PERFORMANCE ASSESSMENT OF OFF-GRID SIMPLIFIED SEWERAGE SYSTEMS IN RAMAGUNDAM MUNICIPALITY

CONTENTS

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Acronyms

APUSP	Andhra Pradesh Urban Services for the Poor Project
CBOs	Community based organisations
Rs.	Indian Rupees
ULB	Urban local body

1. INTRODUCTION

1.1 Programme Solidarite – Eau (pS-Eau) has set out on a study entitled 'How to choose and how to implement small-bore sewers' with the objective of offering relevant and effective infrastructure solutions for urban sanitation in African countries in particular and other developing countries in general. Through an assessment of international experience on small-bore sewers, the study aims to identify strengths and weaknesses of this alternative off-site sanitation technology solution and appraise its suitability in African setting. In this context pS-Eau identified the small town of Ramagundam in the state of Andhra Pradesh, India as one of the locations for studying performance of simplified sewer systems which were installed during 2002-2008. Initial experience emerging from Ramagundam was documented by Mr. Asit Nema in his paper entitled 'Simplified sewerage – an appropriate option for rapid coverage in peri-urban areas of India' which was presented in the 34th WEDC International Conference, Addis Ababa, Ethiopia, 2009 and subsequently published in the conference proceedings (Annex-1).

1.2 In 2012 pS-Eau hired Mr. Asit Nema of Foundation for Greentech Environmental Systems, India to revisit Ramagundam and appraise current status of the same sewer networks. The field visit was carried out from November 23-26, 2012 along with the principal investigator Mr. Jean-Marie Ily of pS-Eau. In the above context, this report presents findings of the field visit.

STRUCTURE OF THE REPORT

1.3 Chapter 2 provides background information and sets the context for the intervention on off-site sanitation in Ramagundam. Chapter 3 provides an analysis of implementation setting, the rational for selection of particular technology of simplified sewerage and the approaches adopted by the ULB in taking the entire process first in the pilot settlement and then subsequently scaling up to eventually cover 13 others. Finally a set of conclusions and recommendations are provided in Chapter 4, which mainly from the point of view of improving the process of implementation and thereby enhancing success rate during operations.

2. BACKGROUND

2.1 This chapter provides a brief description of the background and context under which the initiative on small bore sewerage has been taken place in Ramagundam and how the urban local body could expand coverage from a pilot to over 14 habitations.

SMALL-BORE SEWERS IN INDIA

2.2 The latest available edition of the Manual on Sewerage and Sewage Treatment of the Central Public Health and Environmental Engineering Organisation (CPHEEO), Ministry of Urban Development of India introduces 'small bore' and 'shallow sewerage' as appropriate technology options (CPHEEO, 1995) however as yet they have not been adopted by consulting organisations, municipal engineers and urban local bodies. Apparently lack of local references, design expertise and experience in O&M can be attributed to hithertolow acceptance of these options.

2.3 However, some small-bore sewers have recently been implemented in India:

- Small-scale networks implemented as part of the German NGO Borda's 'Decentralized Water Treatment Systems' (DEWATS) approach, like the one visited by pS-Eau in Nagpur in November 2012.
- DEWATS is now being advanced as a solution by the Indian Consortium for DEWATS Dissemination Society (field visit by pS-Eau with the SANDEC team in Raipur and meeting with the CDD team in November 2012);
- The Punjab Government - World Bank-funded Punjab Rural Water Supply and Sanitation Project "*has a provision to finance, on a pilot basis, construction of small bore sewers and sewerage schemes in about 100 villages which already have good household sanitation coverage but where the release of septic tank outflow on the village streets and open drains creates a serious health hazard";*
- Other Indian stakeholders are also due to test the small-bore sewer option over the coming months (interview with Dr. Meerah Mehta, CEPT University and email communications with her team in 2012).

2.4 The only town in India with long-term experience of using small-bore sewers is Ramagundam, where small-bore sewers have been in place since around 2005. According to a report by Asit Nema, in 2009 these simplified sewerage networks were found to be working well and the community was satisfied with the level of service. This made it an original, if not unique, case in India.

RAMAGUNDAM TOWN

2.5 Ramagundam is a small town in Karimnagar district of Andhra Pradesh in the southern part of India. It is about 240 km north of the state capital of Hyderabad and is located on right bank of Godavari River. The town derives its name from an adjoining village by the same name and which now represents an urban agglomeration of several urban and rural settlements.

2.6 The region is endowed with among others, abundance of coal and water resources and as a result of which it witnessed rapid industrialization during 1981-91 - mainly mining and thermal power plants. During this period the ensuing in-migration of workers led to sustained population growth at a compounded annual rate of over 10% and the town population increased from 82,126 in 1981 to 214,348 in 1991. However, in subsequent decades, the town has recorded significantly reduced growth rate and as per the 2011 Census its population is estimated to be 229,632.

EXHIBIT 2.1: MAP OF RAMAGUNDAM

2.7 Rapid industrialization and population growth also led to transformation of landscape of the town. A number of industrial townships (gated communities) were developed for the industrial workers in the organized sector, while the old town experienced increased trading and transport activities. The town developed in three main clusters and during the process, some of the existing villages were also engulfed into the urban growth and which led to their being transformed into urban colonies of low income communities. Around 2005 the 12 adjoining villages were also merged into the municipal limits of the town and its total area expanded to around 94 sq.km. As expected under such a situation, a number of informal and/or illegal settlements of poor migrant workers also came up in and around the rapidly growing urban agglomeration and by 2011 the town is reported to have about 92 low income/slums localities, out of which 42 are notified and the rest are still considered either illegal encroachments or temporary settlements. The combined population residing in such settlements is estimated to be around 50% while the population of people below poverty line is estimated to be around 40%.

2.8 Evidently while the gated communities and a part of the old town got the required infrastructure in varying degrees, the concurrent low income settlements / slums did not have such provisions of either the city wide or localized infrastructure. The slums in particular are characterised by among others, poor access, low and irregular water supply, poor sanitation, etc.

PHYSIOGRAPHY

2.9 Ramagundam has tropical climate which is characterized by hot dry summers and mild winters. It is also known to be among the hottest places in the region where peak summer temperatures in excess of 48 ^{o}C have been reported. The town receives copious rainfall of around 1200 mm/annum, primarily during south west monsoon in the months of June to October.

2.10 The town has rolling topography with mild gradient towards the Godavari River in the north east direction. There are three main open natural drains which discharge surface run-off and also carry dry weather flow, which mainly comprises sewage and trade effluents, if any. The soil is predominantly impervious clay with high swelling tendency while at about 2 m depth gravel and clayey sand is encountered. Water table is not very deep which in monsoon season is generally found to be at a depth of 4-5 m. With high availability of ground water, typically households are found to have individual shallow wells for domestic use.

URBAN GOVERNANCE

2.11 Because of special character of the town, at the outset the urban local body was given status of a 'notified area committee'. Over the years it got upgraded to 'Grade-III' municipality, then 'Special Grade' municipality and then in 2010 it was given full status of a Municipal Corporation.

2.12 While in principle the ULB jurisdiction expands over the entire 94 sq.km, its administrative scope is limited to about one third of the area and the rest is under the scope of various township administrations. The town is divided into 34 municipal wards. As evident from preceding sections, Ramagundam offers a mix of settlement patterns comprising the main town, the gated communities in townships of central and state public sector undertakings, new private colonies, urban villages, and the low income settlements/slums. Some of the wards comprise only industrial townships while others have a mix of the township as well as other settlements. In the case of industrial townships the urban services for waste, supply, wastewater management, solid waste collection, drains etc. are provided by the respective administrations. In some wards where there is a mix of township and other settlements, the respective industrial administrations are also extending these services to the neighbouring communities.

2.13 Ramagundam Municipal Corporation is characterised by limited human as well as financial resources and therefore has limited capacity in planning or undertaking conventional infrastructure works. It is noteworthy that since 2009 there have been no elections and thus the local body of councillors does not exist. Further, over the last few years the Corporation has also experienced significant transfers of its key officials comprising among others, the commissioner and senior engineering officials. As a result of this political uncertainty and administrative shuffling, lately delivery of municipal services has suffered.

ANDHRA PRADESH URBAN SERVICES FOR THE POOR PROJECT

2.14 Andhra Pradesh Urban Services for the Poor (APUSP) Project was supported by the Department for International Development (DFID), UK which was implemented during 2002-2008 in 32 class-I cities of Andhra Pradesh in partnership with the state government. Ramagundam was one of the cities which was included under the project. APUSP aimed at achieving a sustained reduction in poverty and vulnerability of the urban poor. During the extended period, the programme focused on slum settlements for provision of among others, basic infrastructure and services e.g., roads, drains, water supply, electricity, etc. Provision of sanitation infrastructure was facilitated by way of integration at the planning stage (software support) while it was funded by the state government under the then on-going Integrated Low Cost Sanitation Scheme (ILCS) of the Government of India (ILCS promoted on-site sanitation solutions in the form of pour flush toilets connected to single or twin pits or septic tanks).

INITIATIVE FOR OFF-SITE SANITATION IN SLUM COLONIES

2.15 Interestingly, as part of the APUSP Ramagundam municipality introduced the concept of off-site sanitation on pilot basis in one of the lower middle income communities. This comprised individual pour-flush type household latrines connected to simplified (also called shallow or small-bore) sewer network without on-plot interceptor tanks. The off-grid or community level sewer network served about 300 households which was eventually connected to a large community septic tank and the effluent was let out into an open drain. Although the initial construction was characterised by some lacunae, availability of complete off-site sanitation infrastructure resulted in significant behaviour change in the community, with preference towards fixed point defecation - leading to impressive improvements in environmental sanitation. Provision of, among others, cement concrete pavements in most parts of the settlement alongside simplified sewers also contributed in significant improvement in the quality of life of the beneficiaries.

EXHIBIT 2.1: OFF-SITE SANITATION INITIATIVE IN PRASHANTI NAGAR
The Prashanti Nagar community comprises 300 households of oustees of a coal mining project from a nearby village which were apparently adequately compensated and resettled. While the size of individual homesteads and quality of construction corresponded to lower-middle income status, open defecation was widespread and few households with individual latrines were discharging sewage directly into open storm water drains. However, given the relatively better socio-economic status of the community, there was latent demand for improved quality of life. Responding to the sanitation challenge and leveraging willingness and affordability of the community, around 2003-04 Ramagundam Municipality identified Prashanti Nagar for a pilot project on off-site sanitation. It is noteworthy that each household in the community also had a small individual shallow well and therefore availability of water for flushing was not an issue. Under the then ongoing 'Janmabhoomi' scheme of the state government, the municipality made a preposition of capital cost sharing for laying of simplified sewer network. Each household was required to construct individual pour-flush toilet at own cost and share 40% capital cost of the off-grid sewer network. The network itself comprised a raised connection chamber opposite each property, locally manufactured small bore (150-200 mm diameter) stoneware galvanised pipes and a large community septic tank. The cost of the pilot project was estimated to be Rs. 0.75 million (~USD 15,790, @ Rs. 47.5/USD in 2003) wherein each beneficiary family was required to pay Rs. 1000/- (~USD 21) towards community share while the balance was borne by the municipality.

2.16 Drawing from the positive response of Prashanti Nagar community and overall success of the pilot initiative, in subsequent years Ramagundam Municipality implemented simplified sewer based off-site sanitation solutions in 13 other lower-middle as well as low income communities alongside other infrastructure interventions which were available under APUSP. A full listing of all such sewer networks is presented in Exhibit 2.2 below.

EXHIBIT 2.2: SIMPLIFIED SEWERAGE IN SELECTED SETTLEMENTS OF RAMAGUNDAM

Sl. No.	Name of the colony	Population	Houses	Project cost[1]	Cost/ household	Cost/ person[2]	Remarks
				Rs. million	Rs.	Rs.	
1	Prashanti Nagar	1,500	300	1.75	5,733	1,147	40% cost contributed by the community. Corrected cost includes Rs. 1 million for the septic tank which was funded by the coal mining company.
2	Seetha Nagar	4,025	221	1.41	6,380	350*	Fully funded by the ULB under APUSP. Cost corrected by Rs. 1 million to account for the septic tank.
3	Sanjay Nagar	978	165	1.77	10,727	1,810	--do--
4	Lenin Nagar	2,600	430	3.55	8,256	1,365	Fully funded by the ULB under APUSP.
5	Ram Nagar III	1,142	252	3.62	14,365	3,170*	--do--
6	Ram Nagar IV	2,280	380	4.32	11,368	1,895	--do--
7	Parushuram Nagar	1,395	319	3.54	11,097	2,538	--do--
8	Kakatia Nagar	871	196	3.54	18,061	4,064*	--do--
9	Chandra Nagar	1,427	326	3.03	9,294	2,123	--do--
10	Vijaya Nagar	1,298	294	3.02	10,272	2,327	--do--
11	Vinoba Nagar	363	95	3.15	33,158	8,678*	--do--
12	Bhagath Nagar	1,205	269	3.26	12,119	2,705	--do--
13	Dwaraka Nagar	2,331	330	2.38	7,212	1,021	--do--
14	Vittal Nagar	1,150	254	2.58	10,157	2,243	--do--
	Total	**22,565**	**3,831**	**40.89**			
	Average				**12,014**	**2,531**	

[1] Project costs correspond to period around 2006-2008.
[2] Significant divergence in unit costs (*) could be attributed to either inconsistency in the data maintained by the municipality and/or area of the settlement, population density, household size, etc.

2.17 The subsequent networks were laid with incrementally improved design and construction specifications which eventually covered a total of around 3800 families. The average cost of constructing a simplified sewerage network (excluding individual household toilets and without the on-plot interceptor tanks) is around Rs. 12,000/- per connection (166 euros using the 2012 currency exchange rate, or 210 euros at the 2005 exchange rate). Except for Prashanti Nagar, in the rest of the 13 settlements the scheme was implemented with full funding under ongoing slum improvement programmes of the state government/APUSP.

2.18 As regards operations, Ramagundam municipality is responsible for repairs and maintenance aspects while the community extends necessary support in terms of timely reporting of any blockages and sharing of minor costs. In 2008 during the course of a study sponsored by Water and Sanitation Programme – South Asia these off-grid simplified sewerage networks were found to be working fairly well and so again when revisited in 2012 as part of the global study commissioned by pS-Eau. Barring few lower level households experiencing problems during rains, the community is found to be satisfied with the overall performance of the sewerage systems.

2.19 In the above context, in the following chapters this brief report presents a historical perspective and documents the processes adopted in planning, implementation and maintenance of the simplified sewer networks in Ramagundam. The analysis also identifies key players and success factors and offers a set of recommendations in case the same technology option or one of its variants is considered for adoption under similar settings.

2.20 However it is appropriate to mention here that due to frequent transfers of a number of key municipal officials and in absence of reliable documentation within the urban local body, there has been significant loss of the institutional memory. As a result the data may have some inconsistency in terms of sequence of event, cost estimates, etc. Nevertheless what is important is the set of observations in 2012, viz., significant change in behaviour towards fixed point defecation, effective functioning of the sewer systems and the consequent high level of environmental sanitation in the beneficiary communities.

3. DEVELOPMENT PERSPECTIVE

3.1 On account of rapid industrial growth, the Municipality of Ramagundam experienced stress on its limited infrastructure and also witnessed growth of a number of settlements comprising adjoining villages as well as slums/ encroachments. While the couple of industrial townships offered fairly high level of basic infrastructure, the settlements of poor communities were characterised by its absence and weak support system. Further, while the basic services in the townships were provided by the concerned administrations, those in the settlements and the old town was the responsibility of the Ramagundam Municipality. Evidently the water supply and sanitation situation in these settlements was poor – characterised by among others, widespread practice of open defecation, blocked open drains carrying sewage and solid waste, etc. Being a small urban local body with limited resources, Ramagundam Municipality was not in a position to take up the challenge on its own.

3.2 In this context, the simplified sewerage initiative was first taken up some time during 2003-2004 by the then Chairman of Ramagundam Municipal Council. The Chairman was concerned about the poor environmental situation and was keen on exploring affordable appropriate technology solutions. In this regard it may be pertinent to note that the Chairman had worked as Chief Engineer in a public sector organisation before entering into local politics had thus had strong engineering background.

3.3 The challenge was all the more difficult because of strong preference of the local population towards relatively higher level technology option of water-seal pour-flush toilets as well as the uniform practice of using water for anal cleaning. Evidently there was lack of interest in dry sanitation options. Further, the local boundary conditions characterised by relatively impervious soil and shallow water table were not particularly conducive for on-site sanitation solutions e.g., twin pit toilets, while cost of individual septic tanks was found to be rather unaffordable by most households.

THE RATIONALE FOR CHOOSING SIMPLIFIED SEWERAGE

3.4 Given this background, it is understood that the Municipal Chairman attempted to explore alternate sewerage solution in consultation with the engineers and coincidentally came in contact with advisors working on the APUSP Project. While it is difficult to reconstruct the sequence of events, as over the years the concerned officials have moved on to other positions, but based on the residual institutional memory it is understood that the concept of simplified sewerage or shallow /small-bore sewerage germinated out of this consultation and based on the compulsions of keeping the construction costs low.

3.5 It is also interesting that at that point of time the team of municipal engineers did not have any expertise on designing of simplified sewerage network. This is evident by the quality of planning and construction in the first settlement of Prashanti Nagar where, as shown in Exhibit 3.1, a part of the sewer pipes and house connection chambers are projecting above ground, pipes are partly exposed and prone to damage, and sewer pipe crossing open drains are blocking the flow, etc. However as the team gained experience, quality of construction/ pipe laying is found to have improved in subsequent settlements.

EXHIBIT 3.1: QUALITY OF CONSTRUCTION IN INITIAL AND LATER STAGE OF THE INITIATIVE

3.6 One of the factors in determining the choice of off-site sanitation system of simplified sewerage in the first settlement could also have been the willingness of the community to share 40% of the capital cost under the then on-going 'Janmabhoomi' (motherland) scheme of the Government of Andhara Pradesh where the latter was offering balance 60% of the capital costs towards community infrastructure creation. This arrangement was adopted in Prashanti Nagar - the first settlement where the households agreed to pay Rs. 1000 per connection towards capital costs. However it is surprising that after having established acceptance of the concept of community contribution during the pilot the municipality decided to withdraw the scheme and instead offer full funding. This could have been prompted by availability of donor support under the APUSP Project, withdrawal of the scheme by the state government or could also be attributed to higher affordability on the part of the residents of Prashanti Nagar compared to those in other settlements. Notwithstanding this difference in funding pattern, in 2012 the visit did not bring out any perceptible differences in the quality of construction and service levels.

IMPLEMENTATION SETTING

3.7 Urban growth in Ramagundam has not been as per a predefined plan which is evident by presence of a number of 'slums' in the midst of few gated communities/industrial townships as well as several villages , and as a result development of citywide infrastructure is found to be not in synergy/coherence with its physical expansion. Further, the ULB has limited resources (both financial and human) and thus is not in a position to proactively take up new works or sustain operations of some of the infrastructure. For instance, for a considerable time it was unable to take up the responsibility of pumping and diverting sewage to the two sewage treatment plants (waste stabilisation ponds based systems which were apparently thrust upon it under another national programme) and run them due to lack of funds.

3.8 An important feature of all the 14 settlements where simplified sewer networks have been constructed was the availability of land tenure titles with households which would have imparted a strong sense of ownership and stability for developing community infrastructure for both the ULB as well as the residents. It is obvious that water supply in all the settlements was adequate while in the pilot locality of Prashanti Nagar, almost every house had a private shallow well. Exhibit 3.2 provides a summary of salient features of a selected settlements visited during the course of this study while major aspects are described in the paragraphs that follow.

EXHIBIT 3.2: SETTLEMENTS VISITED DURING THE STUDY

	Prashanti Nagar	Lenin Nagar	Ram Nagar	Parshuram Nagar	Indira Nagar
Number of households	300	430	252	319	NA
Income level	Lower middle	Lower middle	Middle	Lower middle	Very low
Urban layout	Narrow streets and irregular layout for most settlements; generally low lying areas. Paved lanes.				
Tenure status	All the slums covered by small bore sewerage networks are notified and hence each household has legal tenure.				Non notified
Water availability	Reported to be between 60-100 litre/capita/day. User charge is at a subsidized rate of Rs. 100 hh/month.				Hand pump
Year of sewer network	2002-03	2004-05	2004-05	2007-08	NA

	Prashanti Nagar	Lenin Nagar	Ram Nagar	Parshuram Nagar	Indira Nagar
commissioning					
Funding	ULB and users.	DFID/Govt. of India	DFID/Govt. of India	DFID/Govt. of India	NA
Extent of household connections	In all the settlements covered by simplified sewerage network the connexion rate is 100%.				No sewerage; Mostly open defecation.

Physical setting

3.9 By and large all 14 settlements are characterised by gently sloping ground (1-2%) and relatively low ground level; single story compact construction for residential purpose with relatively higher population density; narrow and winding roads (barring the planned resettlement colony of Prashanti Nagar – the pilot settlement) with several branching out small by-lanes. Under this setting, the sewer network is not laid in a grid pattern but rather in a branched out pattern. Secondly, with a gently sloping ground, laying of sewers was not difficult and being off-grid, the need for sewage pumping was not felt.

3.10 It is pertinent to mention that the narrow roads do not have movement of heavy vehicles and thus the sewers were not expected to bear heavy loads. However with the provision of cement concrete pavements there is occasional movement of small cars but as yet this has not caused any structural damage to sewer lines and is not considered an issue.

Implementation approach

3.11 An interesting feature of the intervention in all the 14 settlements is the total coverage – i.e., sewer connection for each households. This could be attributed to high inputs for community mobilisation and participation on the part of the municipality as well as high willingness of the communities to avail the improved infrastructure facility towards improved quality of life. This could also be attributed to higher political willingness as demonstrated by the personal initiative on the part of the Chairman of the municipal council.

3.12 However, it appears that at that point of time the municipality did not recognise desirability of developing institutional capacity at the community level. As a result, in none of the 14 settlements community based organisations (CBOs) in the form of users' committee/ resident welfare association is found to exist which otherwise could be entrusted with the responsibility of undertaking maintenance and minor repairs of community infrastructure, among others the simplified sewers.

The design approach

3.13 Information on the specific method adopted for designing the system is not available. However it is found that in the upper ends of the network smaller 150 mm diameter pipes were used and towards the lower end the size was increased to 200 or 250 mm. The smaller 150 mm size comprised stoneware galvanised pipes which were procured from a local factory while the slightly bigger sizes comprised asbestos cement concrete pipes. Local procurement for most of the pipe length also helped in restricting cost of construction

3.14 It is noted that the sewer network does not include on-plot interceptor tanks and therefore they do not qualify to be classified as 'settled sewerage' but only either as 'simplified sewerage' or as 'shallow small bore sewerage' systems. Under this setting, for each household and typically at every 10 m shallow connection chambers or simplified manholes are provided, to which discharge pipes from household toilets are directly connected.

3.15 As stated earlier, there is no pumping of sewage involved at any stage which can be attributed to, among others, availability of gentle ground slope of 1-2%. However, under such a setting a limiting aspect related to planning of simplified sewerage is that the municipality was probably not aware of inherent hydraulic constraints of the system. This is evident by the complaints received from few low lying households which experience back flow of wastewater during rains as water level at the outfall rises.

3.16 It is interesting to note that provision of cement concrete pavements and exclusion of open storm water drains (typically provided on the sides of the roads) under the programme for integrated delivery of infrastructure and services have significantly contributed in ensuring a fairly high level of aesthetics and environmental sanitation in the low income settlements.

3.17 However, evacuation of surface run-off and adverse impact on performance of the sewerage networks due to changed hydraulics during rains are issues which still need to be adequately addressed. Another area of concern could be potential risk of contamination of water supply, given that both the sewer and water distribution lines laid at shallow depths in narrow lanes which do not enable adequate vertical or lateral spacing.

Sewage treatment

3.18 For each of the 13 decentralised sewerage networks large size septic tanks (36m x 6m x 3m) are provided for treatment of wastewater and the effluent is then let out to an open storm water drain. As seen in Exhibit 3.3, prima facie the effluent is found to be reasonably clear - having relatively low level of suspended solids. Since data on typical effluent characteristics is not available, at this stage it is not possible to comment on overall treatment efficiency. However, further polishing by incorporating a gravel filer or an oxidation pond/ mini-wetland could have helped in achieving higher level of treatment. Exclusion of these measures could be attributed to among others, resource constraints, lack of space and lack of specific regulatory measures on sewage discharges from off-grid urban settlements.

EXHIBIT 3.3: SEPTIC TANK OUTFALL FROM ONE OF THE SETTLEMENTS

3.19 It is noted that because of proximity of the large size septic tanks to the settlements, some of the houses on the lower end of the system experience odour problem. However, the problem is not severe and it is experienced only when wind direction is towards the settlement. Nonetheless, this is indicative of lack of consideration on environmental/ social impact aspects and community consultation during the planning stage.

MANAGEMENT/ MAINTENANCE PRACTICES

3.20 As mentioned earlier, in none of the settlements where simplified sewerage networks have been laid out any noticeable development towards institutional capacity building has been made. As a result, formal community level institutions with focus and capacity for maintenance of sewerage system in particular and water and sanitation in general do not exist.

3.21 Under such a situation it is observed that minor maintenance works e.g., desilting of individual connection chambers, small stretches of sewers as well as removing blockages, if any are taken care of by individual households by hiring private service providers (Exhibit 3.3). Although this is an informal arrangement, typically involving an expenditure of Rs. 10 – 30 per household per month, it is found to have been working fairly satisfactorily. One of the factors for this could be easy availability of private service providers who belong to a particular community which typically takes up conservancy services for livelihood. Exhibit 3.3 also shows the improvised tool typically used for manual cleaning of sewer lines by the service providers.

3.22 However, as shown in Exhibit 3.4 it is also found that after removing pathogenic sludge from sewer lines/ chambers, it is often left on the pavement near the chamber (either on the side or middle of the lane, depending on the location of the chamber) for drying. This is indicative of lack of awareness on the part of individual service providers and lack of training and sensitisation on the part of the ULB to the former regarding maintenance and risk to public health. This is also indicative of certain level of weakness in monitoring and supervision/ inspection system on the part of the ULB as letting pathogenic sludge on the pavement will be counterproductive to progress in on- or off-site sanitation.

EXHIBIT 3.4: SERVICE PROVIDER AND TYPICAL UNSAFE PRACTICE OF STOCKING PATHOGENIC SLUDGE AND SEDIMENTS ON THE PAVEMENT AFTER REMOVAL FROM THE CHAMBER

3.23 It is pertinent to reemphasise here the role of the municipality towards maintenance. Although need for such support has not arisen as yet, but it is understood that the ULB will undertake major repairs to the pipeline and other structural components and also empty septic tanks as and when required. In this respect, it is also interesting to note ULB's initiative in setting up a help-line where the residents can convey their problems and inform any major issues with the infrastructure. Apparently this facility is not well advertised and therefore only a small section of the community is aware of the help-line service, however it is understood that in due course of time the ULB aims to utilise it for improving its monitoring systems.

Solid waste management

3.24 An interesting off-shoot of the intervention towards improvement in off-site sanitation in the selected settlements is the changed behaviour of the communities towards domestic solid waste management. As shown in Exhibit 3.5, it is noted that households in almost all settlements have now adopted the desirable practice of storing domestic waste at source and handing it out only to a separate private service provider who comes on daily collection rounds. It is understood that anchoring and evolution of this system has been facilitated by the ULB in consultation with the local communities.

3.25 As a result of this practice, as shown in Exhibit 3.5, the settlements are found to be very clean and free of any litter or trash. An added advantage of this is the reduced risk of blockage of the small bore sewer lines and thereby improved operations.

3.26 As shown in the bottom photograph in Exhibit 3.5, improved aesthetics in the habitations have also motivated residents to practice the traditional art of ‘Rangoli’ – floral motifs with chalk powder and colours on the pavements in front of individual houses. This adds to the ambience and is considered auspicious.

EXHIBIT 3.5: IMPROVEMENTS IN DOMESTIC SOLID WASTE MANAGEMENT LEADING TO IMPROVED AESTHETICS IN THE HABITATION

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Based on a rapid assessment and analysis of the situation in selected settlements in Ramagundam, this section provides a set of conclusions and recommendations.

CONCLUSIONS

4.2 A set of key conclusions emerging out of the case study are briefly listed below:

- It is evident that as a result of introducing simplified sewerage along with other basic infrastructure and services in the selected 14 settlements, the concerned communities have benefitted significantly in terms of improvements in environmental sanitation and thereby the overall quality of life.

- Provision of cement concrete pavements on one hand offered additional structural safety for shallow sewers and on the other acted as a catalyst for mobilising community support in related areas.

- The community showed high level of willingness to participate and contribute towards capital cost of basic infrastructure, however due to external factors e.g. availability of central grants, new political establishment at the state level, etc the ULB could not leverage the successful experience from the pilot intervention.

- After successful implementation of the pilot the technical team of the ULB was able to move up the learning curve and improve design and construction specifications in subsequent settlements.

- The sewerage systems have survived the test of time and have been found to be working satisfactorily after 4-6 years of commissioning. While formal community level institutional capacity was not created, it is clear that the individual households have taken the responsibility of ensuring adequate maintenance.

- The community has also shown higher level of commitment by embracing improved solid waste management practices, leading to lower operational risk to the sewer system and improved aesthetics in the habitations.

- The planning and design of the off-grid simplified sewerage systems could have been further improved if more consideration was given to (a) adverse hydraulic conditions during rains, (b) environmental impact of locating community septic tank near the habitation, and (c) final quality of effluent released into the environment.

RECOMMENDATIONS

4.3 A set of recommendations are made from the point of view of enabling further improvements at the time of planning, designing and operations of the simplified sewerage systems. The recommendations are by no means comprehensive, but are expected to improve success rate and overall performance of the systems.

Planning stage

4.4 At planning stage of a simplified sewerage system, among others, following aspects should be taken into consideration:

- The settlement/ habitation to be served by simplified sewerage system should have at least 60-70 litre/capita/day of water supply.
- In order to assess willingness and affordability of the target community for somewhat higher order sanitation infrastructure and service, the ULB should initiate a series of consultation prior to taking up physical works.
- Through extended engagement, the ULB should prepare the community towards its responsibility for maintenance of the sewer network and preventing vandalism, if any.
- From an early stage, the ULB should facilitate building of institutional capacity (e.g., CBOs) at the community level involving with the objective of mobilising support for monitoring and supervision during construction and eventually maintenance during operations.
- Involvement of the community during planning stage of a proposed system would help identify a set of unforeseen challenges, create consensus and mobilise its contribution towards part of the capital costs.
- Location, type and extent of treatment to be given to the collected sewage and the required environmental safeguards, if any could be better identified through community consultation at planning stage.
- In order to impart sense of ownership it is desirable to have the community contribute a small part of the capital costs.

Design stage

4.5 At design stage of a simplified sewerage system, among others, following aspects should be taken into consideration:

- Wastewater flows resulting from discharge of both sewage and sullage should be considered for hydraulic calculations.
- Each household in the community should be planned and expected to connect to the sewer network.
- For enhanced environmental sanitation and aesthetics a typical project should include provision of cement concrete pavements and exclusion of roadside open storm water drains.
- For safe and rapid evacuation of surface runoff alternate effective arrangements should be provided.
- The design should account for difficult hydraulic conditions resulting from localised flooding due to high intensity rainfall. To this effect, to avoid the problem of back flows in some areas, toilets in low level plots should be constructed on raised plinth.
- A multi-chamber septic tank followed by a stone filter and constructed wetland would enable adequately high level of treatment for the wastewater. Size of the entire treatment system should be determined based on the expected hydraulic and organic loads.
- Changed hydraulic conditions at the outlet of the treatment system (receiving drain/ water body) after heavy rains should be adequately accounted. Appropriate safeguards in the form of diversion channel, etc. should be provided.
- Since both the sewer lines and the water supply lines are laid shallow in narrow pathways, appropriate construction safeguards must be taken to prevent risk of contamination of drinking water supply.

Operation and maintenance stage

4.6 After paying necessary attention to the planning and design aspects, it is imperative that the ULB needs to continue its focus on community level systems and processes such that smooth operation of simplified sewer systems can be guaranteed. To this effect, among others, a set of measures that could be considered are briefly listed as follows:

- The users' committee formed at planning stage should be suitably supported and strengthened to discharge its responsibility of monitoring and supervising upkeep and maintenance.

- The ULB should evolve and clearly define appropriate institutional arrangements (service either by municipal workers or by private service providers) for maintenance services e.g., cleaning, desilting, etc.

- From time to time the ULB should impart training to its sanitary workers and private service providers alike, as the case be, on occupational health, safety and hygiene aspects. The training should also cover technical aspects relating to pipe safety, septic tank operation, timely removal of sludge and sediment and their safe disposal, etc.

- The ULB should evolve and institute a system of licensing for service providers who could then be authorised for rendering cleaning and maintenance services for simplified sewers.

- The ULB should hold regular meetings with the community to get feedback and identify operation and maintenance issues, if any and provide timely solutions.

- The ULB should also adopt a system of regular participatory inspection of the sewer system.

- In order to ensure required/desired level of community engagement and sustain it, the ULB should consider hiring services of a social worker cum communication specialist.

- In order to minimise risk of blockage of small-bore sewers, the ULB must take all necessary measures to improve solid waste management operations in the respective settlements. It must sensitise the residents to prevent disposal of solid objects e.g., sanitary napkins, diapers in to the toilets.

Annexures

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WATER, SANITATION AND HYGIENE:
SUSTAINABLE DEVELOPMENT AND MULTISECTORAL APPROACHES

Simplified sewerage – an appropriate option for rapid coverage in peri-urban areas of India

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[OFFICE USE ONLY: REVIEWED / REFEREED PAPER]

With increasing population pressure in the cities and towns across India, clearing the backlog, and improving and maintaining sanitation service levels has become increasingly challenging. Water borne human excreta disposal through conventional sewerage system is expensive and increasingly infeasible for congested, small plot habitations which experience low or declining service levels of water supply. Although this represents the higher order technology option, it is increasingly being questioned because of its water intensive feature. In areas where on-site sanitation is technically not feasible and where conventional sewerage is financially unaffordable, simplified sewerage as an intermediate technology solution offers an appropriate option. Successful experience of over 20 years in Latin American countries has positioned this technology as an important and only feasible option for peri-urban areas and low income settlements. A small municipality of Ramagundam (Andhra Pradesh, India) with a population of around 250,000 has successfully adopted this technology and has been able to provide full sanitation in 13 low- and middle-income communities covering over 6600 households. Lessons from this success story could be drawn for wider application and rapid coverage under the ongoing infrastructure strengthening programs. There is a need to evolve appropriate policy and technical guidelines such that the sanitary engineering community can confidently adopt this unconventional technology and extend the benefits of improved sanitary conditions and better public health to a larger population.

Introduction

There are over 4300 cities and towns in India wherein a thriving population of over 285 million resides. This section of the population is estimated to contribute over 60% of the Country's GDP. This urban population had recorded a growth of 31% during the 1991-2001 decade and is expected to be growing at an even higher rate in the present and the coming decades given the increasing impetus on industrialisation and urbanisation. In 1991 there were 24 'million plus' cities which rose to 35 by 2001.

As per the Census 2001, about 53% of the urban population had access to improved sanitation while the World Health Survey of 2002 estimated it to be around 62% (WHO/UNICEF, 2004). To address the wide gap, the Tenth Five Year Plan (2002-07) had kept the target of raising coverage in urban areas by 2006-07 to 75% which corresponds to reaching to an additional 31 million people and for which a budgetary estimate of Rs. 231.57 billion (~USD 4.8 billion, @ Rs. 48/USD in 2002)[1] was made (Planning Commission, 2002). In the Eleventh Five Year Plan (2007-2012) the coverage target has been raised to 100% which requires reaching to 198 million urban population by 2012, and out of which 138.8 million (70%) population is proposed to be served with sewerage connection. For the latter component the fund requirement in the Eleventh Plan is estimated to be Rs. 416.34 billion (~USD 9.7 billion, @ Rs. 43/USD in 2007) (MOUD, 2006). If India is to meet the Millennium Development Goal on sanitation then at least 92.5 million urban population has to be covered by year 2015, and in order to achieve the global goal of full sanitation coverage by 2025, then additional 240 million people have to be covered (Planning Commission, 2002).

While access to household toilets in urban areas could be increasing, sanitation beyond home toilets is a different story. The Census 2001 and the World Health Survey, 2002 estimated sewer connectivity as low as 15-17%. Out of 423 Class-I cities, only about 70 have partial sewerage network, while the rest of the Class-I, II and III cities and towns do not have this increasingly critical public health engineering infrastructure. Under such situation, typically septic tank is the preferred option but which in most cases is not followed by a soak-away/drainage trench, and as a result its overflow is let out either on the ground, into open storm water channels or drains. This, along with the practice of indiscriminate disposal of septage from filled septic tanks leads to release of pathogens into the open environment which poses a major risk to public health (municipal service for emptying of filled septic tanks is commonly not available; local bylaws for safe disposal of septage are not clearly laid out or implemented effectively and as a result, septage is disposed of into water bodies or on to agriculture fields). Often lack of space for construction of septic tanks and non-availability of sewer lines compels low income households to construct direct discharge latrines or to resort to the unhealthy practice of open defecation. In the case of relatively larger villages (population > 5,000) which are rapidly acquiring semi-urban characteristics, similar or still challenging situation prevails.

Further, as per the Central Pollution Control Board (CPCB) estimates for year 2003-04, over 26,054 million litres/day (mld) of sewage is generated in 921 Class-I & II cities and towns across the country and the aggregate available capacity for treatment is only 7,044 mld (MoUD, 2006). In view of this wide gap (effective operational capacity may be still less), 19,210 mld untreated sewage is discharged into water bodies and which in-turn leads to the associated adverse environmental and public health impacts.

In recent years the Government of India has initiated two very comprehensive urban infrastructure strengthening programmes, viz. Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) with a tentative outlay of Rs. 1000 billion (~USD 22.5 billion, @ Rs. 44.5/USD in 2006) which are co-terminating with the Eleventh Five Year Plan by 2012. Under these programmes, among others, construction of on- and off-site sanitation infrastructure is one of the key components (accounting for almost 40% of the outlay) and it is understood that several large, medium and small municipalities are planning or have already started construction of conventional sewerage system. It is also noted that for its perceived benefits, municipal councillors and officials increasingly prefer water borne excreta disposal system. While sewerage network represents a higher order technology option and which can enable significant improvement in sanitary conditions in a habitation, one of the preconditions for its satisfactory working is adequate water supply. However, with several urban areas being characterised by restricted water supply and declining service levels, it would be a challenge to ensure trouble free operation of a conventional sewerage system. It is also recognised that there are several challenges in its construction in congested areas, low income settlements, and even in new layouts in the suburbs because of high capital cost, space constraints, higher gradient requirements, subsidence, etc. Moreover, where topography is unfavourable, sewage pumping stations are unavoidable and it has been observed that municipalities find it difficult to sustain their operation because of high energy costs.

Simplified sewerage - an appropriate technology option

Rapid urbanisation and the accompanying pressure on the existing sanitation infrastructure require innovative and affordable solutions for meeting the needs of growing population. In this regard Brazil took the lead in early 1980s in developing an unconventional sewerage system which has come to be recognised as simplified sewerage, shallow sewerage or interceptor sewerage, etc. All of these systems are characterised by few basic features, i.e., provision of a solid interceptor tank at individual property connections and small diameter sewers laid at shallow depths. These features enable design of the sewer lines based on tractive force criteria rather than the minimum velocity criteria (as in the case of conventional sewerage). Secondly the sewer gradient is designed based on initial design flow and the diameter is designed based on the final design flow (Mara, et. al., 2001). These considerations enable use of smaller diameter pipes (minimum 100 mm) at mild slopes. With mild slopes, excavation is shallow, allowing cover of 400 mm or less, and minimising or altogether eliminating the need for lifting of sewage. As the sewer lines are installed below sidewalks/footpaths or inside private properties, heavy vehicle loads are not expected and as a result the need for providing a minimum depth of soil cover is also reduced. Further, with shallow pipes, the requirement of deep manholes is eliminated and instead shallow and less expensive cleanouts or access chambers are provided. All these modifications result in almost 50% reduction in capital cost compared to conventional sewerage. Further, experience in Brazil has shown that simplified sewerage is cheaper than on-site sanitation in areas with population density higher than 175 persons/ha.

Maintenance requirements of such a system comprise occasional flushing of sewer lines, removal of blockages through rodding machines or flushing equipment, repairs of sewer lines and connection chambers, as needed, manual inspection, and desludging of interceptor/septic tanks once every 5 years or so.

One of the essential and desirable aspects of developing a simplified sewerage project is the need for community participation in its planning, construction and O&M. For instance while interceptor tanks are essential, further cost reduction is possible on users' end by sharing of the interceptor tank by a group of houses before connecting to the network. The users also need to ensure that no large objects are disposed into the toilets and the tanks are emptied when full.

Simplified sewerage system has been found to be reliable, upgradeable and extendable. It is applicable in all situations but especially suitable for areas characterized by gently sloping topography, high and low-density population with reasonable water supply, small homesteads with lack of space, high water table, impervious soil and shallow bedrock. Variation occurs in rolling terrain where need for intermediate pumping may arise, however generally one or two lifts may be all that would be required. In Orangi slum settlement of Karachi, Pakistan, over the years the community with support from facilitating organisations is reported to have developed a wide network covering over 600,000 poor people and has been able to bring about significant sanitation improvements. In Brazil initially this system was provided in low income habitations, however, it is now successfully and appropriately used for low density middle- and high-income neighbourhoods as well.

Another advantage of this system is that it enables decentralised treatment of sewage in the form of either a low cost community septic tank followed by a wetland or somewhat higher order treatment option according to the applicable discharge standards. In this regard, it is to be recognised that on account of individual interceptor tanks, settled sewage also requires lesser degree of treatment.

Indian experience

The latest available edition of the Manual on Sewerage and Sewage Treatment of the Central Public Health and Environmental Engineering Organisation (CPHEEO), Ministry of Urban Development introduces 'small bore' and 'shallow sewerage' as appropriate technology options (CPHEEO, 1995) however as yet they have not been adopted by consulting organisations, municipal engineers and urban local bodies. Apparently lack of local references, design expertise and experience in O&M can be attributed to hitherto low acceptance of these options.

However, a small beginning has been made during last 5 years under the Department for International Development, UK (DFID) supported project 'Andhra Pradesh Urban Services for the Poor' at Ramagundam (Census-2001 population 247,751) in Karimnagar district of Andhra Pradesh[2]. To start with, the municipality identified a resettlement colony of 300 lower-middle income families for a pilot project wherein each family agreed to construct an individual household latrine at its own cost and contribute towards 40% cost of sewer network. Each house connection includes a raised chamber at the front of a property. The sewers are of 150 mm diameter and are laid rather shallow, with invert between 150-200 mm below ground (Photographs 1&2). The combined sewage from 300 houses is discharged into a common large septic tank which subsequently overflows into a storm water drain. Although there are no individual interception tanks on any of the properties, the pipes are not laid perfectly and the treatment is not complete, the system can be characterized as 'shallow sewerage' or a variant of 'simplified' sewer system. It has resulted in significant behaviour change with preference towards fixed point defecation among the beneficiaries and improvement in environmental sanitation within the community. In 2003-04 the project cost was Rs. 0.75 million (~USD 15,790, @ Rs. 47.5/USD in 2003) wherein each family contributed Rs. 1000/- (~USD 21) towards community contribution and the balance was paid by the municipality. Drawing from this successful initiative, in subsequent years Ramagundam Municipality has by now provided total sanitation coverage in 13 middle and low income colonies benefiting around 6600 families with incrementally improved design and construction specifications and the average cost of construction is found to be Rs. 1100/- per person (~USD 23.2). This is found to be one third of the going estimate of Rs. 3000/- per person (~63.2 USD) for the conventional sewerage system. An interesting aspect under the whole programme has been provision of cement concrete pavements along with the simplified sewerage which together have led to significant improvement in the quality of life of the beneficiary communities.

These simplified sewerage networks are found to be working well and the community is satisfied with the level of service. The municipality is responsible for repairs and maintenance aspects while the community extends necessary support in terms of timely reporting of any blockages and sharing of minor costs. In due course the municipality plans to collect overflows from community septic tanks, which are currently discharged into open drains, and divert them to one of the two existing sewage treatment plants (which are based on waste stabilisation pond technology) which were constructed under a separate centrally sponsored programme. However it has yet to overcome several challenges, mainly resource constraints, before the overflows could be fully intercepted and the treatment plants could be commissioned satisfactorily.

Photograph 1. Simplified sewerage in a resettlement colony in Ramagundam.

Photograph 2. A shallow chamber for house connection.

Conclusion

Based on the experience from Brazil and several other Latin American countries, simplified sewerage has been recognised as an important, appropriate and affordable off-site sanitation technology option in peri-urban areas, high density slums, squatter settlements and comparatively larger rural areas of developing countries. It is recognised as the only technically feasible solution in areas characterised by high population density, small plots, relatively reasonable water supply levels, adverse groundwater and soil conditions, and has been successfully implemented even in affluent areas as well. However, this sanitation technology has not received due recognition and acceptance within Indian sanitary engineering community. Limited experience from Ramagundam in Andhra Pradesh shows that this is a feasible and acceptable solution in the Indian context as well which enables significant improvements in sanitation conditions with substantial reduction in costs and time of construction. The current impetus on urban infrastructure strengthening under the JNNURM and UIDSSMT programs of the Ministry of Urban Development and on sanitation in rural areas (with reference to villages with population > 5000) under the Total Sanitation Campaign of the Ministry of Rural Development offers an opportunity to adopt this technology for wider and rapid coverage of un-served and under-served population. There is a need to evolve appropriate policy and technical guidelines so that the sanitary engineering community, the consultant fraternity, the urban local bodies and the state public health engineering departments can develop confidence on this option and start offering as a 'standard solution' for not only low income areas but high income areas alike. A few more success stories within the country will lay the ground for its wide scale adoption and thereby bring the country closure to meeting the Millennium Development Goals and the global goal of full sanitation.

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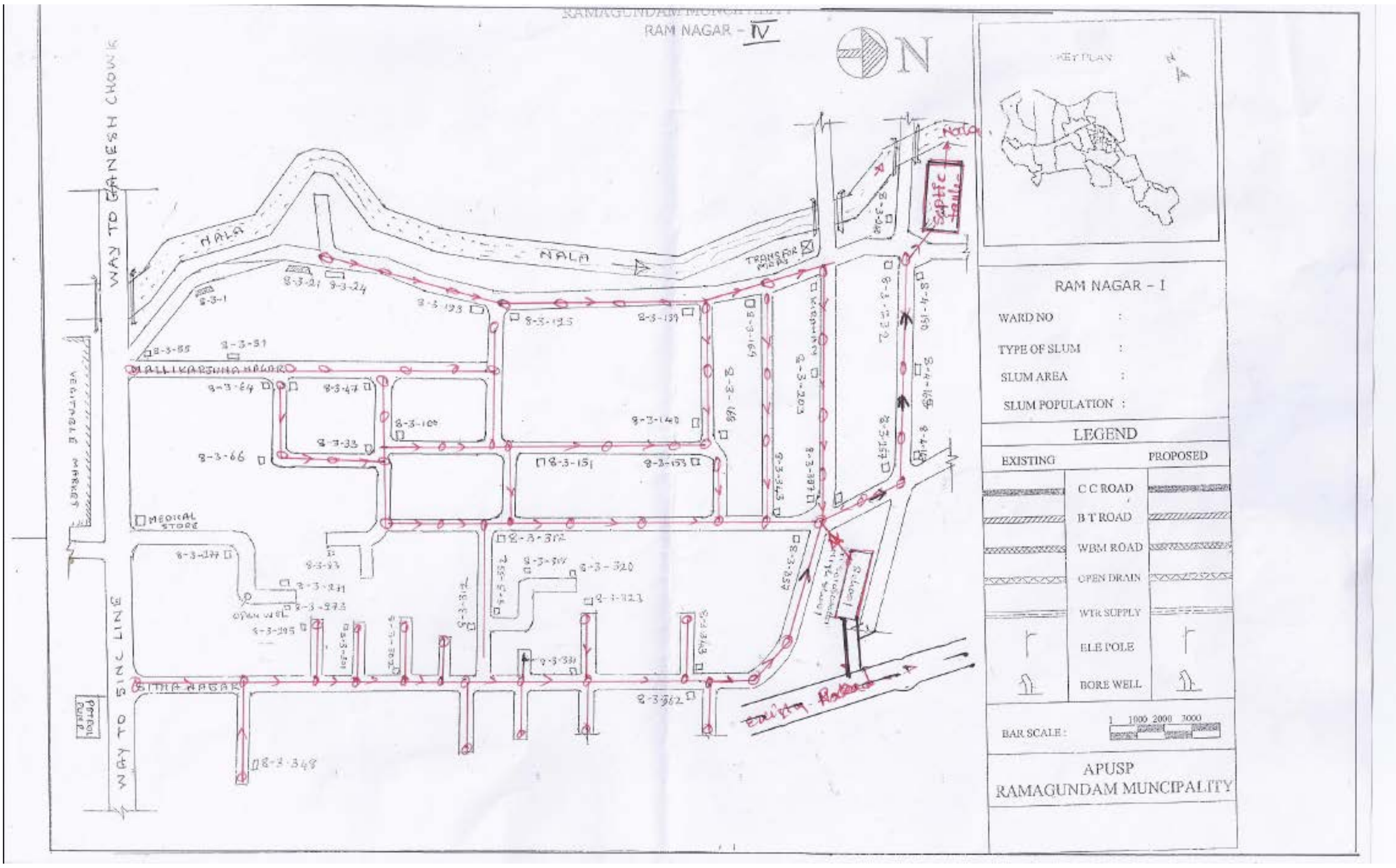
[1] Exchange rates for various years have been taken from www.exchangerate.com.
[2] The author has been involved in preparation of strategic sanitation and solid waste management plans for Ramagundam and four other small municipalities in Andhra Pradesh and Maharashtra on behalf of the Water and Sanitation Program – South Asia of the World Bank during 2006-08. The information presented here is based on first hand data and personal visits to the sites.

ANNEX 2: MAP OF THE SIMPLIFIED SEWERAGE NETWORK IN RAMNAGAR SLUM



ANNEX 3: MISSION AGENDA

DATE	AGENDA
Nov 23, 2012	Travel to Ramagundam
Nov 23, 2012, Evening	Meeting with the representative of the Ramagundam Municipal Corporation.
Nov 24, 2012, Morning	Briefing meeting with the Municipal Commissioner and Engineers of the Ramagundam Municipal Corporation. Visit to Lenin Nagar and Ram Nagar low income settlements – Community consultations.
Nov 24, 2012, Afternoon	Meeting with the Engineers – Data collection.
Nov. 25, 2012, Morning	Visit to Prashanti Nagar resettlement colony – Community consultations. Visit to Lenin Nagar – Consultations with service providers. Visit to Parshuram Nagar low income settlement – Community consultations. Visit to Indira Nagar low income settlement which does not have sewers and roads and represents baseline – Community consultations.
Nov. 25, 2012, Afternoon	Debrief meeting with the Municipal Commissioner and Engineers of the Ramagundam Municipal Corporation. Evening - departure for Nagpur.