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NUSP
NATIONAL URBAN SANITATION POLICY
TOWARDS CITY WIDE SANITATION

Septage Management in Urban India

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wsp
water and sanitation program

Foreword

Census 2011 (provisional) results have indicated that nearly 17 million urban households (more than 20 percent of the total 79 million urban households) suffer from inadequate sanitation. According to the report of the Central Pollution Control Board (2009), the estimated sewage generation from Class - I Cities and Class - II Towns is 38254.82 million liters per day (MLD) out of which only 11787.38 MLD (30%) is being treated and the remaining is disposed into the water bodies without any treatment due to which three-fourths of surface water resources are polluted. The Ministry of Urban Development conducted a rating of class I cities on sanitation related parameters in 2009-10. Out of 423 cities, only four were in the blue category scoring more than 66 points out of 100. No city achieved the distinction of being a green city i.e. a city scoring more than 90 out of 100.

According to the Constitution of India, water supply and sanitation is a State subject and the States are vested with the responsibility for planning, implementation of water supply and sanitation projects including O&M and cost recovery. In recognition of the need for a special focus on sanitation, the National Urban Sanitation Policy (NUSP) was adopted in October 2008 with a focus on elimination of open defecation, integrated city wide sanitation, proper O & M of all sanitary installations etc. The initiatives under the policy include rating of cities, awareness generation and support to cities for preparation of city sanitation plans. The Ministry has adopted service level benchmarks for the water and sanitation sector with a view to shift the focus of urban development projects from infrastructure creation to improvement of service levels. The handbook of service level benchmarks can be accessed at http: // www.urbanindia.nic.in /programme /uwss /slb /slbhandbook. The 13th Finance Commission has made it mandatory for all cities having municipalities and municipal corporations to disclose their performance in terms of these benchmarks annually. The Ministry is committed to mainstreaming these benchmarks through its various schemes.

A major part of Urban India is yet to be provided with sewer system and the people are mainly dependent on conventional individual septic tanks. Census 2011 (provisional) results show 30 million urban households (38 percent of urban households) have septic tanks. USAID (2010) estimates, that by 2017, about 148 million urban people would have septic tanks. Although the number of septic tanks will grow steeply in the next few years, there is no separate policy or regulation for septage management in India at present. The Manual on Sewerage and Sewage Treatment published by the Ministry in 1993 provides guidelines on construction of septic tanks, but it lacks guideline on septage management. This document on septage management in urban India is providing the strategies and guidelines for the national level septage management. I gratefully acknowledge the contribution of Water and Sanitation Program (WSP), Central Public Health and Environmental Engineering Organisation (CPHEEO) and Center for Science and Environment (CSE). This document will prove formidable for all the authorities involved in planning, designing, operation and maintenance of septic management facilities.

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Joint Secretary

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ABBREVIATIONS

Suggest presenting a list of abbreviations and acronyms used

Effluent: the wastewater that flows out of a treatment system (in this case septic tank) or supernatant liquid discharged from the septic tank.

Pit Latrine: latrine with a pit for collection and decomposition of excreta and from which liquid infiltrates into the surrounding soil.

Pour-flush Latrine: Latrine that depends for its operation of small quantities of water, poured from a container by hand, to flush away feces from the point of defecation.

Septic Tank: An underground tank that treats wastewater by a combination of solids settling and anaerobic digestion. The effluents may be discharged into soak pits or small-bore sewers, and the solids have to be pumped out periodically.

Sludge: is the settled solid matter in semi-solid condition – it is usually a mixture of solids and water deposited on the bottom of septic tanks, ponds, etc. The term sewage sludge is generally used to describe residuals from centralized wastewater treatment, while the term septage is used to describe the residuals from septic tanks.

Fecal sludge: Fecal sludge is the solid or settled contents of pit latrines and septic tanks. Fecal sludge differs from sludge produced in municipal wastewater treatment plants. Fecal sludge characteristics can differ widely from household to household, from city to city, and from country to country. The physical, chemical and biological qualities of fecal sludge are influenced by the duration of storage, temperature, intrusion of groundwater or surface water in septic tanks or pits, performance of septic tanks, and tank emptying technology and pattern.

Septage: Fecal sludge produced in septic tanks..

Sullage: Domestic dirty water not containing excreta. Sullage is also called grey water.

Scum: is the extraneous or impure matter like oil, hair, grease and other light material that float at the surface of the liquid, while the digested sludge is stored at the bottom of the septic tank.

Source: Indian Standard: Code of practice for installation of septic tanks (IS:2470 (Part 1) – 1985; Sanitation, Hygiene, and Waste Water Resource Guide, World Bank. http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTWAT/EXTTOPSANHYG/0,,contentMDK:21191474~menuPK:3747921~pagePK:64168445~piPK:64168309~theSitePK:1923181,00.html. Accessed on March 15 2011

SEPTAGE MANAGEMENT IN URBAN INDIA

1.0 BACKGROUND

1. Introduction to National Urban Sanitation Policy and City Sanitation Plans

India's National Urban Sanitation Policy (NUSP, 2008) defines sanitation as "safe management of human excreta, including its safe confinement treatment, disposal and associated hygiene-related practices." The NUSP envisages preparation of State Sanitation Strategies by States, and City Sanitation Plans (CSPs) by cities. The overall goal of the NUSP is "to transform Urban India into community-driven, totally sanitized, healthy and liveable cities and towns." The specific goals include awareness generation and behaviour change; open defecation free cities; and integrated city-wide sanitation Box (1).

The NUSP specifically highlights the importance of safe and hygienic facilities with proper disposal (Section 4.2, cf. Box 1); proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc. Section 4.4, c); and proper Operations and Maintenance (O&M) of all sanitary facilities (Section 4.5). The other aspects of the NUSP emphasize awareness generation, attention to the full-cycle of sanitation from safe collection to safe disposal, comprehensive provision and operations and maintenance management of household level arrangements and treatment systems. Therefore, the NUSP has accorded high importance to plan and implement actions for the organized and safe management of fecal matter from on-site installations that hitherto have received limited attention.

This Advisory supplements the NUSP (and annexes on State Strategies and CSPs) by outlining the contents and steps of developing a **Septage Management Sub-Plan (SMP)** as a part of the City Sanitation Plans (CSP) being prepared and implemented by cities. Septage refers here broadly to not only fecal sludge removed from septic tanks but also that removed from pit latrines and similar on-site toilets. This Advisory provides references to CPHEEO guidelines, BIS standards, and other resources that users of this Advisory may refer for details while preparing their SMP.

Box 1: The National Urban Sanitation Policy (NUSP): Policy Goals

A Awareness Generation and Behaviour Change

4.1 Awareness Generation and Behaviour Change

a. Generating awareness about sanitation and its linkages with public and environmental health amongst communities and institutions;

b. Promoting mechanisms to bring about and sustain behavioural changes aimed at adoption of healthy sanitation practices;

B Open Defecation Free Cities

4.2 Achieving Open Defecation Free Cities:

All urban dwellers will have access to and use safe and hygienic sanitation facilities and arrangements so that no one defecates in the open. In order to achieve this goal, the following activities shall be undertaken:

a. Promoting access to households with safe sanitation facilities (including proper disposal arrangements);
b. Promoting community-planned and managed toilets wherever necessary, for groups of households who have constraints of space, tenure or economic constraints in gaining access to individual facilities;
c. Adequate availability and 100 % upkeep and management of Public Sanitation facilities in all Urban Areas, to rid them of open defecation and environmental hazards;

C Integrated City-Wide Sanitation

4.3 Re-Orienting Institutions and Mainstreaming Sanitation
a. Mainstream thinking, planning and implementing measures related to sanitation in all sectors and departmental domains as a cross-cutting issue, especially in all urban management endeavours;
b. Strengthening national, state, city and local institutions (public, private and community) to accord priority to sanitation provision, including planning, implementation and O&M management;
c. Extending access to proper sanitation facilities for poor communities and other un-served settlements;

4.4 Sanitary and Safe Disposal:

100 % of human excreta and liquid wastes from all sanitation facilities including toilets *must be disposed of safely. In order to achieve this goal, the following activities shall be undertaken*:

a. Promoting proper functioning of network-based sewerage systems and ensuring connections of households to them wherever possible;
b. Promoting recycle and reuse of treated waste water for non potable applications wherever possible will be encouraged.
c. Promoting proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc.);
d. Ensuring that all the human wastes are collected safely confined and disposed of after treatment so as not to cause any hazard to public health or the environment.

4.5 Proper Operation & Maintenance of all Sanitary Installations:

a. Promoting proper usage, regular upkeep and maintenance of household, community and public sanitation facilities;
b. Strengthening ULBs to provide or cause to provide, sustainable sanitation services delivery

Source: National Urban Sanitation Policy, Ministry of Urban Development, Govt. of India, 2008

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2. Why Management of On-site Sanitation needs attention

At least a third of Urban Indian Households depend on on-site sanitation

The National Family Health Survey-3 (NFHS, 2005-06) reported that that 17% urban households in India did not have access to any toilets at home, 24% households were sharing toilets (technologies not specified), about 19% had their toilets connected to sewers, the majority had on-site installations – about 27.6% households had septic tanks and 6.1% had pit latrines that were classified as "improved"[1]. Another 5% toilets were as "Flush/pour flush not to sewer/septic

[1] The UNICEF-WHO Joint Monitoring Program (JMP, 2008, 2010) classifies those toilets that prevent contact with human excreta as "improved". These include facilities that flush or pour-flush to piped sewer system, septic tanks, or pit latrines; or Ventilated improved pit (VIP) latrines, pit latrines with slab or composting toilets. "Unimproved"

tank/pit latrine" – in other words, human excreta from these installations were being let out untreated into land and water bodies without any confinement or treatment. In other words, about 33% households had "improved" on-site systems and a portion of the 5% households that were likely to be on-site unimproved toilets.

The National Sample Survey (65th Round, 2010) estimated that 8% of the urban households were dependant pit latrines, and 29% dependant on toilets flushing septic tanks. Provisional results from Census 2011 indicate that only 32.7 percent of urban households are connected to a piped sewer system, whereas 38.2 percent dispose of their wastes into septic tanks, and about 7 percent into pit latrines, underlining the pre-dominance of on-site arrangements - and it is not clear how the wastes are disposed from this majority of installations. Further, about 50 lakh pit latrines are insanitary (have no slabs or are open pits); 13 lakh are service latrines – of which 9 lakh toilets *dispose faeces directly into drains*, 2 lakh latrines are serviced by humans (illegally), 1.8 lakh latrines serviced by animals. Finally, about 18.6 urban households still do not have access to individual toilets – about 6 percent use a public /community toilets and 12.6 percent are forced the indignity of open defecation. According to a USAID study (2010) by 2017, the number of urban households with households toilets connected to septic tank will increase to 148 million urban households. *Therefore, on-site pit latrines and septic tanks account for a substantial proportion of toilets in urban India – 48 percent of urban Indian households depend on on-site facilities (Census 2011), and this proportion is increasing.*

It may be noted that sewerage systems only partially cover Indian cities – a NIUA (2005) study of 300 Class I and Class II cities noted that …"while all the metropolitan cities have a sewerage system, only a third- of the Class I cities and less than one-fifth of the smaller sized urban centers have a sewerage system. However, the coverage of population by the sewerage system is partial in all these urban centers".

Further, as households without toilets obtain facilities over the next few years, it is likely that many will acquire on-site arrangements like pit latrines and septic tanks in cities and locations where sewerage systems are not available.

Management of septage from on-site facilities appears to be an area of neglect

In contrast with the large proportion of on-site installations, limited attention has been accorded to proper construction, maintenance management and safe disposal of septage from septic tanks and pit latrines. While construction standards have been codified by Indian Standards Organization (ISO), the actual construction was largely left to households to manage – in practice, the installations are subject to local practices and considerable variations are observed. In many instances for example, soak-away outlets are not provided.

Limited capacities and resources with ULBs also resulted in little regulation of maintenance and cleaning of septic tanks and pits – in many cases, households do not report cleaning for a number of years. Some ULBs have de-sludging equipment or there are private players providing cleaning services but the supply of de-sludging services is far from adequate. In many instances, septage is dumped in drains and open areas posing considerable health and environmental risks. Sanitary workers also work in hazardous conditions having to manually clean on-site pits and tanks without

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facilities include defecation in the open, bucket or hanging latrines, open pit latrines or those without a slab, and facilities flushing or pour-flushing to drains or open areas (that is, not to piped sewer system, septic tank or pit latrine). The JMP classifies "shared" toilets as unimproved,

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adequate protective gear and equipment. In fact, in most Indian cities, there is very limited dis-aggregated information on the types and numbers of on-site toilets and septage disposal systems and practices.

The National Rating of 423 Class I Indian Cities (covering 72% of Indian urban population) on Sanitation (MOUD, Govt. of India, May, 2010) found that 65% per cent (274) of these cities had unsatisfactory arrangements for safe collection of human excreta (whether on-site or sewerage).

Urban India has limited Sewage Treatment Facilities and little experience of Septage Treatment Facilities

There are considerable challenges in respect of treatment of sewage - treatment capacities in Indian cities are only 31% of the generation. The 35 million-plus cities have 68% of the total installed wastewater treatment capacity but nearly 39% of these treatment plants did not conform to discharge standards into water bodies (Central Pollution Control Board, 2009). While conventional sewage treatment facilities are limited (that could potentially also treat septage), there is on the other hand, limited experience in India of developing and managing septage treatment facilities of different types.

Therefore, while considerable proportion of urban Indian households depend on on-site sanitation facilities, their construction, regular cleaning, and safe disposal of septage remain haphazard. Most of the septage is let out untreated posing considerable health and environmental risks. Hence, it is crucial that septage management is accorded urgent attention in Indian cities.

The problems associated with on-site sanitation facilities can be summarized as follows:

(1) ***Insufficient knowledge/capacity/awareness and public involvement:*** There is a general lack of awareness of on-site systems and how these should be planned, designed, installed, operated and maintained, especially among system owners and the public at large, among the water and sanitation utilities, who have historically concentrated on centralized sewerage systems, and among the urban local bodies who did not have incentives and capacities to regulate these systems;

(2) ***Inappropriate system design and selection processes:*** Even though national standards have been issued, more often than not, on-systems are not built to these standards, and constructed and installed in ad-hoc manner by untrained personnel. This leads to poor system performance and even failure, higher environmental risks -- in many cases onsite system planning and siting functions are not linked to larger ground water and watershed protection programs and lead to problems such as water quality problems in sub-surface sources, lakes, coastal bays, and estuaries. The practice of constructing septic tanks with outlets connecting to local open drains or channels is widely prevalent in urban India, especially the centres where sewerage systems have not yet come in (and would have carried the soak-away flows from septic tanks).

(3) ***Poor O&M:*** Many septic tank system failures have been linked to poor operation and maintenance. Typical causes of failure include infrequent de-sludging which results in sludge-filled tanks and leakages, clogged absorption fields, and hydraulic overloading caused by increased occupancy and greater water-use following the installation of new water lines to replace wells and cisterns.

(4) ***Poor inspection, monitoring, and program evaluation, and regulatory components:*** The institutional mechanisms for inspection, monitoring, and other regulatory measures are non-existent, or even if present, are not effectively enforced. This has resulted in a situation where there is no information available that in turn leads to inaction and further deterioration of the situation on ground.

These problems result in poor system performance, public health threats, degradation of surface and ground waters, decline in property values, and negative public perceptions of on-site treatment as an effective wastewater management option.

2.0 DEFINITION, SOURCE & CHARACTERISTICS

2.1 Definition

Septage is the semi-liquid material removed from the septic tank and is made of solids that have settled to the bottom of the septic tank, liquid and scum layer. Grit, oil and grease, solids, organics and pathogenic microorganisms are the constituents of septage.

"Septage" is the settled solid matter in semi-solid condition usually a mixture of solids and water settled at the bottom of septic tank. It has an offensive odour, appearance and is high in organics and pathogenic microorganisms.

Scum – oil and grease that floats on the top

Effluent – The partially treated liquid

2.2 Source

Septic tanks are the primary source of septage generation. A septic tank for the treatment of household wastewater is a horizontal continuous flow type sedimentation tank. This functions as a settling tank and digestion unit. The solids in the wastewater settle to the bottom of the tank where they undergo anaerobic degradation along with the organic matter in the wastewater. Studies have shown that only about 30% of the settled solids are anaerobically digested in the septic tank. Hence, there will be a build up of solids in the settling tank, which if not removed frequently will affect the performance of the settling tank. Oil and grease and other lighter material will rise and float on the surface the liquid. This is referred to as scum. The tank is designed that the sludge and scum together occupy about ½ to 2/3rd of the tank's capacity (prior to de-sludging). Studies have established that a liquid retention of time of 24 hours ensures quiescent conditions for effective settling of suspended solids. Considering, the volume required for sludge and scum, septic tanks are designed with liquid holding times of 2 days (CPHEEO).

A septic tank is generally followed by a soak-away pit to disperse the effluent into the ground. The sludge settled at the bottom and the scum at the top of the sewage is allowed to remain in the tank for several months during which they are decomposed by bacteria through anaerobic digestion.

2.3 Characteristics

The quality and quantity of septage coming out of the tank depends largely on the type of sewage, the frequency of de-sludging, water usage and household chemicals going in the septic tank. The physical and biological characteristics of septage are highly variable. The anaerobic nature of septage results in the presence of odorous compounds such as hydrogen sulfide, mercaptans, and other organic compounds. Septage contains constituents that may result in unpleasant odours, risk to public health and serious environmental hazards. Disposal of septage into a water body could result in depletion of oxygen, eutrophication and health hazard on account of the pathogens. Therefore, knowledge of septage characteristics, its variability, dewaterability are important in determining acceptable treatment and disposal methods. The physical and chemical characteristics of septage are summarized in Table 1 (U.S. EPA (1984)).

Table 1 Physical and chemical characteristics of septage

Constituent (all units but for pH are in mg/l)	**Average**	**Range**
Biochemical Oxygen Demand	6,480	440 –78,600
Chemical Oxygen Demand	31,900	1,500– 703,000
Total solids	34,106	1,132-130,745
Total Volatile Solids	23,100	353- 71,402
Total Suspended Solids	12,862	310-93,378
Volatile Suspended Solids	9,027	95 – 51,500
Total Kjeldahal Nitrogen	588	66 – 1,060
Ammonia-Nitrogen	97	3-116
Total Phosphorus	210	20-760
Alkalinity	970	522-4,190
Grease	5,600	208 – 23,368
pH	-	1.5 – 12.6

Table 2 Characteristics of Septage in Tropical Countries*

Parameter	Type "A" high strength	Type "B" low strength
Example	Public toilet or bucket latrine sludge	Septage
Characterization	Highly concentrated, mostly fresh FS; stored for days or weeks only	FS of low concentration; usually stored for several years; more stabilized than Type "A"
COD (mg/L)	20-50,000	<15,000
COD/BOD	5:1 to 10:1	5:1 to 10:1
NH_4-N (mg/L)	2-5,000	<1000
TS (%)	≥ 3.5 %	< 3 %
SS (mg/L)	≥30,000	7000 (approx)
Helminth Eggs(unit/ml)	20-60,000	4000 (approx)

Source: Strauss, 1996

*** Detailed Septage characterization (BOD, SS & other microbial characteristics) as well as its dewatering characteristics (Specific resistance etc.) should be mandatory prior to the design of any septage management facility.**

3.0 PRESENT STATUS & CURRENT PRACTICES

The National Building Code of India (NBC, 2005) has published guidelines for septic tank design, construction, installation, and their operation and maintenance. But in reality, the sizes and designs of septic tank vary from one place to another and are influenced largely by the local construction practices, material and skill of masons.

NBC also states that septic tanks should be regularly maintained and de-sludged as often as every year. "Septic tanks should be cleaned when a large quantity of septage has collected in the bottom of the tank. The interval of cleaning should not normally exceed 12 months." But poor knowledge and lack of maintenance services often results in accumulation of organic sludge which reduces effective volume, lower retention times and affects the system performance. As septic tanks fill with sludge, the effluent begins to resemble septage with dramatically higher pollution values. However, de-sludging of septic tanks is perceived as a burden by many home-owners and hence they postpone cleaning until the tanks start overflowing.

Most on-site sanitation systems (OSS) are emptied manually in absence of suitable facilities and that too, after long periods. Private operators often transport and dispose of septage in drains, waterways, open land, and agricultural fields.

The NUSP underlines the necessity for safe confinement and treatment of human excreta. The municipalities/local government bodies are usually empowered for ensuring the safe handling and disposal of septage generated from on-site sanitary installations. In conformity with CPHEEO guidelines, these also establish local laws or regulations to govern septage handling and to meet all regulatory requirements and standards. While local bodies or utilities may be responsible for regulation over such practices, lack of systems, resources, capacities and incentives often result in neglect and continuance of uncontrolled dumping of septic tank wastes.

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4.0 PUBLIC HEALTH & ENVIRONMENTAL HAZARDS

Septic tank effluent and septage, with appreciable levels of organics, nitrogen and pathogens, disposed without proper treatment are a cause of concern on account of the organic carbon (as measured as BOD_5), nitrogen, phosphorus and pathogens in the effluent. Discharge of wastewater with organic carbon can lead to the decrease of oxygen and endanger the aquatic organisms in the surface waters. Nitrates in the wastewater can contaminate the ground water and if used for drinking water could cause methemoglobinemia and other health problems for pregnant women. Nitrates and phosphorus in the wastewater can also lead to eutrophication of surface waters. Pathogens reaching the ground or surface waters can lead to human diseases through direct consumption, recreational contact or consumption of contaminated shell fish.

The pollutants of concern in the effluent and septage from septic tanks systems and their potential impacts on ground and surface water resources are summarized in Table 2 (Tchobanoglous and Burton, 1991).

Table (2): Pollutants in the Effluent of On-site treatment Systems

Pollutant	Reason for concern
Total suspended solids	In surface waters, suspended solids can settle and form sludge deposits that smother benthic invertebrates and fish eggs and can contribute to benthic enrichment, toxicity and sediment oxygen demand. Colloidal solids can block sunlight, affect aquatic life and lower the ability of aquatic plants to increase the dissolved oxygen in the water.
Biodegradable organics (BOD)	Biological degradation of organics can deplete the dissolved oxygen in surface waters resulting in anoxic conditions, harmful to aquatic life.
Nitrogen	Nitrogen could lead to eutrophication and dissolved oxygen loss in surface waters. High levels of nitrate nitrogen in drinking water can cause methemoglobinemia in infants and pregnancy complications for women. Livestock can also suffer from drinking water high in nitrogen.
Phosphorus	Phosphorus would also lead to eutrophication and reduction of dissolved oxygen in surface waters.
Pathogens	Parasites, bacteria and viruses can cause communicable diseases through body contact, ingestion of contaminated water or shellfish. Transport distances of some pathogens (bacteria and viruses can be quite significant)

Improper disposal of septic tank effluents and septage can pose direct and indirect socio economic impacts too. A study by WSP estimated the economic losses due to inadequate sanitation at Rs 2.44 trillion per year to India (WSP-SA, 2010).

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5.0 ELEMENTS OF SEPTAGE MANAGEMENT

5.1 Septage Generation Rate

Septage generation rates vary widely from place to place depending on practices of septic tank use, number of users, water used for flushing, and the frequency of cleaning the septage. The size of a septic tank in individual houses in India ranges from 1 to 4 cum, whereas the size of a septic tank in office or apartment buildings may vary from 10 up to 100 cum.

Adopting the US EPA (1984) estimate of septage generation of 230 litres/year and an average household size of 4, the septage generation / household would be 920 litres/year. Alternatively assuming an average septic tank volume of 3 m^3 and emptying of septage when one third of the septic tank is filled with settled solids, the volume of septage emptied would be 1 m^3.

5.2 De-sludging of Septic Tanks

In Indian cities, most of the septic tanks are de-sludged manually. This is considered as an unpleasant and repulsive job, precipitates human contact with faecal matter, and since the sludge (including fresh excreta) generally gets spilled around the tank during emptying, this poses a risk of transmission of diseases of fecal origin – in any case, this is tantamount to manual scavenging. The Government of India has enacted the Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993. This Act serves as a primary instrument to eradicate practice of manual scavenging. The definition of manual scavenging as per the Act, 1993 does not specifically cover manual cleaning of septic tanks and sewers cleaning, though as outlined above, this is clearly implied. Therefore, it is essential that such cleaning operations be included in the definition of manual scavenging. Further, it is suggested that cleaning of septic tanks and sewers need to be carried out using mechanical devices that obviates the need for manual scavenging.

Given the safety and health risks of manual desludging, it is critical for cities to take measures to urgently put a stop to this demeaning practice. This must include stringent restrictions on and punitive measures for all private parties offering septage clearance services. Public sector units including local governments, municipalities (and water utility personnel involved in manual cleaning of sewers and septic tanks) should also be brought under strict vigil to prohibit any manual cleaning, and the full adoption of mechanical devices, safety gear for occupational safety, and practices that reduce to the minimum, any risk of physical contact, as well as protect against hazards posed by noxious gases while cleaning septic tanks, pits or sewer systems.

The most satisfactory method of sludge removal is by vacuum tankers. Though de-sludging frequencies vary, it is generally recommended to de-sludge tanks once every two to three years, or when the tank becomes one third full. Periodical de-sludging also helps reduce the pollution levels in the liquid effluent, which normally enters waterways untreated. However, a small amount of sludge should be left in the tank to ensure that a minimum level of the necessary microorganisms responsible for anaerobic digestion remain in the tank. The gas generated due to anaerobic digestion might escape when tank is open for desludging. Hence, it is highly advisable to avoid using fire (or any incendiary material) in these cases. Regular de-sludging activities require well-organized community and public/private service providers. Because of the delicate nature of septic systems housing microbial processes, care should also be taken not to scrub the septic clean or use chemicals such as detergents etc. to avoid the complete destruction of favourable microbes in the tank.

Before de-sludging, if the liquid level in the tank is higher than the outlet pipe, this may indicate clogging in the outlet pipe or in the drain. The sludge then may be collected through safe containers or pumping. Before pumping, the scum mat is manually broken up to facilitate pumping. Prior to this, the liquid level in the septic tank first is lowered below the invert of the outlet, which prevents grease and scum from being washed into the drain. After the scum mat is broken up, the contents of the tank are removed. Normally, the vacuum/suction hose sucks up to a point where 1 to 2 inches (about 2.5 to 5 cm) of sludge remains at the tank bottom to facilitate future decomposition. The sludge after removal should be transported in a controlled manner to avoid leakage or spillage en-route.

5.3 Septic Tank Cleaning Machines and Septage Transportation

The following norms are suggested to work out the requirement of septic tank cleaning machines.

It may be assumed that one vehicle having a capacity of 2,000 litres shall clean 3 to 10 septic tanks per day. This is based on the frequency of cleaning of septic tanks (once in 2 – 3 years) and also the distance from the location of septic tanks to the septage treatment facility. The vehicles are available in different capacities of from 2,000 up to 12,000 litres. It is to be noted that the requirement of machines also varies depending upon the capacity of vehicles, road width etc. In case of bigger cities having sufficient width of roads, vehicles having larger capacities may be adopted. Adequate provision for standby machines for cleaning of septic tanks may also be made.

Septage transportation is one of the most important components of septage management. There is need for evolving a standard method of collection, handling and transportation of septage. Desludging trucks act as a "mobile sewer network" for onsite sanitation systems. They collect the septage at the household level and transport it to treatment or disposal sites, thereby complimenting the functions of underground sewer network.

Small scale vacuum trucks called Vacutug (from 200 up to 2,000 Litres capacity) also are recommended for use in areas inaccessible to large desludging vehicles. The Vacutug is mounted on wheels and can be attached to a small vehicle. It can be manufactured locally to offer flexibility and mobility without losing the capacity to collect a substantial volume of fecal sludge within one operation. In case of hillside area where vehicle access is difficult, new transportation system should be implemented.

It would be desirable to develop standard operating procedures for pumping, and transportation of septage as part of a Manual of Practice for septage. It is best that the Manual of Practice be prepared by the Septage Program Managers by first reviewing the operating procedures for specific equipment and then documenting all aspects of the day-to-day procedures. These procedures should include:

- Scheduling and routing for trucks
- Customer service protocols
- Locating tanks and cleanouts
- Proper pumping equipment operation and worker safety
- Site control, including post-pumping clean-up

- Transportation requirements, including rules of the road
- Disposal procedures at the treatment facility
- Routine service of equipment – greasing and oiling, minor repairs
- Recordkeeping for all tanks pumped and wastes discharged at the disposal facility

A Manual of Practice is an important document since it provides guidance for the equipment operators. Furthermore, it is a valuable a training document for new employees. The Manual can specify set procedures that employees should follow so that their work is done within specified guidelines. The procedures should be recorded in a step-by-step field manual that becomes an addendum to the septage management regulations.

5.4 Treatment of Septage at Sewage Treatment Plants

Co-treatment of septage along with domestic sewage at a sewage treatment plant (STP), if available, is the most desirable option. Though septage is more concentrated in ~~its~~ strength than domestic sewage, its constituents are similar to municipal wastewater. The sewage treatment plants should have adequate capacity to accept the septage without hampering the functioning of the sewage treatment plant. The municipality should monitor the incoming wastewater load to the STP and accept the septage, if the design norms are not violated with the increased load (on account of the septage). are , Figure 1 provides a method to estimate the allowable rates of septage addition, assuming that a holding tank is provided and that septage is added to the sewage flow intermittently. This chart takes into account the current loadings to the plant compared with its design loadings.

If the STPs are working close to the design capacity, additional loads due to disposal of septage will necessitate expansion or up-gradation of the.

The main factors in treating septage in a sewage treatment plant are:

- Septage addition at the nearest sewer manhole- Septage could be added to a sewer upstream of the sewage treatment plant, and substantial dilution of septage occurs prior to it reaching the sewage treatment plant, depending on the volume of sewage flowing in the sewer.

- Septage addition at the STP- Septage could be added to sewage immediately upstream of the screening and grit removal processes.

- Septage addition to sludge digesters/sludge drying beds- Septage could be processed with the sludge processing units of STP.

If septage is to be co-treated with sewage, it will be necessary to construct a septage receiving station. Such a station will consist of an unloading area (sloped to allow gravity draining of septage hauling trucks), a septage storage tank, and one or more grinder pumps. The storage tank is used to store the septage so that it can be discharged to the treatment plant. The septage in storage tank should be properly mixed by mixers, air diffusers for odor control. Discharge of septage at the upstream is preferable for the removal of grit and screenings. If there are no screening facilities ahead of the septage discharge facility, the septage should be transferred from the storage tank to the treatment plant with grinder pumps. In some cases, this transfer can be accomplished by gravity flow. If the septage is strong, it can be diluted with treated sewage. Chemicals such as lime or chlorine can also be added to the septage in the storage tank to neutralize it, to render it more treatable, or to reduce odors.

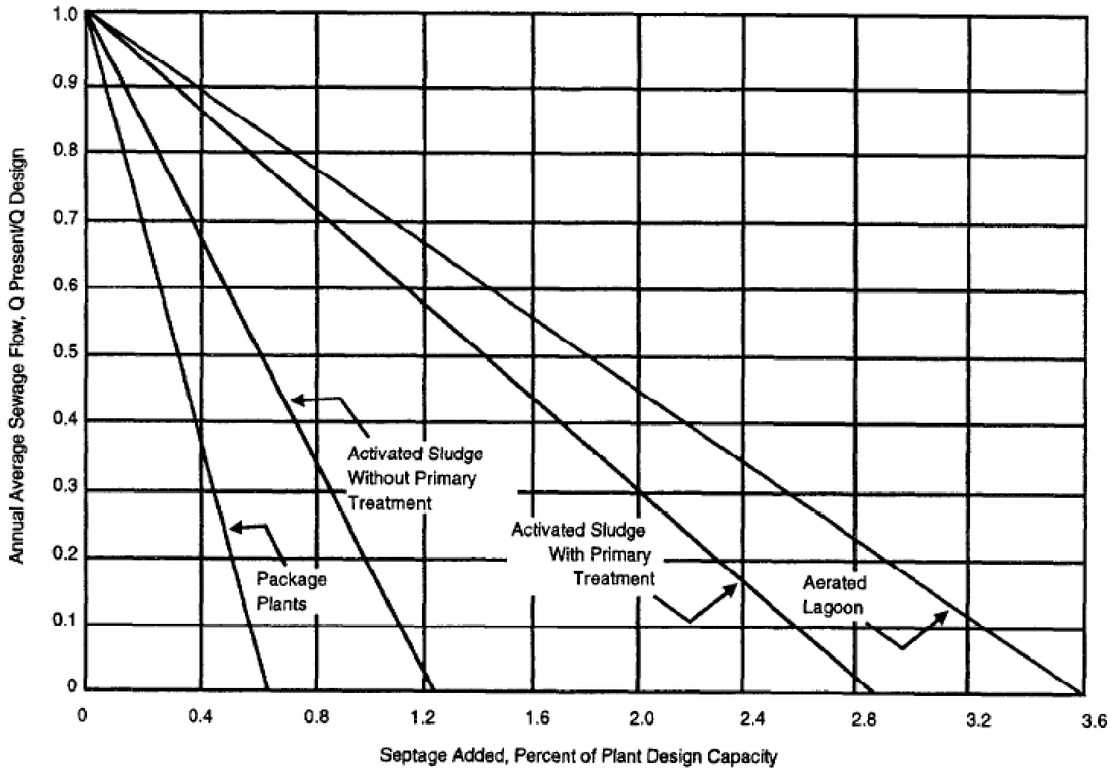

Figure 1: Allowable septage loadings to a sewage treatment plant having septage-holding tank (U.S. EPA, 1984)

The advantages and disadvantages of treating septage at the sewage treatment plant are presented in Table 3;

Table 3 Advantages and disadvantages of septage treatment at sewage treatment plant

Method	Description	Advantages	Disadvantages
Treatment at STPs	Septage is added to the pumping station, upstream manhole or sludge treatment location for co-treatment with sewage sludge. Septage volumes that can be accomodated depends on plant capacity and types of unit processes employed.	Most STPs in India are under utilized and will have the capacity to to handle additional septage. As skilled perosnnel and laboratory facilities are available in STPs, it is easy to operate and maintain.	STP performance may be hampered by addition of septage if the STP is runnig at full capacity. Need to be especially concerned with the increased BOD and NH4-N load. Increased girt and sludge treatment cost (on account of increased volume of septage)

5.5 Treatment at Independent Septage Treatment Plants

5.5.1 General Aspect and Treatment Process

When an STP does not exist for a city, or the distance or the capacity of the available plant becomes a limiting factor, it is not a feasible option to transport and treat the septage at the sewage treatment facilities. Hence, a treatment plant specially meant for septage treatment becomes the option to consider. Independent septage treatment plants are designed specifically for septage treatment and usually have separate unit processes to handle both the liquid and solid portions of septage. These include:

- Lime stabilization – odour control, conditioning and stabilization of the sludge.
- Dewatering – sludge drying beds or mechanical dewatering
- Anaerobic / aerobic wastewater treatment – liquid from the sludge drying beds and mechanical dewatering systems
- Co-composting with organic solid waste.

The choice of mechanical dewatering or sludge-drying beds would be dependant on the land availability, with mechanical dewatering systems being preferred where land is scarce and sludge drying beds being adopted where land availability is not a constraint. The benefit of using these treatment plants is that they could provide a regional solution to septage management. Many septage treatment plants use lime to provide both conditioning and stabilization before the septage is de-watered, and this de-watered sludge can be used as organic fertilizer after drying and composting. Additionally, lime stabilization also helps to reduce / minimize odour. The common practice is to add lime to raise the pH to 12 and hold it for a period of 30 minutes. The filtrate from the dewatering units needs to be further treated through treatment process such as waste stabilization ponds, anaerobic baffled reactor, constructed wetland or aerobic treatment systems before discharging into the environment.

However, the choice of an appropriate septage management system is dependent on land availability, hauling distance, technical requirements, availability of skilled labour, legal and regulatory requirements. The management option selected should be in conformity with local, state, and central regulations.

The following table summarizes the septage treatment options for two conditions, namely, when space is a constraint and otherwise:

	Unit operations			
	Space not a constraint			
	Conditioning and stabilization	Lime treatment	2.4 – 3.0 kg/1000 l of septage	
	Dewatering	Sludge drying beds	0.09 – 0.23 m^2/capita	2000/m^2
	Wastewater treatment (Filtrate / liquid from dewatering units)	Any one of the options below could be adopted		
		Anaerobic baffled reactor	2- 3 m2/m3 of septage	35000 – 70000 m3/septage

		Aerobic / stabilization ponds	Storage volume 2 – 3 years	
		Constructed wetland	5 – 10 m2/m3 of septage	
	Space is a constraint – dewatering with mechanical dewatering system and liquid waste from dewatering units in an anaerobic baffled reactor. The other unit operations are the same.			
	Dewatering	Mechanical dewatering		

Cities will need to ascertain availability of land and land costs along with preparing preliminary estimates for options for the above technical options. These preliminary estimates will be utilized at the time of conducting feasibility analysis (see Section 10 below).

5.5.2 Pretreatment of Septage

Pretreatment/stabilization includes physical and or chemical treatment to decreases odours and ease in handling for further treatment.

Pretreatment requires (Figure 2)

- **Septage Storage Tank:** To store and homogenize the collected sepatge.
- **Pumps:** To pump the septage from storage tank to the screens.
- **Mechanical/manual screens**: To remove large size particles, such plastic, rag from the sepatge and protect downstream treatment facilities.
- **Grit channels or aerated grit chambers:** To remove coarse sand and cinder from the septage to prevent abrasion of downstream mechanical equipments, such as pumps, etc. Aerated grit chambers can also help in reducing odor emissions from the septage.
- **Odor control System (optional):** To eliminate or reduce odour through treatment either in biological or carbon adsorption system.

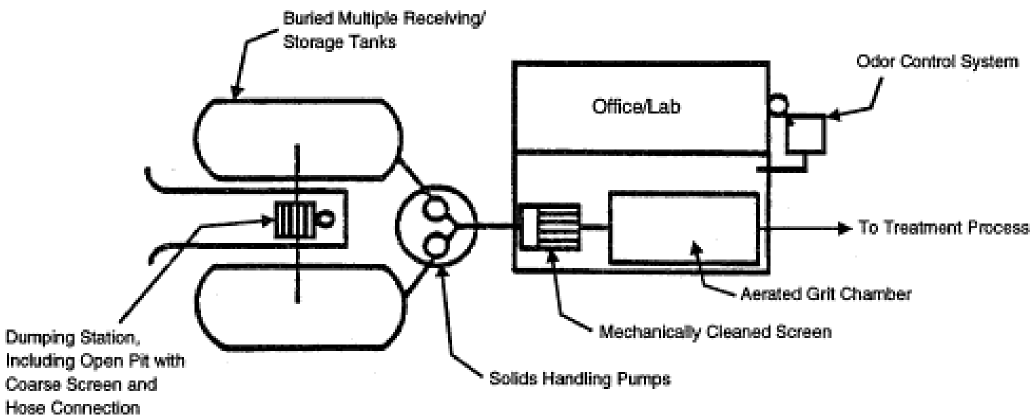

Figure 2: Pretreatment of Septage

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In addition, lime stabilization is also practised to stabilize, control odor, vector and pathogen destruction. Lime stabilization involves adding and thoroughly mixing lime (alkali) with each load of septage to ensure that the pH is raised to at least 12.

Lime addition could be done at any of these three points:

i) In the hauler truck before or while the septage is pumped,

ii) In a septage storage tank where septage is discharged from the hauler truck (Figure 3).

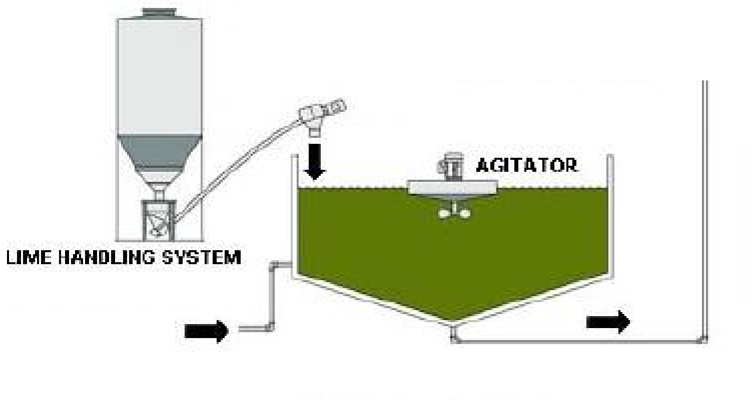

Figure 3 - Lime Stabilization of Septage

5.5.3 Septage Dewatering

The septage after lime dosing is pumped to screw press or any other mechanical dewatering machine (Figure 4). Polyelectrolyte is added to improve the dewatering efficiency. The liquid residual/ /filtrate from dewatering machine needs to be further treated before disposal. The dewatered sludge needs to be dried or composted prior to reuse as soil conditioner / organic fertilizer.

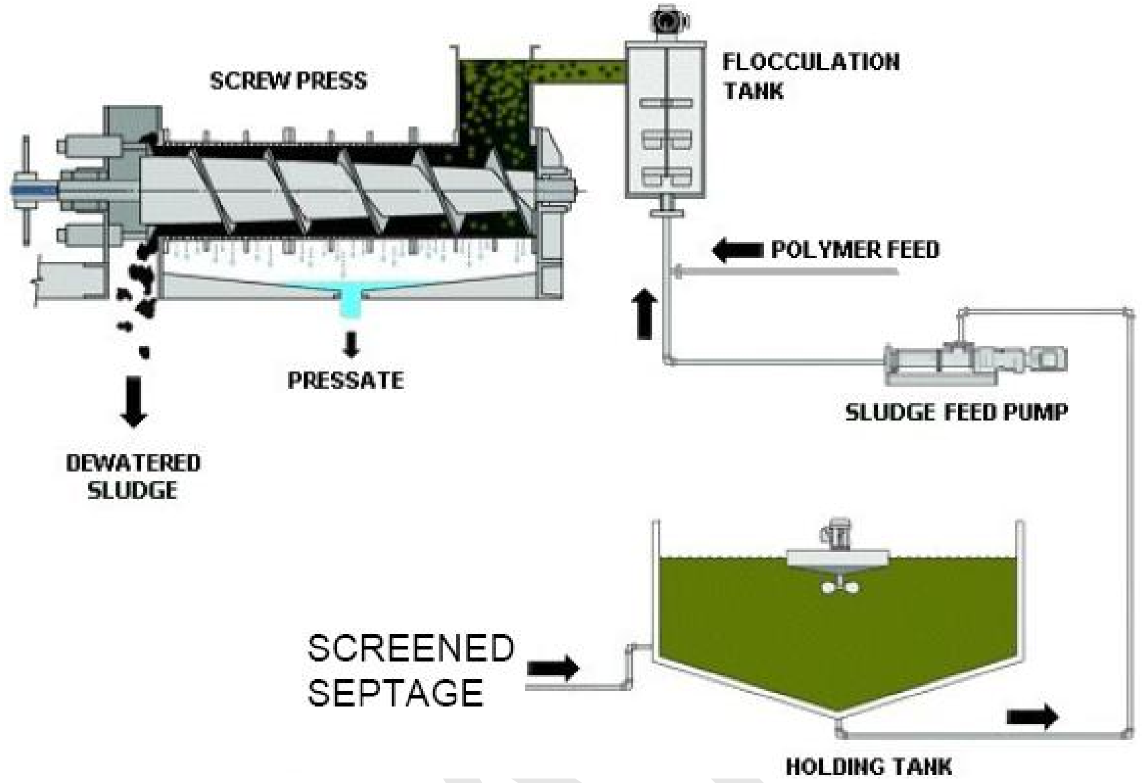

Figure 4. Typical Mechanical Septage Dewatering System

Instead of Screw Press the other options can be:

1. Centrifuge
2. Belt Press
3. Filter Press

Many companies are manufacturing sludge dewatering machines.

The advantages and disadvantages at independent septage treatment plant can be summarized in Table 4.

Table 4. Advantages and disadvantages of independent septage treatment facility

Method	Description	Advantages	Disadvantages
Treatment at independent septage treatment plants	A facility is constructed solely for the treatment of septage. Treatment generates residuals, i.e., de-watered sludge which must be dried and composted (de-watered sludge)	Provides regional solutions to sepatge management. Also makes available organic fertilizer.	High capital and operation and maintenance cost (compared to co-treatment at a sewage treatment plant). Requires high skilled manpower for the operation of of mechanical de-

	and filtrate which must be properly treated (filtrate) prior to being disposed off.		watering machines.

5.6 Composting of Dewatered Septage or Sludge

Another feasible option is composting where bulking agents are easily available. The humus is produced after composting which can be used as a soil conditioner.

Composting is another popular method of treating septage. Compost is defined as “the stabilization of organic material through the process of aerobic, thermophilic decomposition.” During the composting process organic material undergoes biological degradation to a stable end product. Approximately 20 percent to 30 percent of the organic solids are converted to carbon dioxide and water. As the organic material in the septage decomposes, the compost heats to temperatures in the range of 50 to 70 degrees Centigrade and harmful pathogens are destroyed. The resulting humus-like material is suitable as a soil conditioner and source of nitrogen and phosphorus. Septage can be composted directly. The basic procedure for composting is as follows:

1. Septage is mixed with a bulking agent (e.g. wood chips, sawdust) to decrease moisture content of the mixture, increase porosity, and assure aerobic conditions during composting.
2. The mixture is aerated either by the addition of air (“aerated static pile”) or by mechanical turning (“agitated”) for about 28 days.

The most common “agitated” method is windrow composting: the mixture of septage or wastewater solids and bulking agent is pushed into long parallel rows called “windrows”, about 1 to 2 meters high and about 2 to 4.5 meters at the base. The cross-section is either trapezoidal or triangular. Several times a week the mixture is turned over. Although specialized equipment has been developed for windrow composting, it is possible to use a front-end loader to move, push, stack, and turn the mixture. Factors affecting the composting process (US EPA 1984) include moisture content (40 percent to 60 percent); oxygen (5 percent to 15 percent); temperature (must reach 55 to 65 ^{o}C); pH (6 to 9); and carbon-to-nitrogen ratio (30 to 1) and are detailed in the Table 5 below:

Table 5 Operational parameters for de-watered septage composting *

Parameter	Optimum range	Control mechanisms
Moisture content of compost mixture	40-60%	Dewatering of septage to 10 to 20% solids followed by addition of bulking material (amendments such as sawdust and woodchips), 3:1 by volume amendment: dewatered septage.
Oxygen	5-15%	Periodic turning (windrow), forced aeration (static pile), mechanical agitation with compressed air (mechanical).
Temperature (compost must reach)	55-65 ^{o}C	Natural result of biological activity in piles. Too much aeration will reduce temperature.
pH	5-8	Septage is generally within this pH range, adjustments not normally necessary.
Carbon/nitrogen ratio	20:1 to 30:1	Addition of bulking material.

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For effective operations there should be sufficient laboratory equipment to monitor these parameters during the compost process. Moisture can be added and turning can be increased based on monitoring results. The operator should measure temperature at least once per day by placing a thermometer into the mixture at various locations. Maintaining temperature of 50 to 60 ^{o}C for the compost period assures destruction of pathogens. Co-composting septage or wastewater solids with the organic fraction of municipal solid waste (MSW) is possible. The organic fraction includes food wastes, paper, and yard-wastes (e.g. leaves, branches, shrubbery, etc. cut or removed during landscaping). The MSW serves as the bulking agent.

Compost from septage or wastewater solids can be used as a soil amendment to reclaim land or used in landscaping or horticulture. Agricultural use or use that may include human contact (e.g. at parks or playgrounds) requires detailed laboratory analysis to confirm concentrations of pathogens and heavy metals are within safe limits. In order to produce treated septage of suitable quality for soil amendments, limiting septage collection to residential housing is required.

6.0 DE-WATERED SEPTAGE SLUDGE REUSE

For dewatered septage/sludge use as fertilizer in agriculture application, it should satisfy the following criteria of Class A Bio-solids of US EPA:

- A fecal coliform density of less than 1000 MPN/g total dry solids

Salmonella sp. Density of less than 3 MPN per 4 g of total dry solids WHO (2006) suggests Helminth egg concentration of < 1/g total solids and E coli of 1000/g total solids in treated septage for use in agriculture.

MSW rules (2000) has recommended the following quality for compost:

Parameter	Concentration not to exceed (mg/kg dry basis, except for pH and carbon to nitrogen ratio)
Arsenic	10
Cadmium	5
Chromium	50
Copper	300
Lead	100
Mercury	0.15
Nickel	50
Zinc	1000
C/N ratio	20 - 40
pH	5.5 – 8.5

In the absence of any standards, it is recommended that these be adopted until such time standards are notified by the Central Pollution Control Board.

Properly treated sludge can be reused to reclaim parched land by application as soil conditioner, and / or as a fertilizer in agriculture. Deteriorated land areas, which cannot support the plant vegetation due to lack of nutrients, soil organic matter, low pH and low water holding capacity, can be reclaimed and improved by the application of treated septage. Septage sludge, as a result of lime stabilization has pH buffering capacity that is beneficial for the reclamation of acidic soils. Treated septage with a solid content of 30 percent or more are handled with conventional front-

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end-loading equipment, and applied with agricultural manure spreaders. Liquid sludge, typically with solid content less than 6 percent are managed and handled by normal hydraulic equipment. Treated septage contains nutrients in considerable amounts, which supports the growth of a number of plants.

7.0 REGULATION AND MONITORING BY ULB/CITY UTILITIES

The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act, 1974 also apply to households and cities in regard to disposing wastes into the environment. ULBs/Utilities also have to comply with discharge norms for effluent released from sewage treatment plants and to pay water cess under the Water Cess Act, 1977. The ULB is responsible for ensuring the safe handling and disposal of septage generated within its boundaries, for complying with the Water Act, 1974 for meeting all state permit requirements and regulations (CSE, 2010).

There are no specific legal provisions relating to urban sanitation or septage management, but there are a number of provisions relating to sanitation services and environmental regulations, following from the above Acts. Municipal Acts and Regulations usually refer to management of solid and liquid wastes but may not provide detailed rules for septage management. Therefore, it is recommended that ULBs formulate their own bye-laws and rules for management of septage in the city – this could be taken up as a State-level activity in consonance with the Municipal Act in place.

The State and appropriate development authorities would need to review the building regulations to ensure proper construction of adequate on-site facilities for loads projected to be generated, and for ensuring safe disposal. These will need to be disseminated to the construction industry and households through periodically scheduled interactions like workshops. Sites selected for sludge application by the ULB and by other parties (like residential layouts) would need prior consent to operate from the competent authority (like the PCB).

The Rules should address:

- Design of Septic tanks, pits etc. (adapted to local conditions) and methods of approval of building plans, or retro-fitting existing installations to comply with rules
- Special provisions for new real estate developments
- Periodicity of de-sludging, and O&M of installations
- Operating procedures for de-sludging including safety procedures
- Licensing and reporting
- Methods and locations of transport, treatment and disposal
- Tariffs or cess/tax etc. for septage management in the city especially disposal
- Penalty clauses for untreated discharge: for households as well as de-sludging agents

The septage management program for the cities should provide for issuing licenses to private operators providing de-sludging services. All public and private sector staff should adhere to safety norms as provided in the Manual on Sewerage and Sewage Treatment published by the Ministry of Urban Development and such other safeguards that the ULB may provide under its own rules. For disposal of septage, the ULB will need to follow the standards set out in the Environment (Protection) Act, 1986, depending on the mode of disposal.

Inspection of onsite system and pumping of septic tanks: should be carried out by the ULB/Uility. Following the design norms adapted to local conditions that are notified under the Septage Management Rules, the ULB should carry out regular inspection of properties with on-site systems.

Baseline Data Collection: For any serious Septage Management Plan to be effective, robust data on septage arrangements, volumes and locations are required. The ULBs would need to make arrangements to collect baseline data – type of latrine disposal, effluent disposal arrangement, size, age, when it was last cleaned, availability of access, arrangement for disposal of effluent if any) of existing installations, to plan for workable desludging schedules. It is advisable to divide the city into working zones and carry out this baseline activity in one or a few of these zones, pilot desludging schedules by area to learn operational issues and devise solutions, before scaling up to the whole ULB area. The selection of zone could be based on availability of septage disposal sites – existing STPs could be potential septage disposal/application sites or trenches provided in solid waste landfill sites or suitable urban forestry sites where the septage trenches would serve to fertilise the plants. It is felt suitable that households in demarcated septage management zone should be within a 30 km. travel distance from identified disposal sites, for workability.

The ULB will need to coordinate with existing service providers (if any) and ensure that collection, transport and disposal of septage, is carried out in a manner safe to households, environment and public health. It would be advisable for the ULBs to set up a one-time registration mechanism for service providers with nominal fee. This would also build up a database of available facilities within designated service areas. Periodic interactions with the service providers would aid in improving the septage management process over time.

Recordkeeping and Manifests

Keeping accurate records regarding tanks and volume pumped is important for billing and compliance. Recordkeeping and manifest forms are an integral part of a comprehensive septage management program. Recordkeeping requirements should be codified into the law governing the program. Manifest forms are simple receipts that specify:

- the location or address of the pumped septic tank
- septage characteristics (residential or commercial)
- the name and address of the property owner or occupier
- the volume of septage pumped
- any notes regarding tank deficiencies, missing pipes or fittings, improper manholes or access ports, any other cracks or damage observed

Once completed, a copy of the manifest is given to the owner as a receipt. When the load is delivered to the disposal site, the disposal site operator:

- accepts the load
- verifies the volume
- takes a sample if needed
- signs the manifest proving receipt of the volume of septage disposed of

It may be advantageous for the operator to pump out multiple tanks before going to the disposal site. In this case, a multiple-load manifest form should be completed as well as individual manifest/receipt forms. The completed document or documents should be given to the local government for their records. The manifest system is a tracking and compliance tool. It helps ensure that all of the septage pumped arrives at the disposal site and minimizes the opportunity for illegal discharge. It is also a record that some septage programs may choose to use for paying septage hauling subcontractors. For example, Manila Water Company pays its hauling contractors based on the cubic meters of septage delivered to the disposal site as recorded on the manifest. This system accomplishes two main goals. First, it provides an incentive for haulers to make proper disposal at the treatment facility. Second, it provides an incentive for the pumper to pump as much volume out of the septic tank as possible. This is important since simply removing the liquid fraction of the septic tank doesn't remove the sludge, which is the fundamental goal of the pumping service.

8.0 FINANCIAL MANAGEMENT

8.1 General Aspect and Public Private Partnership

Right from the planning stage, it is necessary to draw up a long term financing and investment plan for septage management for the city. While public funding (national, state and ULB level) will be needed to finance septage management systems, facilities, equipment and manpower, it will be beneficial to consider options for public private partnerships (PPP) wherever possible. As in many cities in India, as well as in other countries, services for emptying the septic tanks and their transport, involves private sector parties. Similarly, private parties may also be invited to operate and maintain the septage management facilities (as being done for STPS). However, the success of these options will be dependant on the formulation and implementation of a suitable user-fee system. A cleaning charge (payable directly by the household to the septic-tank cleaning service provider) may also be supplemented with appropriate taxes and fees the citizens pay directly or indirectly for the part/full financing of the O&M of the septage management/treatment facility (as is done in the case of STPs).

The Key issues are:

1) Policy and legal framework for financing and involvement of private sector
2) Target setting for revenue generation
3) Tariff structure design,
4) Role of government and other stakeholders
5) Contractual arrangements for PPP projects,
6) Monitoring, evaluation and accountability for services provision and environmental and economic regulation

Suggest thorough review of table above. Aim and contents are confusing.

8.2 Costs and Cost Recovery

Neither local authorities nor water supply authorities in India have adequate capital or are able to leverage finances for expensive sewer networks or sewage/septage collection and treatment facilities. Thus, major sanitation improvements are dependent on a mix of government's budgetary funding, loan assistance and user charges. Thus, the design of septage management projects need to accord high importance to financial considerations. Obtaining funds and enacting necessary tariff changes (e.g., linking revenues with expenditures) requires careful negotiation and cooperation between local stakeholders, especially when elected officials are sensitive to popular concerns regarding tariffs. Exploring financing options from several sources can help lower the financial contribution of the ULB for the project and revenue generation from the sale of end products could partially or fully meet the operation and maintenance costs.

Operation and maintenance (O&M) expenses for septage management programs typically include the following:

a. Labour
b. Overheads (e.g., benefits, employment taxes)
c. Utilities for septage treatment
d. Transportation of septage and for processed septage
e. Vehicles and other equipment maintenance
f. Taxes
g. Disposal costs for dried cake
h. Licenses and permits; insurance
i. Testing and other monitoring
j. Miscellaneous supplies

8.3 Revenue Generation Plan Issues?

1. Political approval and effective administration of sanitation-related taxes and charges have proven to be difficult for local governments and utilties to implement. However, many cities in the country are increasingly realizing the importance of septage management and trying to introduce taxes to recover at least part of the cost, as a part of the water bill, as is done in many locations for sewerage taxes and user charges.

2. The disadvantages are that the water service provider (in some cases, a utility not responsible for septage management) is not always able or willing to collect sanitation charges, and, while there are strong synergies in financial management, sanitation services require different skills and resources to those needed for water supply.

3. Government funding is also essential, notably for city level infrastructure like for treatment, as well as for the provision of sanitation services to the urban poor, who remain excluded from public sewerage and on-site sanitation services.

4. Some cities charge a flat rate (or zero) tariffs, collect revenues lower than their O&M costs and, are dependent on subsidies from the ULBs or, where managed by a water utility, on cross-subsidies from water supply income.

5. Wherever, septage is disposed in a sewage treatment facility for co-treatment with domestic wastewater, a tipping fee needs to be collected for the septage disposed and treated at the sewage treatment facility. The tipping fee can be calculated as a proportion (hydraulic and organic load) of the septage discharged to the wastewater treated at the plant.

6. In most cities, desludging is done only when requested by households and usually when the septic tank overflows. Costs are paid by the household directly to a private desludging company. To implement a citywide septage management program, there is a need for the ULB and/or water supply authority to maintain a Master database of on-site sanitary installations, and a system to update it for scheduling and reporting de-sludging of septic tanks, etc. Each ULB needs to develop a system that works for them. The ULB/water supply authority could collect fees from the households and pay the contractor for each truck-full of septage brought to the treatment facility. This would give the contractor an incentive not to simply dump the septage indiscriminately in non-designated places, as is currently being done. This can be a source of revenue generation.
7. In case septage is collected, transported, treated and disposed in a sewage treatment facility, the treated sewageand sludge shall comply with relevant Minimal National Standards (MINAS) notified under Environment (Protection) Act, 1986.

8. Reuse of treated sludge for agriculture application should comply with the standards notified for compost under US EPA /WHO guidelines and MSW Rules – are these being adopted for India?

9.0 OPERATION & MAINTENANCE

9.1 General Aspects

Inspection of onsite systems and pumping of septic tanks should be carried out by the ULB/Utility personnel or authorized competent agencies contracted by the ULB/Utility. Following the design norms adapted to local conditions, the ULB should carry out regular inspection of properties with on-site systems. This must be combined with establishment and later updation of the Master city database of on-site sanitation installations.

The ULB will need to coordinate with existing service providers (if any) and ensure that collection, transport and disposal of septage is carried out in a manner safe to households, environment and public health. It would be advisable for the ULBs to set up a one-time licensing or registration mechanism for service providers with an annual license fee. This would also build up a database of available facilities within designated service areas. Periodic interactions with the service providers would help in improving the septage management process over time.

As described in earlier sections, appropriate record-keeping systems and reporting procedures will need to be set up for the ULBs to establish the master database, prepare de-sludging schedules and update on completion, through integration to the property tax database.

9.2 Personnel, training and capacity building

Under the NUSP, 2008, a separate Sanitation Cell has been recommended as a part of the City Sanitation Plan (CSP) planning and implementation. It is recommended that this Cell should have

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the full responsibility for septage management in the city. Apart from deploying full-time personnel, there will be need for their capacity building and training.

9.3 Communication and Community Participation

The NUSP overview of the sanitation situation in urban India has pointed out the low priority accorded to sanitation and the lack of awareness about its linkages with public health. The fact that significant proportion of urban households is currently not connected to sewerage network highlights the importance of on-site sanitation arrangements at household level. Likewise, the uncontrolled nature of construction and septage disposal practices enjoins the need for making them aware of safe management practices, citizen's civic responsibilities and the duties of civic bodies (and facilities offered by them). In the wake of decentralized system management needs, it is necessary to adopt differentiated communication system (in terms of messages and channels) to target different stakeholders like the municipal agencies, other frontline government agencies and most importantly, the people of the city. There is a need to focus not just on awareness building, but on inculcating behavior change amongst the various constituents of civic society.

The socio-cultural biases against sanitation and sanitary work need to be targeted, and dignity and humane approach promoted with an emphasis for priority to sanitation in public affairs. The visible lukewarm attention to occupational hazards faced by sanitary workers in the cities needs immediate attention, because of the public and personal health implications and the right to dignity enshrined in our constitution.

In preparing and implementing City Sanitation Plans (CSP), the cities will need to bear in mind the need and advantages (in a data-sparse environment and variation of sanitation arrangements) of a participatory approach, to ensure speedy and informed planning and implementation. Further, the public-good nature of urban sanitation necessitating collective action needs to be highlighted in the minds of all stakeholders. The public health implications of insanitary disposal and faulty sanitation arrangements make it all the more crucial that a participative and transparent approach with multiple streams of communication to identified stakeholders, form one of the pillars of the CSP strategy.

Awareness needs to be created amongst the authorities, households, communities and institutions which are part of the city fabric, about sanitation and its linkages with public and environmental health. CSP implementation strategies and the communication component of this should also seek to promote mechanisms to bring about and sustain behavioral changes aimed at adoption of healthy sanitation practices.

Communication would need to make use of popular and cost-effective channels (hand bills, notices, announcements in radio/TV, part of water bill, etc.) and messaging would need to be oriented to different stakeholders – households, institutions, government agencies, etc.

10.0 PLANNING AND IMPLEMENTATION OF SEPTAGE MANAGEMENT SCHEMES

For effective Septage Management Plan, robust data on septage arrangements, their quantity and locations of its generation etc. are required. The ULBs would need to make arrangements to collect baseline data – type of latrine disposal, effluent disposal arrangement, size, age, when it was last cleaned, availability of access, arrangement for disposal of effluent if any) of existing installations, to plan for workable desludging schedules. It is advisable to divide the city into different sanitary zones (if not already done) and carry out the baseline survey in one or a few of these zones, pilot desludging schedules by area to learn operational issues and devise solutions, before upscaling to the entire ULB. The selection of zone could be based on availability of septage disposal sites – existing STPs could be potential septage disposal/application sites or trenches provided in solid waste landfill sites or suitable urban forestry sites where the septage trenches would serve to fertilize the plants. In order to be economical and financially competitive, it is suggested that households in demarcated septage management zone should be within 20 to 30 km travel distance from identified treatment and disposal sites.

The steps in planning and implementation can be summarized as follows; while guidelines for selection of septage management disposal system can be summarized in the Table 8.

a) Collect data on the households and other properties with on-site arrangements in the city.
b) List out the municipal, private and other septic tank/pit cleaning services active in the city.
c) Identify catchment-wise land for septage treatment facility: use existing STP where available; or acquire land if not available for construction of septage treatment facility.
d) Formulate draft regulations for septage management
e) Choose technology for septage treatment: prepare design of Septage Treatment and Disposal Facility (STDF) along with operation and maintenance costs
f) Conduct Techno-economic feasibility of the STDF
g) Implement construction of septage management and Disposal facility
h) Purchase vehicles and vacuum trucks etc.
i) Launch awareness campaign
j) Initiate Training and capacity building
k) Provide cleaning services incrementally in areas completing surveys of tanks and pits

Table 8 Guidelines for the selection of septage disposal system

A two step process will be followed:

i) To determine the appropriate treatment option on the basis of size of town, land availability, proximity / availability of sewage treatment plants and proximity to residential areas; and
ii) To conduct a techno-economical feasibility to choose the most appropriate technology on the basis of capital, operation and maintenance costs.

Town/Category	Conditions	Recommended Technologies	Capital Cost	O&M Cost	Management
Unsewered Class-III, IV and V towns and rural	Remote land area avoidable with suitable site	Sludge drying beds and waste stabilization pond	Low	Low. User fees to recover O&M	Municipality or private (if implemented by private sector through a

Town/Category	Conditions	Recommended Technologies	Capital Cost	O&M Cost	Management
communities	and soil condition			costs.	management contract)
	Land available but close to neighbor	Lime stabilization, Sludge drying beds and waste stabilization pond	Low to medium	Low to medium. User fees to recover O&M costs.	Municipality or private(if implemented by private sector through a management contract)
	Inadequate land area with unsuitable site and soil condition, but available STP capacity within 20-30 km distance.	Disposal at STP	Low to medium	Low to medium. User fees to recover O&M costs.	Municipality
Partially sewered Medium size (class-II towns)	Land area available with suitable site and soil condition but close to settlements	Lime stabilization, Sludge drying beds and waste stabilization pond	Low to medium	Low to medium. User fees to recover O&M costs.	Municipality or private (if implemented by private sector through a management contract)
	Inadequate land area, but available STP capacity	Disposal at STP	Medium	Medium. User fees to recover O&M costs.	Municipality or private (if implemented by private sector through a management

Town/Category	Conditions	Recommended Technologies	Capital Cost	O&M Cost	Management
					contract)
	Inadequate land area; no available STP capacity	Disposal at independent mechanical treatment facility	High	High. User fees to recover O&M costs.	Municipality or private (if implemented by private sector through a management contract)
Class-I and Metro-cities	Available STP capacity	Disposal at STP	Medium	Medium. User fees to recover O&M costs.	Municipality or private (if implemented by private sector through a management contract)
	No available STP capacity	Disposal at independent mechanical treatment facility	High	High. User fees to recover O&M costs.	Municipality or private (if implemented by private sector through a management contract)

APPENDIX A:

DESIGN OF INDEPENDENT SLUDGE DRYING BED TYPE SEPTAGE TREATMENT FACILITY

Under the full-fledged on-site sanitation approach, no separate sewage treatment facility will be necessary as all sewage will be disposed on-site. Only the septage (septic tank sludge) will have to be safely removed for further treatment and disposal. The design of a septage treatment facility is described below with an illustration from the City Sanitation Plan for Hoshangabad, a town in Madhya Pradesh (WSP, 2010).

The septage cleaning frequency is assumed to be once in 2 years and volume decanted per cleaning is considered to be about 2 cubic meters (Cum). Further it is assumed that each vehicle (smaller capacity 2000 litres) will clear 3 tanks per day and the vehicle will operate for 300 days per year [2] (Table A.1) and assuming that the septage treatment facility is very close to the city.

Table A.1: Basic Norms, Specifications and Assumptions

No.	Component	Norm Unit
A	**Household sanitation infrastructure**	
1	Latrine connected to septic tank	1 per household
2	Grit and grease trap	1 per household
B	**Septage** cleaning**, Treatment and Disposal**	
1	No. of septic tanks cleared per vehicle per day	3 tanks per day per vehicle
2	Frequency of septage cleaning from septic tank	Once in 2 years
3	Septage volume removed per tank	2 m^3
4	No of operational days per annum	300 days
	Sludge Drying Beds	
5	Area of drying bed (average)	225 m^2
6	Dimensions of drying bed	15m x 15 m
8	Thickness of liquid sludge layer in drying bed	0.20 m
9	Septage Sludge Drying Cycle	10 days
10	Sludge volume per bed	45 m^3

In order to provide uninterrupted service to nearly 20,000 households that will be using septic tanks, about 11 trucks will be required, which would have to be operated for about 300 days every year to service all the households. These computations are provided in Table A.2.

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Table (A.2) Computations: Septic Tanks cleared, septage volume and sludge drying beds	
Septage clearance vehicles	• A total of 11 (***eleven***) septage clearance vehicles will be needed. The ULB currently has one septage clearance vehicle • To efficiently manage septage clearance, 10 (***ten***) additional vehicles will have to be purchased • Out of this, 9 (**nine**) vehicles will be purchased in year-1, whereas 10th (**tenth**) vehicle can be purchased in year-4.
Tanks cleared per year	• No. of septic tanks cleared per year = 11 trucks x 3 tanks x 300 days • No. of septic tanks cleared per year = 9900
Daily septage volume	• Daily septage volume = 11 trucks x 3 tanks x 2 cum/day • Daily septage volume = 66 m^3
Septage drying bed	• Single Drying bed area = 12 x 12 m • Single Drying bed area = 120 m^2 • Max. Septage depth = 0.30 m = 30 cm = 300 mm • Capacity per bed = 36 m^3 • Daily requirement of beds (Nos) = 66 m^3/36 m^3 • Daily requirement of beds (Nos) = 2 • Considering a drying cycle of 10 days, a total of 20 drying beds are suggested
Indicative Site Area	• Total Site Area = SD bed area + 10 % SD bed area + Area for office and dried storage + area for ancillary units. • Total Site Area = (2,880 + 288 + 5,000 + 2,250) m^2 • Total Site Area = 10,418 m^2

The septage is proposed to be converted to sun-dried sludge cakes by dewatering on sand filter beds. Land requirement of about 10,500 m^2 (1.05 Hectare) has been estimated. Over most of the year, the septage drying time is expected to be about 7 days; however, an average of 10 days are considered to accommodate longer drying periods during the rainy season. A total of 20 drying beds are proposed, considering the longer drying time in the wet season. The sludge drying beds could possibly be located near the Solid Waste processing site.

Treatment of Filtrate:

For 66 m^3/day septage, it is assumed that 80 % of water is percolated through sludge drying within 1-2 days of application. Hence, filtrate generated = 0.8 x 66 = 52.8 m^3/day or 53 m^3/day. For more than 95 % solid capture, the TSS in filtrate would be 1000 mg/L (Assuming raw septage TSS 2% or 20,000 mg/L). The corresponding BOD can be assumed as 1000 mg/L. The system can be designed based on the CPHEEO manual on Sewerage & Sewage Treatment.

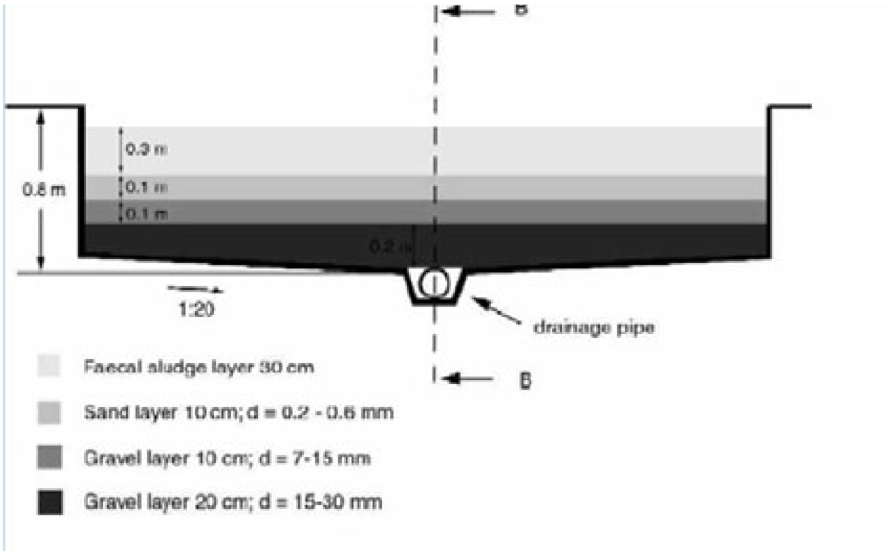

Figure A1: Typical Sludge Drying beds

Note:The layer thickness should be refferd to as per BIS 849 (Requirement for water filtration equipment)

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APPENDIX B:

DESIGN OF INDEPENDENT MECHANICAL SEPTAGE TREATMENT FACILITY

This is the method of collecting and delivering sludge to a septage treatment facility where the septage is treated through mechanical dewatering and the filtrate through a biological treatment system. Figure B.1 shows the standard flowchart of such processes, which include pre-treatment, dewatering the septage, and treating the filtrate through biological process for the treatment of the organics

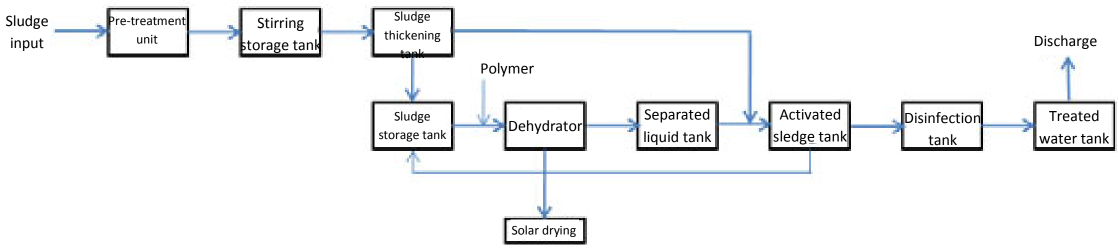

Figure B.1. Flowchart of treatment in a septage treatment facility

i. Characteristics of collected septage

Septage extracted from on-site treatment systems such as septic tanks is dependant on the design and frequency of emptying of septage from the septic tank. The following calculation shows how to find the sludge generation rate from a septic tank where excreta and domestic wastewater are treated together.

Flow rate of wastewater: 135 L/person/day

Septage generation rate: 135 L/person/day × 200 mg/L × 10 - 3 = 27 g/person/day

ii. Configuration of Septage treatment facility

The septage treatment facility consists of pre-treatment, solid-liquid separation, activated sludge treatment, and disinfection units. The dewatered and dried septage is used as a soil conditioner / fertilizer.

>Pre-treatment unit

This unit removes debris and sand and feeds the septage to the stirring storage tank, in which the septage is aerated and stirred for five or more days to make the nature uniform and to improve solid-liquid separation.

>Solid-liquid separation unit

- Septage thickening tank

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This tank settles the septage by means of gravity. The tank capacity shall be determined so that the retention time is about one day. If the inflow septage concentration is 1%, the tank is expected to double it - the concentration of outflow septage is 2%.

- Flocculation mixing tank

This tank forms flocs by adding a high-molecular or inorganic coagulant to the septage to facilitate solid-liquid separation.

- Chemical injector

This injector, which consists of a chemical storage tank, dissolution tank, and injection pump, adds a given amount of coagulant to the flocculation mixing tank.

- Solid-liquid separator

After the flocculation mixing tank, this unit (dehydrator) separates the septage into solid and liquid. The dehydrator is classified into centrifugal, belt press, and screw types.

- Activated sludge treatment unit

This unit, which consists of an activated sludge tank, sedimentation tank, sludge returning unit, and air supplying unit, removes BOD-related contaminants from the separated liquid.

a. **Typical design - Type design for septage collection of capacity 300m^3/day**

The following is a typical design of a septage treatment facility for a population of 200,000 persons.

- Basic data:

Number of users: 200,000

Regular septage extraction ratio: 50%

Septage generation rate: 30 g/person/day

SS concentration of septage: 1%

Septage collection rate [Q]

Q [m^3/day] = 200,000 [persons] × 30 [g/person/day]/10,000 × 0.5 = 300 [m^3/day]

- Stirring storage tank

Septage retention time [T]: 5 days

The necessary capacity [V] is given by the following formula:

V [m^3] = Q × T

= 300 × 5 = 1500 m^3

- Septage thickening tank

Septage thickening time: [T]: 24 hours

The necessary capacity [V] is given by the following formula:

$V\ [m^3] = Q \times T$

$= 300 \times 24/24 = \underline{\underline{300\ m^3}}$

- Dense septage rate

The dense septage rate [Q1] is given by the following formula:

Q1= Q × SS content of inflow septage [%] / SS content of dense septage [%]

$= 300 \times 1/2 = 150\ m^3/day$

- Septage storage tank

Septage retention time [T]: 1 day

The necessary capacity [V] is given by the following formula:

$V\ [m^3] = Q1 \times T$

$= 150 \times 1 = \underline{\underline{150\ m^3}}$

- Septage hydrator

Septage hydration time [T]: 5 days a week and 6 hours a day

The necessary capacity [C] is given by the following formula:

$C\ [m^3/h] = Q1/T \times 7/5$

$= Q1/5 \times 7/5 = \underline{\underline{35\ m^3/h}}$

$15\ m^3/h \times 3$ units

- Hydrated septage rate [Q2]

Assuming that the water content of hydrated septage is not more than 80%,

$Q2 = Q1 \times 2/(100 - 80)$

$= \underline{\underline{15\ m^3/day}}$

- Inflow rate of liquid to be treated biologically [Q3]

Q3 = Dense supernatant + Liquid separated by dehydration

$= 150 + (150 - 15) = 285\ m^3/day$

- Activated sludge tank

Inflow wastewater: BOD of 600 [mg/L] or less

BOD volume load: 0.4 [kg/m^3/day] or less

The necessary capacity [V] is given by the following formula:

$V\ [m^3] = Q3 \times 600/0.4$

$= 285 \times 600/0.4 = \underline{\underline{428\ m^3}}$

- Sedimentation tank

Assuming that the retention time [T] is 3 hours,

$V\ [m^3] = Q3 \times (3/24)$

$= 285 \times 3/24 = \underline{\underline{36\ m^3}}$

- Disinfection tank

Assuming that the retention time [T] is 15 minutes,

$V\ [m^3] = Q3 \times (1/24) \times (15/60) = \underline{3.0\ [m^3]}$

Table B2: Example of designing a septage treatment facility

Capacity	300 m^3/day		
Tank Volume	Tank name	Effective volume m3	Setting value
	Mixing storage tank	1,500	Retention time 5 days
	Thickener	300	Retention time 1 day
	Septage storage tank	150	Retention time 1 day
	Separate liquid tank	135	Retention time 1 day
	Activated sludge tank	428	BOD volumetric loading : 0.4 kg/m^3/day
	Sedimentation tank	36	Retention time: 3 hr
	Disinfection tank	3.0	Retention time: 15 min
Equipment Capacity	Centrifuge	15 m^3/h × 1 units	Operating hours 5 days/1week, 18 h/1 day

a. Septage collection truck

Septage collection trucks are available in a range of different capacities. It is necessary to select an appropriate truck according to the roads, traffic conditions, and transportation efficiency. In many cases, a large tank truck is used for a medium- to large-scale treatment facility, because a large amount of septage is extracted at once. The facility shall have a truck

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waiting space to avoid ~~a~~ traffic jam when the septage delivery may be intensive in a certain time slot.

Motorised Emptying and Transport

Motorized Emptying and Transport refers to a vacuum truck or another vehicle equipped with a motorized pump and a storage tank for emptying and transporting faecal sludge, septage and urine. Humans are required to operate the pump and manoeuvre the hose, but they do not lift or transport the sludge.

The pump is connected to a hose that is lowered down into a constructed tank (e.g. septic tank or aquaprivy) or pit, and the sludge is pumped up into the holding tank on the truck. Generally the storage capacity of a vacuum tanker is between 3,000 and 10,000L. Multiple truckloads may be required for large septic tanks.

Both the agencies responsible for sewerage and private entrepreneurs may operate vacuum trucks, although the price and level of service may vary significantly. Some public operators may not service informal settlements, whereas some private operators may offer a reduced price, but can only afford to do so if they do not empty the sludge at a certified facility. The cost of hiring a vacuum truck can sometimes be the most expensive part of operating a sanitation system for some homeowners.

Vacutug

The Vacutug consists of a 0.5 m^3 steel vacuum tank connected to vacuum pump which is connected to a gasoline engine. On level ground, the vehicle is capable of around 5km/h. The waste sludge can be discharged under gravity or by slight pressurization from the pump. Recent results indicate that under certain circumstances (constant number of pits, transfer station, short transfer distance, etc.) the Vacutug can be sustainable and cover its operating and maintenance costs.

Although smaller more mobile vehicles have been developed, large vacuum trucks remain the norm for municipalities and sanitation authorities. Unfortunately, large trucks cannot access all pits/septic tanks especially in areas with narrow or non-driveable roads. Also, vacuum trucks can rarely make trips to peri-urban or rural areas since the income generated from emptying, may not offset the cost of fuel and time.

Depending on the collection or treatment technology, the material that needs to be pumped can be so dense that it cannot be pumped easily. In these situations it is necessary to thin the solids with water so that they flow more easily, but this may be inefficient and costly. If water is not available, it may be necessary for the waste to be manually removed.

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