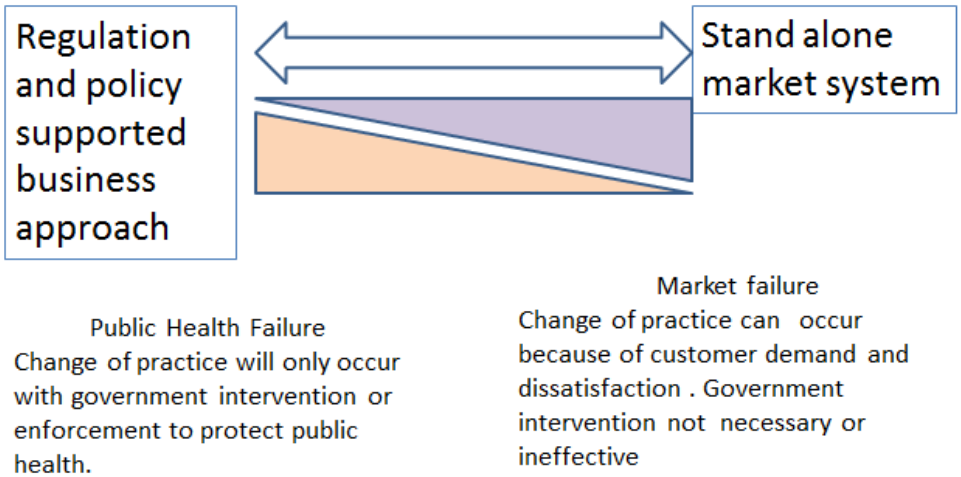
Closer to the main urban centers, or where roads converge in block headquarter, railway stations or markets, there is a demand for housing closer to the main center and the ribbon form of growth gives way the ribboned sprawl. The gaps between the roads which were previously open fields become housing areas and households gradually begin to face problems with regard to the discharge of their effluent and in finding somewhere socially acceptable to dump their tank contents after emptying. As these smaller rural town areas do not possess tankers, this may represent an opportunity to develop private sector based emptying services.

Change through Government enhanced support to FSM

Some public health related business opportunities exist because of customer demand and the dissatisfaction with the alternatives. High acquisition and use is assured used marketing principles with only a light regulatory touch. For example, refrigerators keep food at temperatures which prevent pathogenic organism replication and in doing so prevent food poisoning. Household buy these as ‘must have’ items and all the government needs to do is to regulate there electrical safety.

Some public health related business opportunities exist only because government has deemed a process so hazardous to public health that they dictate it has to be undertaken in a highly controlled manner. For example, asbestos stripping in old building can only be undertaken by licensed companies with stringent monitoring and households are not even allow to remove it from their own properties. Asbestos stripping companies flourish under such controls and would fail if the regulations were relaxed. This market would not exist without government regulation.

In-between the extremes lay a range of possible business based private sector options with greater or lesser degrees of government involvement. This is represented by the following diagram,



The analysis of the FSM sector in West Bengal would indicate that the opportunities for pure stand-alone market based businesses are limited and that government enforcement is unlikely to be effective. If a business based FSM idea or technology is to reach scale in India, it has to be developed in the space between the two extremes and the government involvement at any level cannot be ignored or by-passed. The extent and dependence on government support can be variable and an approach requiring a 'light touch' from the government is more likely to be successful and sustainable. Although working with government makes the whole process slower and less predictable, it would seem to be unavoidable with regard to improving most aspect of FSM in West Bengal.

The way forward for the Sanihub and FSM

Based on the analysis of the FSM sector in West Bengal, the Sanihub will pursue the following business based ideas,

1) **In situ technology to dewatering pits**

A pure market based idea based on supplying a simple low cost pump which extracts the thin weak sludge from the top of pit and delivers it to a soak away to safe disposal. The public health advantages are that it reduces the likelihood of human contact with pathogens by ensuring the pit effluent is safely disposed and that the sludge pit emptying frequencies are elongate. The household will benefit as it enable them to control of the pit filling process and it will significantly reduce the need to self- empty or pay a manual scavenger.

It will be tested in two forms, the first will discharge to a soak away to safely disposal, but it is recognized that householders could easily by-pass the soak way process in which case the public

health benefits would be lost. The second form will use a micro-membrane to remove the bacteria and suspended material from the effluent and in doing so remove the public health risk from inappropriate discharge.
Currently two types of low cost pump are being tested and both have received positive feedback from potential customers. The plan is to market the pumps through existing rural sanitation cement product manufacturers.

If the initial work on membranes proves successful and a better understanding is gained of their limitations, the Sanihub will work on a membrane filter which can be retrofitted to the outflow of septic tanks and a version which is capable of handling greater volume of effluent for use with the larger septic tanks of apartment blocks.

2) **Improved pit emptying device to remove the need to directly handle shit**
Although manual scavenging is illegal, no simple low cost pump is available to replace the bucket and rope. The Sanihub has developed a low cost pump based on the Gulper and demonstrated this to a group of manual scavengers. They liked the pump and said it was quicker, clean and easier to use than buckets, but the design was too heavy and too expensive. As the pump was designed to remove sludge of over 1000 Pa, and the West Bengal pits are mainly filled with sludge below 250 Pa, it should possible to reduce both the cost and the weight.
After developing an acceptable pump the next step will be to work with the GP and the Block officials support in promoting "manual scavenging free GPs" in the same way the ODF works for CLTS. The current idea is that the manual scavengers would have to agree to registration and a code of practice in exchange for some form of help to purchasing the pump.

3) **Reduce emptying frequencies and improving safety though Tiger Toilets.**
The Tiger Worm based toilet work in Pune has proved to be popular with householders and vermicomposting using worms is practiced within Parnter Partima. The production of vermicompost and the cleaner functioning of the Tiger Toilet may be sufficient for householders to adopt this new design in preference to the traditional pit latrine. The Sanihub will build 10 vermicomposting toilets to gain further consumer and technical insights, after which they could be sold through the cement ring manufacturers. Pune has a low water table and a more permeable soil, which are an advantage with the operation of a Tiger Toilet. The Sanihub will work on a design which allows the worm to survive in the wet season.

4) **Micro-tanker based emptying businesses in Block Headquarters and trading centers**
The FSM analysis for West Bengal shows that the sludge transport and treatment process are most likely to be commercially viable in higher density areas which have started to develop in ribbon sprawl manner. This is type of development seems to be occurring within Block Headquarters and Market towns and therefore one of these is the most likely candidate for the second test bed area. A rapid survey will be undertaken to find the most suitable location.
In the meantime, the assumption is being made that such block headquarter towns will have narrow streets which prevent tanker access and that demand would be insufficient for a dedicated tanker

based emptying business. A micro-tanker, based on the E-Vac, will be developed which is detachable from the pulling unit so as to provide greater flexibility to the service provider.
Once the tanker is developed it will be tested in the second test bed area with, in theory, an existing business from within the area. One of the criteria for test bed selection will be the availability of an existing dumping site on which a test treatment plant can be constructed. This will not be a conventional site as the design will be governed by the nature of the pit / tank contents.

5) **The dream latrine and FSM service**

The FSM valve chain is often viewed as being four separate and unconnected parts. In reality they are all connected and the operation of the collection process has a knock on effect to the transport and the treatment processes. In its simplest form the treatment process can be viewed as way of separating water from the solids and making sure both are safe before returning them to the environment or reuse. A well-functioning septic tank performs the water / solid separation process on-site. One of the largest failures within the West Bengal FSM system, or indeed global FSM system, is that tanks or pit fails to perform this task effectively. This can be for multiple reasons, but the outcome is always the same; too much water in the sludge leading to over frequent pit emptying, environmental contamination, public health risks, and over expensive emptying fees. The normal vacuum tanker style of FSM benefits from emptying watery thin sludge as it is easy to remove and the householders need their services more frequently. This not necessary the most efficient solution

The key to good FSM is the efficient and safe removal of water at each stage of the value chain. The dream latrine and FSM system would therefore comprise of,

- A household pit or septic tank made from plastic water or concrete tank with no leaching of effluent to the groundwater. This would protect the groundwater resource from contamination.
- The water is only removed from the tank via a micro membrane and simple pump. The water could be reused for flushing in water stressed areas. Higher density sludge will accumulate in the pit at a rate which requires less frequent emptying and which makes the latrine cheaper for the household to maintain.
- The removal service is equipped with pumps capable of removing thick sludge with no need to add water to fluidize the sludge. Transporting water is an inefficient use of resources. Some further water removal using centrifuges and membranes may be possible prior to transportation.
- The sludge arriving at the treatment plant would not require dewatering; only drying and would therefore require a simpler process, using less space and be cheaper to construct.
- The most promising method of recovering value from sludge currently seems to be through its conversion to fuel briquettes. The lower the moisture content of the sludge entering the treatment process, the more cost effective this will be.

The longer term goal of the Sanihub is to work towards creating the dream latrine.