



Water and Sanitation Program

An international partnership to help the poor gain sustained access to improved water supply and sanitation services

Case Study

**Of the people,
by the people,
for the people:**

Community-Based Sewer Systems in Malang, Indonesia



Water Sanitation Program
for East Asia and the Pacific

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MALANG AT-A-GLANCE

- Malang is located 80 km south of Indonesia's provincial capital Surabaya, in East Java.
- At an altitude of 400-650m, the climate is markedly cooler than the coast; volcanoes to the north and north-west loom over the city, which is divided by several quite deep river valleys.
- 1997 population was about 790,000, growing at the rate of 2 percent per year.
- The Municipal area is approximately 11,000 Ha (housing 4,721 Ha; schools 500 Ha; industry 165 Ha and other 5,620 Ha).
- Employment: commerce, mainly small trade (30%), and services (40%), with industry playing a relatively minor role in the city's economy (14%); the city is also a regional academic center.
- The recent economic crisis has caused an influx of thousands of people, many of whom have found refuge in the poorer valleyside settlements, some of which are considered slums (kumuh) by locals. Annual population growth rates in these localities are estimated at 5 to 8% per year by local NGOs.

The Sewerage Scene in Indonesia

Indonesia has one of the lowest rates of urban sewerage coverage in Asia, causing widespread contamination of surface and ground waters. As a result, the country has experienced repeated local epidemics of gastrointestinal infections, and has the highest incidence of typhoid in Asia. Economic losses attributable to inadequate sewerage are conservatively estimated at US\$ 4.7 billion per year, or 2.4% of 1997 GDP-roughly equivalent to US\$12/household/month (ADB 1999).

The low coverage is partly the result of the Government of Indonesia policy, which currently assigns responsibility for sanitation to households (World Bank 1993). This policy-which is a result of the poor past performance of large centralized sewer systems- has inhibited the evolution of effective local government institutions for the planning, implementing and operating of sewer systems.

Since about 1980, the proportion of the urban population in Indonesia served by sewer systems has stagnated. Yet in 1995, 73% of urban households had some form of private on-site sanitation. The partially-treated, or untreated, effluent from these facilities typically flows into open drains or directly into water bodies. Proper disposal of human waste, either septage or sullage, is a rare exception. Given the scale of the problem, interest in neighborhood or community-based sewer systems (CBSS) is increasing.¹ This study summarizes one of the more successful examples of CBSS in Indonesia.²

The main lesson that has emerged are familiar one: ***there is a direct relationship between community participation in all aspects of decision making, construction and operation of a CBSS- and its operational success.***

Mr. Agus Gunarto: a catalytic role

As they say, it takes one man to make a difference. In 1985, Mr. Agus Gunarto, or Pak Agus*, took the initiative to develop a CBSS for his own community, Tlogomas, on the outskirts of the city of Malang.

Since then, he has been instrumental in encouraging other communities in Malang to establish their own systems. His catalytic and supportive presence has been especially important in helping communities to gain confidence in their capability to meet the technical, financial and organizational challenges of constructing and operating CBSS systems.

Over the past several years, these local efforts have begun to receive active external support-first from NGOs, then multilateral donors and the municipal government.

In 1997, Pak Agus received a Presidential Award for individuals' contribution to environmental preservation and improvement.

The same year, he became a staff member of the Malang municipal Sanitation Department, where he now leads a small team with a mandate to replicate

* 'Pak' is the public form of address for Indonesia men

the example of the CBSS in Tlogomas. During the past two years, this team has played an active role in assisting other communities in Malang to establish their own CBSS. This included assisting them with community organizing, accessing sources of external funding and negotiating permission to construct treatment facilities on government land.

Where it all began: Malang, East Java

Malang, like most medium-sized cities located in the hilly areas of Java, has fairly deep river valleys dividing the urban area. Most of the older parts of the city have been built on ridgelines; the newer parts, especially lower income areas, are spread along the river valleys where land is "available". In general, riverside locations make disposal of human waste physically easier than on the ridges, but not necessarily healthier or more environmentally responsible.³



Typical Riverside Low Income Community

How it all began

The first CBSS in Malang was established in Tlogomas. A localized diarrhea epidemic in 1985, led to the death of five children from poor families. This propelled the women in the community to start agitating for improvements in drainage and sanitation. Until then, children still defecated in open drains just outside their homes, making living conditions both unpleasant and unhygienic. Many families used the river as their toilet.

The openly expressed concern by the women led to a group of six families initiating community action to overcome the problem. Pak Agus, newly appointed to the position of neighborhood head (RT), became the facilitator and leader of this group. He searched out information on sanitation systems from friends and colleagues in Malang. The solution chosen was to build a community sewerage system.

The group of families began by pooling their own limited funds, and then organized with neighbors to collect more funds, acquire materials and start construction of the system. In Tlogomas, both men and women played an equal role in making plans, accumulating funds and constructing the system- but women were the initiators.

A recent poverty study showed that in urban areas, access to proper environmental sanitation is the second highest priority for women, and only the eight highest priority for men.

For over a year, Pak Agus worked to convince other members of his neighborhood to contribute to the construction of the system. Space was available for the treatment facility on communal land adjacent to the graveyard and watercourse. Even with significant community support, it took nearly two years of focused work before the system was operational. And although the six initiating households started using the system in 1987, it was almost 10 years before all members of the community were connected to the system.

Since then, CBSS have been established in five other communities: Watugong, Mergosono, Bareng, Samaan and Gadang. These are communities at the edge of poverty, with sections that can rightly be classified as slums. The systems in these communities have all been evolving since 1993, with most being constructed since 1997.

Just as in Tlogomas, it was the women in most of these communities who were most concerned about open drains and unsanitary conditions, and who played a central role in initiating action.

In addition to the community-initiated systems there are now three larger World Bank-financed pilot systems in final planning stage, while USAID's CLEAN Urban Project will support the community organization aspects of these schemes.

These will service large portions of the kelurahan (*districts?*) of Ciptomulyo, Jodipan and Mergosono, serving a population of more than 25,000 people.

How does the process work?

The emerging pattern for establishing CBSS is that a community, often with outside stimulus, first decides to take action.

The community then begins the lengthy process of accumulating funds and planning technical aspects

of the system. Using community labor supported by craftsmen, they construct the system. Work begins with the treatment plant, progressively extending the main collection network and connecting households. The speed with which the system becomes operational depends mainly on the extent of community organization and motivation. The rate at which households connect depends on their willingness to pay for the connection, internal plumbing and equipment requirements (which they may be able to fulfill through installments or a local revolving fund).

Some houses do not have space available for building a WC, and the need for communal or shared toilet facilities is fairly common in the most densely populated areas.

Table 1: CBSS in Malang

Kelurahan	Potential Service Area (H'holds)	No. H'holds Currently Connected	Approx. No. People (Currently connected?)	Population Density (pers/ha)
Tlogomas	67	67	585	64
Watugong	223	108	540	64
Mergosono	600	200	1,000	367
Samaan	60	20	100	243
Bareng	60	9	45	183
Gadang	95	0	0	78
Sub-Total	1,105	404	2,020	-

Yes, even the poorest communities pay for services they really want....

All of the communities accumulated funds from their members to pay for public (main pipe network and treatment plant) and private investments (household connections and interior plumbing). As can be seen in Attachment 1, communities' contribution ranged from only 10 percent in Samaan, to 100 percent in Tlogomas.

The funds are managed by special committees set up either in the immediate neighborhood (as in Tlogomas) or a grouping of adjacent neighborhoods (as in Mergosono). All of the communities, except Tlogomas, received funding from government and/or donors as a contribution towards payment for the initial public elements of the systems. A combination of voluntary and paid labor undertook the construction.

In each community, all the households connected to the system are required to pay a small monthly service charge, and most communities have engaged one or two local people who are paid a fee for maintaining the treatment plant. Community arrangements for funding major repairs and longer-term maintenance are handled on an ad hoc basis, requiring special collection of funds.

What about the technical angle?

All of the CBSS studied are based on a network of 100 mm (4") plastic collecting pipes laid beneath footpaths or below existing drains running along walkways through the communities (see Attachment 2 for details). Flow is entirely dependent on gravity. The treatment plant is located at the lowest point in the system, and discharges into the river or local watercourse. Treatment plants are constructed from concrete and plastered brick tanks and chambers, and some of the facilities are covered with light sheet metal shutters.

The treatment process used in all locations is Anaerobic-Suspended Biomass, often referred to internationally as communal septic tanks. Locally this has come to be known as the "Tanki AG" (or "Sistem AG") - from the initials of Agus Gunarto, who popularized it in Malang.

Lessons Learned

The treatment efficiencies in the five CBSS are widely divergent. On average, Biological Oxygen Demand (BOD) loads declined by 55%, Chemical Oxygen Demand (COD) loads by 47% and Total Suspended Solids (TSS) loads by 67%. The variation in treatment efficiencies is mainly due to the quality of construction and operation of these systems. As a result, most CBSS still do not meet Class C effluent quality standards.

With the exception of the CBSS in Tlogomas, all of these systems are in the early stages of evolution and there are a number of important challenges still

to be met. On the other hand, Tlogomas is a clear illustration that it *is* possible for a community to finance and build a CBSS that is self-supporting, meets national effluent discharge standards and operates successfully for an extended period of time.

The three broad lessons learned from the Malang CBSS experience to date are:

- ***There exists a significant "unrevealed" demand for sanitation services beyond the household level in poorer and middle income neighborhoods. This is contrary to the conventional wisdom that demand is low or nonexistent, and that poorer people are not willing to pay for these services.***

In Malang, the example of Tlogomas has generated the interest of other communities in the city. Once there was a practical demonstration in a local community, other neighborhood groups were much more open to taking action themselves. The efforts of a few people have thus established that it *is* possible for communities to fund, organize, build and operate CBSS.

Five additional systems have been set up since Pak Agus took over as a "consultant" to other communities in Malang. The local government engaged him to work full-time, promoting the CBSS approach and, through the provision of investment subsidies, has helped to encourage community-based action.

It has become quite clear that people are willing to pay for investment and O&M costs, but the amount and reliability of their payments is closely related to the degree of community participation in decision making. The most obvious example of this is the CBSS in Samaan. This system was heavily subsidized by the Government under a social safety net program, but there was little community involvement in the design or decision making. Consequently, consumer satisfaction turned out to be very low.

- ***The main reasons for this "unrevealed" demand for sewer service are that many people in Indonesia do not really know what 'sewers' are, nor are they fully aware of the benefits of sewers and that there are innovative, low-cost ways to build them.***

Tlogomas offered concrete proof that CBSS could be built by the community. Until then, local people had no knowledge of what might be possible. Because of the "big and expensive" mind-set, the government had not been active in informing people that there were low-cost options available, let alone constructing demonstration systems.

Once local interest has been aroused, providing basic technical and organizational support is key to a community making the necessary commitment.

- ***Sewerage does not have to be prohibitively expensive; community-based systems can be built for per-household costs that are comparable to the costs of individual 'septic' tanks.***

Capital and operating cost information currently available suggests that CBSS are cost competitive with individual septic tanks. In situations where households already have septic tanks, the total additional investment per household to connect to a sewer system is roughly equivalent to the cost of three years of sludge removal service, equal to Rp 150-300,000.*

Technical issues appear to be the most easily addressable; existing systems can be modified quite simply and cheaply.

Emerging Issues

During the course of the case study, several issues emerged, which need to be addressed in establishing sustainable CBSS.

* Approx. US\$ 20-40, as of Jan 2000

Organizational Issues

The lessons summarized above suggest that the most important issues are political and institutional rather than financial or technical. What would help to change this?

- decision making authority should be located where consumer services and those responsible for O&M are located.
- local (and provincial/national) government institutions need to assist communities to take the initiative in establishing a CBSS.
- when communities take the initiative, governments should be better prepared to meet the communities' demand for technical, financial and/or organizational support.⁴
- a critical issue is to find effective means for channeling appropriate financial, technical and management support to communities.
- a need exists to combine community efforts with support from third parties, including NGOs, external support agencies (ESAs), the private sector and local government.



Tlogomas: Main pipeline laid in lane.

It is unrealistic to expect that local governments will be capable of delivering all of the needed support to communities. The local government should act as an umbrella organization for the channeling of broader public funds and technical backstopping, while ensuring adherence to national standards and regulations. There is a need to identify other institutions, which can assist in the effective delivery of social and technical support to the communities. The obvious candidates as implementation partners are local and national NGOs (with the social expertise, and which have or can develop the necessary technical skills), the private sector (e.g., local artisans and contractors) and, to a lesser degree, local technical colleges and universities.

The main organizational lessons learned include the importance of:

- establishing linkages between communities, NGOs and the private sector which can provide social and technical assistance to move from initial commitment to planning and constructing CBSS;
- defining the role of local government; given its current capabilities in Indonesia, this should be to serve as a channel for public sector financing and technical support;
- fostering the technical skills of local artisans and contractors, who can play a pivotal role in constructing and maintaining CBSS;
- limiting the scale for CBSS systems in one neighborhood (RW) to a manageable but efficient size (between 150 and 300 households). In some areas, for technical reasons, this may be too large and about 50 households would be a more appropriate size; and
- establishing or working through local institutions that can provide consistent, appropriate longer-term technical and organizational support to large-scale popularization of CBSS.

Social Issues

The systems studied clearly demonstrate that poor urban communities in Indonesia have adequate capacity to initiate, organize, design, finance, construct and operate their own sewer systems. In the prevailing socio-political climate in Indonesia, this is a significant finding. The success of CBSS appears to be directly proportionate to the level of community engagement. It is also fairly clear that an "animator" is often necessary- in this case, Pak Agus- to get social processes moving.

Specific lessons learned include the importance of:

- Strong links between the level of community involvement in planning, financing and construction and consequently the successful operation of the systems;
- Social incentives in the opening stages of preparation, through early facilitation, outreach/extension programs and cross-fertilization among communities; and
- Proceeding at community's own 'social pace,' especially in terms of the evolution of management structures, and the financing operations and improvements.



Brantas River - multiple uses: bathing, washing, and open-air toilet

Financial Issues

The Tlogomas system was completely self-financed by the community. The five subsequent systems studied all received outside financial support in one way or another at different stages in their evolution. It is widely recognized that communities, even relatively wealthy ones, are not capable of wholly self-financing sewer systems if they are to begin operating within a fairly short time span, and be technically effective.

Financial support to communities needs to be carefully designed. Subsidies for the public goods component of CBSS, e.g. main pipelines and treatment facilities, might be justified. This type of financial support could help accelerate the establishment of CBSS, especially in poorer communities and those lacking favorable topographical conditions. Yet, the sustainability of such subsidy schemes needs to be carefully examined. The question is how external support can encourage community-based financing, without negatively distorting community expectations or "ownership."

Thus the critical issues are:

- estimating how much incentive is required, while avoiding undermining local fund raising efforts;
- establishing institutional mechanisms for providing, managing and accounting for funds;
- targetting subsidies with regards to the economic status of the community and the technical difficulties involved in establishing the system - e.g., proportionately more for poorer communities in flat areas; and
- determining the timing and type of subsidies - e.g. direct (cash/material subsidy or loan funding), or indirect (via provision of technical support.

Technical Issues

There is a fundamental need for improved technical support for system design and operation, as only a few of the current systems meet even basic effluent discharge standards. Needless to say, all of these systems would have benefited if appropriate technical advisory services had been available early in the process.

The currently established CBSS in Malang have basically been designed using 'folk technology.' Such technologies are based on a pre-scientific understanding and explanation of the biological processes occurring. Despite this, Tlogomas meets the Class C for effluent quality established in Indonesia standard (and is just short of meeting the Class B standard). All other systems roughly halve the pollutant levels in the influent stream, even though they fall short of meeting national Class C standards. In most of the existing CBSS, the influent level of BOD (400-800 mg/l) indicates that wastewater also includes kitchen and commercial food manufacturing residues. Hence, treatment systems either need to be designed to deal with high BOD loadings or be used only for toilet waste.

Despite technical shortcomings, the physical basis (piping, house connections, treatment structures) for relatively inexpensive upgrading now exists, where nothing at all existed previously. The systems are slowly but systematically being improved. As a result the same structures, sometimes with additional treatment tanks and filters, can be made more effective, while keeping the technology suitable for local O&M.

The main technical lessons learned include the importance of:

- early provision of low-key, informal technical advice and planning support to communities that have made a commitment to construct CBSS, possibly as part of a broader package of assistance;

- provision of short-term, hands-on technical training for communities and contractors), who will be involved in constructing and operating the system. These should include cross-visits among communities, and advanced training courses targeted specifically at community organization and functions; and
- development of technical standards and guidelines suited to the actual economic realities of low-income communities (including practical design, construction, connection and operating guidelines).

Environmental Health Issues

The study revealed a widespread awareness of, and broad improvements in, personal hygiene practices in the communities studied. Such awareness is unusual in Indonesia.

It is likely that this increased awareness is largely due to the participatory nature of the CBSS approach. Thus the establishment of CBSS provides the ideal opportunity to address issues related to community awareness and responsibility, and environmental health. This is an area where a working partnership between the community, NGOs and local government is possible- and necessary.

The main environmental health lessons learned include:

- the need for local governments to organize sanitation promotion campaigns and mobile field assistance teams to work with local communities in developing participatory approaches;
- encouraging external support agencies to provide educational and technical materials to support such efforts;
- complementing the above with similar campaigns in schools; and

- establishing a community environmental management group, which can later become part of a broader network for managing CBSS and organizing a wider range of activities for improving local environmental health (as demonstrated by the NGO CARE in Malang). (include cross reference to further CARE info).



Malang - Congested housing in a poorer neighborhood

Possible Roles for External Support

The challenge for ESAs is to devise means of speeding up the establishment of technically robust CBSS in suitable locations in urban Indonesia. This is based on the conviction that CBSS is a valid, if not the only, alternative to large-scale sewer systems for significant portions of the country. The effluent from properly constructed and managed CBSS can meet national discharge standards (Class B), and they are potentially a permanent alternative to large-scale sewer systems.

For parts of urban and small town Indonesia, they could also evolve to form components of larger networks involving trunk sewers.

The immediate challenge is to identify appropriate means for flexible delivery of basic technical, organizational and financial assistance, in order to improve capacity in communities interested in establishing CBSS. The involvement of NGOs and private firms will almost certainly require funding from external sources, at least in the near term. In the medium term, it may be necessary to devise ways of providing institutional support to enhance delivery of technical backstopping to local communities for CBSS start-ups or expansion.

Having NGOs and private firms work simultaneously with municipal sanitary departments (or their equivalent) and local communities, will probably still be required during the short to medium term. In addition to other types of ESA assistance discussed above, city-wide and multi-city projects could also be supported by:

- seeking agreement/acceptance from the major GOI agencies involved (Ministry of Public Works, Ministry of Home Affairs and Ministry of Environment), that CBSS is an appropriate solution for community wastewater management;
- contracting with national and international NGOs or private firms to establish small teams capable of providing roving organizational, technical and financial skills support to both local communities and local governments;
- providing small "seed" loans/grants, possibly delivered via NGOs, to communities to construct those parts of CBSS which have a clear 'public goods' character, e.g., the treatment plant and main pipelines; and
- providing finance from MOF to local governments, to initiate small revolving funds or grants, distributed to and controlled at the district level.

In Conclusion

Does CBSS work? Is it the solution to urban and small-town wastewater disposal problems? Can the success of Tlogomas be replicated elsewhere?

The answers are mostly yes, yes.... and but.

Yes, it works. Yes, it is a viable option for urban and small-town Indonesia. We now know what the overall enabling and inhibiting factors are. And as with any success story, Tlogomas may not be replicable in every detail, but it can- and should- be used as a model, and adapted to fit local conditions.

And when we're talking CBSS, it's important to remember that the greater the level of involvement of the 'Community Based' component, the greater the sustainability of the 'Sewer Systems' component.

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- ¹ The complex range of social, economic and institutional issues related to the advantages and disadvantages of centralized and decentralized sanitation systems, and the advantages of "unbundling" sanitation services is fully explored and discussed in Wright (1997).
 - ² Other examples of CBSS can be found in Yogyakarta and Bandung.
 - ³ The topography of cities like Malang is in sharp contrast to the (larger) urban areas located on the coastal plains, such as Jakarta, Semarang and Surabaya, where the landscape is flat and flood prone, and the physical problems of waste disposal are exacerbated by size, sprawl and very moderate slopes.
 - ⁴ The findings in Malang echo findings from the International comparison and assessment of best practice for provision of urban infrastructure services to low-income communities (World Bank 1996).

Photo Credits: all photos by Richard Pollard.

Attachment 1

Case Study Results - Financial

These findings clearly reveal the willingness of even poorer urban communities to contribute to the costs of constructing and operating CBSS. Nevertheless, some kind of financial support will be necessary if the CBSS approach is to make a substantial and timely contribution to resolving the worsening sanitation problems in Indonesia.

System Investments

Information on the financial aspects of five CBSS was collected through sample surveys of 10%-50% of the households connected to each CBSS. Information on the history and involvement of third (external) parties was collected through informal discussions in each community.

Several types of investments are required to establish a system: (i) public investments for the construction of the treatment plant, main pipe network, and the connection from individual households to the main pipe; and (ii) private investments for the construction of household WCs. The chronology of system development and the sources of different public investments are summarized in the table below.

Table 2: CBSS Chronology and Sources of Finance for Public Investments.

Location	Project Initiated	Began Operation	Total Public & Semi-public Investment	From Community	From Gov't	From Other Sources	Contribution per H'hold
Tlogomas	1985	1987	6,000,000	6,000,000 100%	- 0%	- 0%	95,000 ¹
Watugong	Mar 1997	Jul 1997	17,000,000	8,800,000 51.7%	1,000,000 5.8%	7,200,000 ² 42.3%	75,000
Mergosono	Mar 1997	Jul 1997	18,500,000	16,000,000 86.5%	2,500,000 13.5%	- 0%	100,000
Bareng	Mar 1997	Aug 1997	4,295,000	2,045,000 ³ 47.6%	2,250,000 52.4%	- 0%	50,000 ⁴
Samaan	Nov 1997	May 1998	6,100,000	600,000 9.8%	5,500,000 ⁵ 90.2%	- 0%	20,000

Notes: All amounts in Indonesia Rupiah (IDR) at time of construction. The last column is the average amount each household had to contribute.

1 = In Tlogomas, poorer households had to contribute Rp. 75,000, while other households contributed more.

2 = Watugong received a total of Rp.17,200,000 for a variety of local improvements (mainly roads and sanitation). Of this amount, about Rp.7,200,000 was used for sewerage.

3 = In Bareng, accumulated community savings was actually only Rp 450,000 and the remainder was pre-financed by one wealthy family; conditions attached to this pre-financing were not clear, and as a result it has become a source of serious conflict in the community.

4 = In Bareng, only Rp 22,000 has so far been collected from each household.

5 = In Samaan, the financing includes a large amount of funds from the special government program called the "social safety net" (JPS). In other words, the CBSS was driven by this government project.

It should be noted that high inflation and the drastic devaluation of the IDR over 1997 and 1998 have radically increased the cost of construction materials in local currency, especially those with a large imported content (Table 3). A substantial part of the investments necessary for household connections have been borne (in most systems) by individual households. In Tlogomas, the community put into place a cross-subsidy system, in which poorer households had to pay less than wealthier

households. In three other communities, the cost of house connections was included in the total per house hold investment in the entire system so that all households paid the same amount, and external financial support subsidized the total investment. In two of the systems (Tlogomas and Watugong) there has been an increase in the average household contribution for all new household connections - from Rp 75,000 to Rp 150,000 and Rp 95,000 respectively in response to local current inflation.

Table 3: Current System and Per Capita Investment Requirements.

Location	Total <i>Public</i> Investment Required (in 1999 Rupiah)		Population Served (actual)	Public Investment per Capita	
	IDR	US\$		IDR	% of monthly family expenditures
Tlogomas	12,614,000	1,417	585	194,062	24.9%
Watugong	19,058,000	2,141	880	95,290	14.5%
Mergosono	19,780,000	2,223	800	106,919	19.9%
Bareng	6,428,000	722	145	139,739	NA
Samaan	9,143,000	1,027	150	304,767	NA

Notes:
 Calculation of Public Investment Required is based on material prices in IDR at 1999 rates, and a participatory community approach using mainly voluntary labor. Population Served based on the current number of people connected, in some communities, is significantly higher than the normally assumed 5 persons/household, e.g. in Tlogomas. The original contribution to Watugong from USAID's CLEAN Project was used for a number of other community projects in addition to the CBSS, the figures used in Tables 2 and 3 are based on investments required only for CBSS in 1999 Rupiah. In Bareng and Samaan the number of people connected is below design capacity, hence the public investment required per capita appears to be higher.

Typically, the initial investment required to construct a CBSS in Tlogomas was about US\$22 per household. The investment required depended on: (i) the number of households served per system; up to a point, the more households are connected, the cheaper it is; (ii) population density, higher density allows more people/households to be covered with a similar length of main piping; and (iii) favorable slopes; these reduce costs as smaller pipes can be used for the mains. Assuming that payment could be spread over 20 equal montly installments- as appears to be the current pattern- this US equivalent to about US\$1/month/household (not including private investments in building a WC or bathroom). The comparative costs of building an individual septic

tank are currently about US\$45, and maintenance costs (desludging) about US\$9 per year.

Manageability is a factor that should be taken into account. A system which serves too many households and covers too large an area is likely to be beyond the management scope of community-based organizations. In Indonesia, the RW (community group) of about 150-300 households is probably the optimal size from both the technical and organizational perspectives. It is also large enough to be able to accumulate the capital necessary for public and semi-public investments. Within this group (made up of a number of adjacent RTs or households) there is a high degree of cohesiveness, solidarity and mutual social control.

Community Contribution vs. Community Income

There has been much discussion in Indonesia concerning willingness-to-pay and the priority placed by a community on sanitation systems vis-à-vis other priorities. In general, the conclusion has been that providing primary treatment sewer systems is a challenge beyond the abilities of the community. A closely related issue has been communities' ability-to-pay for 'expensive' sewer systems, especially in low-income areas where it has been argued (or assumed) that they are not capable of financing even communal facilities. This has led to a situation where, for a long time, it has been assumed that improved sanitation depends largely on government investment. In reality, the cost (per capita) of the system depends mainly on the feasible technology options, the technology chosen and the degree of community contributions (in the form of voluntary

labor) possible during construction. In general, investment costs will be higher per household for (smaller) piping systems constructed on flat or nearly flat land, and lower for larger gravity-based systems.

In Malang, the most effectively operating system is the one that was built without any outside contributions - so clearly the community assigned it a high enough priority and, having done so, managed to accumulate the needed funds. Table 4 shows that even poorer communities, like Mergosono, where 58 percent of the population lives below the poverty line, are willing to pay a significant part of the investment cost for a CBSS system. Regardless of whether the system was totally or partially financed by the community, the lower income families have contributed a higher percentage of their monthly expenditures (hence, income) than higher income groups. This is a particularly clear example of the willingness of low-income households to pay for what they consider to be an appropriate sanitation system.

Table 4 Monthly Family Expenditures of Households Connected to CBSS.

Location	Family Monthly Expenditure Range				
	<300,000	300,000 - 450,000	450,000 - 600,000	600,000 - 750,000	>750,000
Tlogomas	0%	10%	20%	20%	50%
Watugong	0%	36%	27%	18%	18%
Mergosono	29%	29%	15%	21%	7%
Bareng	25%	25%	0%	0%	50%
Samaan	13%	0%	50%	38%	0%
Average	13%	21%	23%	21%	21%

Notes:

All amounts are in early 1999 IDR. Families with monthly expenditure below Rp 300,000 (2nd column) are classified as being below the current poverty line, while those in the Rp 300,000-450,000 range (3rd column) could easily slip into the lowest income group through illness or any number of other family misfortunes. At the time of writing (March 1999) the actual 'poverty line' is probably close to Rp 450,000/month/family. The survey enumerated all family expenditures using prepared schedules, i.e. here expenditures are a surrogate for family income. In Indonesia this is regarded as a much more reliable means of judging a family's economic situation than attempting to identify and quantify all sources of income. It is similar to the method used by BPS in National Socio-economic Survey (SUSENAS).

Operations and Maintenance Costs

Information on contributions towards O&M costs were collected by interviews and compared with other recurrent costs (see Table 5 below). However, non-cash contributions to O&M (e.g. voluntary labor) were not included. With the exception of Samaan and Bareng, the level of the O&M fee in each community has been set at Rp. 750/household/month (or US\$0.10/household/month). This fee covers annually between 6 and 9 percent of the total investment cost. The amount for this O&M fee was determined by consensus among the users. Only compensation

for personnel responsible for O&M and minor repairs were taken into account when calculating this amount, and depreciation costs were not considered. The monthly O&M fee is the same for every household, regardless of the number of people who live there.

In Tlogomas, there is an explicit undertaking by the community of users that they will be jointly responsible for paying a special levy in instances where major repairs are required. In all the other communities, the CBSS are quite newly constructed and there has not been any need to undertake major repairs so far.

Table 5: Grouping and Percentage of Family Expenditure in Study area

Expenditure Group	Tlogo Mas	Watu Gong	Mergosono	Bareng	Samaan
Total Expenditure allocated to Utilities	2.59%	2.99%	4.14%	4.45%	2.54%
Electricity	2.32%	2.68%	3.60%	2.67%	2.34%
Water	0.00%	0.01%	0.28%	1.47%	0.00%
Solid Waste	0.16%	0.15%	0.13%	0.15%	0.19%
Sanitation	0.11%	0.15%	0.14%	NA*	NA*

* = No sanitation fee is being paid at present, due to internal conflict in the community.

** = Sanitation fee in Samaan is not yet determined, as construction has just completed.

Based on this information, all families connected to CBSS in Malang spent significantly less than one percent of total monthly expenditures on O&M of sewerage, and an almost identical amount on solid waste services, compare to total expenditures of 2.5% to 4.5% on all utilities (water, electricity, solid waste and sewerage). This percentage was higher for poorer families. The amount spent on sanitation definitely underestimates willingness to pay for these services. Communities have agreed to pay for major repairs on an ad-hoc basis. However, these systems are all relatively new, and have not yet encountered major repairs. In the long-run, it is therefore likely that the amount spent on O&M will be significantly higher than the current monthly sanitation tariff.

Attachment 2

Case Study Findings - Technical

These findings indicate that local people have not yet had an opportunity to learn about important biological processes and the role that good design and management play in facilitating or hindering waste treatment. This illustrates the need for much improved technical support.

Technical Performance

One of the first criteria used for assessing technical performance was the ratio of the *used capacity (m3)* to the *maximum hydraulic design capacity (m3)*. In all but one case (Tlogomas), the used capacity was only 23% to 87% of design capacity. As a result, the retention time available for biological processing will be shortened. The number of people per household and the types of waste the systems process varied widely between the communities studied. Official

population data of average family size can be misleading, as in three of the communities, boarders (mainly students) added substantially to the number of people living in many houses. In most communities, the systems are also used for gray waste (kitchen, bathroom and laundry) plus waste from food processing, laundry services and catering - this greatly increases BOD and COD. Based on the findings from the surveys, an average of 80 liters/capita/day of wastewater production was produced for calculating system capacities and performance in this study.

Table 6 : People Served, Daily Treatment Volumes and System Capacities.

Location	No. of H'holds Connected	No. of People Served	Volume Treated (m3)	Design Capacity (m3)	Used Capacity (m3)	Present Retention Time (hrs)	Potential Retention Time (hrs)	Max No. of H'holds
Tlogomas	65	585	46.8	72	72	36.0	36.0	70 *
Watugong	104	880	70.4	33	23	7.8	11.3	50 #
Mergosono	160	800	64.0	42	24	8.9	15.8	80 #
Bareng	22	145	11.6	18	16	32.0	37.0	30 *
Samaan	30	150	12.0	59	13	26.4	117.6	98 *

Notes: 'Volume Treated/day' is based on 80 l/capita/day times 'No. of People Served'. The 'Design Capacity' is calculated from measurements of the treatment chambers in each system; 'Present' and 'Potential Retention Time' are average retention times, actual times fluctuate widely throughout each day. In the last column ('Max. No. of Households Possible to Connect'), * = possible to connect additional households and # = system already overloaded.

The CBSS, as Table 6 and Table 7 show, were both "under" and "over" loaded. Both occurred as a result of misunderstandings by local people about the hydrological and biological principles underlying

operation. They were under-loaded because the full design capacity was not usually used (such as Samaan). As a result, the retention time became shorter than it could or should be. Some of the systems were

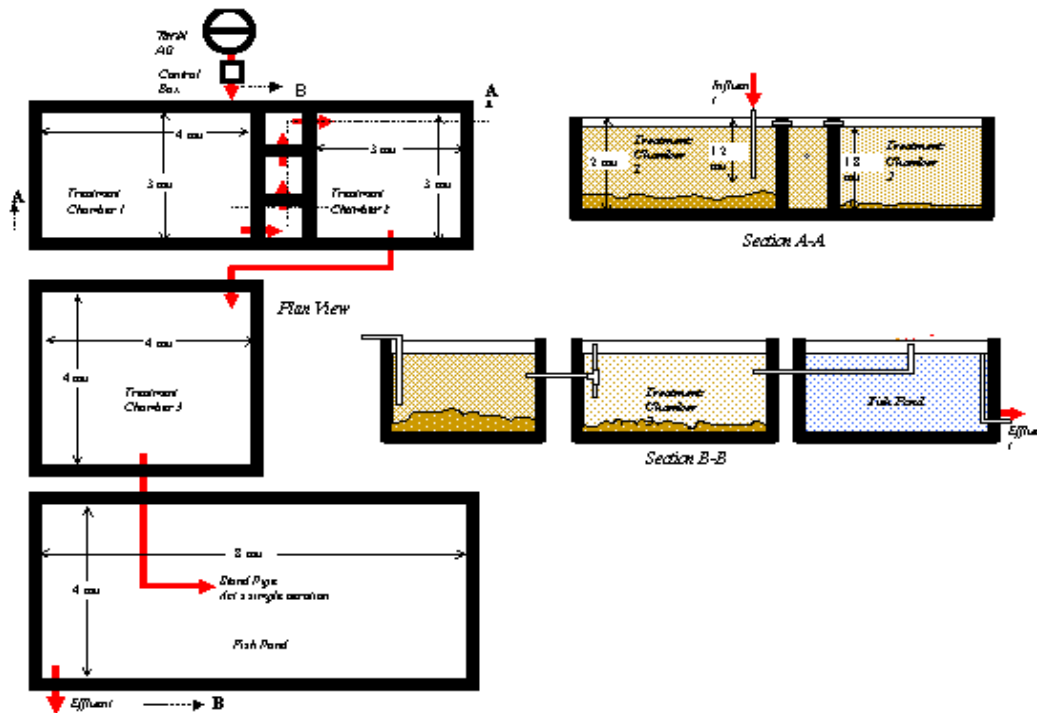
over-loaded, as volumes were too high to be processed to meet National Istandards for the second owest classification (Class C) effluent standard, even if they were to be operated at full design capacity.⁶

Of the five systems studied, only one system (Tlogomas) almost met the Class B (see below) effluent standard. Discharges from Watugong and Mergosono were short of meeting the standard because the *used* capacity was lower than the maximum hydraulic design capacity for organic loading. In Bareng and Samaan, systems were not operated properly due to lack of understanding in the

community about the need for adequate retention time, and due to poorly designed treatment works.

Treatment systems consist of the following main components: Grit chamber - a concrete cylinder with a wall/baffle in the middle (except in Mergosono) - to prevent solid material from entering the next processing chamber; Control Box; Treatment chambers 1 and 2; Settling chambers (three small) - between chambers 1 and 2 - to reduce the amount of suspended solid entering chamber 2; and Treatment chamber 3 and Fish pond - the latter two in Tlogomas only.

Tlogomas CBSS: Plan and Cross-section of the Treatment System



All of the systems individually achieve a significant reduction in pollution discharge. The pollution load originating from the community had been halved, despite the systems' current inability to meet national technical standards. One of the main reasons some of these systems have trouble meeting the standard is the high loading from disposal of kitchen and small-scale industrial food processing wastes. For example,

in Mergosono this is probably responsible for 200-400 mg/l of the BOD load. In practice it is almost impossible to separate black and gray waster streams, as in most communities this would require re-plumbing almost all household and many public connections. As a result, it is important that new systems are designed to cope with this additional loading and 'shocks' from sudden load increases; existing systems need to be retrofitted to improve processing capacity.

Table 7: CBSS Treatment Effectiveness: BOD, COD and TSS Levels and National Standards.

Location	BOD			COD			TSS		
	influent (mg/l)	Effluent (mg/l)	% reduc'n	Influent (mg/l)	Effluent (mg/l)	% reduc'n	Influent (mg/l)	Effluent (mg/l)	% reduc'n
Tlogomas	202	60	70%	331	121	63%	58	23	60%
Watugong	300	220	27%	563	422	25%	250	149	40%
Mergosono	938	400	57%	1,447	965	33%	850	230	73%
Bareng	400	180	55%	984	351	64%	131	53	60%
Samaan	475	180	62%	884	382	57%	247	53	79%
Average	463	208	55%	842	448	47%	307	102	67%
National Water Discharge Standards (mg/l)									
Class B	50			100			200		
Class C	150			300			400		

Notes: BOD = Biological Oxygen Demand (5 day); COD = Chemical Oxygen Demand; TSS = Total Suspended Solids. pH and turbidity were also determined; pH for both influent and effluent was consistently in the range of 6-7.

Identified Problems and Proposed Solutions

The treatment efficiencies in the five CBSS divert widely. On average BOD loads declined by 55 percent, COD loads by 47 percent and TSS loads by 67 percent. However, there is a wide variety in treatment efficiencies, mainly due to the quality of the construction and operation of these systems. As a result, most CBSS still do not meet class C standards. The technical study of the five systems found different issues that have to be addressed in order to improve the technical quality of CBSS.

Design Criteria. From a hydraulic point of view, the topography of the Malang municipal area is generally favorable, making it relatively easy that the slopes of piping will be adequate. Major problems may arise in areas with moderate slopes/flat terrain areas where detailed measurements are needed. These problems can be addressed if small "CBSS technical teams" receive basic training in how to assist community groups and are equipped with simple instruments such as hand levels.

Design Standards. The differences between systems do not appear to be related in any systematic way to the number of people to be served, the location, or land area available for the treatment plant. There is a need for simple, graphical design standards and construction guidelines, as the CBSS in Malang all have largely *ad hoc* designs that derive from the original system in Tlogomas.

Understanding Biological Treatment. The technical shortcomings noted above can be explained by lack of local knowledge about how a sewerage treatment plant operates. Without this technical understanding, people do not realize the impact of different dimensions and practices on operations - e.g. relative heights and volumes of treatment chambers. It is also clear that the biological processes involved are barely understood at all, making it even more difficult for people to judge the effect of design on performance.

Facilities for Maintenance. None of the CBSS studied were equipped with 'manholes' to allow clearance of blockages. Local people explained this had not led to any problems because the steep slopes allowed flushing through a few control boxes, usually located at junctions. Control box covers are made from concrete slabs, with no provision for lifting.

Quality of Materials Used. People are aware that lower quality materials reduce the durability of the system, but make a conscious choice between using affordable (i.e. lower quality) materials and having no project at all. Hence, the PVC piping used was of the lowest quality, the quality of the bricks was good but the reinforced concrete was poor quality. For control boxes and the grit chambers, lower quality materials are acceptable because they are visible and easily accessible for repairs, but for the treatment facility good quality materials and construction is required to ensure structural strength, proper operation and a long service life.

Maximum Service Capacity. Discussion with community leaders revealed that they did not have a clear idea of how many households could be served by the existing systems or how this number might be estimated. Usually the total number of households in the community was used as the service target, with the idea that "more connections is better", as this would increase income from the connection fee and monthly service fees. In three of the communities it is possible to connect more households, but in two the system is already overloaded (see Table 6).

⁶ There are four classes (A, B, C and D) for water quality according to the Indonesian National Discharge Standards (Baku Mutu Air Limbah): 'B' standard water is suitable for disposal into water bodies that are processed for drinking water, while 'C' standard water is deemed suitable for fisheries and livestock watering. The most relevant standard in this instance is somewhere between Class B and C, as the current ambient level of pollution in the Brantas River at Malang is 50-100 mg/l BOD.



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