Chapter 4: Case Studies

4.1. Introduction

Considering the objective of identifying the characteristics by which low-cost sanitation programme is more likely to succeed, this study was based on six low-cost sanitation programmes developed in Brazil.

The case study areas were selected in order to cover different technologies (on-site and off-site systems) and different arrangements for community/institution participation and for O&M of the systems. Therefore, the selected sanitation programmes were:

4.1.1. On-site Systems

- **Case Study 1**

Study developed in a low-income urban area known as Peixinhos Triangle in the city of Olinda (NE Brazil). The sanitation project implemented there was based on VIP latrines for the deposition of excreta and microdrainage channels for sullage collection. This project was an initiative of the city of Olinda prefecture and its implementation started in 1982 as part of a larger programme for the development of community infrastructure, which also included actions on: drainage, solid waste collection/composting and street paving among other social programmes.

- **Case Study 2:**

Also developed in a low-income urban area, this study was focused on a pour-flush toilets programme in the Favela Aero Rancho in the city of Campo Grande (West central of Brazil). This sanitation intervention was part of the PROSANEAR programme (discussed in Section 2.4.3) and was implemented in 1993/4 under the management of the State Water and Sanitation Company of Mato Grosso do Sul (SANESUL).

4.1.2. Off-site Systems

- **Case Study 3**

This study was developed in the community of Rocas/Santos Reis (Natal – NE of Brazil), which is known as the first experience applying the condominial sewerage technology. This project dates from 1982 and had CAERN (the State Water and

Sanitation Company of Rio Grande do Norte) as its implementing agency. CAERN has also been responsible for operating and maintaining the system since its implementation.

- **Case Study 4**

This case study was centred in the Vila Planalto sanitation project (Brasilia – Federal District of Brazil), which was one of the first experiences of CAESB (the Water and Sanitation Company of Brasilia) in adopting the condominial sewerage technology (1991). Additionally, information was obtained on two innovations adopted by CAESB: the implementation of condominial sewerage in high-income areas of the city and the implementation of "100% plastic" condominial systems.

- **Case Study 5**

This study was initially developed in the low-income urban area of Mangueira, in Recife, but then expanded to cover another 12 locations that also have had condominal sewerage systems implemented through the same programme of the prefecture of Recife. For the management arrangements of this sanitation programme, the prefecture of Recife acted just as the executing agency and COMPESA (the State Water and Sanitation Company of Pernambuco) was the agency responsible for the O&M of the systems. The transition from the prefecture to COMPESA had not been the same for all 13 systems and this led to different solutions that have directly influenced the performance of the systems.

- **Case Study 6:**

The focus of this study was on the SISAR programme (an Integrated System for Rural Sanitation) in the State of Ceara (NE of Brazil), developed by CAGECE (the State Water and Sanitation Company) and by the German Bank KfW. This programme implemented sanitation systems based on condominial sewerage and waste stabilization ponds, and septic tanks and leach pits in 45 districts of the State, from which was selected four for the development of this study. The O&M of the system was arranged to be the communities' responsibility through the local residents' association and without the participation of CAGECE.

Figure 4.1. shows the location of the case studies in relation to the map of Brazil.

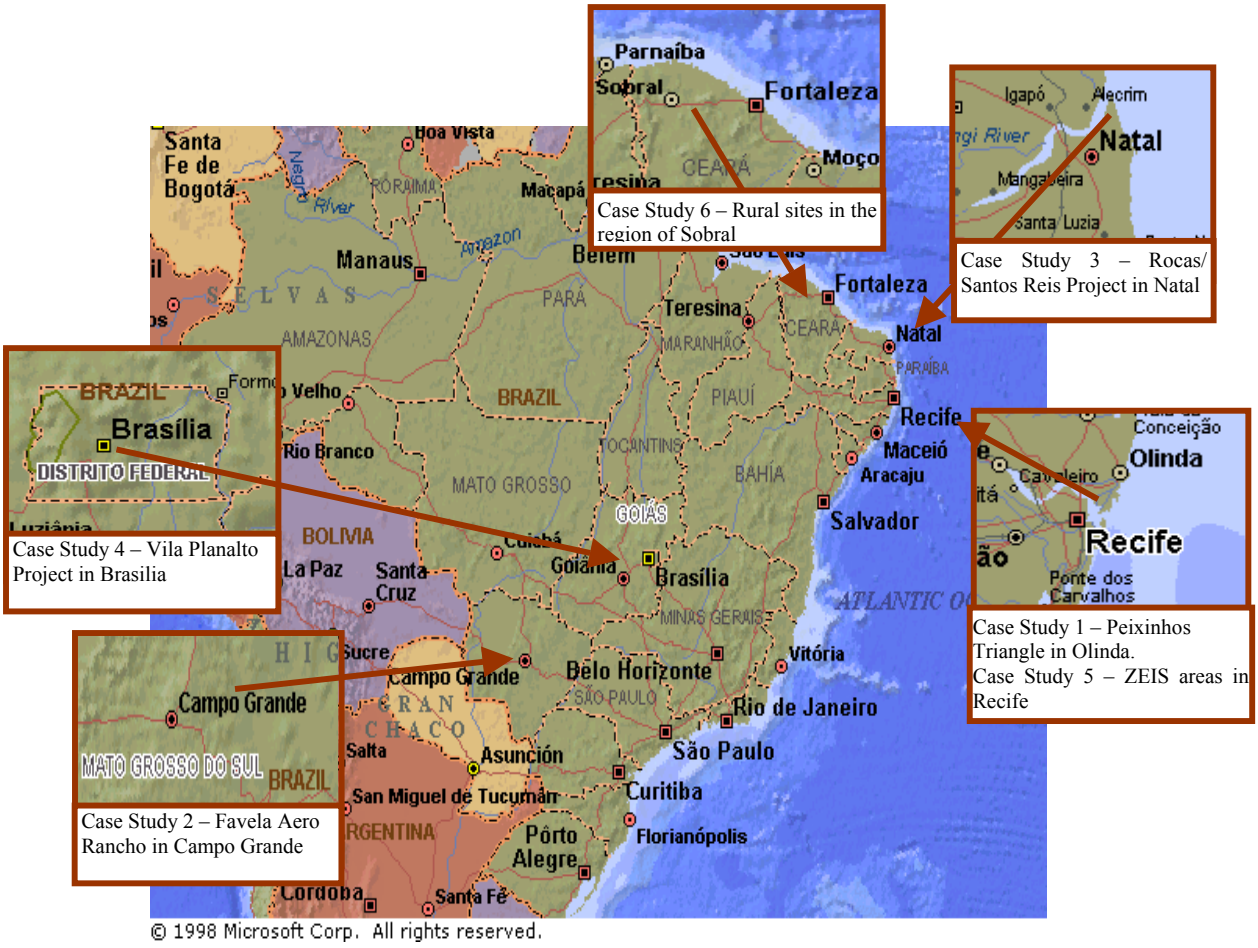


Figure 4.1. Map of Brazil showing the Case Study locations

4.2. Case Study 1: Peixinhos Triangle (Olinda-PE)

4.2.1. Introduction

In 1984, the Peixinhos Triangle community, located in the Northeast of Brazil, was part of a pilot experience promoted by its local government on the implementation of alternative technologies to improve basic infrastructure in low-income areas.

The sanitation solution adopted by the programme was based on VIP latrines for excreta deposition and micro-drainage channels for sullage collection, which have now been in operation for more than 15 years.

- **Programme Background**

The Peixinhos Triangle is a poor peri-urban area located in Olinda, a coastal city in the state of Pernambuco – Northeast of Brazil. In 1982, the city of Olinda received the title of World Heritage City from UNESCO. This event placed the city in an "in focus" position on the world tourism route and also motivated local politicians to develop the city's infrastructure services.

In this context, the city's mayor launched a programme for the improvement of low-income urban settlements using low-cost alternative solutions. Therefore, the area known as "Peixinhos Triangle" was chosen for the implementation of a pilot project. The main reasons that influenced this choice were:

- The area's well-defined boundaries and small size (240 households at that time),
- Its high level of poverty, and
- The presence of an organised residents' association.

The area, which was already very densely occupied, has approx. the shape of an equilateral triangle of 350m sides, well defined by three main roads (Figure 4.2). These roads were reported to be at a higher elevation than the houses creating a permanently flooded area. Consequently, drainage and landfill interventions were identified as main priorities and a micro-drainage system using precast fibre-reinforced cement mortar channels was initially implemented.

At the same time, infrastructure actions on: road and sidewalk paving in soil-cement; sealed underground water tanks; decentralised refuse collection (small handcarts and composting) and sanitation were also taken. Following this, actions started to be also developed on urban agricultural production potential, employment and income creation, housing, health services and sanitary education.

Figure 4.2. Map of the Peixinhos Triangle area.

- **The sanitation project**

The sanitation project, the focus of this study, was based on VIP latrines for the deposition of excreta, and on sullage collection through precast fibre reinforced concrete channels connected to the micro-drainage system. For the selection of this technology, a study was carried out to identify the existing sanitation solutions in the community. As a result, it was found that (Greenhalgh, 1984):

a) All houses appeared to have some form of excreta disposal, but many toilets were inadequate (both structurally and hygienically), and sullage was invariably directed to the streets;
b) Most households had a conventional glazed earthenware flush toilet bowl, although some had installed a roughly moulded type of toilet bowl ("rustic bowl");
c) Bowls were manually flushed (generally only after defecation). The volume of water used for flushing was estimated from 0 (rustic bowls) to 60 l/house/d (manually flushed toilets).
d) Leach pits were the adopted excreta disposal technology. Many pits did not function satisfactorily. The population perceived the failure of the pits in terms of aesthetics and inconvenience, and not in terms of health hazards.
e) Pits were always manually emptied with the pit contents usually being buried in a hole dug next to the pit for this purpose.
f) No sewer line existed in the vicinity and, although one of COMPESA's sewage treatment works (trickling filters) was located in the suburb, the investments costs needed to reach this were beyond the financial resources of URB-Olinda.

Therefore, the Greenhalgh (1984) study concluded that:

a) The introduction of VDR's was likely to have little effect on pit functioning (10 out of the 28 unflushed bowls surveyed were found to be in use with failed pits).
b) For the adoption of an improved flush system nearly all households would require the construction of a new leach pit.
c) Not all households had space available for a new leach pit site.

It was therefore decided to convert the existing flush toilets to a dry system, adopting a standard single pit VIP latrine. At the beginning, 5 VIP latrines units were built and used as a "shop-window" for the promotion of the technology among the householders. A total of 40 units were reported to be built during the implementation phase of the programme (until 1984).

4.2.2. Study Methodology

Considering the objective of collecting data on aspects such as the technical implementation and operation, social aspects, health benefits, and, institutional arrangements of the programme, five different methods were applied during the study.

Analysis of the documentation of the project was the first approach used. However, the Peixinhos Triangle project was developed very informally, where the actions were implemented as the ideas came up, with very little documentation being produced. This aspect made the second selected method – **interviews** – even more important. The interviews provided two different levels of data: one from the professionals who planned and implemented the programme (nearly the only source for institutional data) and the other, informal interviews with the local people.

Field observation was the next method applied. Its utilisation was justified by the possibility of obtaining a general feeling on the current sanitary situation and to probe information gathered during the interviews. The other two methods applied were a **survey questionnaire** and a **technical inspection** of the sanitation units.

The whole community (households placed in the physical limits of the area) was considered the target population for the study. This population was randomly sampled using the simple random sample design methodology (section 3.5.2).

In the early stage of the identification of the project site, three different situations relating to the households and the sanitation programme were observed. They were: (1) Households that had a VIP latrine built and it was still in use;

(2) Households that had a VIP latrine but it was no longer in use; and

(3) Households that had never participated in the programme.

Therefore, the first draft of the **questionnaire** was adapted for each situation and this resulted in three questionnaires printed on different coloured papers (Annex 1).

The questionnaires were divided into sections as described below:

Group 1 – households that had had a VIP latrine built which was still in use:

Section I - Identification

Section II - Socio-economical Aspects

Section III - Water Supply and Usage

Section IV - Community Participation

Section V - Sanitation Technology Adopted (VIP latrines)

Group 2 – households that had had a VIP latrine built but which was **no longer in use**:

Section I - Identification *(same as questionnaire 1)*
Section II - Socio-economical Aspects *(same as questionnaire 1)*
Section III - Water Supply and Usage *(same as questionnaire 1)*
Section IV - Community Participation *(same as questionnaire 1)*
Section V - Technology Adopted by the Family in substitution of the VIP latrine

Group 3 – households that had **never** participated in the sanitation:

Section I - Identification *(same as questionnaire 1)*
Section II - Social-economic Aspects *(same as questionnaire 1)*
Section III - Water Supply and Usage *(same as questionnaire 1)*
Section V - Technology Adopted by the Family in substitution of the VIP latrine *(same as questionnaire 2)*

The **sanitation inspections** occurred at the same time as the application of the questionnaires. For this, three different inspection sheets were designed, one for each type of questionnaire:

Group 1 –	**Section I -**	The VIP latrine
	Section II -	Sullage collection
Group 2 –	**Section I -**	The VIP latrine
	Section II -	Sullage collection
	Section III -	Solution adopted by the family
Group 3 –	**Section III -**	Solution adopted by the family

Considering that only 40 VIP latrine units were reported to be installed during the implementation phase of the programme (Greenhalgh, 1984), a parallel "non-probability" survey (second survey) among the households that were not part of the sampled population but were still using the VIP latrines was also carried out. These households were identified, interviewed and the VIP latrine units were inspected following the same procedures as the households of group 1 of the sampled population.

4.2.3. Study of the project documentation

The main sources of information were the people who worked on the implementation of the programme, and three documents: the Peixinhos Triangle Pilot Project for Urbanisation, the PhD thesis of Eng. Greenhalgh (1984), who implemented

the sanitation system, and a report from Eng. Rego (1987). These constitute the basis for the description of the project presented next:

- **Design of the VIP latrines**

The standard VIP latrine adopted was a single pit unit designed to serve five people for five years having a working volume of 0.76 m^3 and a 0.3 m freeboard. The possibility of designing double pit VIP latrines was discarded due to: the high ground water table (the pit contents were expected to be a very liquid slurry requiring pumping for emptying, anyway); the financial limitations of the project; and, the difficulty in integrating double pits with the existing facilities.

The pit was lined with three precast unreinforced concrete rings and the cover slab was built in reinforced concrete using nine 4.6 mm diameter bars running in each direction and leaving two 100 mm holes: one for the toilet bowl inlet and the other for the vent pipe (Figure 4.3).

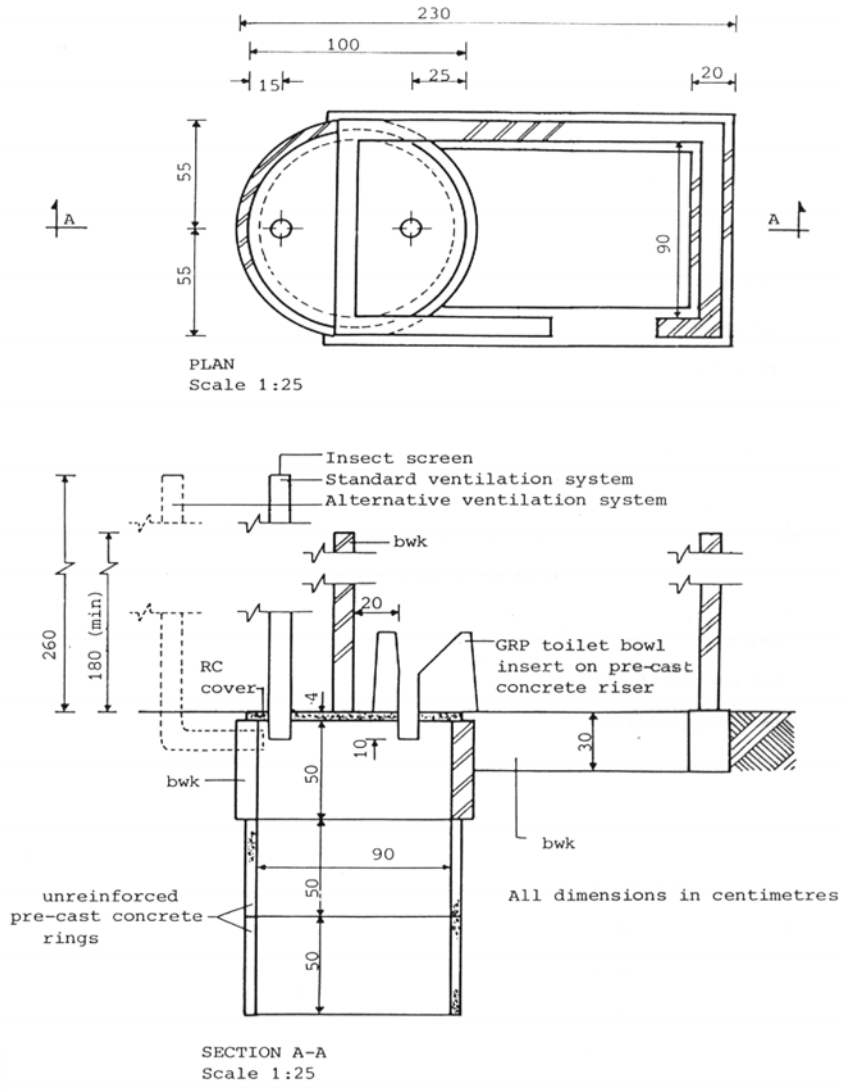


Figure 4.3. Details of the standard VIP latrine *(after Greenhalgh, 1984)*

- **Toilet Bowl**

Considering that the squatting position is not socially acceptable in the area, a toilet bowl was specifically developed for this programme. This bowl was produced in glass-reinforced plastic and secured to a precast concrete riser with cement (Plates 4.1 and 4.2).

- **Pit Emptying**

The pit emptying process was designed to occur at 5 yearly intervals. The removal of the contents, which were expected to have slurry-like consistency due to the high ground water table, should be done mechanically. For that, the residents should contact the council services to arrange for emptying under hygienically secure conditions.

- **Sullage Collection**

The sullage was designed to be collected through precast fibre reinforced cement mortar channels connected to the microdrainage system. These channels were designed as uncovered units in order to reduce costs and facilitate households' maintenance (Plate 4.3).

- **Project Costs**

The Triangle of Peixinhos Programme had the following costs (Rego, 1987):

Total Investment (inc. all projects, i.e. landfill, paving, solid waste, sanitation…)	US$ 53,387
- Olinda City Hall (75.1%)	
- SUDENE (17.7%)	
- FIDEM (7.2%)	
Investment per household	US$ 110
Investment per inhabitant	US$ 26
Direct unitary costs	
- the pit for 5 people (inc. vent pipe)	US$ 21
- superstructure in pre-cast concrete panel (inc. toilet bowl)	US$ 53
- superstructure in soil-cement (inc. toilet bowl)	US$ 34
- pre-cast reinforced concrete channels (per metre)	US$ 1

Plate 4.1. Glass-reinforced plastic toilet bowl

Plate 4.2. Pre-cast concrete riser to secure the toilet bowl

Plate 4.3. Channel for microdrainage and sullage collection

4.2.4. Interviews

Through interviews, information was collected on institutional participation and community organisation:

- **Institutional participation**

The prefecture is no longer acting in the programme and very few people from its staff were able to give information about the programme. Thus, information was mainly obtained from the engineers S. Cuentro and R. Rego, who were initially responsible for the development of the programme.

Initially, the programme comprised the drainage and the sanitation projects, then a solid waste collection and a composting project were also incorporated. Many ideas were then also incorporated into the programme, increasing its dimension and resulting in actions for the social and health development of the community.

The financial resources were very limited and innovative ideas were required in order to effectively achieve improvements. Hence, after identification of the main problems, actions on drainage, landfill and paving were initiated.

According to Cuentro, the programme was developed with high level of motivation and collaboration between both the staff and the residents, emphasising the importance of community participation in the planning and implementation phases. Nevertheless, the actions were taken to solve existing problems, and, at least in regard to the sanitation project, no plans were drawn for further actions or upgrading.

Currently, there are no institutions acting in the programme.

- **Community organisation**

Based on the information available, the Peixinhos Triangle community had a well-organised residents association at the time of the programme (1982). Currently, the city of Olinda have a good structure for the support of residents associations; however, the Peixinhos Triangle association is no part of this and is no longer an active institution.

The process to have a residents association in Olinda starts inside the community, which organises itself and funds the association. Then, documents must be signed, a physical space should be provided and the chairpersons are elected. Thereafter, these associations are recognised as institutions and should have the responsibility to represent and act for the benefit of the communities. Together, the associations constitute FECOMO (Federation of the Olinda residents associations), having as its

chairperson Mr. Joãozinho, who is also employed by the public services secretariat of the Olinda prefecture and acts as a facilitator between the communities and the prefecture sector responsible for the implementation of programmes and the delivery of infrastructure services.

Mr. Joãozinho participated in this community study and it was discovered that the Peixinhos Triangle residents' association has no participation in the FECOMO. The residents do not have any participation in the local association and the chairperson does not develop any activity. Some residents informally interviewed expressed the desire of re-starting the activities of the Peixinhos Triangle association, but they complained that the chairperson kept the documents and did not allow any mobilisation.

This situation represents a serious problem for the functioning of the association, leaving the community without either representation outside the community (i.e. in the prefecture) or internal organisation.

4.2.5. Field observation

- **General aspects of the area**

The majority of the houses in the area are still typical of the construction of low-income areas in Brazil. However, improvements such as residences with two floors and the presence of air conditioning equipment can be readily seen on the main streets. The main thoroughfare is the Rua do Cajueiro, where these housing differences can be seen (Plate 4.4). This street was paved during the project implementation using paving stones (rather than soil-cement, the material generally used in the project for paving).

The Travessa do Cajueiro is the second main street and it still has the soil-cement paving placed during the programme (Plate 4.5). This type of pavement is also found on the pedestrian access and has been repaired by few householders.

The solid waste composting unit is not in operation and is being used just as a refuse deposit (Plates 4.7 and 4.8). The collection system, using small handcarts, is still in operation; however, the presence of household waste on the streets and inside the drainage channels can be observed.

With regard to the drainage channels, two unemployed residents of the community do periodic services. They informed that approximately once a month they are called by residents to clean the drainage channels and are paid about 0.50 to 1.00 reais per household. In spite of that, just a few sections are kept clean having the water flow freely running. The majority are clogged, poorly maintained, having household

waste, rats and pipes suggesting the discharge of excreta. Moreover, the material removed from the channels (basically, solid waste and sludge) is usually deposited in the place that use to be the composting unit. Plates 4.6 and 4.9 to 4.12 illustrate these situations.

- **The sanitation project units**

Through the field observation it was noticed that nearly all the latrines identified had some kind of operational or maintenance problem.

The absence of the vent-pipe was a common failure in the functioning of the latrines. Although a number of residents claimed that the vent pipe had never been installed, there was evidence that the vent pipes had been installed but later stolen or removed by the residents themselves for some other use. Among the latrines that had vent pipes, they were frequently not vertically positioned and the flyscreens were missing (Plates 4.13 and 4.14).

Some latrines were also found without appropriate openings for ventilation in the superstructure (also in Plate 4.13). Plate 4.15 shows the designed openings for ventilation in the superstructure. Another aspect observed was the presence of toilet bowl covers and the misinformation among the users on the operation of the system. Plate 4.16 shows a vent pipe hole covered by bricks.

One abandoned VIP latrine was also found in the site (Plates 4.17 and 4.18).

4.2.6. Survey questionnaire

- **General Considerations**

Two surveys were carried on during this study. The **first** was the random sampled survey with a sample size of 64 households (Table 4.1. presents the summary).

Table 4.1. – Households included in the first survey

Group	No. of houses	%
Group 1 – households that are still using the VIP latrines	3	5
Group 2 – households that are no longer using the VIP latrines	9	14
Group 3 – households that never participated in the programme	36	56
Houses used just for commerce	11	17
Residents not possible to be interviewed	5	8
Total	**64**	**100**

Plate 4.4. Rua do Cajueiro, the main thoroughfare of the site.

Plate 4.5. Travessa do Cajueiro, paved in soil-cement at the time of the programme implementation

Plate 4.6. Broken section of drainage channel

Plate 4.7. The entrance of the composting unit

Plate 4.8. Interior of the composting unit.

Plate 4.9. Clogged drainage channel

Plates 4.10. Presence of solid waste in the drainage channels

Plate 4.11. Presence of rats in the channels

Plate 4.12. Discharge of excreta into the drainage channel

Plates 4.13. and 4.14. Details of a vent-pipe found with one of the latrines – note the tin blocking the vent-pipe and the positioning of the pipe.

Plate 4.15. The original ventilation designed for the latrines

Plate 4.16. Brick covering the vent-pipe hole.

Plates 4.17. and 4.18. Abandoned VIP latrine unit

The houses used just as commerce were located on President Kennedy Avenue and were not interviewed (none of them had a VIP latrine and were considered as having a very different behaviour than the households). Therefore, the houses categorised in groups 1, 2 and 3 above were interviewed making a total of 48 households (representing 75% of the original sample).

Based on the information that 40 VIP latrines were installed and that just 12 latrines where found in the random sample survey (3 latrines from group 1 and 9 latrines from group 2), a **second survey** was carried out aiming to find the remaining 28 units. Thus, a further 15 units were found (14 that are still in use and one abandoned latrine). Table 4.2. summarises this information.

Table 4.2. –VIP latrines implemented by the programme

VIP latrines		No. of units
Latrines found in the first survey:	still being used	3
	no longer in use	9
Latrines found in the second survey:	in use	14
Not found		13
Total		**40**

➢ Results from the Random Sample Survey

❑ Socio-economical aspects

As shown in Table 4.3., the average number of people per household was 5.13 and only 4% of the householders take part in the residents association.

Table 4.3. – Socio-economic aspects

Variable	Group 1 (out of 3)	Group 2 (out of 9)	Group 3 (out of 36)	Total (out of 48)
Mean No. of people living in the houses	5.67	5.22	5.06	5.13
Mean No. of people employed[1] per house	1.00	1.67	1.83	1.75
Families living in the site for > 14 years	1	5	18	24
No. of rented houses	0	1	3	4
Households with TV	67% (2)	100% (9)	92% (33)	92% (44)
Households with radio	100% (3)	100% (9)	89% (32)	92% (44)
Participants in a residents association	0	0	6% (2)	4% (2)

[1] – The occupation of the employed people suggests a range of 1 to 3 Brazilian minimum wages (R$ 136.00 approx. US$ 80.00 per month – exchange rate R$ 1.00 = US$ 1.70)

- **Water supply level**

Households in group 1 presented the lowest percentage of in-house level of service (67% presented a yard tap level of water supply) as shown in Table 4.4.

Table 4.4. – Water Supply Service

Variable	Group 1 (out of 3)	Group 2 (out of 9)	Group 3 (out of 36)	Total (out of 48)
Household served by COMPESA	100%	100%	100%	100%
Level of service: yard tap	67% (2)	11% (1)	14% (5)	17%
in-house	33% (1)	78% (7)	78% (28)	75%
collected from neighbour	0	11% (1)	8% (3)	8%
Water shortage: every day	33% (1)	22% (2)	36% (13)	33%
every week	0	45% (4)	17% (6)	21%
rarely/never	67% (2)	33% (3)	47% (17)	46%
Home treatment for drinking water: boil	0	11% (1)	8% (3)	8%
filter	67% (2)	33% (3)	22% (8)	27%
buy mineral water	0	45% (4)	50% (18)	46%
chlorine	0	0	6% (2)	4%
none	33% (1)	11% (1)	14% (5)	15%

- **Community participation in the sanitation programme**

This section was applied just for group 1 and 2 (households that built the latrines). Nevertheless, only 45% (5 families) of the interviewed householders were living in the area at the time of the implementation of the programme.

The main finding regarding the participation of the community was that the prefecture decided on the technology applied, provided the material and built the units. The main reasons reported to have positively influenced the acceptance of the technology were its low cost and the community's need for appropriate sewage disposal.

Only two families (out of five) remembered having received any advice on using the latrine and none remembered having paid anything (although in the second survey it was found that 5 households – out of 14 – remembered having "paid" 2-5 cement bags).

- **Technology adopted by the sanitation programme (VIP latrines)**

This aspect was just applied for group 1 (3 households), therefore, the results will be presented together with the results from the second sample.

- **Solid waste deposition**

As demonstrated by Table 4.5., 81% of the households were still having their solid waste collected by the prefecture in small handcarts.

Table 4.5. – Disposal of solid waste

	Group 1 (out of 3)	Group 2 (out of 9)	Group 3 (out of 36)	Total (out of 48)
collected by the prefecture	100% (3)	89% (8)	78% (28)	81% (39)
deposited on the main road	0	11% (1)	11% (4)	11% (5)
deposited in the former composting unit	0	0	3% (1)	2% (1)
didn't answered	0	0	8% (3)	6% (3)

- **Technology adopted by the families (not VIP latrines)**

Among the families not using the VIP latrines, the high majority adopted leach pits or septic tanks as their sanitation solution, having also, water sealed toilet bowls. The septic tanks effluent were discharged into the drainage channel and 3% of the householders interviewed were discharging their sewage directly to the channels.

As a way to improve the sanitation conditions of the site, the majority of the households indicated the cleansing of the drainage channel and the adoption of an off-site sanitation system. Table 4.6. presents these results.

Table 4.6. – Aspects regarding the technology adopted by the families not using VIP latrines

Variable		Group 2 (out of 9)	Group 3 (out of 36)	Total (out of 45)
Excreta disposal: leach pit/ septic tank (sealed toilet)		100% (9)	97% (35)	98%
direct connected to drainage channels		0	3% (1)	2%
Sullage deposition:	leach pit/septic tank	0	3% (1)	2%
	drainage channels	100% (9)	94% (34)	96%
	don't know	0	3% (1)	2%
Satisfaction:	yes	67% (6)	58% (21)	60%
	no	0	25% (9)	20%
	more or less	33% (3)	17% (6)	20%
How to improve:	clean the drainage channels	11% (1)	33% (12)	29%
	close the channels (put covers)	33.5% (3)	17% (6)	20%
	adopt off-site sanitation system	33.5% (3)	28% (10)	29%
	nothing	22% (2)	11% (4)	13%
	didn't know	0	11% (4)	9%

➢ Results from the Second Survey

This section presents the results of the second VIP latrine survey (14 units) together with those of group 1 (3 units), a total, therefore, of 17 units.

❑ Technology Selection

As presented by Table 4.7, the low-cost characteristic of the system attracted over half of the users.

Table 4.7. – Acceptance of the system

Why agreed with the system	No.	%
The system already existed when the family moved to the house	3	18
It was cheap	9	53
Saw the system functioning in other house	3	18
Don't know	2	12
Total	**17**	**100**

❑ Technology usage

100% of the interviewed householders said that all members of the house, including children, adults and elderly people used the VIP latrine units. They also declared that there was no other place where the excreta had been deposited.

❑ Technology operation and maintenance

The main problems reported by households were of bad smell (59%) and insects (23%).

53% of the VIP latrine users had never emptied their pits. As shown in Table 3.8., 23% of the householders emptied their pits manually, in spite of the recommendations for the utilisation of mechanical equipment.

Table 4.8. – Pit emptying and sludge disposal

Pit emptying	No.	%
Manually	4	23
Mechanically	2	12
Never	9	53
Don't know	2	12
Total	**17**	**100**

Sludge deposition	No.	%
Buried	4	23
Drainage channels	1	6
Vacuum tanker	1	6
Never emptied	9	53
Don't know	2	12
Total	**17**	**100**

Also about the O&M, 3 households had painted the VIP latrine superstructure and 2 households had changed the vent pipe. No household said that it had changed the flyscreen.

Regarding educational messages concerning the maintenance of the VIP latrines, 41% of the householders remembered have had received messages from the prefecture and 5% from neighbours.

4.2.7. Technical inspection

The results of the technical inspection were as follows:

- **Inspection Sheet Group 1 plus Second Survey**
  - **Inspection of the VIP latrines**

Number of units:	17 VIP Latrines	
Latrine Type:	100% single pits located outside the houses	
Cover slab (floor):	100% made in concrete	
	59% were cracked	
	1 case reported of collapse	
Sanitary bowl:	76% project designed type	
	24% flush toilet bowls	
	71% with bowl covers	
Superstructure:	82% presented cracks on the walls	
	71% did not have door	
Ventilation:	12% had openings in the superstructure for ventilation	
	65% had vent pipes, of which:	18% had the pipes high above the roof
		36% had flyscreens
		82% used 100mm diameter pipe
		18% used 150mm diameter pipe
Hygiene conditions:	23% good	
	59% acceptable	
	12% bad	
	6% very bad	
Presence of facilities for handwashing:	24% yes	
	76% none	

- **Inspection of the sullage disposal**

Sullage connected to channels:	82% of households connected the sullage from the kitchen 82% connected the sullage from the clothes washing facility 76% of households connected the sullage from the bathroom
Presence of sullage around the house:	65% with sullage in the backyard
Sullage channels conditions:	24% were clogged 18% with household waste 35% cracked

- **Inspection Sheet Group 2**

Inspection of the VIP Latrines

Number of units:	9 VIP Latrines
Latrine Type:	56% single pits located outside the houses 22% single pits located inside the houses 22% do not remember
For what are the units being used now:	67% nothing 11% as a store 22% destroyed

Inspection of the sanitation facility adopted by the family

The technologies adopted by the households were leach pits or septic tanks discharging into the drainage channels.

Number of units:	9 units
Hygiene conditions of the sanitary unit:	44.5% good 44.5% acceptable 11% very bad
Presence of facilities for handwashing:	67% yes 33% none

Inspection of the sullage disposal

Sullage connected to the channels:	100% of the households connected sullage from the clothes washing facility 100% of the households connected sullage from the kitchen 100% of the households connected sullage from the bathroom

Presence of sullage around the house:	44% with sullage in the backyard
Sullage channels conditions:	33% were clogged
	56% with household waste
	44% cracked

- **Inspection Sheet Group 3**

  - **Inspection of the sanitation facility adopted by the family**

As in the case of group 2, the technology adopted by the households was leach pits or septic tanks discharging into the drainage channels. However, one household (out of 36) admitted discharging the excreta direct to the drainage channels.

Number of units:	36 interviewed households
Hygiene conditions of the sanitary unit:	36% good
	47% acceptable
	11% bad
	6% very bad
Presence of facilities for handwashing:	58% yes
	36% none
	6% don't know

- **Inspection of the sullage disposal**

Sullage connected to channels:	97% of the households connected sullage from the kitchen
	100% of households connected sullage from the cloths wash facility
	92% of the households connected sullage from bath
Presence of sullage around the house:	28% presented sullage in the backyard
	72% did not present sullage around the house
Sullage channels conditions:	56% were clogged
	50% presented household waste
	36% cracked

4.2.8. Summary of the Results

- **Technology applied**

VIP latrine technology for excreta disposal is considered simple to implement, to use and to operate. In the Peixinhos Triangle sanitation project, the adoption of this

technology appears to have been determined by two main aspects: the possibility of integrating the new system with the existing (failed) facilities and the financial limitation of the programme.

The selection of the material used for the component parts of the system was supported by local production. The application of fibre to reinforce the precast cement parts as well as the development of a specific toilet bowl for the system illustrates, therefore, the experimental facet of this programme.

As noted in Section 2.4.3, the ventilation of VIP latrines is the mechanism responsible for fly control and absence of foul odours; however, only 65% of the latrines still had the vent-pipes of which only 18% had pipes high above the roof and just 36% still had a flyscreen (none had the flyscreen changed, which is supposed to occur every 5 years).

The adoption of a single pit design is justified by the lower capital costs required and the unavailability of space in comparison with double pit latrines. However, the mechanical emptying process required by single pit latrines relies on the support of institutions (councils, community associations, etc), which should not be a problem if the programme is well integrated and the actors are participative; nevertheless, this requirement makes the operation and maintenance of this simple technology dependent not only on the householders but also on the institutional arrangements for the programme. Therefore, the majority of latrine users (53% of the households) had never emptied the pits and only 12% had done it mechanically.

- **Sociocultural aspects and community organisation**

The participation of the community was reported to have been intensive during the implementation phase. However, considering the sanitation project itself, only 40 latrines were installed (out of 240 households) suggesting that the technology was not fully accepted by the community.

On first walking around the site, a common opinion among residents on the streets was that the VIP latrines were being substituted by “proper toilets” and that the few remaining units were there only because “the users had no money to replace them yet”. In fact, it was observed that the community perceives the latrines as a “primitive” system, attributing to them the cause of foul odour. Another important aspect for the lack of satisfaction among the users was the absence of water-sealed toilets. Generally, in the public or work places with which this low-income peri-urban residents interact, it

is common to have sealed toilet bowls. Therefore, the direct discharge of the excreta gives the idea to a number of residents that the latrines are a "dirty" system.

The latrines that were found to be functioning well were apparently installed in the poorest households, whose owners claimed to be very satisfied with them; however, this just represents a tiny proportion of the community.

- **Health and educational aspects**

A characteristic commonly observed in low-income areas is the moving in and out of the resident's families. This "movement" requires intensive continuity of educational programmes to supply the new residents with the information necessary for proper use and maintenance of the system installed (only 45% of the sample population were living in the area during the time of the implementation of the programme).

Considering the Triangle of Peixinhos infrastructure programme, as a whole, improvements can be identified in the living conditions of the households. However, due to the limited number of VIP latrines built in the community, health benefits from the sanitation project are very localised and biased due to the interaction among residents that are sharing the same public environment.

4.3. Case Study 2: Favela Aero Rancho (Campo Grande-MS)

4.3.1. Introduction

This study was focused on the sanitation programme implemented in 1993/4 in the favela Aero Rancho. The site is 28.2 ha in areas and is located in the Southern part of the city of Campo Grande (capital of the State of Mato Grosso do Sul in West Central Brazil). The favela Area Rancho was one of the areas selected to take part in the PROSANEAR programme (a World Bank funded programme to deliver water supply, sanitation and hygiene education following a community participation approach).

4.3.2. Programme Background

Traditionally, Brazilian Sanitation Companies have not given sewerage systems the same priority that is given to the water sector. SANESUL – the Water and Sanitation Company of the State of Mato Grosso do Sul, was not an exception. According to Diretriz/SANESUL (1995), SANESUL was imbued with the "water culture", with almost all its technicians and directors concerned only with water supply issues.

Therefore, it is not surprising that the majority of the population of Campo Grande (about 450.000 inhabitants in 1996) is not served by sewerage systems and that the adoption of on-site sanitation solutions, mainly septic tanks followed by infiltration pits, is a natural option among householders.

With respect to the domestic solutions, Diretriz/SANESUL (1996) reported that although there were construction limitations and a lack of operational actions, 57% of the domestic on-site systems over 2 years old had never failed. This emphasises the suitability of on-site sanitation systems for the city of Campo Grande, which is supported by three main factors:

- The ground water table level is over 4 m deep in about 90% of the city;
- The favourable geomorphological conditions; and
- The medium to low population-density, even in urban areas due to regulations set for land occupation conditions.

Therefore, the adoption of on-site technologies seems to be a well technically supported option for sanitation in Campo Grande, and this was considered through the opportunity of implemented sanitation systems under the PROSANEAR programme.

Following the criteria set by the PROSANEAR programme, the sanitation actions that took place in Mato Grosso do Sul were centred in two cities: Dourados and Campo Grande. The sanitation system implemented in Dourados adopted the condominial sewerage technology complemented by in-house sanitary installations, and, for the sites in Campo Campo, the option was for the on-site technology based on pour-flush toilets.

The areas selected in Campo Grande were the favelas Aero Rancho and Los Angeles and surroundings (Los Angeles plus four smaller areas: Centro Oeste, Meninas, Macaúbas and Campo Nobre). These areas were characterised by (SANESUL, 1992):

- Lack of infrastructure necessary for provision of basic living standards such as sanitation, health, urban transport, paving and education;
- Population mainly composed of migrants from rural areas;
- Highly unhealthy environments aggravated during the rainy season when solid wastes and sanitary effluents were visible on the streets;
- Water consumed in the areas was mainly from shallow wells shared by neighbours. Health risks resulting from this source were considered high due to: inadequate deposition of excreta, inadequate domestic storage (utilisation of large tin containers without covers), utilisation of rusty receptacles and presence of insects.

- Lack of hygiene regarding both personal and domestic practices was identifiable;
- Violence was a common concern, especially vandalism caused by youth gangs; and
- Community organisation was found to be dispersed and restricted mainly to religious and sports (football) groups;

The size, population and density of these sites are given in the table below (SANESUL, 1992):

Table 4.9. – Profiles of the PROSANEAR programmes in Campo Grande

Locality	**Project Area (ha)**	**Actual Population (hab)**	Population **for Saturated Area (hab)**	**Actual Density (hab/ha)**	**Saturated Density (hab/ha)**
Favela Aero Rancho	28.20	1,770	2,560	62.78	90.78
Los Angeles and Surroundings:	220.98	8,027	14,811	36.38	67.02
Los Angeles	125.04		7,137		57.08
Centro Oeste	31.45		2,292		72.88
Macaubas	26.51		1,703		64.24
Campo Nobre	20.00		1,483		74.15
Meninas	17.98		2,196		122.14

The Aero Rancho favela (the focus of this study) is a narrow band, about 300 m long, following the bank of the Anhaduí ravine. The land slope ranges from 0 to 10% and the soil infiltration capacity was 40 to 60 l/m^2/day. The level of the ground water table varied from 4 to 7 m below the surface and the site had neither paving nor drainage.

4.3.3. The Sanitation Project

The project implemented in Favela Aero Rancho comprised a conventional water supply system with individual house connections, a pour-flush toilet sanitation system (including a sanitary unit kit) and social programmes on sanitary education and community development.

The sanitation system adopted was the double pit variant, in which the pits should work in alternating periods (see Section 2.5.4.). Therefore, while one pit receives the effluent from the household, the other one "rests" for enough time to digest the deposited excreta and restore the soil infiltrative capacity. It was also agreed that the first pit of the double pit scheme would be constructed during the implementation phase (having its material and construction schedule included in the programme's scheme), and, the householders would be responsible for the provision of the second pit.

The sanitary kit, provided by the programme, consisted of a reduced flush toilet bowl (VDR), a 5 litre flushing device, the design and the material for the construction of the superstructure (bricks, door and roof), a shower, a water-sealed drain and the connecting pipes. This material was not equally distributed; rather, the families received them according to their individual demand.

The educational aspect of the programme was planned and implemented following a community development approach. It demanded the formation and training of a team of community workers that orchestrated the mobilization introducing the sanitation project, the educational messages and the development of community-based activities.

4.3.4. Study Methodology

The data collected for Aero Rancho was based on: **study of the documents of the project** (supplemented by informal interviews with professionals that had worked on it), a **survey questionnaire** and **technical inspections** of the sanitation units.

During the **study of the documentation** information was collected on the institutional arrangements of the project, its costs, the technical parameters applied and the social/educational activities developed.

For the **survey questionnaire** and the **technical inspections**, the whole community (households in the physical limits of the area) was considered the target population for the study. The questionnaires were applied in a sample of households selected systematically; therefore, a map of the area was obtained containing the main streets, pedestrian accesses and the houses. A walking orientation was defined, with each fifth house in the walking line of the surveyor being interviewed. The size of the sample obtained by this method was therefore approximately 20% (N = 76).

The questionnaire applied here (Annex 2) contained the following sections:

Section I - Identification / Social Economic Aspects and Level of Water Supply
Section II - Technology Usage, Functioning and Satisfaction
Section III - Health and Educational Programmes

The technical inspections were carried out at the same households and it was based on the fulfilment of a factual inspection question-sheet containing the following parameters: location of the sanitary unit (inside or outside); presence of flushing device; ventilation of the pit; sealing of the pit cover, if single or double pit; presence of grease

trap; connection to discharge rain water into the pit; and if the sullage was openly or pipe-connected to the pit.

4.3.5. Study of the project documentation

The activities related to the implementation of PROSANEAR in Aero Rancho had been reported in a series of documents considering: (a) the primary characterisation of the area (May 1992), (b) the implementation of the programme (1993/4), (c) the development of field activities and (d) the appraisal of the programme 14 months after implementation (March 1996). Thus, this material provided knowledge on the arrangements of the programme as well as a basis for comparison with the data obtained by this study.

- **General Considerations**

The number of families reported to be living in the area by the end of the implementation of the programme (Oct/1994) was approx. 510 and the number of the sanitation units built was 465 leach pits and 377 sanitary units. However in the PROSANEAR/SANESUL (1997) report the number of houses in the area were reduced to about 460 and during this study it was about 400 households.

Big changes in the community area during the implementation of this programme were reported. Nevertheless, from the end of the implementation to the present time (nearly 5 $^{1}/_{2}$ years) no significant improvements could be noticed. The streets were still not paved and the drainage system had not been constructed. Empty plots and houses that had started to be built but not completed were found, as well as abandoned properties. A general view of the site is shown in Plate 4.19.

- **Institutional Arrangements**

PROSANEAR in Campo Grande (favela Aero Rancho) had 50% of its costs financed by the World Bank, 25% covered by the "Caixa Econômica Federal" (Brazilian Federal Savings Bank) and the remaining 25% by SANESUL.

The programme was managed by SANESUL under the rules and approval of the PROSANEAR team. For the development of the activities, the following arrangements were made:

- ***For the Water System:*** Private firms were employed to construct the system. The O&M was the strict responsibility of SANESUL. However, in late 1999 SANESUL lost the concession to operate in the city of Campo Grande, which now has its water and sanitation sector run by the municipal government.

Plate 4.19. General views of the Favela Aero Rancho area

- ***For the Sanitation System:*** The construction of the leach pits and the sanitary units was carried out according to a resident self-help scheme. The material supplied by the programme was distributed by the consultant team, which provided technical information on the construction of the units and on the O&M of the individual systems (that were also set to be under the householders' responsibilities).
- ***For the Community Participation Programme:*** A consultant firm (Woll Consultoria) was hired to implement the community development programme. This included the mobilisation of the community towards the sanitation programme and the delivery of environmental/sanitary educational messages.

➢ **Community Organisation**

The Aero Rancho community was mainly composed of migrants from rural areas who were described as being dispersed. Therefore, the community participation and mobilization actions were targeted on a community development strategy, which focused on the strengthening of the householders' identification with their new environment, on the growth of self-esteem and on citizenship. This work was managed in four stages, as follows (SANESUL/PROSANEAR, 1992):

- ***Stage 1***: An office was physically established and a community team was installed consisting of a field coordinator, eight social technicians, three architects, six sanitation technicians and ten trainees. All the schedules were planned and the field team was trained for the coming activities. This stage lasted a month (July - August 1993).
- ***Stage 2***: In this period, the focus of the work was on the characterization of the site, recognising and updating information previously obtained. This was developed together with householders following the concept of "action research" and aimed to develop citizenship and the "historic process" of these originally rural families. Social Groups and Institutions were also invited to participate; these were religious people working with the migrants, health and the movement for housing, and also the municipal secretariats of health, social security and housing. For the meetings, the community was divided into groups of 50 families and the meeting were just carried on when at least 60% of the families were present to the sections.
- ***Stage 3***: This stage consisted of the formation of "construction groups", signing of the Participation Agreement and the elaboration of the timetable for the

construction of the units of the system. Householders with experience of civil construction works composed the "construction groups", which approved the designs and the proposal for self-help construction. The groups received training and were made responsible for the spread of the designs among the other householders (facilitating the acceptance of the sanitation programme by the community).

- ***Stage 4***: The sanitation programme was physically implemented at this stage. The community development activities were also carried out and these included: meetings for health, alternative medicine and diet education; presentations on AIDS; school groups for adult literacy; women's groups; solid waste removal activities; sports, cultural and religious meetings.

The activities related to sanitary education were reported to have been carried out during all stages of the implementation. However, as criticised in IBAM (1997), the messages were very focused on community development and the actions directly related to the sanitation project, such as the need to construct the second pit and the importance of the reduced flush devices (VDR), were not fully incorporated by householders. Criticisms were also made against the process of technology selection, which seems to have limited community participation in the "decision taking" process.

The consulting firm responsible for the development of the activities related to community participation completed its work by the end of October 1994 and no more actions were been developed or given continuity.

4.3.6. Design of the Project Units

- **Water Supply**

The system designed to supply water to the community was based on the existing main ring of the water supply system of Campo Grande (the Guariroba system – 1400 l/s and 400 mm pipe diameter). Therefore, an interconnection was installed using a 150 mm pipeline delivering the flow calculated for the site (6.4 l/s – adopting a per capita consumption of 120 l/person/day).

Because of the lack of appropriate storage reservoirs, it was decided to install a central reservoir. The volume of this unit was based on 20% of the average daily flow. Thus a standard mild steel reservoir with a capacity of 50 m^3 was adopted (SANESUL, 1992). Consequently, individual in-house water storage tanks were not considered for

this programme. However, in the 1996 appraisal of the system, it was found that, in spite of the reliability of the water supply system, one of the main requests of the householders was for a subsidy to acquire domestic water storage tanks. The householders justified this by saying that the high pressure in the system was causing problems in the domestic hydraulic appurtenances (valves, taps, etc), which were usually of very low quality (PROSANEAR/SANESUL, 1996).

- **Leach pits**

PROSANEAR adopted the leach pits for the Favela Aero Rancho based on the results of a pilot experience developed by Dr. Stephen Greenhalgh in low-income areas of Campo Grande, in 1986. He tested the double leach pit as a sanitation solution that would provide a final disposal for the household effluent. This was motivated by the inappropriate destination given to the sludge removed from septic tanks by companies specialised in mechanical emptying in the city.

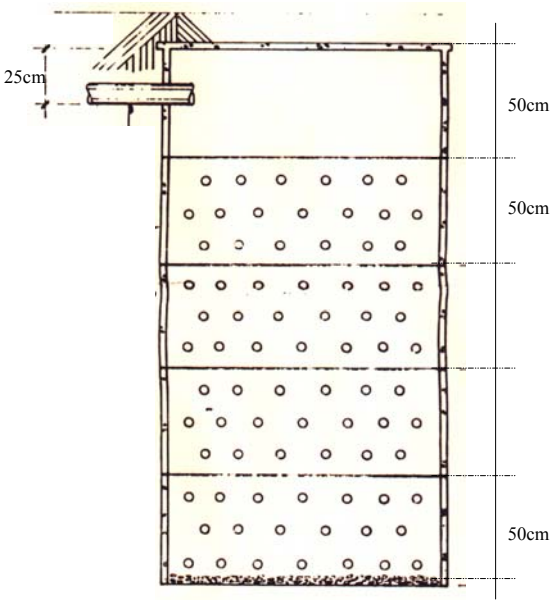
Although this study had not been fully concluded, the PROSANEAR team visited the area after 8 years of functioning and found that even the first pit had still not exhausted its capacity (Diretriz/SANESUL, 1996).

Moreover, Greenhalgh also found that, for the soil conditions of Campo Grande, pits measuring 1.20 m diameter and 2.50 m deep had not exhausted their capacity in 5 to 6 years of operation, and, even so, they can restore their soil infiltrative capacity in no more than a year if kept out of use. It was also reported that after this "rest" period, the material leftover inside the pit was just a 5 cm layer of completely digested sludge. The dimensions and design of the leach pit are shown in the Figure 4. 4. and Plate 4.20.

- **The superstructure**

The superstructure was designed to accommodate the toilet bowl and the flushing device, also, some households used it as a shower area (Figure 4.5).

A common complaint among householders was related to the small width of the door (50 cm). Problems were also reported regarding the low-volume flush unit (bowl and flushing device): aesthetically, the small size of the units was not easily accepted by users; and the non-availability of spare parts for the flushing device in the local market encouraged householders to substitute the low-volume model for conventional ones or to continue manual flushing of the system.



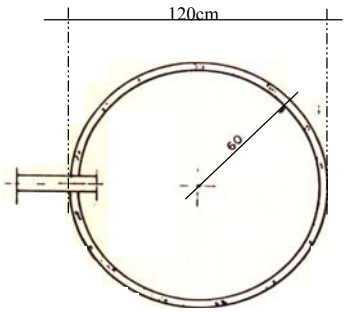


Figure 4.4. Design of the leach pit

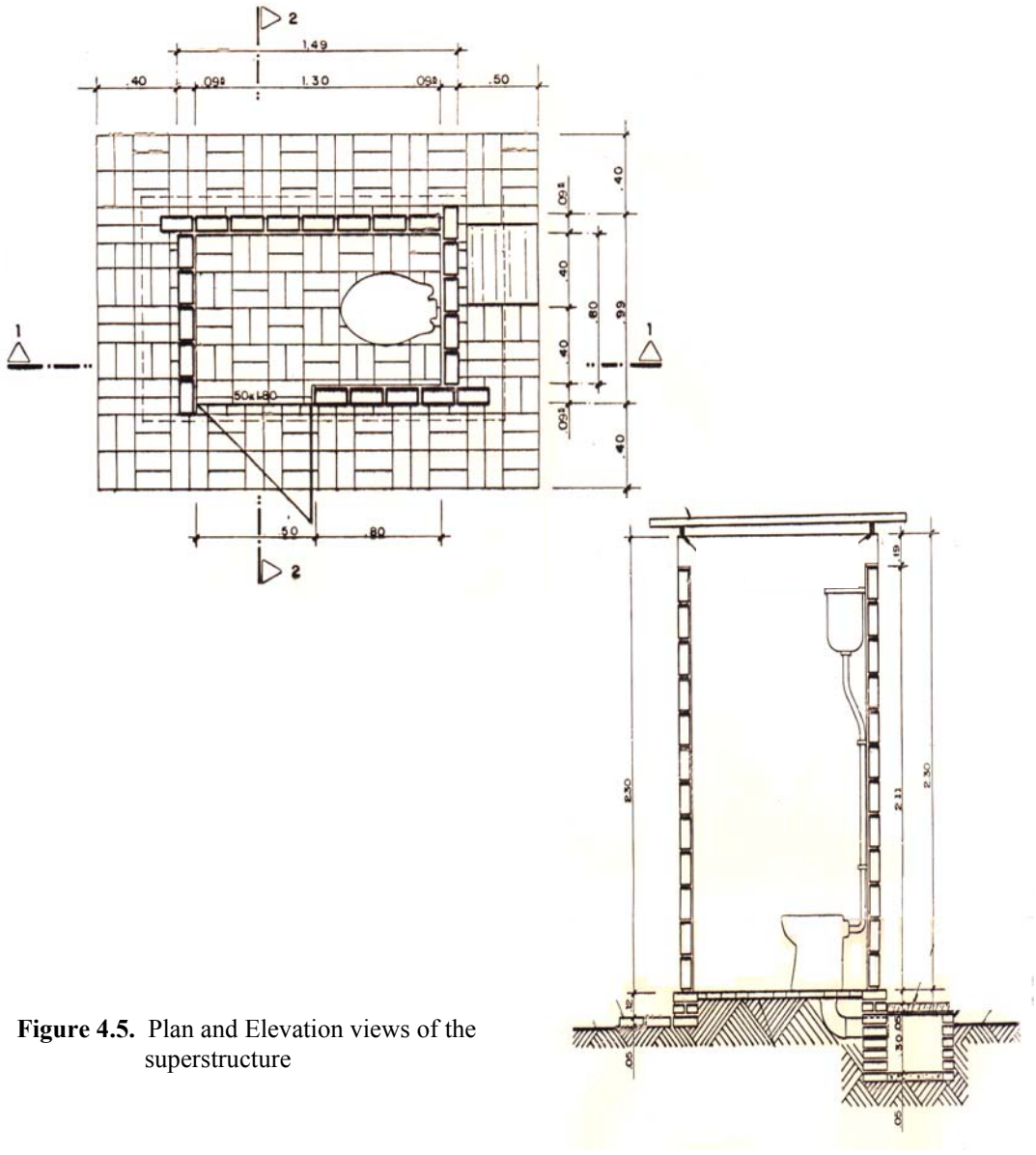


Figure 4.5. Plan and Elevation views of the superstructure

Plate 4.20. Leach pits found in Aero Rancho

Plate 4.21. A view of a typical superstructure

Plate 4.22. Low-volume flush toilet

Plate 4.23. High level cistern

Plate 4.24. Shower inside of the superstructure

Plate 4.25. Shower drain

➢ **Connections**

The proposed connections between the superstructure and the pits followed the scheme shown below:

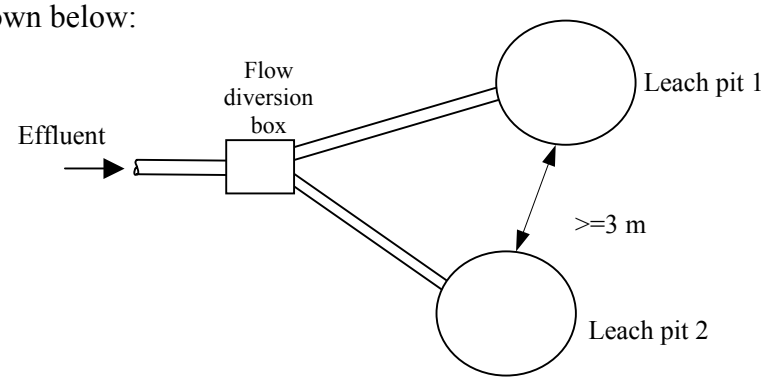


Figure 4.6. Double pit scheme

➢ **Project Costs**

As discussed earlier, the World Bank, CEF and SANESUL financed the costs of the Aero Rancho programme. Therefore, the four main groups of costs were: the water supply system, the leach pits, the sanitary units and the social projects. Based on data from IBAM (1997), Table 4.10 presents the costs.

Table 4.10. – Costs of the Aero Rancho Programme

	Final Costs		Costs per Capita*	
	R$	**US$****	**R$**	**US$****
Water Supply	204,433.12	243,372.76	84.30	100.36
Leach Pits	47,921.08	57,048.90	19.76	23.52
Sanitary Units	82,293.38	97,968.31	33.94	40.40
Social Projects	125,368.07	149,297.70	51.70	61.55
Total	**460,015.65**	**547,637.67**	**189.70**	**225.83**

* Costs per capita based on the pop. of 2,425 inhab. (pop. at the end of the project implementation – Feb/1995)
** Applied the mean exchange rate of Feb/1995, that was 0.84 (URL-21)

4.3.7. Survey questionnaire

➢ **Section I – Identification / Socio-economic Aspects and Water Supply**

- **Socio-economic aspects**

Regarding social-economic aspects two variables were measured: the number of householders, the family monthly income and the time the families were living in the site.

The average number of householders was 5.05 persons per household, and their income levels were as shown in Figure 4.7.

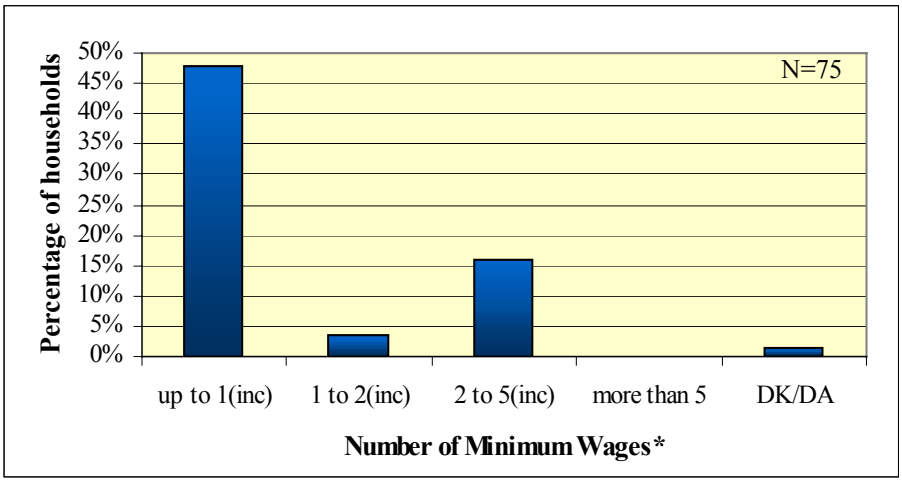


Figure 4.7. Monthly family income in Aero Rancho in Mar/2000
(*The Brazilian Minimum Wage was 136.00 reais (approx. US$ 80) on 28/03/00)

Included in the first category (up to 1 MW) are families with all working-age members unemployed. This represents the main category found in the location, thus 48% of all the families in the community. In the category of families earning between 1 and 2 MW are 35% of the households, giving a total of 83% of the households earning ≤ 2 minimum wages per month. The percentage of families that didn't know/didn't answer this question was 1.3%.

In the survey carried out by SANESUL in 1996 (PROSANEAR/SANESUL, 1996), 38% of the families earned up to 1 MW and 30% between 1 and 2 MW.

Regarding the time that the families had been living in the site, Figure 4.8. shows that approx. 68% of the families had been living in the area since before the implementation of the sanitation programme.

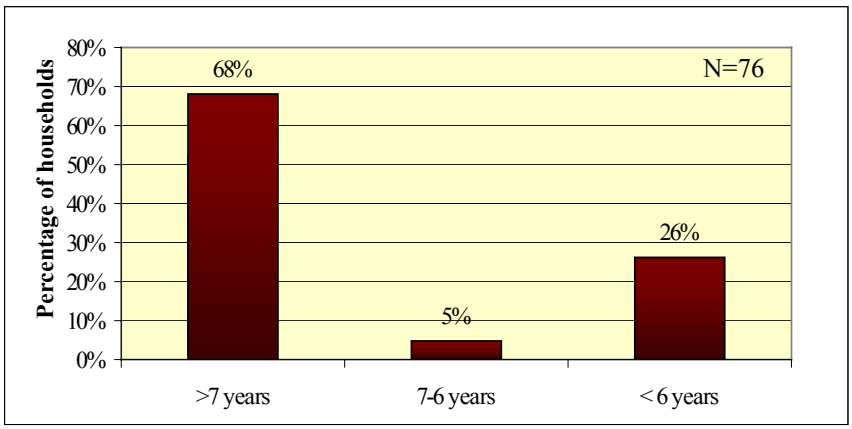


Figure 4.8. Time the families are living in the Aero Rancho area

- **Water supply level**

SANESUL recently lost the concession for supplying water for the city of Campo Grande, which is now receiving water from the municipal company "Aguas de Campo Grande".

As shown in Figure 4.9, the majority of the households are supplied with in-house water and approximately a quarter of them have a yard tap level of service. This gives a total of 81% of the householders using the water supplied by the programme. About 15% of the households are still consuming water from private wells with hand pumps and, the category "others" (4%) mainly covers households that had their water supply cut off due to non-payment (the water currently used by these families is mainly collected from friend's/relations' houses).

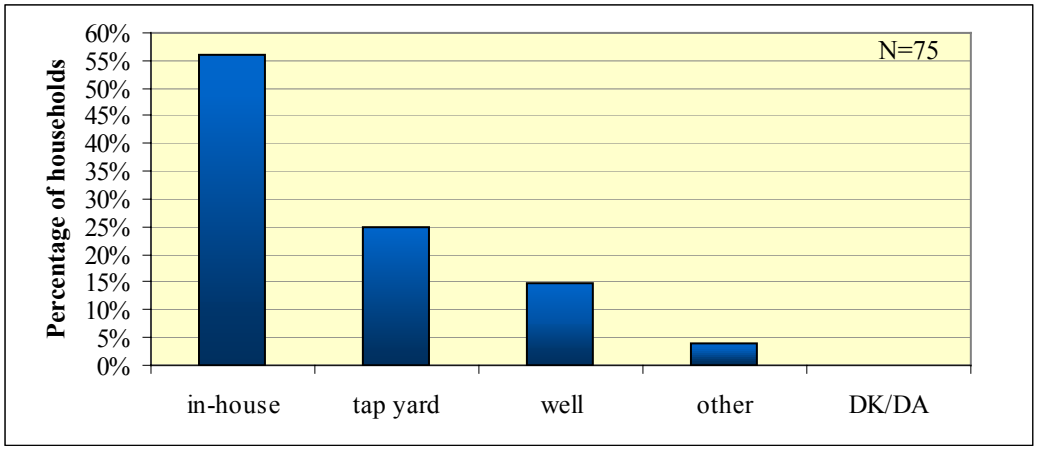


Figure 4.9. Level of water supply in Aero Rancho

➢ Section II – Technology Usage, Functioning and Satisfaction

- **Technology usage**

As shown in Figure 4.10, about 70% of the sampled population are actually using the pour-flush toilets provided by the programme.

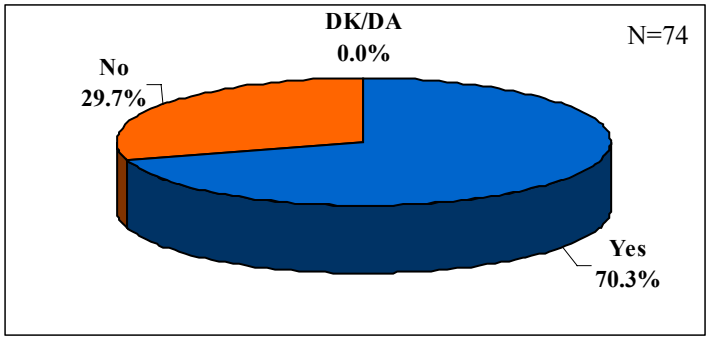


Figure 4.10. Percentage of Households using the system.

Considering the families not using the facilities provided by the sanitation programme, 13% of them had never heard about it (they moved into the area after the implementation of the programme and did not find any sanitation solution already implemented on their plots; therefore nearly 100% of them constructed a leach pit on their own). Another 13% of non-users had received the material and constructed the facility; however, the pits collapsed and were abandoned. The new sanitation solutions provided by these families were that 50% of them constructed another single leach pit and the other 50% dug a dry pit.

Finally, the great majority of the non-users families (approx. 74%) had constructed pits outside the sanitation programme scheme. The sanitation solution adopted by about 95% of them was a leach pit and 5% built a dry pit.

Among the families actually using the sanitation system (at least the first pit), the majority of them had also connected their sullage to the programme's leach pit (as shown in Figure 4.11.).

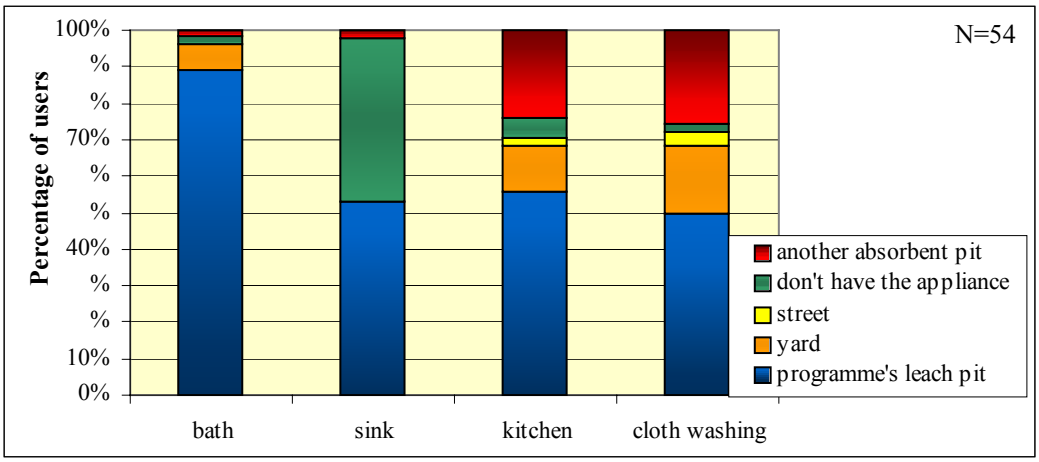


Figure 4.11. Sullage disposal among households participating in the sanitation programme.

From this, approx. 28% of the householders had another pit to receive sullage, which was being used at the same time as the pits from the sanitation programme.

- **Technology functioning**

Out of the families that built the sanitation programme's facilities, 82.5% have had no operational problems. Nevertheless, as shown in Figure 4.12, the main problems have been related to the pits getting full. The solutions given by these families (17.5% of the families that built the unit) were: 10% went for the

double pit scheme, 30% abandoned the system and built another pit and 60% emptied their pits and continued to use them.

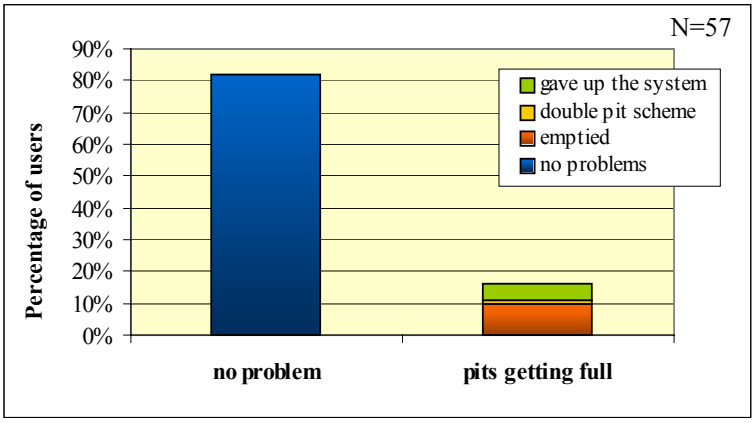


Figure 4.12. – Functioning problems with the leach pits

Considering the families that had had emptied their pits, all had done it just once. As shown in Figure 4.13, 83% of them employed mechanical emptying (hired vacuum tanks services) paying on average R$ 36 (approx. US$ 21) each. The families that had manual emptying deposited the sludge in the local stream.

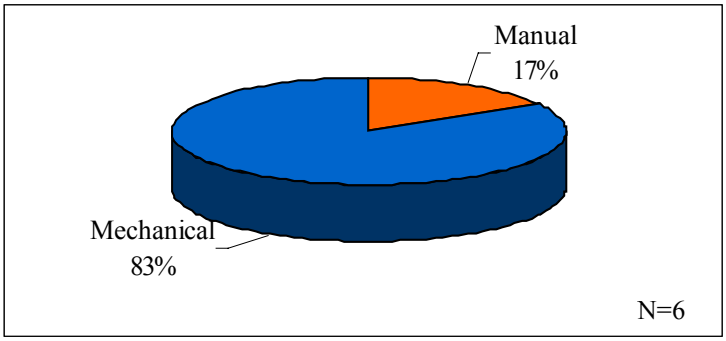


Figure 4.13. Pit emptying process

Regarding the other units of the system, there were complaints about the size of the superstructure door. Families were also not satisfied about the low-volume flush toilets. They complained that the high-level cistern was made of poor material and often broke down. Moreover, to substitute their spare parts was not a straightforward job, mainly due to the non-availability of these materials on the market.

- **Technology satisfaction**

The great majority (77.4%) of the families in Aero Rancho said that the sanitation system implemented in the community was a good system; 13.2%

classified it as average and just 7.5% expressed that the system was bad. The percentage of didn't know/didn't answer was 1.9%.

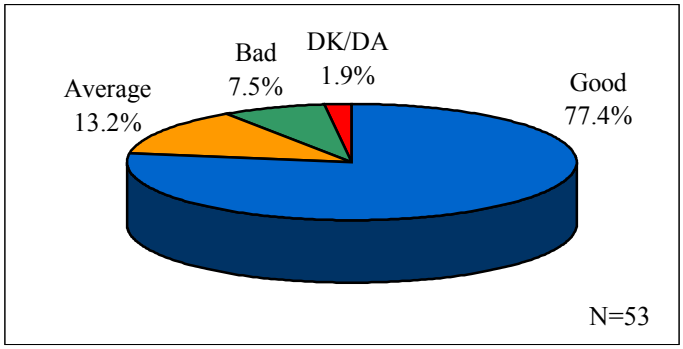


Figure 4.14. Level of satisfaction

- **Section III – Health and Educational Programmes**

When householders were asked whether they experienced any malodour form the pits, 92% answered no. The presence of mosquitoes was indicated by 72% of the families interviewed; however, they associated this with the rainy season. In fact, water deposited in the streets and in the house yards surrounded by vegetation was widely observed. Another possible focus of mosquitoes was the faeces of domestic animals and also deposition of solid waste (although it appears to be reduced in relation to the situation described before the educational programme).

Regarding educational messages, about 60% of the householders said that they are frequently (weekly to monthly) visited by health visitors who give advice on hygiene, water care, children's and women's health.

4.3.8. Technical inspections

Among the families that had participated on the Aero Rancho sanitation programme, 70% have their bathroom (sanitary unit) built inside their houses and 15% have no flushing devices connected to their toilet bowls.

Vent pipes where found in 53% of the leach pits and just 10% of them were properly protected.

Just 6% of the families had opted for the double pit scheme (had built their second pit), and 37% had the sullage from the kitchen sink passing through a grease trap before reaching the pit.

Rainwater was observed to have direct access to the pits in 4% of the households and sullage was being openly discharged in 10% of the houses.

Figure 4.15. and Plates 4.26 to 4.30 illustrate these results.

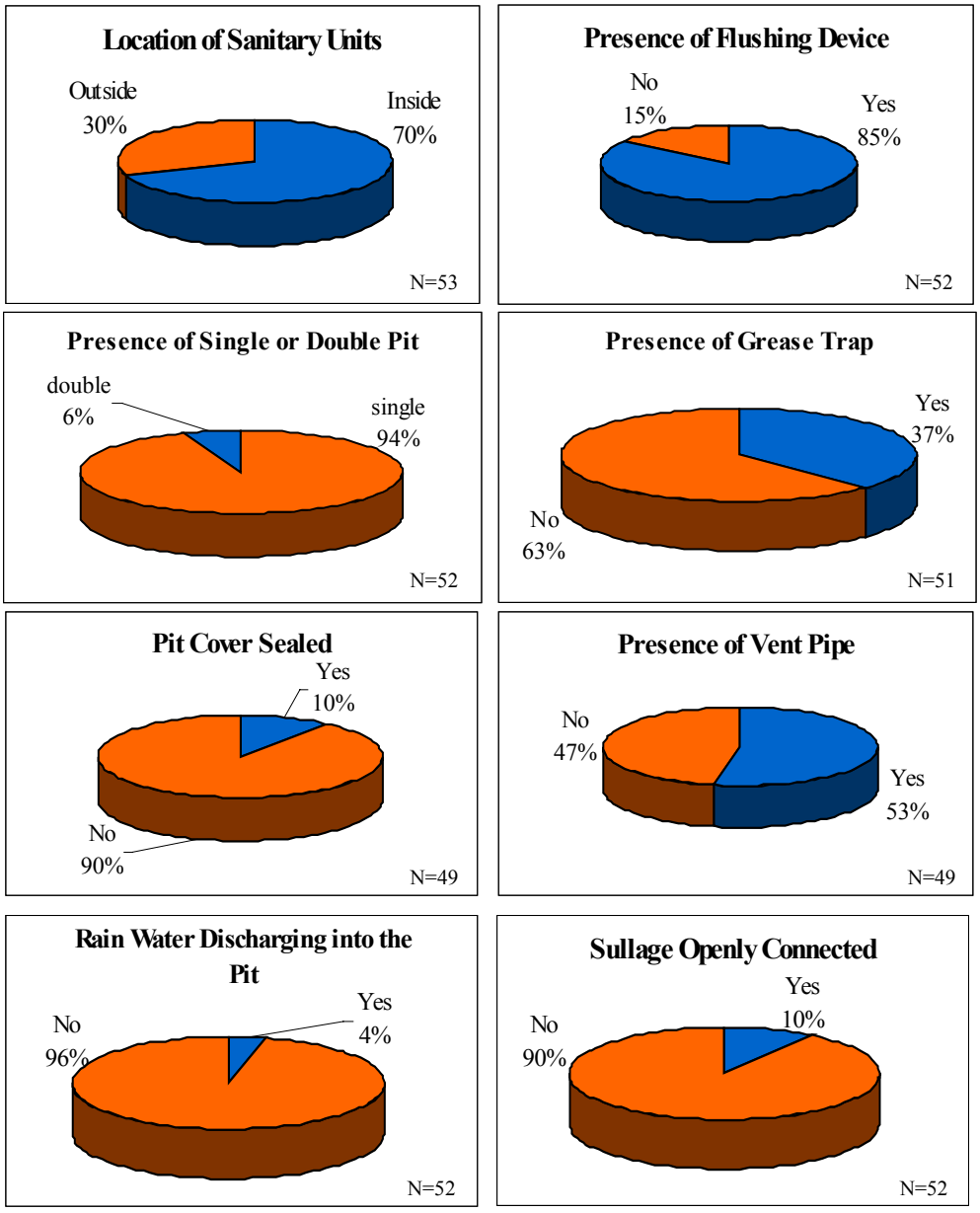
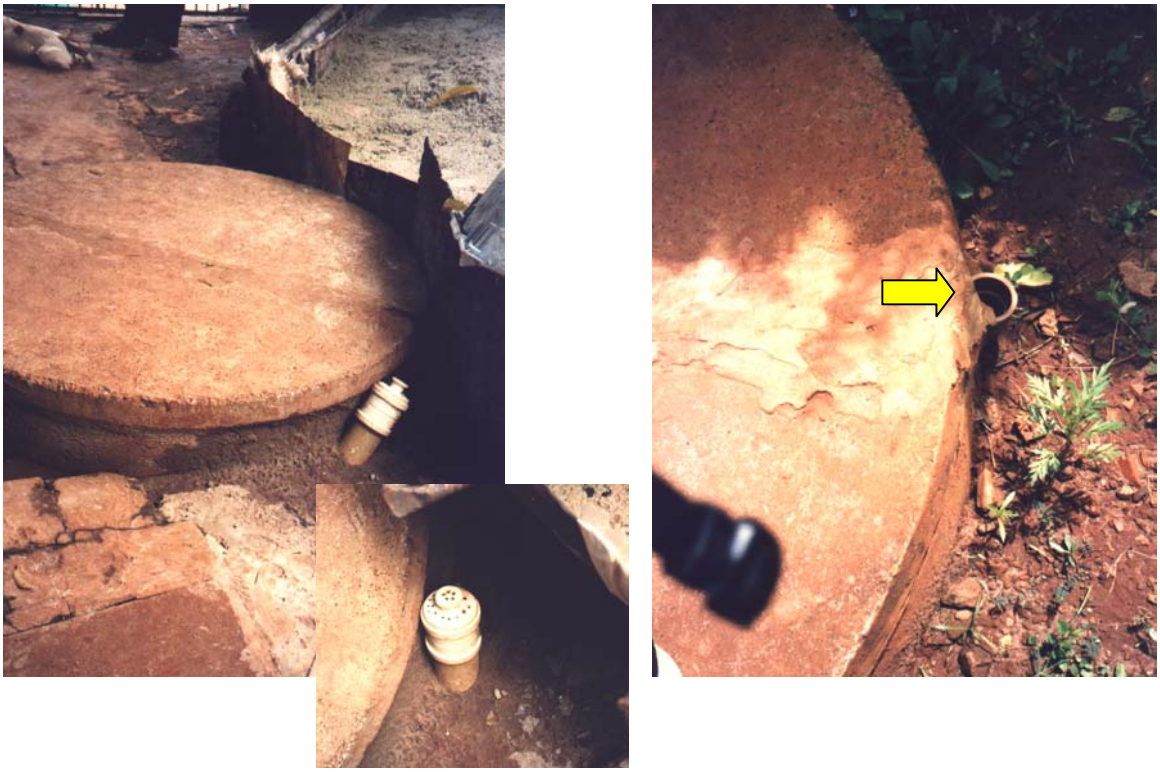


Figure 4.15. Results of the technical inspections

Plate 4.26. An in-house bathroom connected to the leach pit



Plates 4.27. Leach pit Vent pipes

Plate 4.28. An improvised pit cover

Plate 4.29. Leach pit with exposed leach holes

Plate 4.30. Photos from the same house showing sullage not properly connected to the pit

4.4. Case Study 3: Rocas/Santos Reis (Natal-RN)

4.4.1. Introduction

CAERN – the State Water and Sanitation Company of Rio Grande do Norte – is recognised as the company that implemented the first condominial sewerage system. This was in 1980 and the area chosen was the Rocas/Santos Reis district in the city of Natal – capital of the State of Rio Grande do Norte, NE of Brazil (Figure 4.1).

4.4.2. Background

In the early 1980's, CAERN obtained a loan from the World Bank to provide 750 conventional sewerage connections in the area of Rocas Santos Reis.

According to CAERN's president at the time, Mr. Josemar de Azevedo, there was a great motivation among the company's directors to produce as much as possible with the resource obtained; thus, the occasion was considered a great opportunity to put into practice the technical and social parameters introduced by the emerging ideas of the condominal sewerage.

Therefore, after agreement with the World Bank, the initial conventional sewerage project, which would have provided 750 connections, was transformed into the first condominial sewerage system. This project served nearly 3,000 households and used only half of the material that would be needed for the conventional design (the material remaining was used on sewerage projects for other areas).

4.4.3. The Rocas/Santos Reis Site

For the characterisation of the Rocas/Santos Reis district, Sinnatamby (1983) divided the site into two socio-economically distinct areas:

- Area A: Occupying 42.8 ha, this area concentrates the lower income population. There were 3,100 families contributing to an overall population density of 345 persons/hectare (saturation density estimated to be 350 per ha). The general urbanisation and settlement characteristics were:
  - Irregular, unplanned urbanisation with narrow non-aligned roads, with plots of minimal dimensions;
  - A variable topography with elevations between 3 and 20 m;
  - Housing of a low standard of construction, frequently having no lateral space.

- Area B: This was characterised as a high-income area. It covered 22.4 ha and had a population of 700 people (population density of 32 per ha). The urbanization of the area was characterised by:
  - Modern, regular urbanisation with wide roads and large plot sizes;
  - Relatively flat topography;
  - Housing units of a very high standard of construction.

The area defined as "area A" became the focus for the development of the condominial sewerage programme and further investigations found that (Sinnatamby, 1983):

- The location of all sanitary facilities and plumbing fixtures were concentrated at the back of the house;
- Approx. three quarters of the houses were found to have the floor level below that of the road (as much as -1.50 m in some cases);
- Over 90% of the houses had an individual toilet that housed a conventional sanitary bowl (area also used for bathing). Toilets were usually manually flushed using 8 to 10 litres of water;
- Three quarter of the houses had a yard tap level of water supply;
- The common solution for the disposal of excreta was leach pits;
- Sullage was usually discharged by natural drainage to the streets by means of channels and pipes (where this was not possible, sullage was accumulated in tins that were emptied many times a day);

4.4.4. The Sanitation Programme

➢ **The "Quadra 90" experience**

The implementation of Rocas/Santos Reis sanitation programme in 1980 was based on a "pilot block experience". The aims of this "testing phase" were to investigate at pilot scale the technical and social feasibility of the system, and also to use this pilot block as a "shop window" for the acceptability of the system by the householders living in the other blocks of the locality.

For the selection of the appropriate block for the pilot study, the following parameters were adopted (Sinnatamby, 1983):

- It had to be statistically and characteristically representative of the area;

- It should have access to an area which could be utilised for treating and disposing of the collected sewage;
- It should be centrally located to facilitate the access of other members of the community wishing to observe and monitor the operation of the system.

Based on the above, the block known as "Quadra 90" filled the requirements and was chosen for the study. It is a small block covering an area of 2,291 m^2 with 28 plots irregularly distributed. The block population was 132 people and the population density was 576 persons per hectare (357 persons per hectare when considering half the width of the surrounding roads).

Quadra 90 had the condominial "back-yard" system implemented following the steps described below (Sinnatamby, 1983):

- A meeting with the households of the block aiming to: explain the general sanitation conditions necessitating interventions; appeal for cooperation; describe the proposed solution; make the potential users conscious of their responsibilities; exchange ideas and opinions; get permission to undertake a door-to-door survey; and get agreements on: undertaking another meeting; the responsibilities of each person; the costs of the system and tariff policy; the allowance of members of the community to observe the system, and, that CAERN would repair any damages caused to the properties;
- Visits to each house in order to obtain information on: the location of the source of sewage and sullage; the type of plumbing fixtures; the level of the house in relation to that of the road; and the methods used to dispose rainwater, excreta and sullage;
- Visits to each house to mark the location of the inspection chamber (in consultation with the occupants of the house);
- Levelling of the defined points;
- Design of the system; and
- A second meeting for the approval of the scheme by the members of the block.

A small firm of contractors (that was required to employ local workers as much as possible) executed the project without major problems. For the treatment of the collected sewage, a treatment plant consisting of a communal septic tank and drainfields was provided nearby (about 100m away).

By the completion of the experimental system, in December 1981, the total investment cost per household was calculated as US$ 149.10 and a very high level of acceptance among householders was observed.

- **Expansion of the programme**

The expansion of the programme to the remaining residential blocks was greatly benefited by the experimental study. Indeed, the positive impact of the pilot scheme increased the level of awareness of all community members on the importance of the system, and also provided an *in loco* understanding of the technology adopted.

Therefore, the same methodology used for the implementation process of the pilot study was used for the expansion of the programme, which covered 97% of the community. The execution was then completed and the system has now been in operation for almost 20 years.

The others physical improvements observed in the area since the period described above, was that the streets had been paved with paving stones and many of the houses had been refurbished (see Plates 4.31 and 4.32).

4.4.5. Study Methodology

The data collected for the present study were based on: a **survey questionnaire**, a **technical inspection** of the sanitation units, and **observation** of maintenance works. This was further complemented by informal **interviews** with professionals working on the system.

For the **survey questionnaire** and the **technical inspections**, the whole community (households placed within the physical limits of the area) was considered as the target population for the study. The questionnaires were applied in a sample selected systematically, having each tenth house interviewed. The size of the sample obtained by this method was therefore approx. 10% of the total number of houses in the area (N=362).

The questionnaire (Annex 3) comprised five sections, as follows:

Section I - Identification/ socio-economical aspects
Section II - Level of water supply
Section III - Community participation
Section IV - Technology usage, functioning and satisfaction
Section V - Educational programmes and public health

The technical inspections were carried out at the same time as the questionnaire survey and at the same households. These inspections were based on the completion of a factual inspection question-sheet containing the following parameters: sealing of the inspection chambers; damaged (broken) inspection chambers; if there was open wastewater flowing to the system; and rainwater discharging into the sewers.

Plate 4.31. The same street before the sanitation system (1980 - right) and during the field study (2000)

Plate 4.32. Two further views of the Rocas/Santos Reis area, showing condominial sewerage inspection chambers

4.4.6. Survey Questionnaire

➢ Section I – Identification/Socio-economic Aspects

Four variables were measured in this section: the time that the families had been living in the site; the occupation density; the families' income and property ownership.

Thus, 47% of the families had been living on the plot for more than 20 years (before the system started to be implemented). 2.5% had moved in during the implementation of the project (7 to 8 years ago) and 50% had moved in after the sanitation system was put into operation (14.4% of these moved in during the last 2 years), as shown in Figure 4.16.

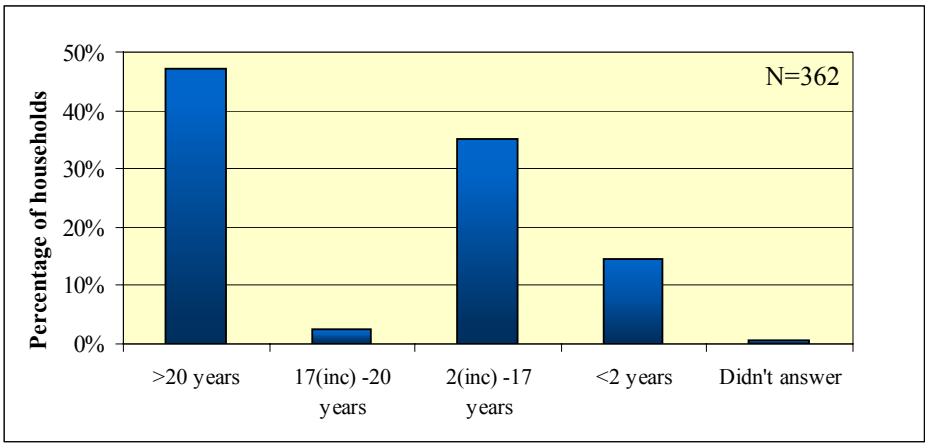


Figure 4.16. Time that the families had been living in the property.

The average occupation density was 4.72 persons per household and the joint monthly family income was up to 1 Brazilian Minimum Wage (MW) for approx. 20% of the households (included in this classification were also families with all working-age members unemployed). In the category of families earning between 1 and 2 MW were 24% of the households leading to a total of approx. 44% of the families earning 2 or less minimum wages per month. The main category found was of families earning between 2 (not included) and 5 MW (30% of the households). The percentage of families that did not answer this question was 14% (Figure 4.17).

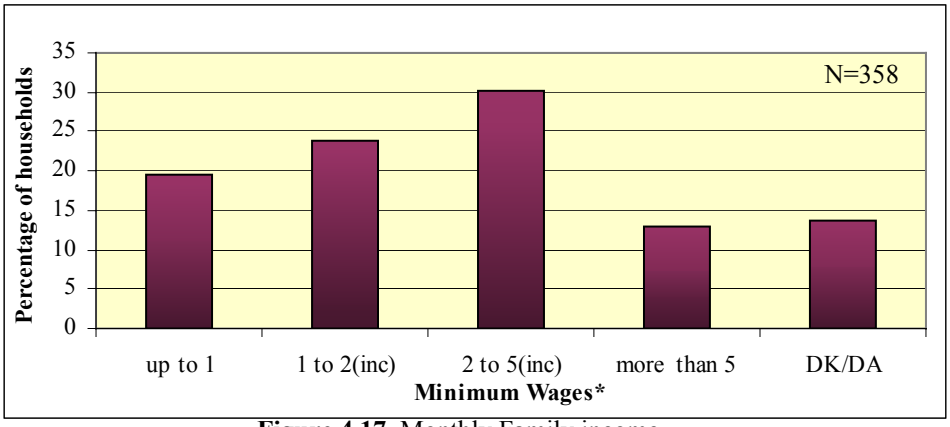


Figure 4.17. Monthly Family income
(*The Brazilian Minimum Wage was 136.00 reais (approx. = US$ 80.00) in 28/03/00)

Regarding the property ownership level, the results revealed that approx. 74% of the householders owned their houses.

- **Section II - Level of Water Supply**

The community is fully served by CAERN water supply systems and there are no families using other sources of water.

Sinnatamby (1983), in a characterisation study of the area, reported that 75% of the households had a yard tap level of supply. This study, however, revealed that the percentage of households with this level of supply had decreased to 12% and that, as shown in Figure 4.18, 88% of the houses now have an in-house level of water supply.

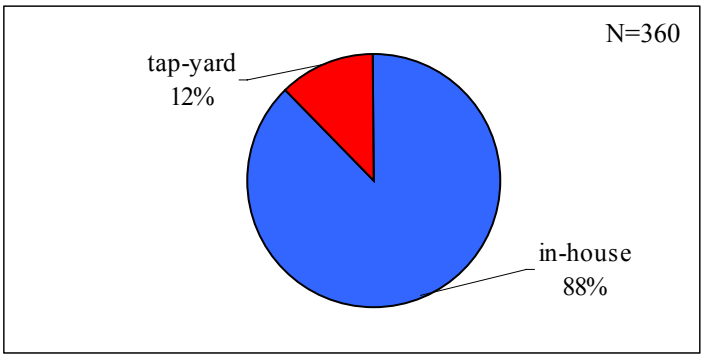


Figure 4.18. Level of water supply

- **Section III - Community Participation**

As shown in Figure 4.19, approx. 83% of the population surveyed were currently connected to the condominial sewerage system. Among the remaining 17%, 2% didn't know/didn't answer whether the house had a sewerage connection or not, and 15% said that they were not connected to the system.

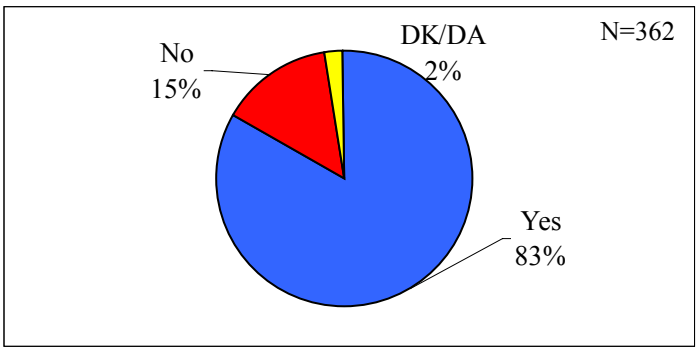


Figure 4.19. Level of house connections to the condominial sewerage system

The reasons why these 15% of the households had no connections to the sewerage system are shown in Figure 4.20; thus, 25% of them said they did not think

that it was important to have sewerage and 23% said they did not know about the programme; 12.5% explained that they were waiting for CAERN to connect their wastewater to the system and 29% didn't know/didn't answer the question.

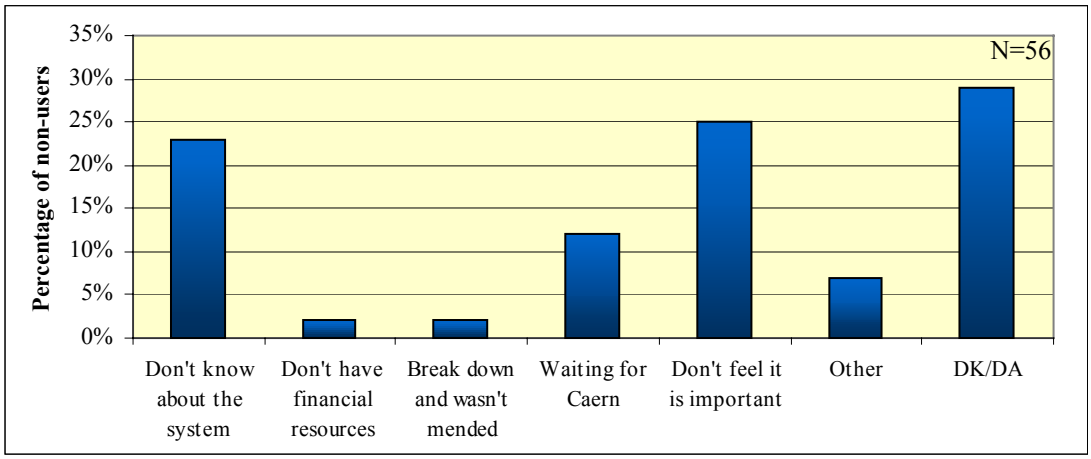


Figure 4.20. Reasons why households were not connected to the system.

Considering the 15% not connected to the system, about 37% was disposing of their wastewater into the drainage system and 39% had septic tanks (Figure 4.21).

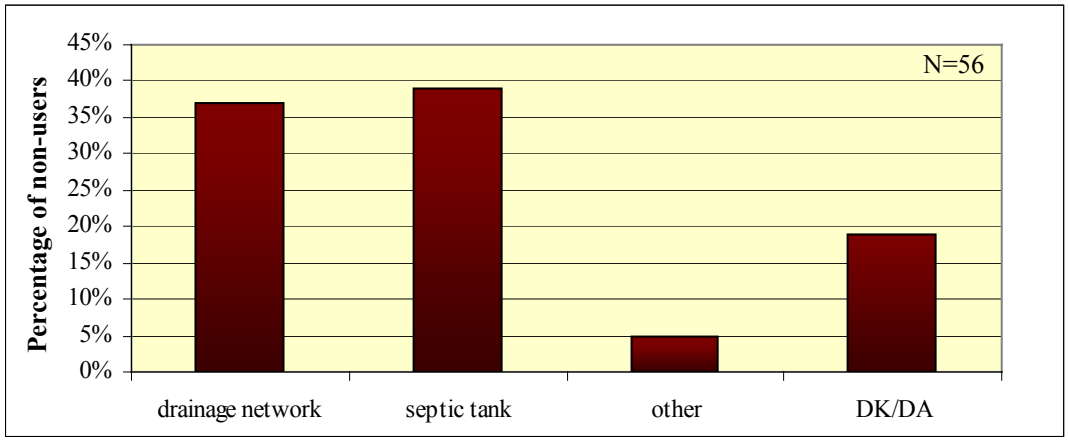


Figure 4.21. Destination of wastewater from the households not connected to the system.

Among the 83% of households that were connected to the sewers, nearly 46% became aware of the sanitation system through CAERN's staff, about 11% said that they were told by neighbours and nearly 4% by persons from the residents' association.

The majority of the families interviewed (37%) started taking part in the programme at the beginning of the implementation phase, whereas 11% said that they starting participating just after seeing the system functioning. Figure 4.22 also shows that only 4% of the households accepted the system since the meeting stage and that less than 1% made the connection when they moved into the houses. About 36% said that

the houses were already connected to the system when they moved in and 11% did not answer the question.

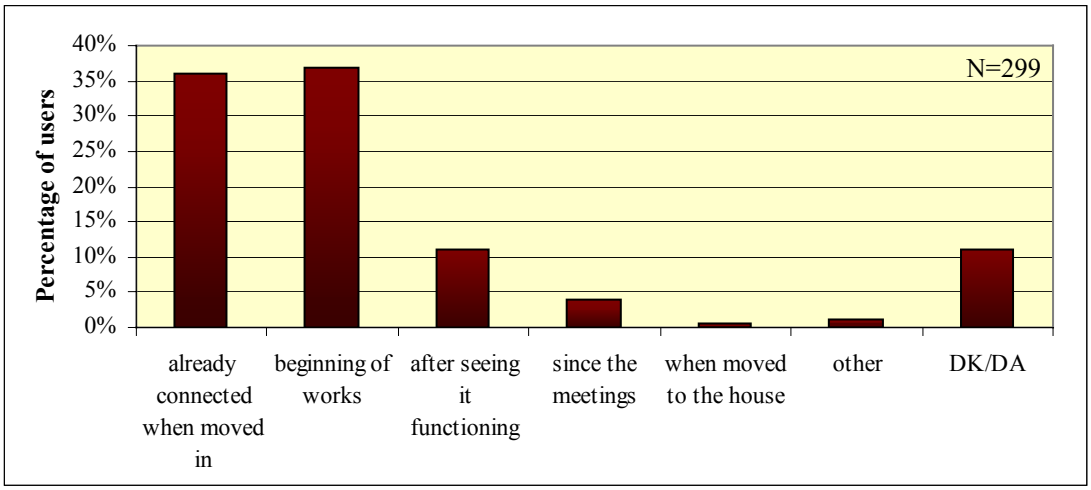


Figure 4.22. Beginning of the participation of the householders in the sanitation programme

➢ Section IV - Technology Usage, Functioning and Satisfaction

❑ Technology usage

Regarding the utilisation, 85% of the households connected to the system said that everybody in the family uses the sanitary facility, 10% said that just the adults and 5% that adults and children over 5 use it.

The connection of the households' sanitation appliances to the system is illustrated in Figure 4.23; thus, 98% of the toilet bowls were connected to the system and connections for showers, wash basins, and kitchen sinks were also high (91 - 94%). For the laundry tanks, about 5% were not connected (sullage flowing to the backyard) and 30% had the wastewater from washing machines connected to the sewers (however nearly 68% of the householders do not have this equipment).

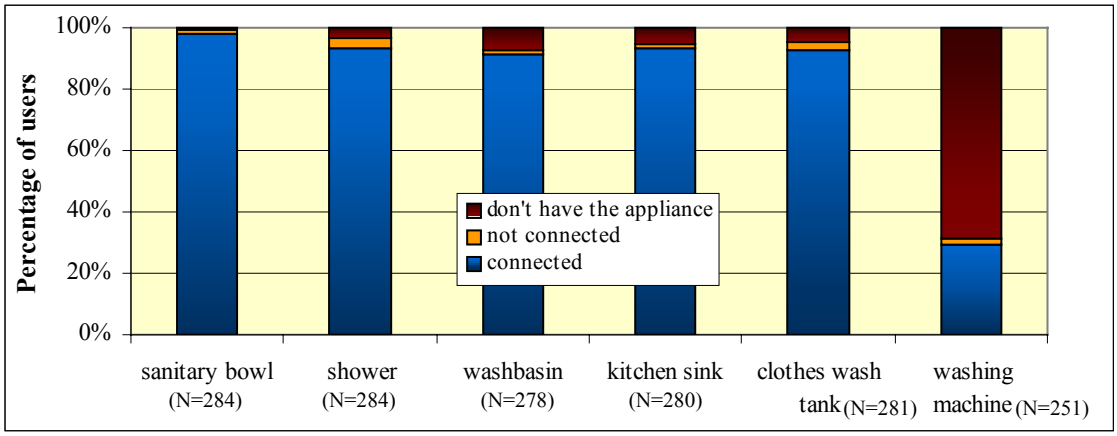


Figure 4.23. Household appliances connected to the system.

- **Technology functioning**

Regarding the frequency of failures in the condominial sewers, 40% of the families interviewed said that they "never" had any problem. About 37% had problems only "rarely" and 14% said that problems occur "sometimes". 2 and 3% reported that operational problems occur monthly and weekly, respectively (Figure 4.24).

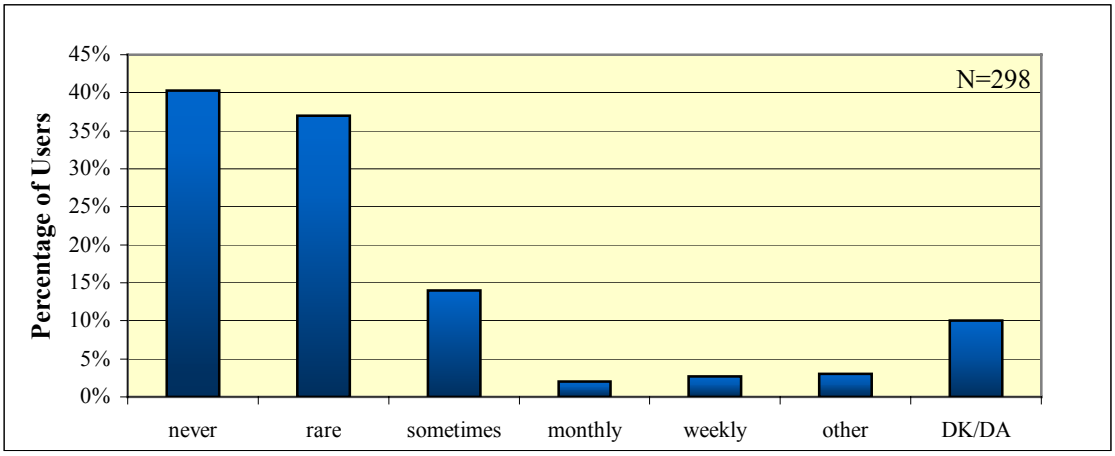


Figure 4.24. Frequency of problems.

Among householders that reported some functioning failure, 36% said that such problems were related to blockage in the main sewer and about 22% to blockage in the condominial sewer. Approx. 4% reported problems related to broken inspection chambers and 1% (each) related to a broken main or condominial sewers (Figure 4.25).

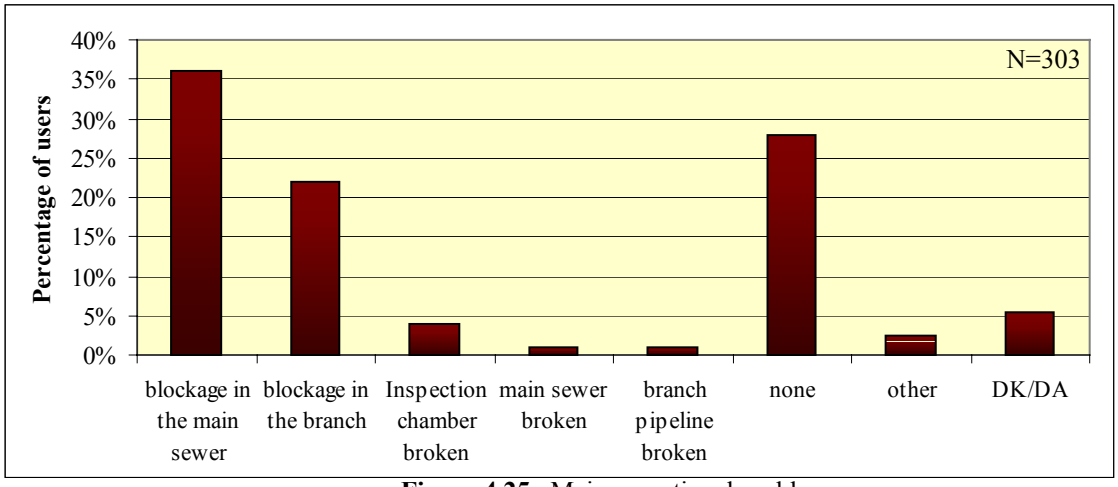


Figure 4.25. Main operational problems.

Asked about who solves the problems that may occur with the system, the great majority of householders (73%) answered that they call CAERN; 3% said that they ask their neighbours to help and 5% answered that they hire a professional when they need to mend anything related to the system (Figure 4.26).

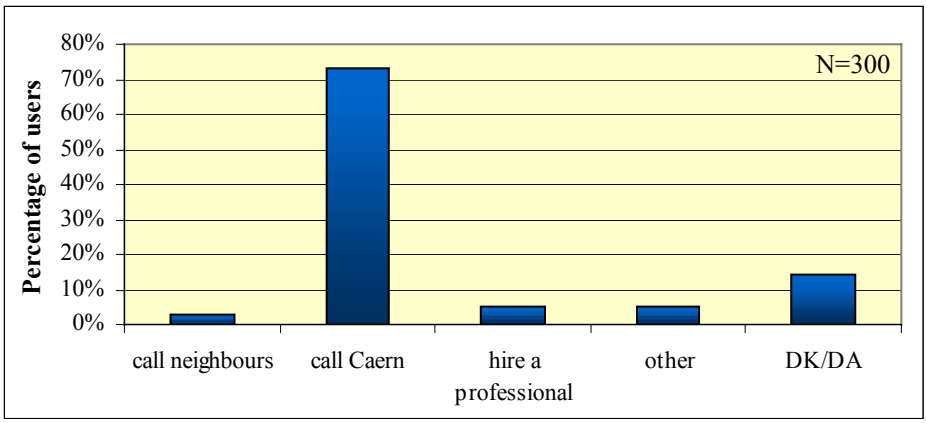


Figure 4.26. Person/institution called to perform the maintenance of the system

According to approx. 20% of the families, CAERN takes 1 day or less to attend a request for maintenance services; 23% said that it takes up to two days and 14% that it takes a week. Figure 4.27 illustrates these data and also shows that 30% of the families did not answer the question.

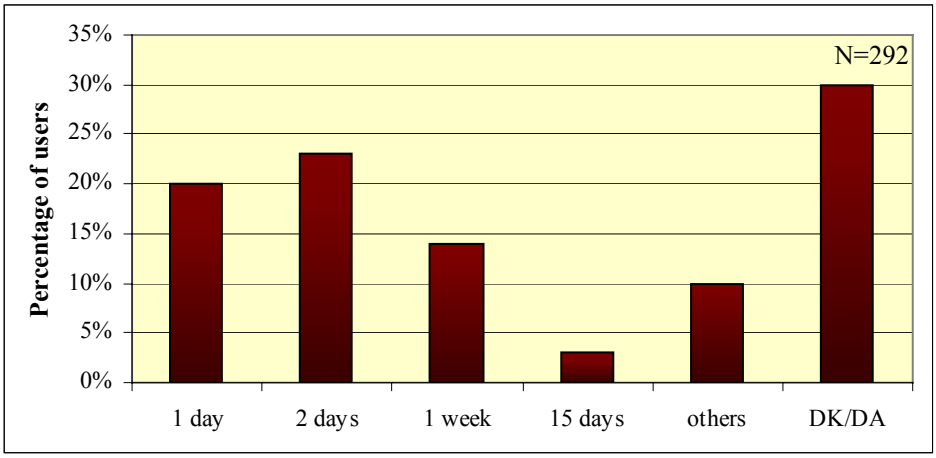


Figure 4.27. Time for CAERN to attend a user's calling.

- **Technology Satisfaction**

As shown in Figure 4.28, 63% of the families classified the system as "good", 18% said that it was "OK" (i.e. average) and 14% were not satisfied with it.

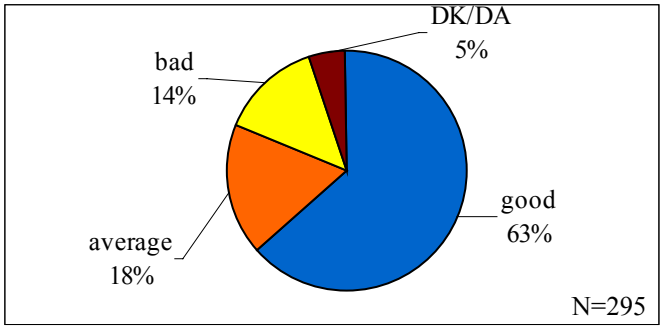


Figure 4.28. User satisfaction with the condominial sewerage system.

The amount of money paid by the users for the sanitation system was classified as high by a quarter of the householders. About 46% thought that the tariff was reasonable and 13% that it was low (Figure 4.29).

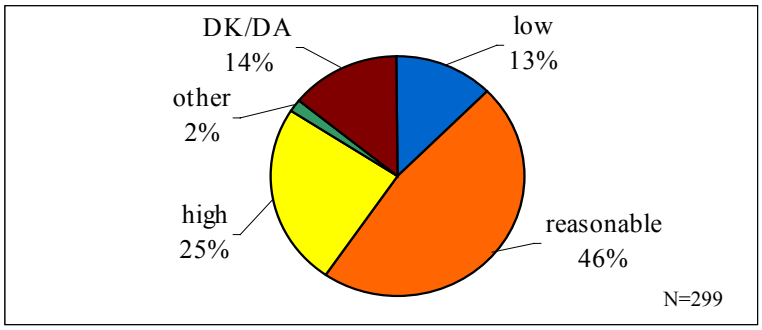


Figure 4.29. Value of charges paid by the users for the sewerage system.

- **Section V - Public Health and Educational Programmes**

The results of the household survey showed that 38% of the households had at least one child up to 5 years old. Considering just the families having "under 5's", at least 1 child in 17% of these households had had a diarrhoeal related disease during the period of 15 days prior to the survey, as illustrated in Figure 4.30.

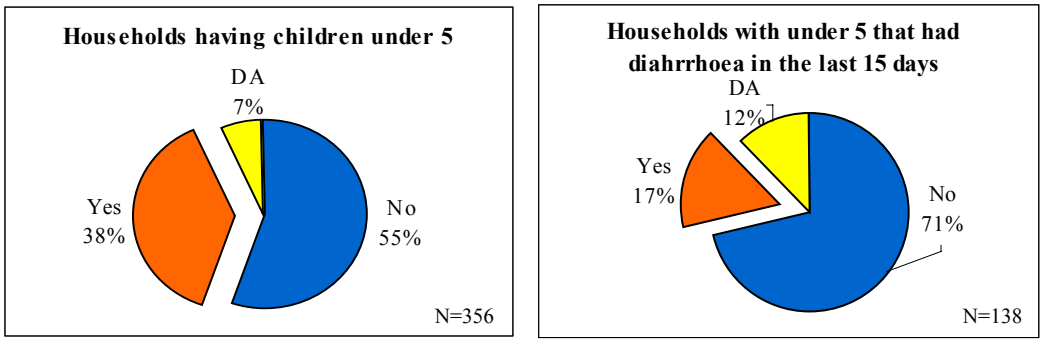


Figure 4.30. Under 5's and the occurrence of diarrhoea in the last 15 days.

In 88% of the households interviewed at least one member of the family had heard about Oral Rehydration Solution (ORS). Figure 4.31 shows the source by which the householders obtained this information. When asked how they make the ORS, 92% of them succeeded in describing a proper preparation.

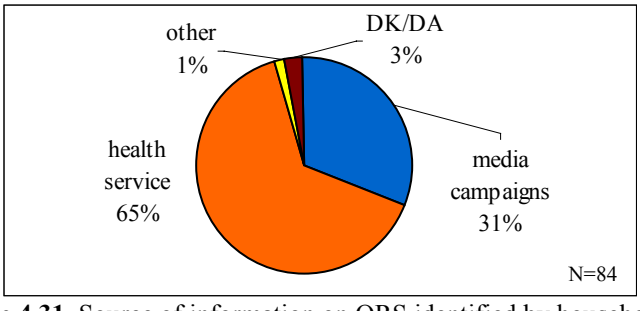


Figure 4.31. Source of information on ORS identified by householders.

It was also found that 64% of the households had at least 1 child under 15 years of age. These households provided a sample of 442 children "under 15", and from this, they reported that 59% had had their faeces tested for helminth infections during the previous 12 months, and 31% were found to be positive (10% answered that they did not remember the result). Figure 4.32. shows the type of helminth infections among the "under 15's" (according to the householders).

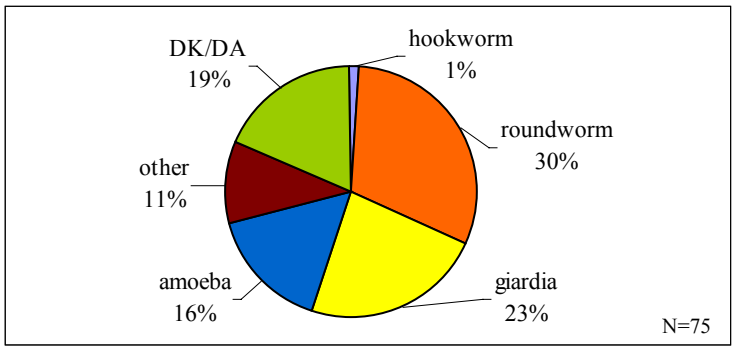


Figure 4.32. Helminths identified in children under 15.

Regarding educational programmes, only 15% of the households recalled having received some information from the sanitation programme, and, 55% said that they received health messages through their health visitors (especially concerning dengue).

4.4.7. Technical Inspections

The inspections revealed that the covers of the inspection chambers were not sealed in 14% of the houses (regardless CAERN's policy of keeping all covers sealed with mortar).

It was also observed that 12% of the inspection chambers had some level of damage either to the box itself or to the covers.

Regarding the house connections, in only 1% of the households were they found to be inadequate, with open wastewater flowing over the ground to the inspection chamber.

Finally, it was possible to identify rainwater connections to the system in 24% of the households inspected (see Plate 4.31).

Figure 4.33 illustrates the above results.

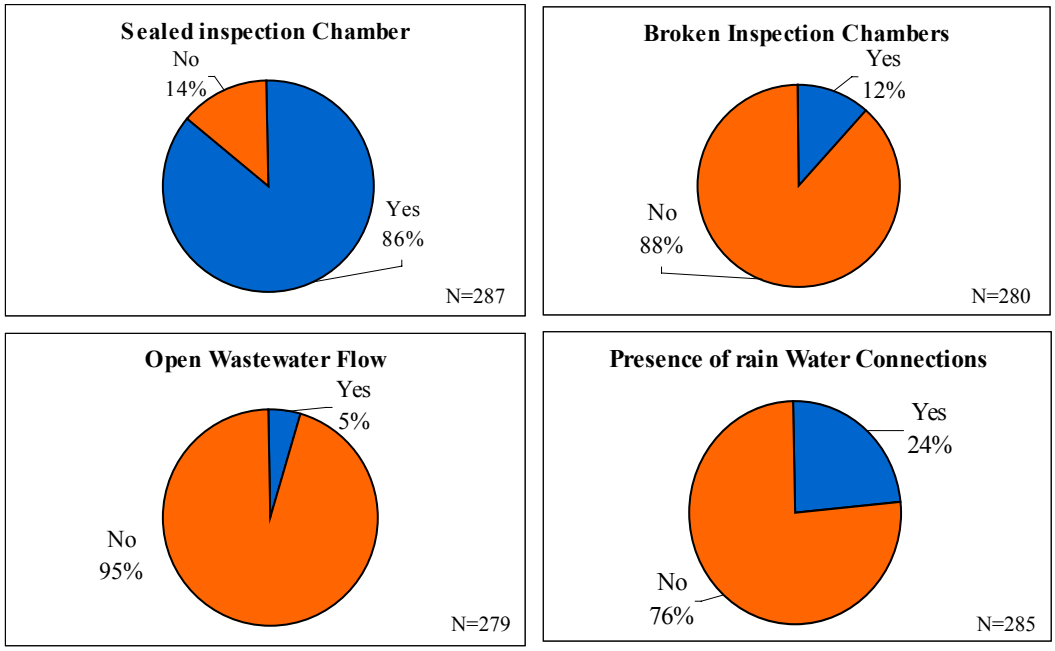


Figure 4.33. Results of technical inspections

4.4.8. Maintenance activities

The maintenance of the system of Rocas/Santos Reis is CAERN's responsibility and was being carried out through an on-site office. However, the Rocas/Santos Reis office was due to close just a week after the end of this field study (September/1999). This decision was taken by the directors of CAERN who were implementing a policy of centralising maintenance services.

The on-site office was, by then, receiving about eight calls per day from the local users for maintenance services related to both the water supply and the condominial sewerage systems. These calls were also being made by telephone, but mainly in person as the office was conveniently located in a corner of one of the inner residential blocks. The engineer responsible for the local office said that all calls are usually seen to in a period of up to 1 day. For sewer maintenance, the local crew was equipped with a vacuum tanker (Plate 4.33) in addition to its normal tools.

The main maintenance service carried out by the crew is, according to the staff, unclogging the condominial sewers and the need for it is often waste dropped into the sewers (leftover food, plastic bags, clothes and stones). The sequence of photos shown in Plates 4.34 and 4.35 illustrates the performance of the crew on two occasions.

In an update of the results carried out in December 2000, members of the residents association and householders randomly interviewed said that no difference had been noticed on the quality of O&M services since the office had been moved.

Plate 4.31. Entry hole for the discharge of stormwater into the inspection chamber.

Plate 4.32. A CAERN crew member re-sealing the inspection chamber cover after a maintenance service.

Plate 4.33. The vacuum tanker used by the sewerage maintenance crew of Rocas/Santos Reis

Plate 4.34. Sequence of photos showing cleaning out of a condominial sewer which had been blocked by a piece of cloth and a plastic bag.

Plate 4.35. Cleaning out another condominial sewer – this time the cause of the problem was solid waste and stones inside the sewer.

4.5. Case Study 4: Vila Planalto (Brasília-DF)

4.5.1. Introduction

In the 1990's, CAESB – the Water and Sanitation Company of Brasília (the capital city of Brazil) – made large investments in sanitation and adopted the condominial system as its sewerage technology of choice in the Federal District (Brasília and its satellite cities – see Figure 4.1).

4.5.2. Background

The Federal District has approx. 2 million inhabitants and through its investments in the 1990's, CAESB had provided condominial sewerage for 121,000 households (1,134,574 people). This resulted in the construction of 1,328,498 m of condominial sewers, 667,485 m of main sewers, 15 new treatment plants and 24 pumping stations. With these numbers, CAESB achieved 90% coverage for sewerage services and 63% of the sewage collected receives treatment.

Considering that the figures for the Brazilian population served by sewerage system is under 40% and that for the treatment of the sewage collected is 10%, CAESB is in fact considerably ahead of the majority of the State Sanitation Companies in Brazil.

- **CAESB's Condominial Philosophy**

CAESB's experience with condominial sewerage started in the early 90's when the company began to acquire knowledge and experience in condominial projects. This led the company to develop its own methodology for the implementation of this technology. Based on Neder (1999a), the methodology developed by CAESB for the condominial systems follows the basic guidelines presented below:

The key points:

- The involvement of all sections of the company linked to the projects;
- The philosophy of the condominial systems rooted in the daily life of the company;
- The utilisation of the normal structure of the company (avoiding isolated groups);
- The complete understanding of the technology by everyone involved in the project;
- The technology was introduced by the directors as a company policy, and this led to a gradual assimilation by the technical group and also to the acceptance of the technology as a hallmark of the company;

- Community participation before and during project implementation (householders must understand and approve the system beforehand and sewer layout designs must be flexible enough to allow adaptations according to users' demands).

The methodology:

- Basic project for initial planning of the work, for financing and for bidding;
- Community mobilisation works;
- No distinction made between project phase and installation works. The executive project should be developed at the same time that the installation works advance. For this, a project team is based on the site.

Basic project steps:

- Preliminary data (urbanisation plans, topography of the area and project parameters);
- Reconnaissance of the area;
- Layout of the networks and pre-dimensioning;
- Budget and survey of material;
- Bidding for the services.

Executive project/installation phase teams *(all teams work simultaneously):*

- **Team for community mobilisation:** responsible for all the work related to the householders' meetings and, also, for the letter of agreement where the families agree with the rules of the project (maintenance responsibilities and charging policy) and define the condominial sewer layout.
- **Team for the creation of service agreements:** responsible for collecting the information necessary for the discussion with the householders (options for sewers layout, interferences, depth, etc). They are also responsible for the development of service agreements for the solutions adopted by the householders.
- **Team for the development of executive project:** responsible for the adaptation of the basic project to the service agreements for the condominial sewers.
- **Team for monitoring the work and contracts**.

Charging policy:

- Users will be charged for both the connection to the system and for its use;
- The amounts charged are based on the level of the user's participation in the implementation phase and also on the responsibilities accepted by them for the maintenance of the system;

- The resources obtained through the connection charges (referring to the costs of the condominial sewer, which represents about 27% of the costs of the overall system) should be totally reinvested in new sanitation projects;
- The connection charge is based on the real costs of the condominial sewer per plot (users that opt for self-construction will not be charged for connection);
- The tariff for the utilisation of the system is based on the water bill and set according to the users' option for the condominial sewer layout. For the backyard layout the tariff is 60% of the water bill (in this case users have the responsibility to maintain the units located in their plots). For the sidewalk and for the front yard layouts, users are charged 100% of the water bill;
- 11% of the tariff revenue is transferred to the same fund as that for the connection charges, and is supposed to be used in reinvestments for sanitation system.

Following the methodology described above, CAESB has been implementing condominial systems with total average costs of US$ 27 per resident and of US$ 16 per meter of network (which is much lower than other experiences reported).

The first condominial project implemented by CAESB following the above methodology was the Santa Maria Project (July/1998). However, CAESB's experience in condominial sewerage dates from 1992 when the company implemented and started to operate seven condominial projects (Areal-QS6/8/10, M-Norte, Bairro Veredas, Expancao/1a. Etapa, Vila Jardim Roriz, QNP/QNQ, and QNH).

4.5.3. The "100% Plastic" System

CAESB's confidence in condominial systems has certainly contributed to innovations. This is reflected not only in the managerial sector of the projects (as discussed above), but also in technical aspects. An example of this is the 100% plastic condominial system that is being tested by the company in full-scale projects.

The so-called "100% plastic" condominial system is a project in which the whole network (pipes and appurtenances) is made of PVC. The utilisation of PVC pipes for sewage is, of course, widespread; the main innovation, therefore, is in the network appurtenances provided in such material. These units are the TILs (an acronym in Portuguese for Tubes for Inspection and Cleansing) and all the necessary connections (bends, adaptors, connections, etc).

The TILs available are:

- *Condominial TIL*: this is used in place of the traditional inspection chambers. These are available for 100 mm diameter pipelines and have three entrances (that receive the household wastewater and the sewage from the previous plot) and an outlet for the next connection. Figure 4.34 illustrates the design of this unit.

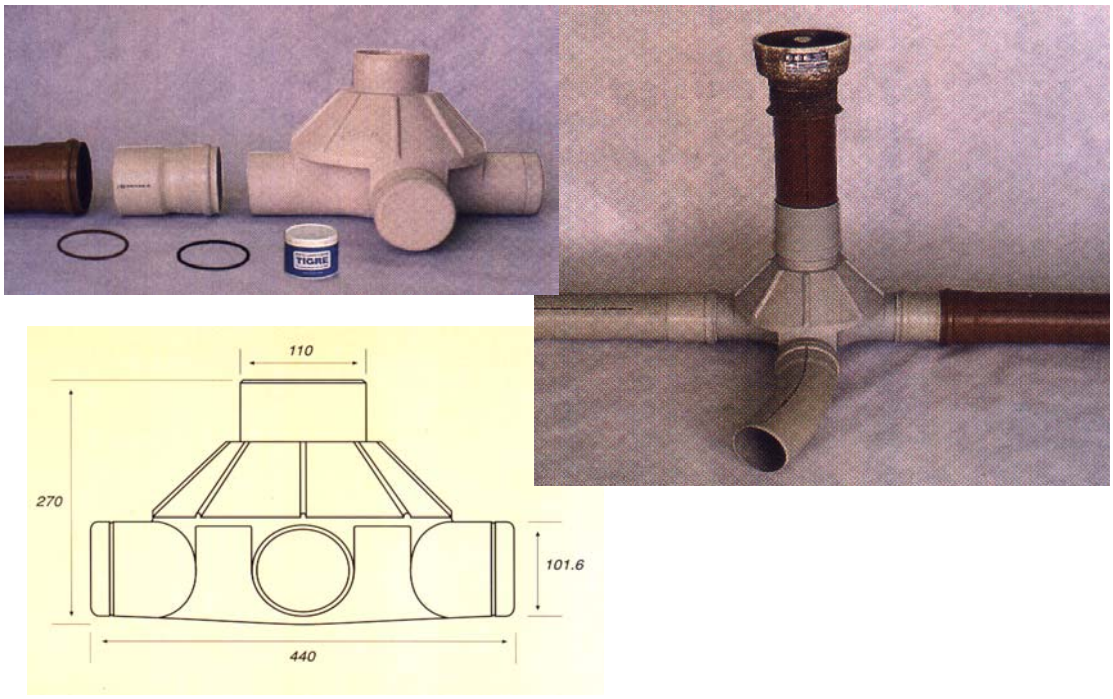
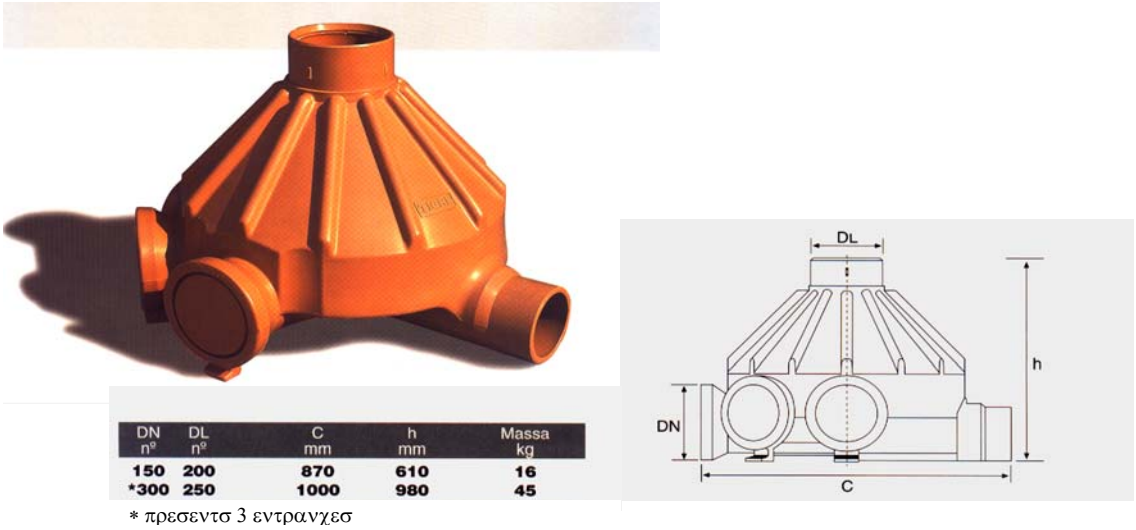


Figure 4.34. 100% plastic condominial TIL

- *Radial TIL*: This unit was developed to substitute traditional manholes. Its shape and dimensions are as presented in Figure 3.35.



DN nº	DL nº	C mm	h mm	Massa kg
150	200	870	610	16
*300	250	1000	980	45

* πρεσεντσ 3 εντρανχεσ

Figure 4.35. 100% plastic manhole

The material described is produced by TIGRE® (URL-19), which claims the following aspects as the main advantages of the 100% plastic over the traditional units:

- Quicker and easier installation (leading to lower costs);
- Higher hydraulic performance and resistance for compression tension;
- Impermeable and easier to clean;
- Reduced access for the entrance of solid waste and objects of large dimension;
- Lightness facilitating the transportation, handling and storage.

CAESB used the 100% plastic condominial system in the sanitation projects of Samambaia and Recanto das Emas. These systems have been in operation for less than a year and a study is currently being undertaken aiming to monitor the projects, its execution (comparative analysis between the 100% plastic and the traditional systems) and maintenance (occurrence of blockages on the sewers, as well as, the related costs). The first results of this study are still to be reported. Nevertheless, considerations based on visits to these 100% plastic systems and on informal interviews with the maintenance staff are presented in Section 4.5.7.

4.5.4. Rich and Poor Areas

The adoption of condominial systems as the standard technology for sewerage in the Federal District of Brazil has been applied independently of socio-economic conditions. CAESB understands that the low-cost characteristic of the condominial sewerage does not make it applicable just to low-income communities. Considering that the technology works well (based on the company's own experience) and is technically appropriate for the site characteristics, the company is applying it universally. Moreover, the lower costs of this system (compared to conventional solutions) allow the company to reach a greater number of users with the same budget.

The above argument seems to be readily acceptable; however, CAESB probably is the first company to put it into practice and had implemented condominial sewerage in two of the highest income areas of Brasília: Lago Sul and Lago Norte.

The community participation programme in theses areas addressed basically the same issues and applied the same rules, than those in the low-income areas.

The main problems regarding these systems were reported by the maintenance staff as been related to poor household connections, which are usually carried out by workers contracted by the householders and not executed under CAESB's supervision.

Regarding the acceptability of the system, a point of concern of the high-income users was about the charging policy, specially the link between the water and sewage bills. These users wish to have their sewerage bills not connected to water consumption, arguing that an elevated percentage of the water does not return as sewage (it is used for swimming pools and watering the gardens). CAESB did not accept this as an argument for changing policy and similar rules to those in low-income areas were being applied.

The access of the workers to the properties was another point of discussion. This was negotiated and the systems had been implemented without major problems. Plates 4.38 and 4.39 show condominial sewerage implemented in these areas.

4.5.5. The site studied

The area selected for this study was Vila Planalto. It is a well-situated area in Brasília, located within 5 minutes from the city's Central Bus Station in the Administrative Region I, between Alvorada Palace (official residence of Brazil's president) and Planalto Palace (the President's office).

Vila Planalto emerged during the period of construction of Brasília (late 1950's). The area originally accommodated the workers of the building companies. The houses were constructed using wood and were of different sizes: in the peripheral areas (where the higher income professionals lived) the houses had large yards and the occupation was of low density; in the central area (occupied by lower income workers) the houses were smaller, and had a much higher occupation density.

The site remained after the end of the works and was the origin of the Vila Planalto district. The physical division is still identifiable with the houses in the peripheral areas having middle class characteristics (some of them still preserve the original wooden construction, but houses recently re-built are easily identifiable), and the majority of the low-income families still occupy the inner areas (with in many instances having more than one family sharing the same plot).

Vila Planalto is now increasing its value as a residential area: it is well located; has the majority of its streets paved; electricity and public lighting; drainage, water and sewerage services; local food suppliers, drugstores, a health centre and a school.

The selection of Vila Planalto for this study was mainly motivated by having its condominial sewerage among the ones with longer period of operation, its easy access and a manageable community size. The Vila Planalto condominial sewerage project dates from November/1991 and the system was in operation by February/1993.

Plates 4.38. The physical contrast between low- and high-income areas in Brasilia. In both, CAESB had implemented condominial sewerage.

Plate 4.39. The inspection chamber of a backyard layout condominial sewer integrated to the garden design of a property in the high-income area of Lago Norte.

4.5.6. Study Methodology

Data from the Vila Planalto's sanitation project were collected through: **project documentation**, a **survey questionnaire**, **technical inspections** of the sanitation project units, **observation** of maintenance works, and complemented by informal **interviews** with professionals working on the system.

For the **survey questionnaire** and the **technical inspections**, the whole community was considered the target population for the study. The questionnaires were applied in a sample selected systematically, with each fifth house being interviewed. The size of the sample obtained by this method was therefore of approx. 20 percent (N=157).

The questionnaire (Annex 4) was composed of four sections:

Section I - Identification
Section II - Level of Water Supply
Section III - Community participation
Section IV - Technology Usage, Functioning and Satisfaction

The technical inspections were based on the fulfilment of a factual inspection question-sheet containing the following parameters: presence of grease trap; sealing of the inspection chambers; damaged (broken) inspection chambers; if there was wastewater openly connected to the system; and the presence of connections to discharge rainwater into the sewers.

4.5.7. Results Concerning the 100% Plastic System

As discussed earlier, a study is still being carried out to compare the productivity of the 100% plastic networks to that of the traditional condominial systems.

Nevertheless, according to CAESB's field staff, the implementation phase of these projects occurred without notable problems and workers did not have serious trouble in dealing with the new materials. On the other hand, problems were reported on the household connections that, in spite of the instructions delivered by the community participation team (Annex 5), not all users had followed the appropriate instructions for connecting of the household sewage to the TIL unit. Thus, causing linkages in such connection points and loss of mechanical resistance of the units.

The crew responsible for the maintenance of the "100% plastic" is based on-site. This maintenance team appears to be working well with the new materials and seems to have understood the characteristics of the system, its experimental condition and the need to overcome possible practical problems.

An example of solving field practical problems is the adaptation made on the covers of the condominial TIL. As shown in Plates 4.40 and 4.41, the upper part of the TIL consists of a neck and the cover, which has a "donut" shape that is filled with mortar to make it heavier and more protected from unauthorised openings. The hole in the inner part gives support for opening in cases of maintenance services. In practice, the problem with this design was the easy removal of the white plug covering the inner hole, making the access to the network not difficult enough (especially for kids playing nearby) and allowing the entrance of both soil and rainwater. The solution given by the crew was to change the ring shape of the covers, making the mould for the mortar without the inner hole. To make the removal of the covers possible, a wad was introduced into the centre of the mortar, giving support to a key that can be used to lift the cover (Plate 4.42).

Considering the reduced diameter of the TIL covers, it was anticipated that there would be a reduction (compared to the traditional system) in the demand for maintenance services caused by the deposition of solid waste into the system. Nevertheless, maintenance services for unclogging of the network are still required and the utilisation of the traditional equipment to solve these blockage problems is no longer appropriate. The steel cable (wire) is still being used but only to facilitate the displacement of the deposited material causing the blockage (Plates 4.43). Thus, to push the material into the pipeline, a pressurised water jet is necessary (Plate 4.44).

The water jet used for this service is a small unit installed in the back of a van (Plate 4.45). To carry out the operation, water from a nearby household is used, avoiding the need for transportation of water tanks. The amount of water used during the operation is quantified and deducted from the user's water bill.

Although the water jet equipment appears to be efficient, the conditions for such maintenance services have to be improved. As described above, the water jet pushes out the clogging materials, but due to the limited access to the condominial TIL units, the removal of this is not always possible. The common procedure is to push the material until it reaches a manhole, which has a wider opening allowing its removal. However, these materials causing the clogging may have to be moved along the whole length of the sewer, which although usually not very long, can in some cases be over 100 m in length.

Plate 4.40. In sequence, the condominial TIL unit; soil compaction during the network implementation phase; and the anchorage (protection) of the upper part of the TIL unit.

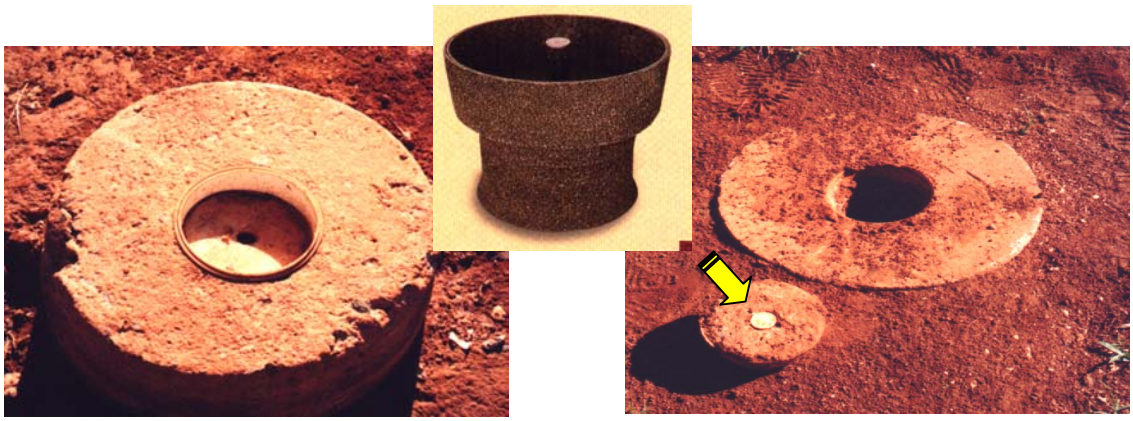


Plate 4.41. The upper part of the TIL (centre); a cover found on-site without the white plug (left); and a cover with the white plug (right)

Plates 4.42. The new mould for the mortar weight and the key to lift the covers

Plate 4.43. A member of the maintenance crew using a steel cable to displace clogging material

Plate 4.44. The utilisation of the water jet to clear clogging material

Plate 4.45. The water jet equipment being connected to a user's tap

Plate 4.46. CAESB's production of traditional inspection chambers

Plate 4.47. Different shapes of the bottom of inspection chambers.

Another consideration regarding the maintenance of the 100% plastic condominial systems is that it limits the performance of simple maintenance tasks by the users (as it is encouraged or even required in the traditional condominial sewerage programmes).

Although the final report of the study on the 100% plastic condominial system are still to be presented, as said earlier, the financial viability of these systems is still being questioned. The prices of the units given by the industry had increased considerably, probably due to the industry vulnerability to economical circumstances. Moreover, given the high standards that CAESB has achieved in the production of traditional inspection chambers (Plates 4.46 and 4.47), the traditional condominial system are still been seen as a very attractive option (Luduvice, 2001).

4.5.8. Vila Planalto – the case study

- **Community Organisation**

The mobilisation of the Vila Planalto community followed basically the main ideas of the now standard methodology applied by CAESB (Section 4.5.2.). Thus, householders were invited to the meetings by the mobilisation team, who presented the sanitation programme, explained its rules and gave the information necessary for the householders' decision making process.

The meetings took place in one of the residences and were organised in order for householders within each residential block to discuss their condominial sewer. A total of 73 meetings occurred during this mobilisation phase.

In spite of the delivery of information regarding all aspects of the programme, cases of misunderstanding on the charging policy scheme were noticed among the householders during this survey. Users asked about when they are going to stop paying for the sewerage system, suggesting that it was understood they would have to pay (by instalments) for the connection fee, but not for the use of the system. The unwilliness of these users to pay for the service was also observed, and a common argument heard was that "the government must pay for the running costs of the system".

- **Design basis**

Vila Planalto is situated in two hydraulic basins; thus, the sanitation system was designed considering this topographical condition which led to a system with two networks. The first is on the main basin and has the majority of the household

connections. Its effluent is directed to a pumping station that discharges into the second network through a 150 mm pipeline. The final effluent (collected in the last manhole of the second basin) is then diverted to a 300 mm diameter outfall discharging into a pumping station on the North Sector of the city and finally pumped to the North Sewage Treatment Plant.

The system was designed for a population of 9,000 and the per capita contribution adopted was of 160 l/person/day. The coefficients K_1 and K_2 were taken as 1.2 and 1.5, respectively, and the sewage return factor as 0.8. The condominial sewers were all of 100 mm diameter built in PVC pipes and having a minimum cover to soffit of 0.3 m. The main sewers were built with 150 mm ceramic pipes and a minimum cover to suffit of 1.00 m was adopted.

- **Survey Questionnaire**
  - **Section I – Identification**

Two variables were measured in this section: the time the families had been living in the house and the occupation density. Therefore, 62% of the families were found to be living in their houses for more than 8 years (before the system started to be implemented); 11% had moved in during the implementation of the project (7 to 8 years ago); and 26% moved in after the sanitation system was put in operation (Figure 4.36). As to the occupation density, this was 6.1 persons per household.

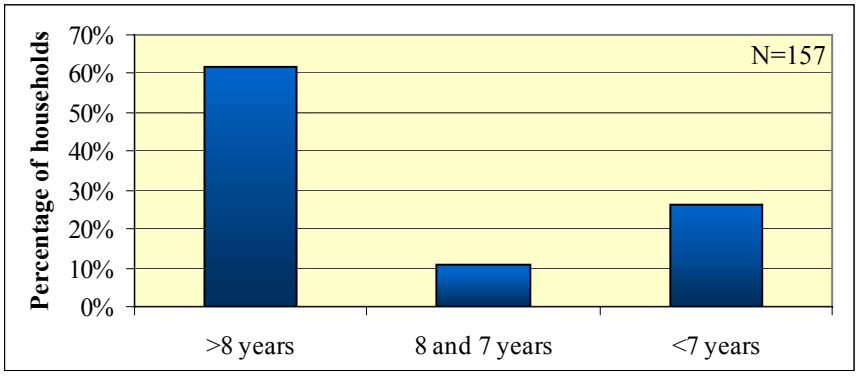


Figure 4.36. Time the families had been living in the house

- **Section II - Level of water supply**

The community is fully served by CAESB's water supply system and no families were found using any other sources of water. Moreover, nearly all the households (99.4%) have an in-house water supply level, and only 0.6% has a yard tap level of supply.

❑Section III - Community participation

About 99% of the population surveyed are currently connected to the condominial sewerage system. The remaining 1% (two interviewed households) adopted septic tanks as the final destination for wastewater. One of the families explained that once the construction of their new house is finalised they will connect its wastewater to the condominial network.

38% of the Vila Planalto families say that they started taking part in the programme since the meeting stage. Figure 4.37 shown that about 27% of the households accepted the system only when the construction works began and 1.5% did it just after seeing the system functioning. About 15% said that the houses were already connected when they moved in and 7% provided the connection after moving in to the house.

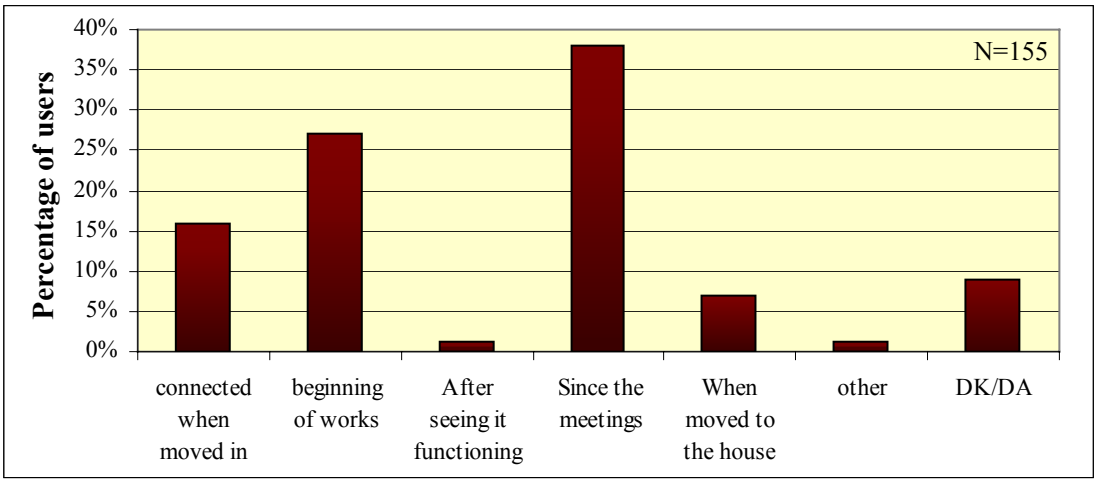


Figure 4.37. Beginning of the participation of the householders in the sanitation programme

❑Section IV - Technology usage, operation and satisfaction

▪ Technology usage

Figure 4.38. illustrates the connection of the households' sanitation appliances to the system. This shows that 100% of the toilet bowls were connected to the system, and that connections for showers, washbasins and kitchen sinks were also very high (more than 98%). For the laundry wash tanks, about 5% were not connected (flowing to the backyard) and 56% of the households had the wastewater from washing machines connected (however nearly 40% of the householders did not have this equipment).

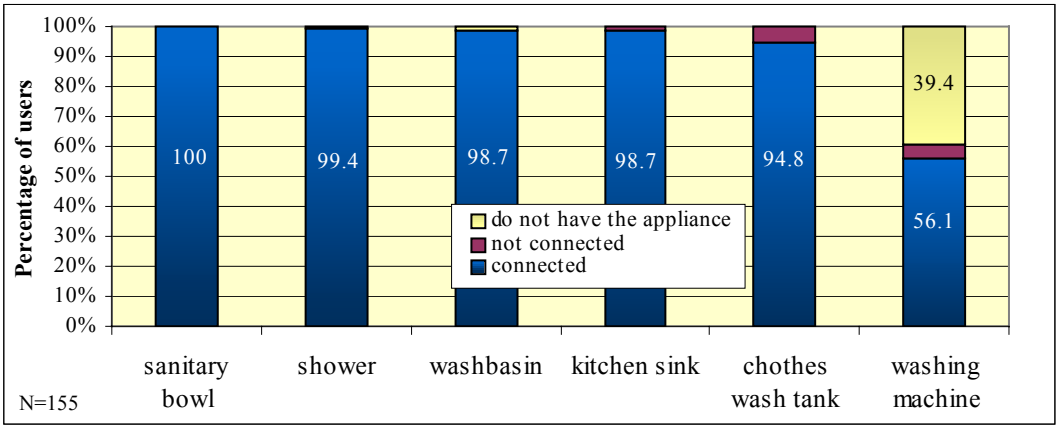


Figure 4.38. Household appliances connected to the system.

▪ Technology operation

Regarding the maintenance of the condominial sewers, only 23.5% of the households said that they were performing such activities. The majority (54.3%) indicated CAESB as being responsible for such service (Figure 4.39).

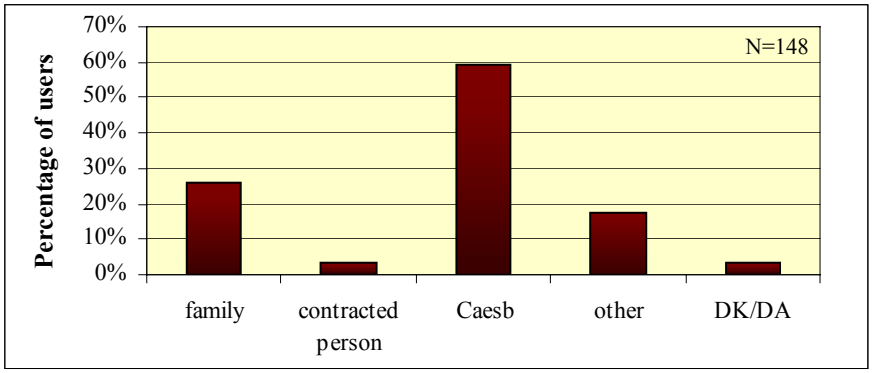


Figure 4.39. Person/institution that solves operational problems with the system

Regarding the frequency of failures, nearly half of the families interviewed said that they "never" had any type of problem with the sewerage system. About 29.5% had problems only "rarely", 13.5% said that problems occur "sometimes" and 6.4% reported that they are "always" having operational problems with the condominial system (Figure 4.40).

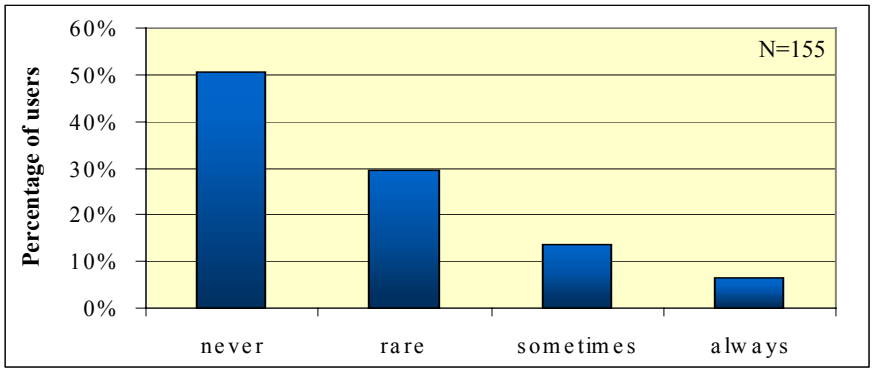


Figure 4.40. Frequency of problems

Among the householders that reported the occurrence of operational failure, 15% said that such problems were related to blockage in the house connection pipeline, and about 34% to blockage in the condominial sewers (Figure 4.41.).

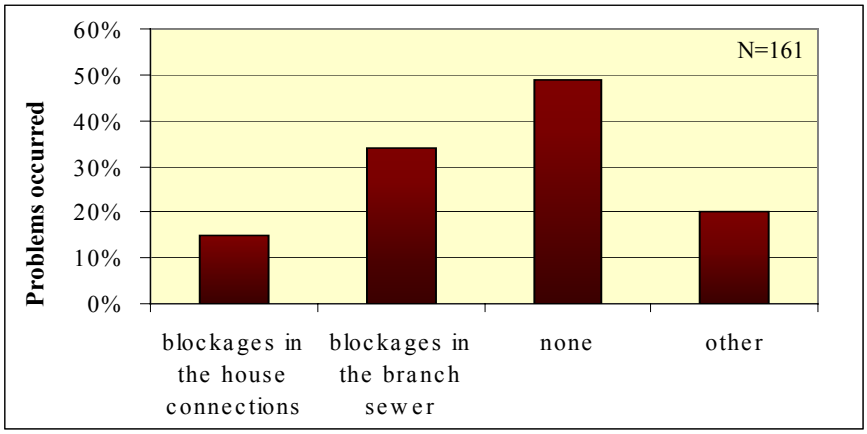


Figure 4.41. Types of problems

The maintenance of sewerage systems in Brasília is concentrated in one central office, which carries out services for both conventional and condominial systems. According to approximately 32% of the families interviewed, CAESB takes 1 day or less to answer a request for maintenance services; 5.2% said that it takes up to two days and 2.6% that it takes at least a week. Figure 4.42 illustrates this and shows that 58% of the families had never requested CAESB's services.

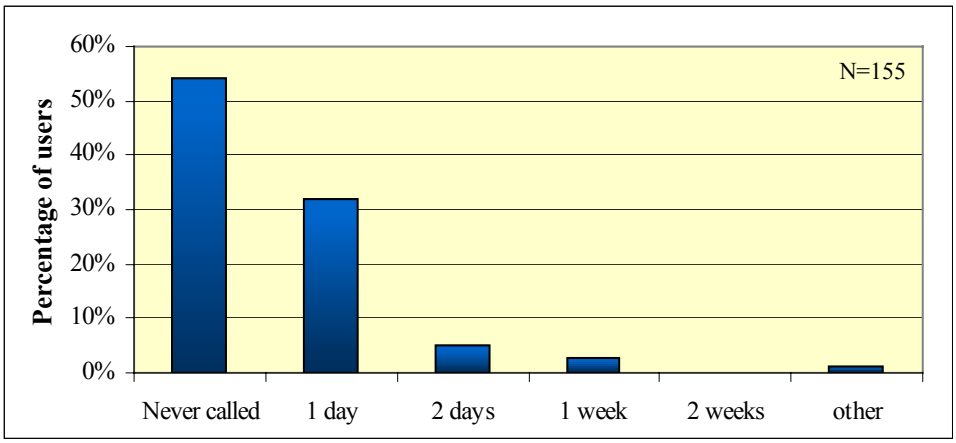


Figure 4.42. Time for CAESB to attend a request for service

▪ **Technology satisfaction**

As presented in Figure 4.43, 64% of the Vila Planalto families classified the condominial system implemented as a good system, 20% said that it is "OK" (i.e. average) and 16% were not satisfied with it.

The amount paid by the users for the sanitation system was classified as high by over half of the householders interviewed. About 38% thought that the price of the sewerage tariff was reasonable (Figure 4.44).

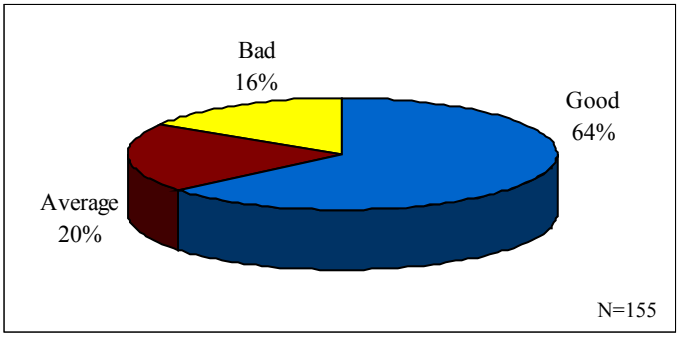


Figure 4.43. Classification of the condominial sewerage system by the users.

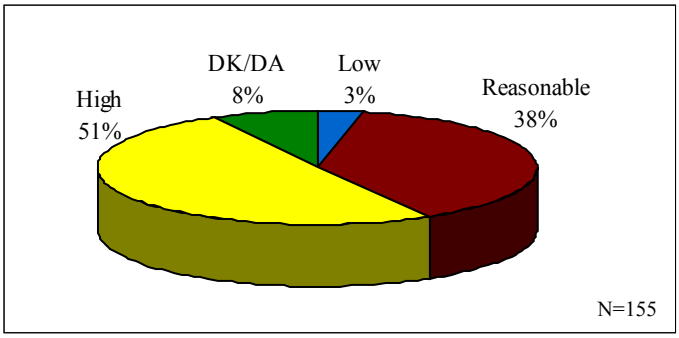


Figure 4.44. Amount of money paid by the users.

- **Technical Inspection**

The inspection results showed the presence of grease traps in 90% of the houses and that 45% of the inspection chamber covers were sealed.

The inspection chambers presented some level of damage either to the box itself or to the covers in 12% of houses inspected.

Regarding the household connections, just 1% presented wastewater flowing across the ground to the inspection chamber and connections of rainwater to the condominial system were identified in 26% of the households.

This seems to be a great contributor to problems occurring in the sewers, as observed in a manhole overflowing after a night of heavy rain (Plate 4.48).

The technical inspection information is summarised in Figure 4.45.

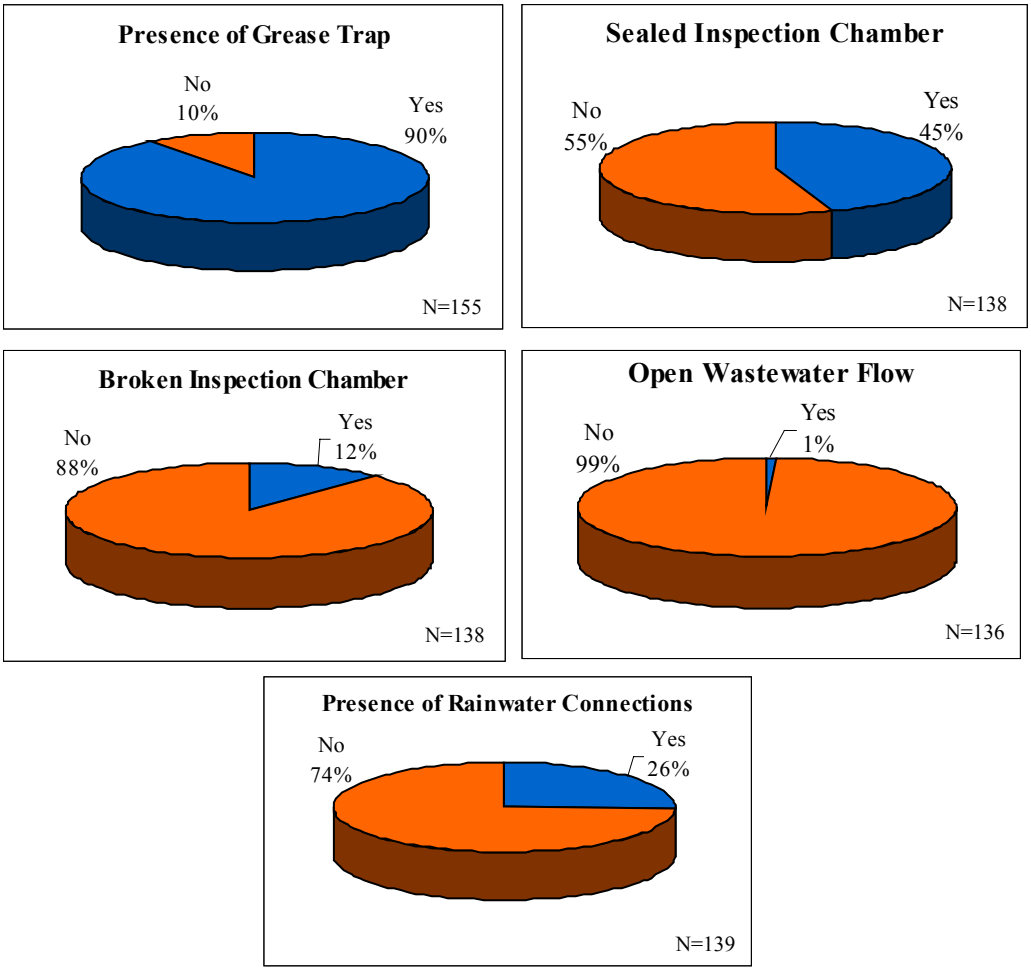


Figure 4.45. Results of technical inspections

Plate 4.48. Manhole overflowing after a rainy night

4.6. Case Study 5: Recife

4.6.1. Introduction

Recife is the capital city of the state of Pernambuco, in the NE Region of Brazil (Figure 4.1). It has a population of approx.1.4 million people distributed in an area of 220 km^2.

As with the majority of the large cities in Brazil, Recife has a range of urban problems that compromise the quality of life of its citizens, especially the poorest ones. Housing is a major problem for low-income families, which is readily evidenced by the great number of favelas around the city (more than 500). These favelas are usually high density and illegally occupied settlements that have a high level of violence and lack any type of basic housing infrastructure.

4.6.2. Background

- **The Sanitation Sector**

The State of Pernambuco Water and Sanitation Company – COMPESA – was established in the early 70's according to the National Sanitation Plan directives and is the primary operator of water supply and sanitation systems for the state. In Recife, COMPESA has provided sanitation for 25% of the population and supplied water for 90% (however due to a water shortage during the period of this study (Jul 1999), the city was undergoing a water rationing of 1 day with water and 9 days without).

Until the early 80's, COMPESA was practically the only organisation receiving financial resources for investments in the sector. However, since the end of the military regime (early 80's), municipal governments have been also able to invest. Then, the Prefecture of Recife, through its Urbanisation Company – URB Recife – started to apply physical and financial resources for the *implementation* of sanitation programmes.

These programmes are based on municipal law No. 15,547/1991, which established that for the city of Recife, the condominial sewerage technology is the standard sanitation technology to be adopted for implementation of new systems.

Considering the difficulties and the complex characteristics found in the favela areas, URB has launched a programme of community participation, so establishing a channel between the low-income communities and the prefecture, and having as main objective the urbanisation (infrastructure services) and legalisation of these areas.

- **Community Participation: the PREZEIS programme**

The law for occupation and utilisation of urban areas, defined by the Prefecture of Recife in 1983, divided the city into four zones and set specific regulations for the utilisation of each one of them. Three of these were: the Industrial, the Residential and the Green zones. The fourth zone is known as Special Zone of Social Interest (ZEIS) and is constituted by settlements (favelas) that had already been consolidated as residential areas. Although families have been living in these favelas for over 15 or 20 years, they are illegal, they do not own the plot that their houses are built on and the houses are not serviced by any infrastructure services. Therefore, the PREZEIS – Plan for Regularisation of the Special Zones of Social Interest – has the objective of legalising these areas and providing support for their development and urbanisation.

In order to be transformed into a ZEIS, and consequently to be included in the PREZEIS programme, the settlement must have a formal community organisation institution. Thereafter, the following steps must be taken: *A community meeting for the discussion of the programme and the production of a request paper* ➔ *submission of the request to URB* ➔ *authorisation by the mayor* ➔ *a law voted and approved by the Local Assembly Members transforming the area into a ZEIS.*

As a ZEIS, the community has its representatives participating in the PREZEIS Forum, which is also composed of engineers, lawyers, social assistants and NGO's consultants. The PREZEIS Forum is where alternatives to guarantee land ownership and the development of infrastructure services are turned into actions.

Community representation in the PREZEIS is carried out by two members of each community, who are elected by the residents, plus two alternates. They receive a monthly stipend from the prefecture as a financial support to keep their participation on track. Initially 27 ZEIS were defined, but soon it increased to 61.

4.6.3. The areas studied

The Mangueira ZEIS was chosen as the case to be studied. Its sanitation system had been in operation for only a year, but it is the largest (servicing 3098 residences) system implemented by URB. Another relevant aspect of the Mangueira sewerage system is the arrangements established for its O&M, in which a private company contracted by COMPESA carries out the tasks for both sewers and treatment plant.

However, by the time the study was initiated, URB-Recife was starting a survey to know more about the condominial systems already implemented in 13 ZEIS areas (including Mangueira). Therefore, both studies were connected and a committee

constituted by URB, COMPESA, two NGO's (Fase and Etapas) members had been formed; thus it was possible to expand this case study to also include a further 12 areas.

Table 4.11 presents the areas studied, the number of families served by the systems, the date the systems started functioning and the destination provided for the effluents collected.

Table 4.11. – The Areas Studied

ZEIS	No. resid.	Beginning	Effluent destination
Vila Sao Miguel	1476	1996	Integrated system (conventional STW)
Vila do Vintém	87	1994	Integrated system (conventional STW)
Poço da Panela	193	1996	Integrated system (conventional STW)
Mangueira	3098	Jun/1998	Isolated system (UASB + polishing lagoon)
Joao de Barros	208	Dec/1995	Integrated system (conventional STW)
Beirinha/Rua do Rio	846	Jan/1999	Isolated system (UASB)
Mustardinha	2932	Dec/1998	Integrated system (conventional STW)
Marrom Glace	201	Dec/1998	Integrated system (conventional STW)
Tamarineira	237	Ago/1994	Integrated system (conventional STW)
Água Fria		1996	Integrated system (conventional STW)
Córrego São José	1138	1996	Integrated system (conventional STW)
Coronel Fabriciano		1993	Isolated System (Septic Tank)

- **Models applied for Operation and Maintenance**

Although the prefecture of Recife (through URB) has been implementing sewerage systems, it does not have either the tradition or the physical structure for the O&M of the systems. Therefore, according to the arrangements made, URB would be responsible only for the implementation of the systems, with COMPESA then being responsible for operation, maintenance and payment collection.

Considering that condominial systems require intensive community participation, the responsibility for the tasks inherent to the systems was distributed among the actors as presented in Table 4.12.

Table 4.12. – Responsibility for the System's Tasks

Task	Implementation Stage	O&M Stage
House connection	User	User
Condominial sewers (backyard, front yard, sidewalk)	URB	User
Main sewer	URB	COMPESA
Pumping stations and STWs	URB	COMPESA
Services		COMPESA

Regarding the household connections, the initial agreement established that it was under householders responsibilities; however, in the middle of 2000 URB decided to provide the connections.

Throughout the study, six different situations (*models)* were identified regarding the O&M conditions of the systems. These *models* are presented below:

Model 1 -	***Conventional:***	Systems operated and maintained by COMPESA, which applies the company's normal structure (centralised offices attending both the condominial systems and the traditional (conventional) systems of the city). The ZEIS under this model are: *Vila Sao Miguel*, *Vila do Vintém* and *Poço da Panela*.
Model 2 -	***Decentralised:***	In this case, COMPESA hired a private company to develop the O&M tasks. This company has an on-site based office to attend to the users' complaints. The only area found under this model is the *Mangueira* ZEIS.
Model 3 -	*Participatory:*	In the *Joao de Barros* ZEIS the system is being managed by the community through its residents' association.
Model 4 -	***Situation of Transition:***	Three ZEIS are undergoing a transitory process, where the implementation stage has just been finished and COMPESA is analysing the systems for their acceptance. These areas are *Beirinha*, *Rua do Rio*, *Marrom Glace* and *Mustardinha*.
Model 5 -	*Situation Undefined:*	These areas had its sanitation systems concluded years ago and COMPESA has not yet taken over the systems. They are *Tamarineira*, *Água Fria* and *Córrego São José*.
Model 6 -	***Situation of Rejection:***	The system in the *Coronel Fabriciano* ZEIS was rejected by COMPESA and has no "actor" responsible for its O&M.

4.6.4. Study Methodology

- **The general study**

The data obtained by the ZEIS study were collected through two methods: **technical inspections** and the application of a **survey questionnaire**.

A group of COMPESA technicians carried out the technical inspections of the systems producing data on their physical and operational characteristics. These data were based on documentation of the company and field observation.

The questionnaire was designed to get information from the community's point of view and it was applied in a sample selected systematically, with each third house in the walking line of the surveyor being interviewed (for the smaller systems) and each fourth house for the larger systems (Mangueira and Mustardinha). The size of the sample obtained by this method was therefore approx. 33% and 25%, respectively.

The questionnaire (Annex 6) contained six sections. The first section was for the identification of both interviewee and residence, obtaining also information on family size and income. Section 2 was comprised of questions relating to the sanitation system and the residence, whilst Section 3 covered issues relating to the sanitation system and the community. Sections 4 and 5 focused on the maintenance activities and, finally, Section 6 obtained information on the sanitation service charging scheme and the willingness of the users to pay for it.

➢ **The Mangueira project study**

In Mangueira, the collection of data was based on **interviews, field observation, technical inspections** and the URB's **survey questionnaire**.

Interviews were carried out with the technical personnel of COMPESA, URB, SIRCAL (the private company hired by COMPESA for O&M tasks) and community leaders. From these interviews it was possible to reconstitute the arrangements made for the implementation of the project as well as for its maintenance.

Field observations and technical inspections consisted of visits to the site, which were in their majority accompanied by community leaders and the technical crew responsible for maintenance. It was also possible to obtain records of the maintenance activities carried out in the area during its first year of operation (Jun 1998 - Jun 1999).

4.6.5. General Study

➢ **Socio-economical aspects**

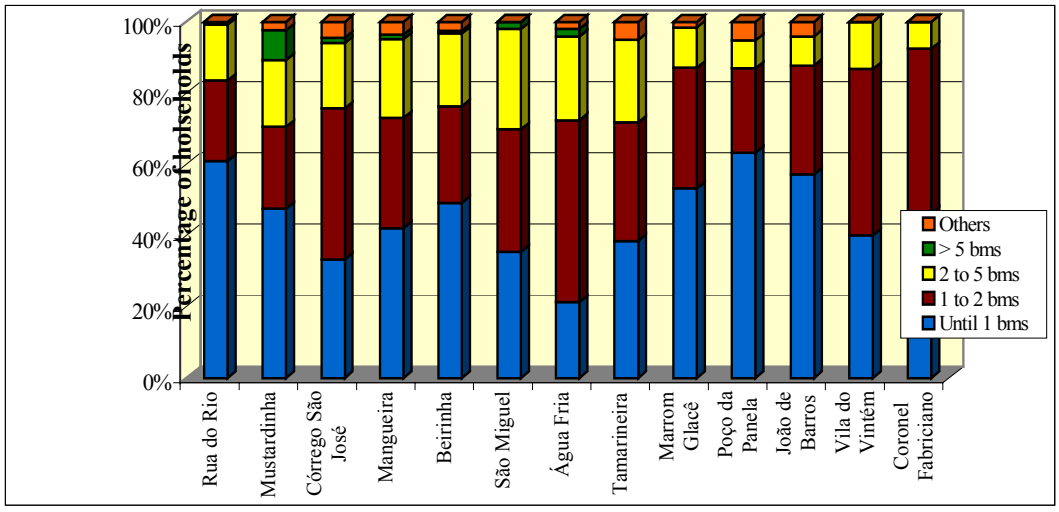


Figure 4.46. Family incomes

In five out of the 13 areas, more than 80% of the families earn a maximum of two Brazilian minimum salaries. In the other seven areas, about 70% had monthly

earnings of up to two minimum wages with a small proportion of families earning more than five BMS's (Figure 4.46). Regarding family size, about 64% of the households presented more than 4 people living in the house.

- **System usage and functioning**

About the utilisation of the sanitation systems, the ZEIS "Coronel Fabriciano" and "Vila do Vintém" had 100% of their houses connected to the system (Figure 4.47.). However, these connections were provided by URB, and therefore they did not follow the established agreement (users responsible for house connections). On the other hand, the "João de Barros" ZEIS had also a high rate of users connected to the systems (96.9%) and this can be attributed to the involvement of the community in the implementation of the programme.

The area with the lowest connection rate was "Rua do Rio". The implementation of the system in this area was only finalised in the year of this survey – 1999, (which is also the case for the "Beirinha" and "Mustardinha" areas). Therefore, it is probable that users may not have had enough time to obtain the necessary resources for the connections (which is expressed in Figure 4.47 as lack of financial resources). Within the "others" category, some of the householders were still preferring their old solutions for wastewater disposal.

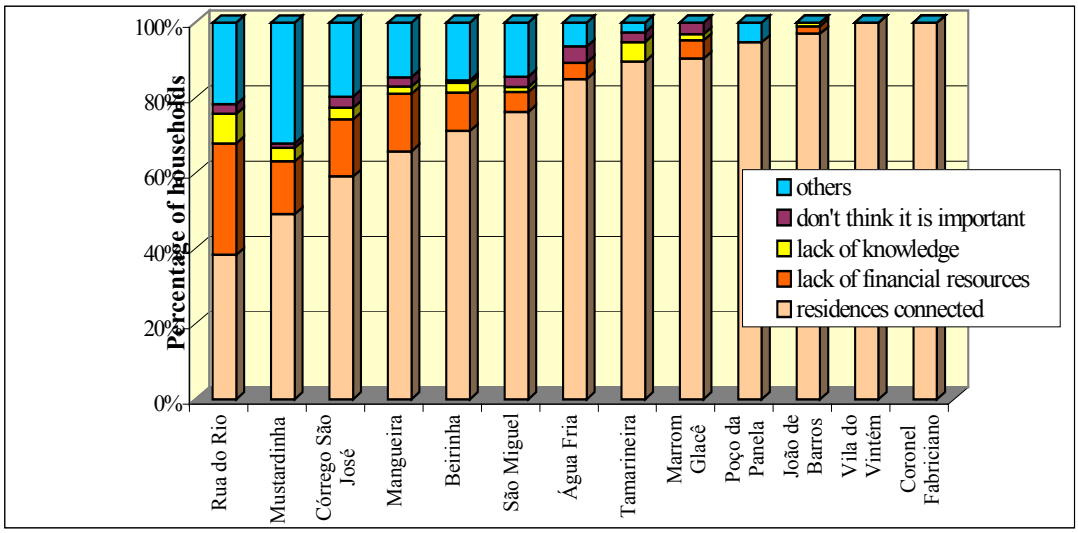


Figure 4.47. Rates of connection to the systems and reasons for non-connections.

Figure 4.48 shows that among the households connected to the condominial systems, over 20% had not yet connected both excreta and sullage. This suggests that, although these households had invested in their connections, they still prefer their old

solution for one or other type of wastewater, which would not make sense if the users had in fact been well informed about the system and perceived it as a reliable solution.

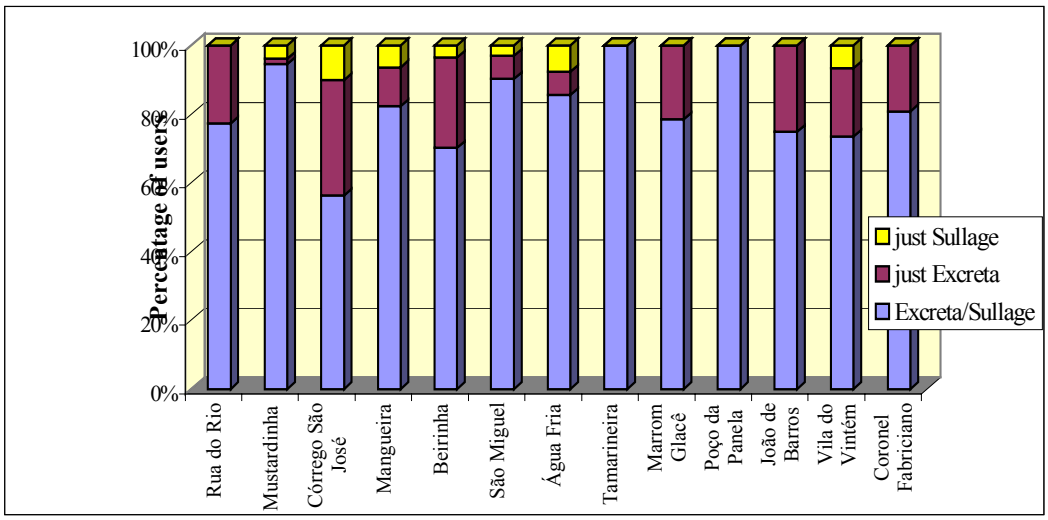


Figure 4.48. Wastewater connected to the system

Information collected in January 2001 for updating the data collected in 1999, shows that URB is now providing the household connections to the sanitation system in some of the areas, including Beirinha, Rua do Rio, Mustardinha and Mangueira.

Regarding improvements, more than 80% (on average) of all households connected to one of the 13 systems believe that the living conditions of the houses had been improved by the implementation of the sanitation system (Figure 4.49).

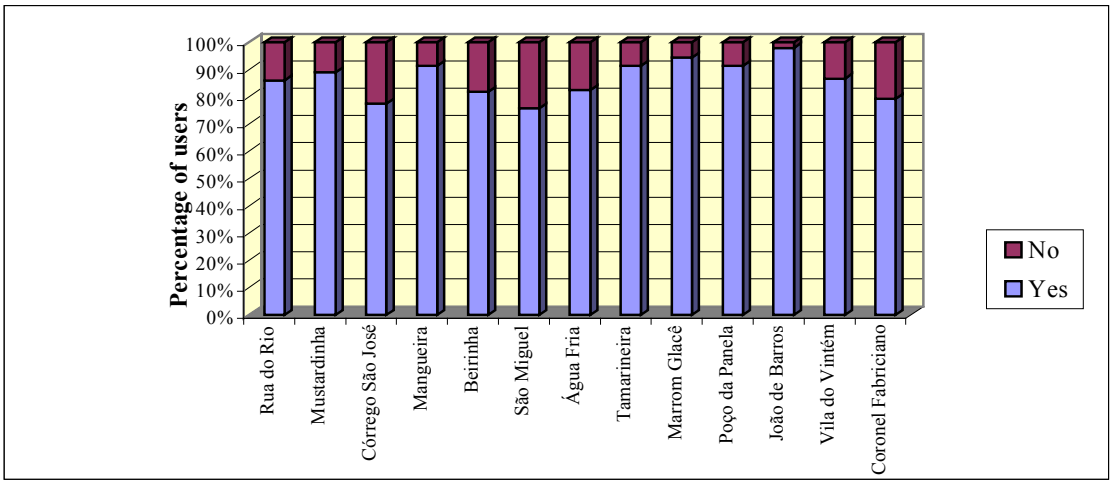


Figure 4.49. Feeling of improvements in the housing conditions after the implementation of the sewerage system.

Regarding the functioning of the condominial sewers, in eight out of the 13 communities it was considered “good” by more than 70% of the households. The main concern in this aspect was in the ZEIS Coronel Fabriciano, where only 35% of the

householders considered the functioning of the condominial sewers "good" (Figure 4.50).

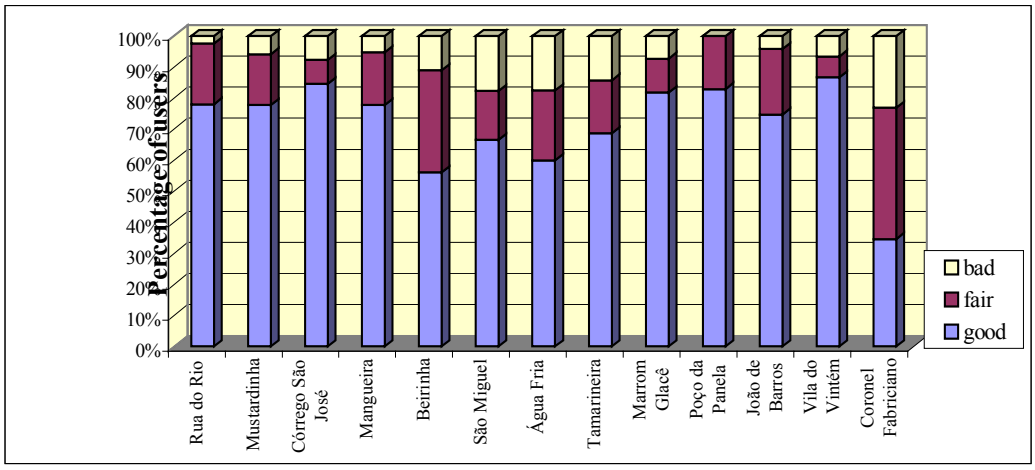


Figure 4.50. Condominial sewer operation

- **Maintenance services**

Regarding "who does" the maintenance of the condominial sewer (Figure 4.51), COMPESA was carrying out such activities in the majority of the areas. In the Joao de Barros ZEIS, approx. 60% of the households recognised the presence of a community organised group for the maintenance tasks required by the condominial sewers.

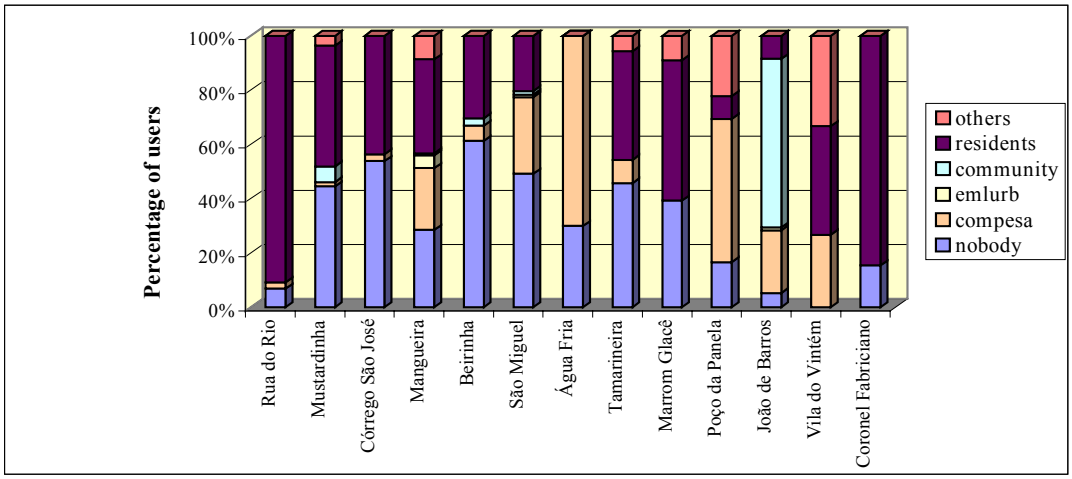


Figure 4.51. Person/institution performing the tasks in the condominial sewers.

Figure 4.52 illustrates how the residents evaluated the maintenance service in the condominial sewers. In the majority of the areas, however, high percentages of answers in the category "didn't know/didn't answer" were obtained, which may express a lack of involvement of the users within the system. The João de Barrros ZEIS (the one maintained by a community group) presented the highest percentage of satisfaction with the maintenance of condominial sewers.

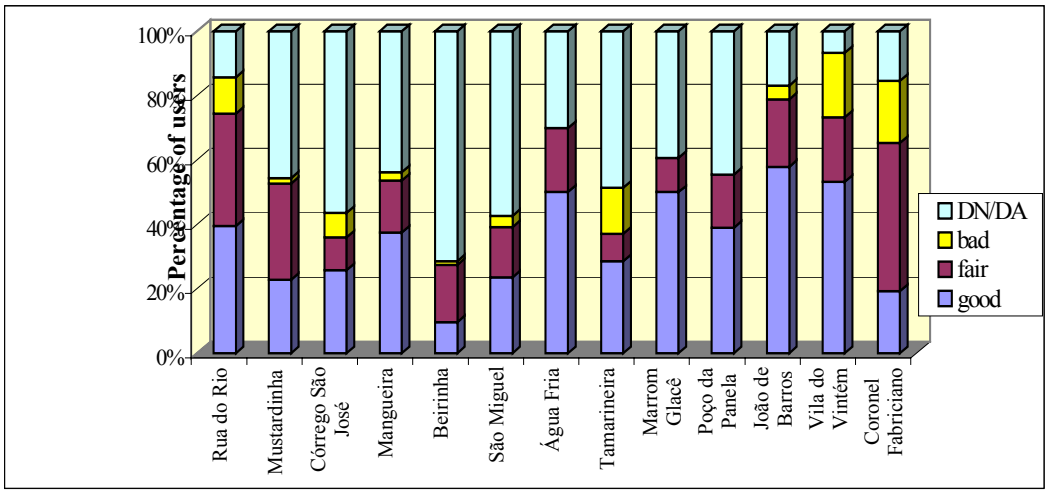


Figure 4.52. Classification of the maintenance service in the condominial sewers by the users

- **Community participation**

As previously introduced, only the João de Barros ZEIS had an organised group working on the community sanitation system (*model 3 – participatory*). As shown in Figure 4.53, some of other ZEIS also indicated the presence of similar community groups; however, the activities of these groups were not systematic or organised.

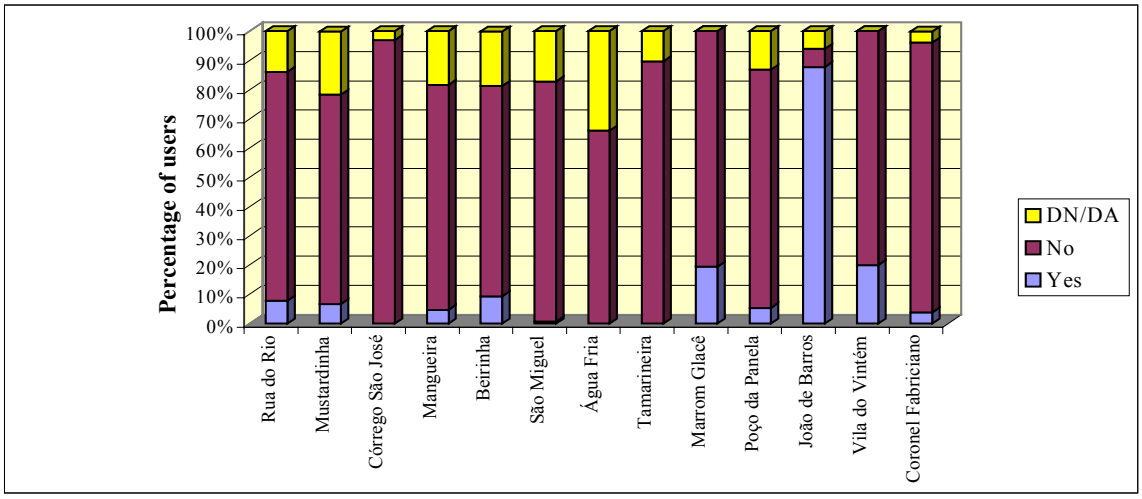


Figure 3.53. Existence of community group working on the sanitation system

- **Willingness to pay**

The charging policy for sanitation systems adopted by COMPESA is:

	Flowing to a treatment plant	Discharged without treatm.
Conventional systems	100 % of the water bill	80% of the water bill
Condominial systems	50% of the water bill	40% of the water bill

Only five out of the 13 systems are being charged by COMPESA. These are the Vila São Miguel, Poço da Panela, Vila do Vintém, Mangueira and João de Barros

(models 1, 2 and 3). However, the lack of control from COMPESA in identifying the users actually connected to the systems has lead to a situation where not all connected households in the same area are being charged (Figure 4.54).

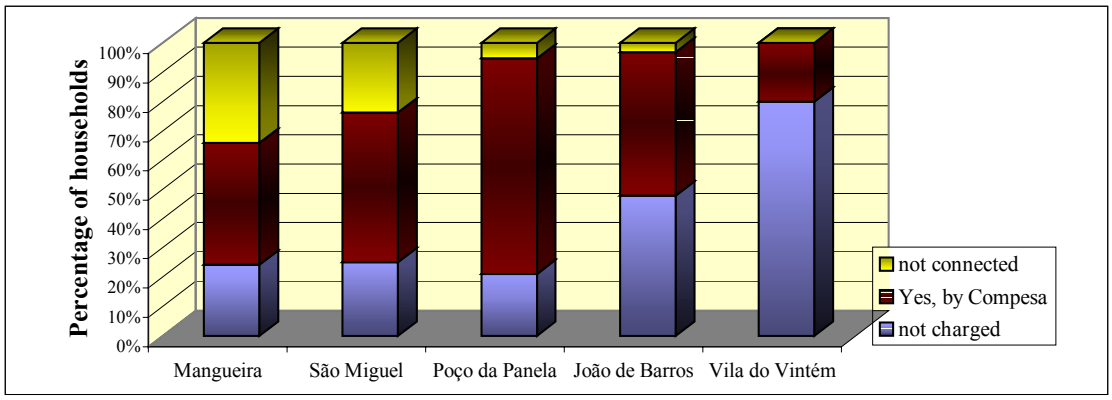


Figure 4.54. Users charged for the sanitation system

4.6.6. Model 1: Conventional condominial system

The three systems under this model are Vila São Miguel, Poço da Panela and Vila do Vintém. They have been in operation for over three years and, with the exception of Vila São Miguel (where the main sewer has still not been fully completed), the other two systems have a high level of house connections (94.7 and 100%).

None of these systems has a local treatment plant and their effluents are connected to conventional sewerage systems flowing to one of the two conventional treatment plants existent in the city. Furthermore, as these systems do not have pumping stations, O&M tasks are limited to the sewers: the condominial sewers (under residents' duties) and the main sewers (under COMPESA's responsibility).

COMPESA has officially taken over the three systems from URB, and is now the agency responsible for them. The tasks developed in these areas are basically corrective actions executed following complaints from the users. In this "conventional condominial" model, complaints are made to a central office that then sends a maintenance crew to execute the services. However, the delays in COMPESA attending to a call are a common disappointment among the residents.

As shown in Figure 4.55, COMPESA had also developed maintenance tasks in the condominial sewers of Vila São Miguel, where residents had not accepted their maintenance duties. This fact may be also adversely influencing the proper usage and acceptability of the system, contributing to a higher number of sewer blockages and illegal connections of wastewater to the drainage channels.

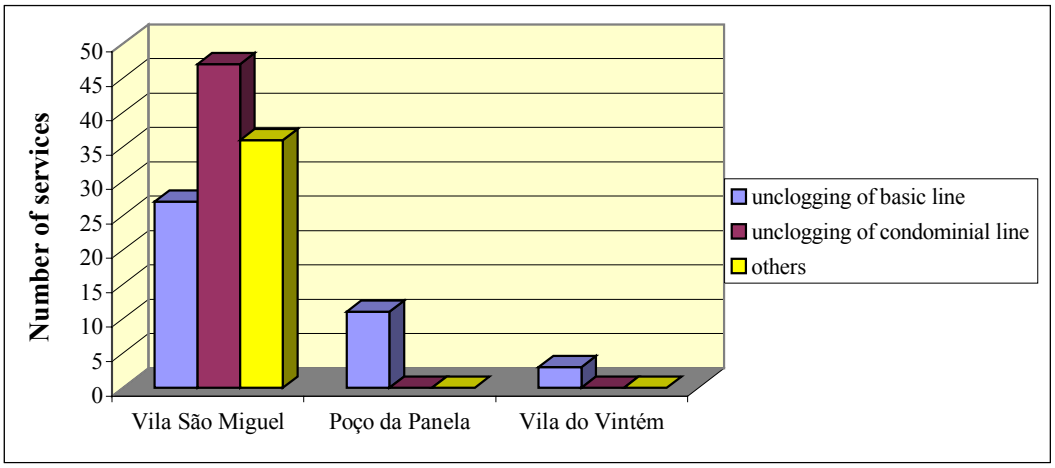


Figure 4.55. Number of maintenance services performed by COMPESA in the period Jan-Aug/1999

Vila do Vintém presented good participation of the residents towards the sanitation scheme. According to COMPESA, these residents have been satisfactorily maintening the condominial sewers, which is certainly contributing to the low number of interventions that have been required.

Finally, the charging system is also confused in these sites. COMPESA only starts to charge the users after they have made their house connections to the system. However, it has been hard (under the established circumstances) for COMPESA to control properly who has or who has not been connected. Therefore, among users of the same system, some are charged whilst others are not (as shown in Figure 4.54). This causes not only a reduction in the company's revenues (which is already affected by the high number of users that are charged and simply do not pay), but also causes an uncomfortable situation amongst those who pay.

4.6.7. Model 2: Decentralised condominial system

The Mangueira project is the system where a decentralised model was adopted for O&M. As mentioned, this system represents the main focus of this study, and therefore a more detailed investigation was carried out.

- **The Mangueira Area**

Mangueira is part of the district of Afogados located in the South of Recife. It covers an area of approx. 70 ha, with a population of 15,490 people living in 3,098 residences. Within the physical limits of the area, there are three "favelas" - Poço da Mangueira, Campo do Piolho and Sigismundo (Figure 4.56).

The average household income is approx. 2 Brazilian minimum wages and, true to national reality, the area has a high level of unemployment. URB-Recife has identified in Mangueira characteristics suggestive of an ascendant area. Local commerce is being established and the area is well served by collective transport systems (buses and metro).

Nevertheless, the site, which has a flat topography and a high ground water table, was characterised by constant flooding, illustrating the demand existenting for drainage services. Under such conditions, the health risks for the householders have also been increased by the absence of sewage collection/disposal (commonly left to flow openly at the streets), causing health hazards to the population, especially to the children. The diseases most frequently observed have been: filariasis, leptospirosis and diarrhoeas in general (Souza, 1997).

The Mangueira sanitation project started to be implemented in March 1993. The project was conceived as an isolated system, having its collected sewage locally treated. This treatment uses an UASB reactor followed by a polishing (nominally facultative) lagoon (Plate 4.49), and, the effluent discharges into a drainage channel flowing to the Jiquiá River.

Having community participation as the basis for implementation and development of the project, an agreement (known as "Parceria" - Portuguese for partnership) was established between URB and the residents of Mangueira. Different arrangements were applied for the definition of attributes in the "Parceria" leading to four distinguishable stages in the implementation of this programme.

The system's operation started in June 1998; however, the Sigismundo favela was still to be included in the programme. This delay was due to the option to relocate some families to a newly built housing area provided by URB (Plate 4.50). This housing area is approx. 700 m away from the original one and has 16 residential units. After relocation of the families, the conditions for urbanisation is expected to have improved making possible the inclusion of this favela in the Mangueira sanitation programme.

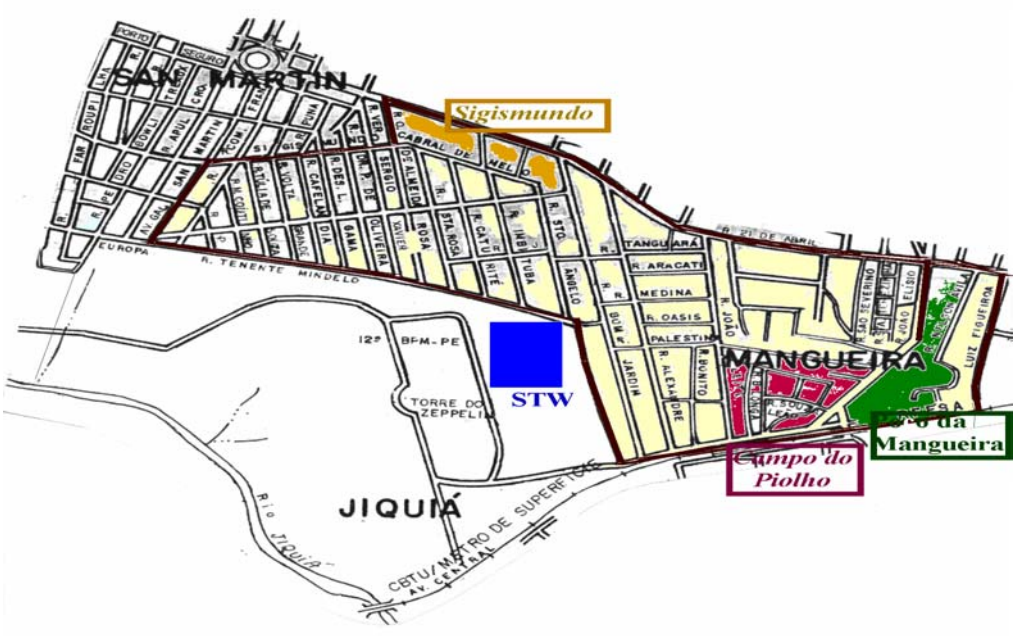


Figure 4.56. Map of the Mangueira ZEIS including the favelas (Sigismundo, Campo do Piolho and Poço da Mangueira) and the sewage treatment plant.

Plate 4.49. Mangueira Sewage Treatment Plant

Plate 4.50. New housing area for the allocation of former Sigismundo favela residents

- **Institutional arrangements for the Mangueira sanitation programme**

The Mangueira sanitation project was initially developed with resources from the prefecture through its Urbanisation Company, URB-Recife. The engineering project was designed by a consulting engineering office and implemented by URB. This implementation was based on community participation and involved both the sanitation engineering and the social service departments of the company.

The social service group worked on the mobilisation and educational activities which occurred block by block. During the day, the residents were invited for a meeting (see the invitation card in Annex 7a) where the sanitation programme was introduced and the rules for its implementation explained. Each meeting was registered in forms containing the names of the residents, the issues discussed and the follow-through actions. Once the residents decided on the implementation of the project, the layout of the condominial sewer was defined and an agreement signed (Annex 7b). Educational material explaining the system and how to do any necessary maintenance was also distributed (Annex 7c).

EMLURB – a municipal company responsible for urban refuse collection – also participated in the programme. It added a selective solid waste collection programme, which was aimed to generate the financial resources necessary for the participation of poorest residents in the sanitation programme. Another agency that also took part in the programme was the municipal Secretariat of Health, which contributed with messages to improve hygienic habits among the residents.

In the last phase (when URB had stopped the programme due to lack of financial resources), COMPESA obtained credit and concluded the implementation. COMPESA carried out actions directly related to sanitation, whilst URB continued with other urbanisation interventions. Nevertheless, the sanitation system continued under URB's responsibility, and just after the system had gone into operation, it was transferred to COMPESA.

For maintenance, COMPESA contracted the service of a private company - SIRCAL, which develops maintenance tasks for the sewer network and the treatment plant. For this, a crew comprising six people (a chemistry technician, a sanitation technician and four labourers) was based in an on-site office (at the treatment works plant). The work developed by the crew is registered on forms (Annex 7d), which are given to COMPESA that uses them as a register of the work carried out.

- **Community Organisation**

  - **The Mangueira community representation**

The Mangueira area has two community representative institutions: the Residents' Association and the Residents Council. They act in physically distinct parts of the community. In the PREZEIS Forum, both presidents (one from the Association and the other from the Council) represent the community. They have a conflicting relationship and their divergences seem to contribute to a political dispute in the area, resulting in difficulties for the acceptance and implementation of community-based programmes. Nevertheless, the area also has a third community leader who is well accepted by both sides and represents the whole community in the commission responsible for the urbanisation and legalisation of the ZEIS areas.

  - **The "Parceria"**

URB-Recife has been investing in programmes based on community participation as a way to make projects viable. For the Mangueira's sanitation project, the "parceria" was adopted as the conceptual model for implementation. However, the conditions for this partnership agreement changed throughout the implementation, leading to four distinguishable stages (Souza, 1997):

- **Stage 1 – from February to December 1993:**

The first parceria agreement stated that the material and labour necessary to build the condominial sewers were of householders' responsibility and that URB was to be responsible for the implementation of the main sewer and for the construction of the treatment plant.

The residents demonstrated resistance to this agreement but, with the help of the local leader, the implementation of the project was initiated in a pilot area covering four streets. At this point, the construction of the treatment plant had not yet been initiated and the condominial sewers were being connected to a nearby conventional sewer.

After seven months, the development of the project was very slow and only three condominial sewers were constructed (a total of just 30 connections). In addition, the construction of many sewers was of poor quality and needed to be re-built. Based on this, URB redefined the "parceria" agreement and started to subsidise

the costs for the poorest residences and to decrease (by up to 25%) the costs to be paid by the others.

The project continued with uncertainties from both sides: the community was still seeing the project with suspicion due to past experiences and URB had not yet been able to close contracts for the construction of the main sewer and the treatment works plant.

At the end of this stage, the results obtained were very discreet and confined to the original four streets.

▪ **Stage 2 – from January to June 94:**

URB took the responsibility for the construction of the condominial sewers and signed a contract for the construction of both the main and the condominial sewers. The Parceria agreement for this stage reduced, therefore, the residents' responsibilities, which now only had the responsibility for buying the pipes.

The fact that the main sewer was being constructed, increased the acceptability of the system, which now had the participation of approx. 900 families distributed in 30 blocks. By the agreement, the community was expected to organise themselves and purchase the number of pipes required for the condominial sewer in each block. However, the residents bought the pipes individually, so each family bought one pipe (6m length), which was not enough to complete the in-block line. To overcome this problem, a programme for solid waste collection was proposed, in which the community collected and sold recyclable solid waste, using the money so obtained to purchase the extra pipes, as well as the pipes for the poorest families. The Residents' Council was in charge of this programme.

The solid waste collection programme had the participation of 550 families and 8 collections occurred during this period (each collection was enough to buy 10 pipes). At the beginning, this programme was well accepted, but then the residents lost interest mainly due to: the absence of a criterion for the distribution of the pipes, lack of organisation, and political dispute between local leaders.

At this point, the community decided to terminate the "parceria". Nevertheless, they wanted the continuity of the construction of the sanitation system but now adopting a sidewalk layout and using only public resources. They also wanted to continue with the solid waste collection, but this time using the money for a food provision programme. URB did not accept this position and suspended the

sanitation programme. Just after negotiations between the mayor and the community, the sanitation programme continued following the parceria model but also including actions on drainage (required by the community).

Due to all these conflicts, a discussion started involving URB, residents and consultants on the political importance of community participation not only on the sanitation programme, but also on the development of the community as a whole. As a consequence, a plan of actions for the community was elaborated, involving the residents, URB, EMLURB and the municipal Health Secretariat.

▪ **Stage 3 – from August 94 to August 96:**

The Plan for Actions in Mangueira determined that the sanitation programme would be continued based on the parceria model and on the development of educational programmes (including orientation on sanitation, health and selective solid waste collection). The creation of committees was promoted and the execution of educational activities was initiated. However, the committees for health and sanitation were not fully developed, and the selective solid waste collection committee only functioned up to January 1996, when the families (especially those that had already got their sewers) stopped the collection.

For the continuity of the sewers' construction, Mangueira was physically divided into three areas making possible a progressive implementation of the system. The work developed at this stage progressed faster than that carried out previously. This was attributed to the extensive acceptance and participation of the residents. The better income conditions of residents in the first area and their decision to use the sidewalk condominial layout also influenced the now smoother progress of the programme. The work continued through to the second area, but then, stopped due to lack of financial resources.

At the end of this stage, the construction of the main sewer had been finished as well as about 50% of the condominial sewers. The urbanisation of the three favelas (Campo do Piolho, Poço da Mangueira and Sigismundo) and the drainage interventions were still to be concluded.

Only the construction of the Treatment Plant, which obtained financial resources from the Caixa Econômica Federal - CEF, continued.

▪ **Stage 4 – from January/97 to June/98**

With the participation of COMPESA (who obtained financial resources from CEF to be applied in the sanitation project and to improve water supply in the area), the programme was re-initiated. The money was also applied on actions on the residents' sanitary installations, house connections and interventions on urbanisation and drainage. Therefore, URB and COMPESA agreed on the following distribution of responsibilities: URB executed the urbanisation of the favelas and the drainage actions, and COMPESA the interventions directly related to sanitation and water supply.

In this context, the parceria agreement was altered again and this time the residents agreed to pay for the costs of the condominial sewers, through the water and sanitation bills, after the implementation and after the system was fully functioning. The community leaders continued to follow the execution of the project, however, the integration between the Social Service Sector of URB and the sanitation system was terminated.

➢ **Costs**

The costs of the Mangueira sanitation system were as presented in table 4.13. (Pinheiro, 2001).

Table 4.13. – Costs of the Mangueira project

Intervention	Pop. (inh)	Costs (R$ per capita)	US$
Trunk + condominial sewers	19535	135.40	69.4
STW[1]	19535	73.90	37.9
Household connections (in 60% of the houses)	11721	20.48	10.5

[1](UASB + Facultative pond + Pumping Station + sludge drying bed)

➢ **Field Observation**

One year after the sanitation system had been in operation in Mangueira, the drainage and paving projects are still to be concluded. Only the main streets of the area had been paved and actions on drainage are still taking place (Plate 4.51).

As with the rest of Recife, the area is undergoing water rationing. The residents (that can afford it) are boring wells and, as illustrated in Plate 4.52, sharing the water with their neighbours.

In the favela areas, drainage services have been concluded. According to the residents the actions executed on drainage and sanitation have, in fact, improved their standard of living. Although none of these favelas has yet been paved, the streets are mostly dry, even during the rainy season (period of this study).

Sewage was not found flowing in the streets; however, this does not necessarily mean that all households have connected their sewage to the sewers. There is considerable evidence of irregular connections having been made to the drainage channels (see Plate 4.53). This is also illustrated by Plates 4.54 to 4.57.

Plate 4.51. Drainage construction taking place in the Mangueira area

Plate 4.52. The queue to collect water from a neighbour who had just drilled a well.

Plate 4.53. Household wastewater being discharged into drainage channels

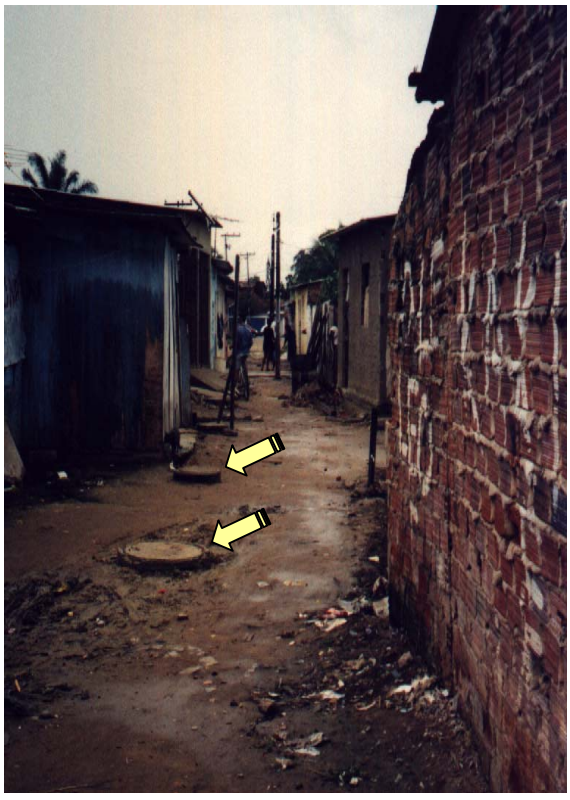


Plate 4.54. Favela of Campo do Piolho – the arrows show the inspection chambers of condominal sewer.

Plate 4.55. Drainage channel in the favela of Poco da Mangueira.

Plate 4.56. Section of a drainage channel in the Sigismundo favela.

Plate 4.57. A resident that uses his older sanitation solution (where the children are playing), in spite of the presence of a condominial sewerage inspection chamber (left).

- **The survey questionnaire**

As to specific considerations that can be made from the results obtained by the questionnaire survey, it is noteworthy that one year after the system had been put into operation approx. 65% of the residences had provided house connections. The majority (93%) recognised that the system brought benefits and about 77% said that the maintenance of both the condominial and the main sewers was "good".

However, only 23% of the households confirmed that they are executing the maintenance tasks of the condominial sewer. This information is in accordance with the observation made that the maintenance crew (instead of the householders) were executing many of the maintenance activities on the condominal sewers. Asked about this, the technician in charge said that they were aware of the division of responsibilities, but that the residents were expecting them to solve the problems.

➢ Technical Inspections

Based on user complaints, which are made by phone or in person, the maintenance crew maintains the main sewer, the system appurtenances and the condominial sewers (in spite of the latter being the responsibility of the users).

As to the presence of this crew on the site, not all of the residents are aware of it. It seems that the residents of the favelas (where the crew has been developing the majority of their work) know the crew well and how to contact them, whilst in other parts of the site the residents appear to have never heard about the group.

Regarding the activities of the maintenance crew, four variables were measured through the analysis of the file of complaint attendances during the period of one year (since the beginning of the operation of the system – Jun/98). These variables were: the number of services executed per month, the response time, the type of maintenance service and the equipment used. Thus, a total of 1,270 service record cards (Annex 7d) were analysed.

Regarding the frequency of complaints per month, in the first month only 2 complaints were registered, but from there on, the number of complaints varied from 76 to 215, as shown in Figure 4.57.

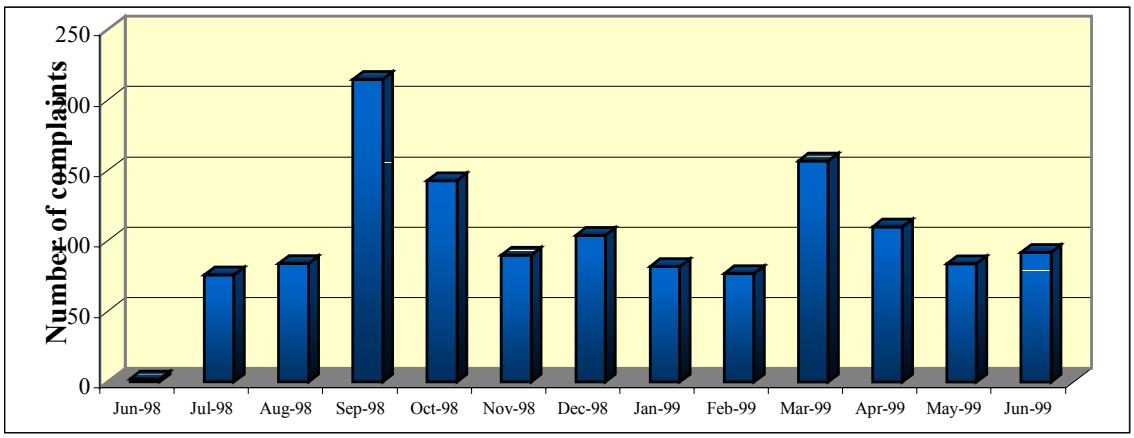


Figure 4.57. Frequency of complaints occurrence in one year period

94% of the complaints were attended to within 24 hours. This rapid response was also observed during the days spent on the site. The maintenance services were mostly for inspection chamber cleaning, followed by unclogging of the basic/condominial sewers, then by substitution of inspection chamber spare parts (rings and covers), by manhole cleaning, and finally by repairs to the condominial sewer, inspection chambers and manholes (Figure 4.58.).

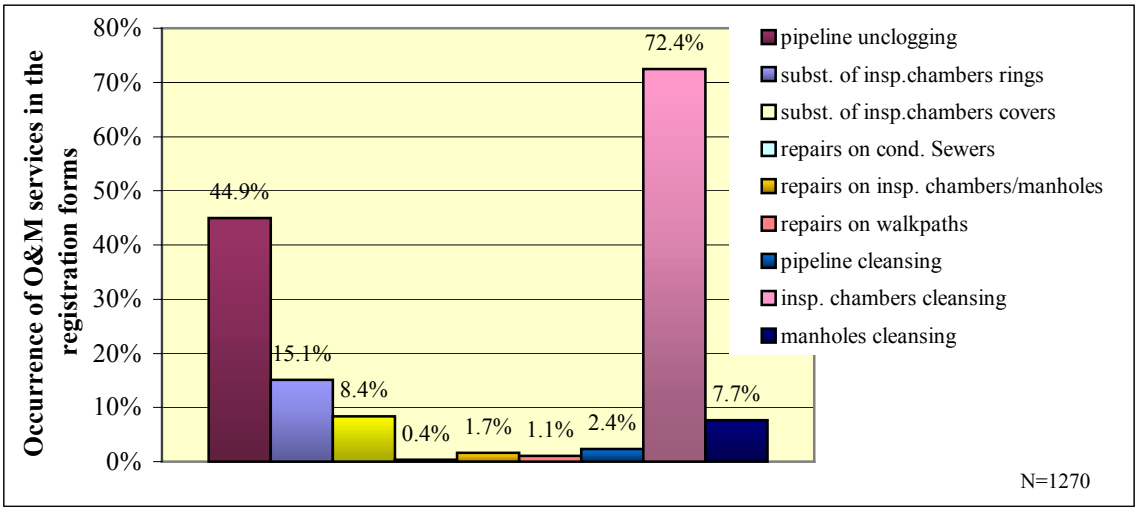


Figure 4.58. - Services registered in the O&M forms for the Mangueira project during the period of Jun/98-Jun/99 (note that more than one service could be registered per form).

The equipment used in the maintenance services was 97% based on "supportive equipment", 1% of "water jet" plus supporting equipment and 2% of the forms do not specify the equipment used. The equipment described as "supporting", shown in Plate 4.58, basically comprises a shovel, gloves, stick, hose, pickaxe and spatula. Plates 4.59-4.67 illustrate the maintenance service in a sidewalk condominial sewer, which was clogged by a piece of cloth.

In addition to the problems caused by the lack of sanitary education, COMPESA also indicated that the system has construction defects on the pipelines and inspection chambers, which makes the maintenance difficult. Building erected over the sewer lines and over the inspection chambers were also observed.

Another problem in the area, this time causing a potential health hazard, is the proximity of the water supply pipes to sanitation appurtenances in some parts of the system. In one site, for example, the sewer line was laid in parallel with the water supply pipes at a separation of only 20-30 cm. Water pipes crossing inside of the inspection chambers were also identified. This situation is made worse when considering the water rationing situation and the possibility of contamination of the water supplied due to the lack of pressurised water flowing into the pipes or by the possibility of negative pressure in the water supply network.

Plate 4.58. "Supportive" equipment used for maintenance

Plate 4.59. Three clogged inspection chambers

Plate 4.60. Close up of one of the inspection chamber

Plate 4.61. Workers using the hose to unclog the pipeline

Plate 4.62. Removal of sand from the inspection chamber

Plate 4.63. Removal of sand

Plate 4.64. The cause of the blockage

4.6.8. Model 3: Participatory condominial system

The João de Barros ZEIS is a community of 208 households that has a distinct community organisation. The president of the Residents' Association has been in charge for over 7 years and has the approval of nearly 100% of the households. Under his administration the Association has improved the infrastructure conditions of the community and generated jobs through a co-operative society, which produces furniture and is now employing 83 people from the community.

Regarding the implementation of the sanitation programme (condominial/main sewers and pumping station), the community had a close participation. It managed all of the construction phases: inspecting, measuring and controlling the activities of the firm contracted. Through this management, the costs of the system were kept below those of the initial budget, making possible to start drainage and paving activities on the site (for an example on community self-management sanitation see a review on the Orangi Pilot Project – URL-32, 2001).

As to the maintenance of the condominial sewers, a "community based" group executes the tasks. Thus, instead of each householder operating and maintaining the part of the system located on his land, the Residents' Association employs a group of four people (a mason, a plumber and two labourers) for this. The maintenance of the main sewer is also carried out by this group and hence the services from COMPESA are requested only when the problem in the main sewer requires more specific equipment (such as the water jet) or for problems in the pumping station. This maintenance service scheme costs 610,00 reais per month (R$ 410,00 for the workers' payments and R$ 160,00 for materials) and is supported by the revenue obtained from the furniture co-operative society.

The community (or the Residents' Association) considers itself the owner of the system and their intensive participation may have influenced the growth of confidence in taking technical decisions regarding the sanitation system. An example of this is the decision made on the substitution of some lengths of both the condominial and the main sewers. This occurred a few months after the system had been in operation and was due to constant blockages of the pipelines. According to the president of the Residents' Association, "the diameter of the pipes selected by the project design (100 mm – the minimum diameter allowed by the code) was the main cause of the blockages". He also indicated the poor quality of the PVC pipes used as the cause of pipe breakdown.

Therefore, he decided for the substitution of these lengths of sewer for better quality PVC pipes of 150 mm diameter. For this, 1,810.00 reais were spent (money obtained from the furniture co-operative society).

Considering that the sewerage system is supposed to receive only household wastewater, the choice for 100 mm diameter pipelines follows the calculation parameters of this system design. Nevertheless, the residents seem very happy about their decision on the substitution of the pipes, saying that the blockage problems that occur now are localised and easily solved. However, through the technical inspections of the system, and based on the records from COMPESA, a large quantity of sand was found to be entering in the system. This sand comes into the sewers through connections of backyard drainage water to the inspection chambers, what certainly contributes to a rise in the volume of "wastewater" flowing in the pipelines. Moreover, the presence of solid waste deposited in the sewerage system is still high (in spite of intensive education of the residents by the maintenance group). In addition to contributing to blockages, solid waste also causes faults in the pumping station (which was initially constructed without a screen and recently installed by the Residents' Association).

Thus, the services executed by COMPESA in the Joao de Barros sanitation system are of main sewer unclogging, and cleansing out (sand removal) of the pumping station. The number of the services realised in the period of Jan – Aug/99 is:

Unclogging of the main sewer	Sand removal from the pumping station
3 times in 7 months	13 times (nearly twice a month)

The João de Barros sanitation system cost R$ 286 (US$ 146.6) per household, including the main sewers, the condominial sewers and a pumping station (Pinheiro, 2001).

The percentage of connections to the sanitation system was 97%. This high number of house connections was executed by the householders themselves under advice (or in some cases, pressure) of the Residents' Association. Based on the URB-questionnaire survey, 98% of the connected householders recognises that the sanitation programme promoted a better quality of life and 75% assess the quality of the maintenance service developed by the community group as "good".

4.6.9. Model 4: Transition Situation

The systems implemented in the ZEIS of Rua do Rio, Beirinha, Marrom Glacê and Mustardinha have now been in operation for about 10 months (since Jan/99, Jan/99,

Dec/98 and Dec/98, respectively), and are in a transitory stage for their O&M. URB-Recife (the implementing agency) considers the systems finalised and has provided the documentation for their transfer to COMPESA, which is still analysing the projects.

According to COMPESA there is no deadline to take a position in relation to the systems (accept, ask for modifications or reject). Nevertheless, during this long period of transition the systems are in operation and, consequently, needing services. COMPESA are not yet officially responsible for the systems, which are still under URB's responsibility (that has no physical structure to undertake maintenance tasks). Therefore, the residents are being left without technical support to solve the problems and just in extreme cases COMPESA has been "unofficially" attending these areas.

The system implemented in Rua do Rio has, among the 13 systems, the lowest rate of house connection (38%). This system is interconnected with Beirinha through a "shared" treatment plant based on UASB technology. In both areas, householders recognise the benefits of the systems; however, they appear to be poorly informed about its availability and, also, about its utilisation.

On the other hand, the system implemented in Marrom Glace has a high rate of house connection (90%); however, the residents are not accepting their role in the maintenance of the condominial sewers and this has been even more aggravated by the non-operation of the system by COMPESA.

In Mustardinha, just over 40% of the houses are connected. During the implementation phase, URB decided to make the house connections in approx. 40% of the residences (which does not follow the original agreement). However, the whole community was expecting to have their connections provided by URB and, therefore, the householders do not consider the system completely implemented. They are still waiting for URB to connect the remaining 60% of the houses.

In fact, these are the most recent systems implemented by URB. Therefore, the connection rates are still expected to improve, and COMPESA should also soon be defining its position regarding O&M.

Nevertheless, after the implementation of ten other condominial systems it would have been expected that the main problems should have been solved, or at least minimised. Currently, factors such as: the long period of transition; institutions incoherence on the application of rules agreed; the lack of programmes stimulating house connections; and, the lack of information on the system functioning and usage are still compromising the operation of the systems.

4.6.10. Model 5: Undefined Situation

In the areas of Tamarineira, Água Fria and Córrego São José, a model for the O&M of the sanitation systems was not possible to be determined. The systems in Água Fria and Córrego São José have been in operation for three years; however, COMPESA has not yet officially "accepted" them. COMPESA has, instead, been performing some critical (not systematically) maintenance services requested by the communities, and this has led the communities to consider the company as the operator of the two systems. Nevertheless, under this situation, COMPESA cannot charge the users or be made responsible for the system. The operation of these systems has been verified as of poor quality, with high occurrence of blockages and breakage of sewers and inspection chambers. The rate of household connection was of 85% and 59%, and, even among householders that had their houses connected, there were users bypassing their inspection chambers to the surface water drainage channels.

In Tamarineira, the maintenance conditions of the sanitation system seem better than that of the two other systems discussed above. This system has been functioning for over five years, and, in spite of COMPESA also having not yet assumed the system, the community accepted their role in the maintenance of the condominial sewer and is developing this task satisfactorily. Therefore, the main operational problems in the Tamarineira system are related to the main sewer.

The case of this system illustrates well a problem that may be caused by bureaucracy. URB claims that it has been five years since it sent the documentation necessary for the transference of responsibility to COMPESA. In reply, COMPESA states that have had never received a request from URB. Regardless of which institution is providing the most accurate information, the fact is that has been 5 years that the system is functioning without an official operator.

4.6.11. Model 6: Rejection Situation

The sanitation system in the ZEIS of Coronel Fabriciano went into operation in 1993 (over seven years ago). This system was designed as an isolated system having a communal septic tank unit for the treatment of effluents. During the implementation phase, URB provided the house connections for 100% of the residences.

COMPESA had rejected the operation and maintenance of this system because of the location of the treatment unit. The system has its septic tank located within the playground of a local school. This position has led EMLURB to solve the main

operational requirements of the system. However, this latter company has no experience in the maintenance of sanitation systems and the residents are dissatisfied, with approx. 54% of the householders classifying the maintenance of the main sewer as "bad".

In summary, the PREZEIS programme is a very important channel for community participation, allowing not only the communities to express their needs, but also to be involved in decisions and to participate in the execution of programmes. However, the effectiveness of this participation is not easily achieved and seems to depend largely on the charisma of community leaders.

The rules set out for condominial projects were not always followed either by the implementing agency (URB-Recife) or by the residents. For example, the residents seem to lose motivation to carry out maintenance of the condominial sewers. URB, on the other hand, is constantly changing its position on the execution of household connections. This undefined situation adversely affects the residents in a community, as well as those of other areas participating in similar programmes. Therefore, a revision of the rules for division of the responsibilities would be worth undertaken (changing the objectives that have not been accomplished and creating mechanisms to increase the effectiveness on the execution of the responsibilities).

Moreover, reports suggest that educational programmes only existed during the implementation phases of the system. However, to achieve behavioural changes, leading to a better utilisation of the programme, continued actions on the delivery of educational messages are clearly needed.Another aspect worth considering is the long period of transition, in which URB concludes the implementation and COMPESA does not starts the O&M, results in a gap in the continuity of the programme. This discontinuity, at the beginning of the operation phase, leads to a lack of both motivation and reliability on the functioning of the implemented technology.

4.7. Case Study 6: SISAR Programme (Ceará)

4.7.1. Introduction

The focus of this case study is on a sanitation programme, initiated in November 1992, aiming to deliver safe water and appropriate sanitation to rural villages in the Northern area of the State of Ceará - NE of Brazil (Figure 4.1).

Out of the regions of Brazil, the Northeast is the poorest one, presenting the highest rates of infant mortality, malnourishment and illiteracy in the country (Section 1.2.1.). The rural areas of the state of Ceará are representative of such a picture. The employment opportunities are limited and the main economic activities are usually crop plantations (basically domestic production), fishing and crafts (usually done by women and children).

The areas included in this programme usually have a health centre (with a "visiting" doctor on a weekly basis) and a primary school. The typical sanitation conditions prior to the implementation of the systems were of water collected from shallow wells (or nearest watercourse) and excreta buried or deposited in the backyards.

4.7.2. Background

- **Objectives**

This programme became known as the Rural Sanitation Programme of Ceará having as its main target the delivery of water and sanitation systems to rural communities through a "self-sustainable model". According to CAGECE (The Water and Sanitation Company of Ceará), the implementation of this sanitation programme had three main objectives:

- The recovery of citizenship;
- The reduction of water and excreta-related diseases; and,
- The improvement of the community's quality of life.

- **Adopted technologies**

The communities under this programme received both water supply and sanitation systems. The basic water supply systems were constituted by:

- Water source (90% wells with macro measurement);
- Minimum provision for water treatment (chlorination);
- Distribution reservoir; and,
- Household connections (100% measured).

The sanitation projects were based on two solutions: individual projects where the houses were located well apart or did not have a favourable topography (household level much below sewer level), and sewerage for areas with a higher population density.

The individual sanitation projects consisted of septic tanks followed by an anaerobic filter and the final infiltration of the effluent into the soil. The technology adopted for sewerage systems was the backyard condominial sewerage, and treatment was based on either waste stabilisation ponds or communal septic tanks.

Bathroom units were also provided for every residence. Its superstructure were made in precast concrete panels and located at the back of the plot.

- **Selection of the sites to be benefited**

The areas that received the programmes were geographically limited to the Northern part of the State (the region of Sobral). For their selection, a population size criterion was primarily used: the sites had to have between 250 and 3,000 inhabitants. The other requirements that the sites had to comply with were:

- Availability of water in sufficient quantity and adequate quality;
- Availability of electricity; and
- Existence of some level of community organisation.

By the end of this process, 45 districts were selected to take part in the programme.

- **Institutional arrangements**

The donors of the programme were: the Government of the State of Ceará (represented by CAGECE); KfW (a German Bank – Kreditanstalt für Wiederaufbau – as the financing agent); and the Federal Government (as the financial guarantee institution). Four main stakeholders were identified: CAGECE (as the responsible technical agency); the district prefectures (responsible for the payments of the electricity bill and the salary of the person operating the system); a German consulting firm (Kittelberger); and the residents' associations (indispensable for the development of community participation activities).

After 1996, SISAR (an institution to represent the community associations in the management of the sanitation programme) was created and became responsible for the management and O&M of the systems. Therefore, after the creation of SISAR, CAGECE assumed just a supportive role.

- **The implementation phase and community participation**

The implementation phase of the programme was launched between Nov 1992 and Jun 1997. The projects were designed by CAGECE and for construction a self-construction scheme was initially considered (using the labour of householders); however, having in mind that a day out of the householders from their usual activities might aggravate their already high level of poverty, CAGECE decided to hire a construction company to build the systems and encourage it to employ local workers as much as possible.

A consulting firm (AcquaPlan Consulting) was contracted to develop the activities related to community participation. The social activities were developed in parallel to the construction work and the aspects prioritised were:

- ***Community mobilisation:*** the community participation team started helping the areas without an established Residents Association to become organised, and then the planned activities were introduced; these were: presentation of the programme, explanation of the technology adopted, users' responsibilities and agreement on the rates to be charged for the service.

- ***Environmental and sanitation education:*** delivery of messages on the proper utilisation of the systems, hygiene habits and adequate storage of water.

- ***Training of personnel for the operation of the systems:*** The householders were invited to nominate three persons to attend a training course on the operation of the systems. The requirements for this were that the persons must: live in the community; be able to read and write; have good relationship and reliability; and be nominated by the community itself. The best qualified in the course was employed as the local operator receiving a salary of one Brazilian minimum wage to be paid by the local prefecture. The responsibilities of the operators were basically to keep the system units clean, operate the pumps, check the treatment units, solve blockage problems in the sewers and read the water meters.

Regarding the O&M of the systems, the operators performed the daily and simpler activities; however, until the beginning of 1996, CAGECE was the main organisation responsible for the system. The company provided the material necessary for its operation, spare parts and all technical assistance that the systems would require.

A charging policy for the system was considered a fundamental issue for the "sustainability" of the programme. Nevertheless, householders were expected to resist

paying for these services due to the common vote-catching practice of local politicians ("vote for me for free water and sanitation"). Thus, the tariff value was negotiated and gradually introduced (Table 4.14.).

Table 4.14. – Tariff values for the SISAR programme

Date	No. of system in operation	Value of the tariff (R$ per month)	Consumption limit (per month)
Jul 1994	15	0.70	unlimited consumption
Dec 1994	18	1.14	unlimited consumption
Dec 1995	37	2.15	*initially 5,000 l and then rise to 10,000 l

*Additional tariff charged for exceeding consumption.

- **The SISAR organisation**

Considering that the programme was designed to be self-sustainable, SISAR – a Portuguese acronym for Rural Integrated Sanitation System – was created to manage the systems. The essence of SISAR is to organise the districts – which have similar sanitation projects, as well as, social/economic characteristics – into an association that not only represents them, but is also managed by them. Providing, therefore, a stronger structure for the physical sustainability of these small sanitation systems.

Figure 4.59. – The SISAR flow diagram

As shown in Figure 4.59 (above), SISAR comprises:

a. The **General Council** is composed of 1 representative from each householders association;
b. The **Administrative and Financial Council** is composed of 12 members: 7 from the householders associations; 3 from the prefectures; 1 from CAGECE; and 1 from KfW (represented by the German consulting firm Luso Consult).
c. The **technical sector** is composed of 8 people: 1 coordinator; 1 engineer, 1 maintenance technician, 1 social technician, 1 financial technician (treasurer) and 3 field workers.

Excepting the coordinator of the technical crew, who is designated and paid for by KfW, the other members of the technical sector have their salary paid by SISAR through the money collected from the tariff for usage of the systems. After the establishment of SISAR (1996), the value of the tariffs has been defined annually by a general assembly. The systems have then been charged as follows:

- residence = R$ 3.50 (10 m^3/month)
- commerce (big premises) = R$ 4.70 (10 m^3/month)
- commerce (small premises) = R$ 1.20 (10 m^3/month)
- public = R$ 4.70 (10 m^3/month)

The users have their water meters read by the local operator, who tells them how much their bill will be and the treasurer collects the tariff at each locality. By the time of the field survey (Jan/2000), the tariff was based solely on the water consumption without any additional charge for sewerage; however, an update of the survey in December 2000, showed that the water bills were about to be increased (from 15/12/2000) and a sewerage tariff was being implemented. Therefore, the new charging system adopted for residences is now as follows (values per month):

Residences just served by the water system	Residences served by both water and sewerage systems	Residences just served by the sewerage system
R$ 4.00*	R$ 4.50*	R$ 1.50

* For residential water consumption up to 10 m^3 per month

The amount collected from the tariff is the only regular income received by SISAR. From this, a contribution to each residents' association is also made, as follows:

- Districts having up to 100 water connections = R$ 35.00
- Districts with more than 100 water connections = R$ 60.00

This contribution is to be used for small expenditures on the sanitation system, such as for telephone calls to the SISAR office, to buy cleansing material, small repairs (i.e. change light bulbs), etc. Some residents associations also add a charge of between R$ 0.50 and 1.00 per household per month to create a reserve fund for the association.

In order to empower SISAR and stimulate the districts (residents' associations) to join it, CAGECE stopped giving technical assistance to the systems. However, not all of the 45 districts that participated in the sanitation programme decided to join SISAR; 13 of them opted to manage their own systems independently and others decided to leave afterwards. Therefore, SISAR is now being composed by 27 districts (5,249 household connections).

A second phase of the programme (SISAR II) is currently being implemented. This time, however, the programme has the objective of attending areas located in the central part of the State, and, the SISAR I office is preparing a second maintenance crew to attend the 11 new districts of SISAR II.

4.7.3. The Areas Studied

Among the districts that received the sanitation programme, four were selected to participate in this study, they were:

- ***Serrota:*** This district is located at approx. 287 km Northwest of the city of Fortaleza – capital of the Ceará. The last 23 km is along an unpaved road and there is no regular public transport. Serrota has 203 houses with the majority of them concentrated in the highest (topographically) part of the area.

  The water supplied by the programme is collected from the dike Tucunduba, which is located about 300 m from the central point of the district (church square), this dike is also an important supplier of fish for the householders.

  Serrota has a residents' association that is being criticized by a dissident group; however, in the last election (Jan/2000) there was no opposition candidate and the group already in charge of the association was re-elected.
- ***Panacuí:*** The best access for the district of Panacuí is passing through the district of Serrota (above). However, the 10 km that separates the two districts is on a very badly maintained unpaved road, which is not possible to drive through during the rainy season. As in the case of Serrota, Panacuí is also located by the border of the dike Tucunduba (also the source of water for the water supply project). This district has 175 houses and the residents' association has been run by the same president for years without significant dissatisfaction among the householders.
- ***Parapuí:*** This district is located in the municipality of Santana do Acaraú, approx. 20 minutes by car from the city of Santana do Acaraú. In spite of the road giving access to the district being unpaved, Parapuí has a better-maintained and safer access than the two previous sites. The district has 220 households and the main economic activity is small-scale agriculture.

  The water used to supply the district is pumped from a deep well and the wastewater is treated in two waste stabilisation ponds. The residents' association has as its president a young woman who seems to be a strong

local leader. The main difference with this association is that it decided not to join SISAR and is managing its sanitation system independently.

- ***Juritianha:*** Located in the coastal area, this district has a much easier access than the areas described before, having a paved road crossing the site. It is part of the municipality of Acaraú and its population is approx. 1035 people.

  Fishing is one of the main economic activities of the district, which also has a better commerce than the other areas studied. Another important activity is making handmade lace, which is made by women and girls to supply the tourist market in the State capital.

  The water supplied is pumped from a deep well and the wastewater is being treated in a waste stabilisation pond or in a communal septic tank.

  The residents' association has just elected a new president, but the ex-president, who is now a local councillor, still has a strong participation.

4.7.4. Study Methodology

The data collected from the four areas studied (Panacuí, Parapuí, Serrota and Juritianha) were based on: **the project documents** (supplemented by informal interviews and visits to the projects units), and a **survey questionnaire**.

During the **study of the documentation,** information was collected on the institutional arrangements, on the project costs, the technical parameters applied and the social/educational activities developed. For the **survey**, the whole community was considered the target population and the questionnaires were applied in a sample of households selected systematically. The sample size for each area was: Serrota, 15%; Panacuí, 10%; Parapuí, 14% and Juritianha, 17.5% (N=30, 12, 31 and 36 respectively).

The questionnaire (Annex 8) comprised the following sections:

Section I - Identification / Social Economic Aspects
Section II - Participation of the community in the Programme
Section III - Technology Usage, Functioning and Satisfaction
Section IV - Health and Educational Programmes

4.7.5. Design of the Sanitation Units

➢ **The septic tanks**

The septic tanks, adopted for the houses that were located topographically out of the area attended by sewerage, followed the design presented in Figure 4.60.

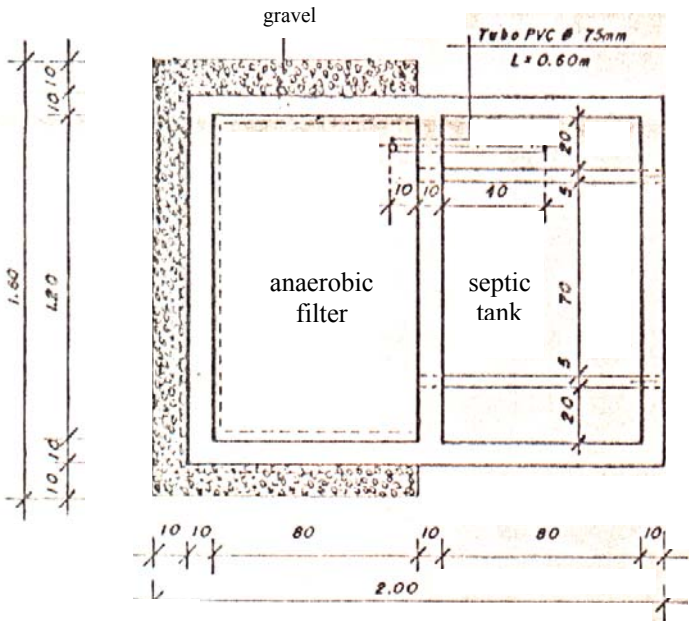


Figure 4.60. Dimensions of the septic tank and anaerobic filter (in cm).

- **The condominial sewerage connections**

The bathrooms constructed in the households in the area served by the condominial sewerage were connected to the network through inspection chambers, as illustrated in Figure 4.61.

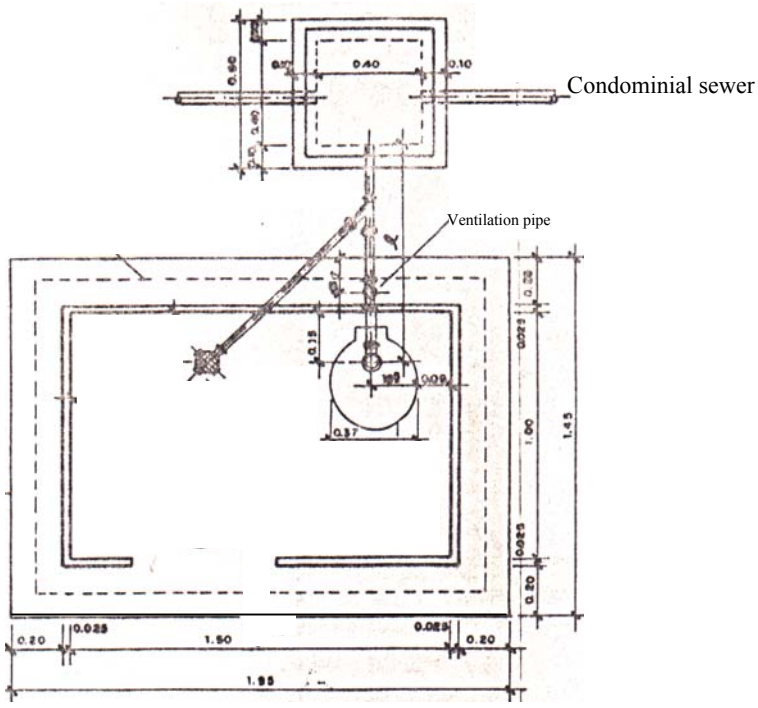


Figure 4.61. Bathroom connected to the condominial sewer through the inspection chamber

- **The bathrooms**

Independently of whether the sanitation option was an individual solution or sewerage, a bathroom was constructed for each residence that did not have the facility

or had an inappropriate unit. These bathrooms were built in precast concrete panels having a wooden door, a water-sealed drain and the toilet bowl (see Plates 4.65 to 4.67).

- **The design parameters for the sewers**

The parameters adopted by CAGECE and KfW for the design of the sanitation units were: contribution per capita, 100 l/person*day; return factor, 80%; coefficients K_1 and K_2, 1.20 and 1.50 respectively; minimum diameter of condominial sewers, 100mm; minimum slope of sewers, 5‰ and minimum cover to soffit, 40 cm.

The designers considered that due to the small size of the communities (smaller than 2,000 people), there was no need for a detailed hydraulic design of the sewers and adopted 100 mm for the entire network.

- **The wastewater treatment plants**

The waste stabilisation ponds were designed as facultative ponds considering a BOD contribution 45 g/person*day, a surface loading of 350 kg/ha*day and a maximum depth of 1.50 m.

4.7.6. Project Costs

The financial resources applied in the programme are shown below:

Institution	Quantity	Restrictions
KfW (loan)	US$ 8.4 millions	5 years interest rate (90-95) – i = 4.5% p.a.
KfW (donation)	US$ 1.5 millions	Exclusively for the payment of a German Consultant Group, during the implementation stage.
Ceará State	US$ 2.5 millions	For costs of personnel, transportation and administration.

The cost of the systems was, in average, of US$ 183 per capita – US$ 105 for the water supply systems and US$ 78 per person for the sanitation systems (exchange values from January 1999-URL 21).

As to the charging scheme, the system initially presented a “non-payment” percentage of 55 to 60%. This high value certainly constitutes a concerning factor and, therefore, a programme for the reduction of this figure had been launched. Through this programme, the community that presents the lowest “non-payment” rate during a semester is awarded with R$ 250.00 (US$ 126) in materials to be used in the water and sanitation systems. It has also been organised events (a football competition) among the four districts with lower rate of non-payment (see a report in the SISAR informative paper – Annex 9).

Plare 4.65. A bathroom unit

Plate 4.66. The toilet bowl and drain

Plate 4.67. A septic tank/bathroom unit

Another action to reduce the number of users not paying their bills is to disconnect the service. However, this represents high operational costs for SISAR, which has to provide personnel transportation and training in service disconnection.

The last figure obtained for non-payment rate was that in November 2000, the value reduced to 37% (average among all 27 districts).

According to SISAR's technical consultant, the former tariff value (R$ 3.50) was "sufficient" to just cover the operational costs of both water and sanitation systems; however, it is still not "sustainable" in terms of coverage of costs related to depreciation and preventive maintenance. In fact, the average maintenance costs for the months of Jul-Aug/2000 (considered a typical period) was R$ 21,100.00 (an average of 4 reais – US$ 2.20 – per household) for both water and sanitation systems.

4.7.7. Institutional participation

A point of concern in the institutional arrangement of SISAR is the participation of the prefectures. They, in general, have not been reliable in their participation and fulfilment of their responsibilities towards the programme (see page 186).

In December 2000, just one prefecture (responsible for the district of Cruz) was fulfilling its agreement to pay the electricity bill for the system operation and the salary of the local operator. Another one (responsible for the district of Cruatá) was covering just the energy costs. For all the other districts SISAR was covering the costs of the salary of the local operator, and some of the districts were charging the users with R$ 0,70 in order to cover the energy costs and guarantee continuity of the service.

Moreover, some of the prefectures are among the "non-payers" users, i.e. not paying the water bill of public institutions such schools and health centres.

4.7.8. Field observation

- **General aspects of the areas**

The four areas studied present similar characteristics with respect to both physical layout and householder's habits. The presence of women and girls contributing to the domestic income through the production of handicrafts was very common.

- **The Serrota and Panacuí districts**

Serrota and Panacuí are districts located by the embankment of the dike Tucunduba, which is the source of water adopted by the programme for both districts

(Plate 4.68). The water treatment in each district is composed of slow sand filtration and chlorination (Plate 4.69). The treated water is stored in reservoirs and then distributed to the network. In Serrota, the water is also delivered to a public fountain that supplies a group of houses located away from the centre of the district.

The sanitation systems of both districts are based on condominial sewerage and septic tank units. In Serrota, the system was conceived as one basin that discharges into a waste stabilisation pond. This treatment unit has, in fact, been working as "an open tank" and the surface level has never reached the level of the outlet (Plate 4.70). The Panacuí sanitation system was conceived as three micro-systems, with each one having a waste stabilisation pond (Plate 4.71).

- **Parapuí**

The water source adopted for the Parapuí water supply system was a deep well. However, high levels of iron were identified in the water, requiring the incorporation of an aeration device. The treatment plant also has a slow sand filter and a chlorination unit (Plate 4.72). The sanitation system was topographically divided into two drainage basins with each network discharging into a waste stabilisation pond (Plate 4.73).

The Parapuí district manages its sanitation system independently from SISAR. This decision was taken through a householders' meeting in which the president of the association was one of the main proponents for the self-management of the system. The main contributor to this decision was the resistance of householders in transferring the financial resources collected from the tariffs. Thus, the residents' association manages the water supply and the sanitation systems without support from either SISAR or CAGECE. To be able to do that, the association charges the householders the same tariffs as SISAR and relies on the expertise of the local operator, who was trained together with all the others at the beginning of implementation of the programme. The association pays him the same salary that SISAR.

The Parapuí operator seems to be a confident professional and reported that there were no major problems in the O&M of the systems; and, when he needs advice he affirmed that can always contact other operators or the instructors from CAGECE or SISAR. In order to cover costs for spare parts for the system units, for services that cannot be carried out by the operator, or even for contracts for private technical assistance, the Parapuí association keeps a bank account into which is placed the money collected from the tariffs.

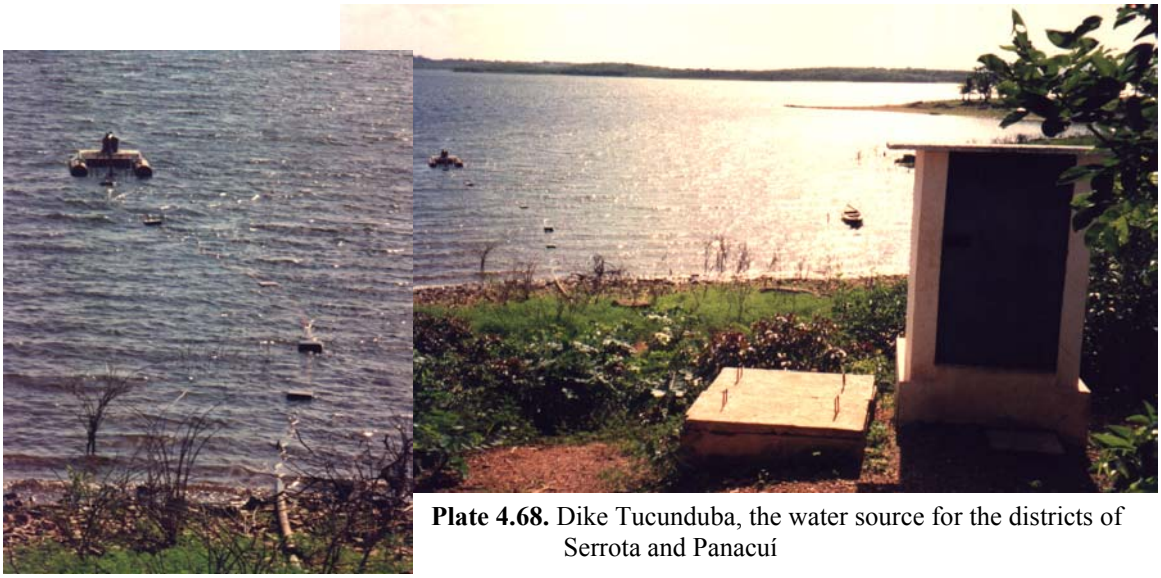


Plate 4.68. Dike Tucunduba, the water source for the districts of Serrota and Panacuí

Plate 4.69. The water treatment plant of Serrota (right) and Panacuí (left).

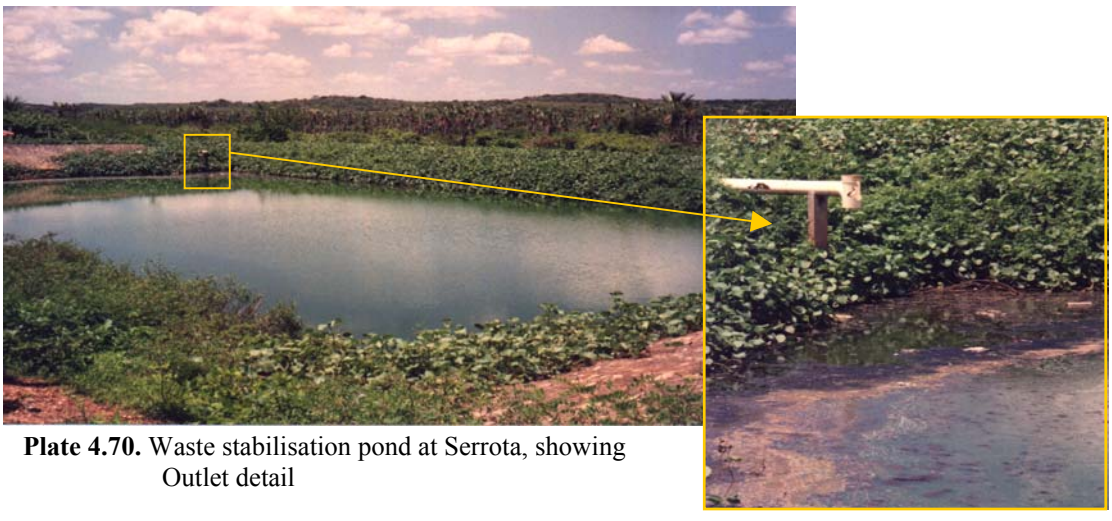


Plate 4.70. Waste stabilisation pond at Serrota, showing Outlet detail

Plate 4.71. The three waste stabilisation ponds at Panacuí.

Plate 4.72. The aeration and sand filtration of the water treatment plant at Parapui

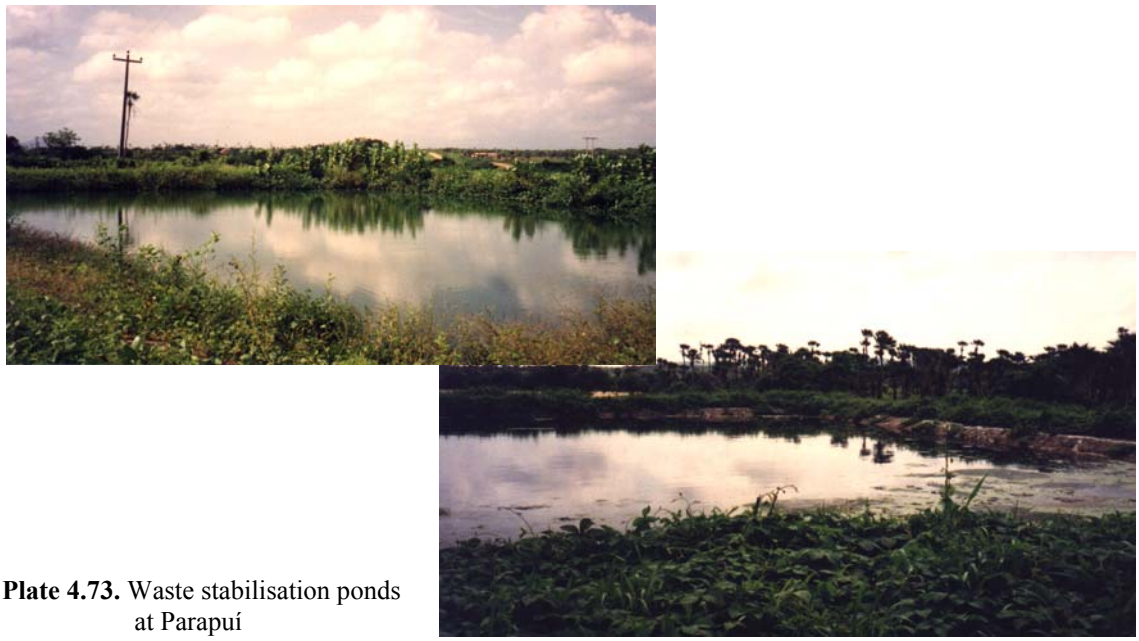


Plate 4.73. Waste stabilisation ponds at Parapuí

Plate 4.74. Waste stabilisation pond at Juritianha

Plate 4.75. **Communal septic tank at Juritianha**

- **Juritianha**

The district is associated to SISAR and its water supply project followed the basic scheme of the programme: water is collected from a deep well, chlorinated, pumped to a reservoir and then distributed by gravity throughout the district.

As a characteristic of this area, the majority of the households used to collect water from shallow wells through hand-pumps in their backyards. Therefore, for the majority of the community water was always available nearby. In spite of the public health risks of these wells (due to the proximity of latrines and vulnerability from domestic animals - including goats, chickens and horses), the householders reported a preference for the hand-pumped water, which, they say, is tastier than the water supplied by the programme (complaints about the chlorine). Thus, although nearly all the houses had initially received water connections, many continued to use their backyard water for some purpose and then when the water tariff started to rise (SISAR charging policy), householders started asking for the removal of their connections.

The sewerage system was designed as two micro-systems, one discharging into a waste stabilisation pond and the other into a communal septic tank (Plates 4.74 and 4.75). The effluent of the waste stabilisation pond discharges into a rock filter that, during this field study, was being rebuilt due to under-dimensioning (according to the field technician).

The septic tank was not in operation due to a blockage problem. The operator reported that, despite repairs that had already taken place, this unit had never functioned well. In fact, there seems to have a construction problem regarding the level of the tanks. To solve this, technicians were considering two alternatives: the reconstruction of the septic tank unit, or its abandonment (for the last alternative the option for the collected wastewater is to be pumped to the existing waste stabilisation pond).

4.7.9. Survey Questionnaire

- **Section I – Identification and Socio-economic Aspects**

The variables measured in this section were: occupation density, property ownership and the time that the families had been living in the area.

The four districts had household occupational densities varying from 4.2 (Serrota) to 5.7 (Panacuí), and the average for the four communities was 4.9 persons per household. The property ownership level revealed that more than 80% of the householders own their homes.

As shown in Figure 4.62, the majority of the families had been living in the houses for more than 7 years and had had, therefore, the chance to take part in the sanitation programme since its beginning.

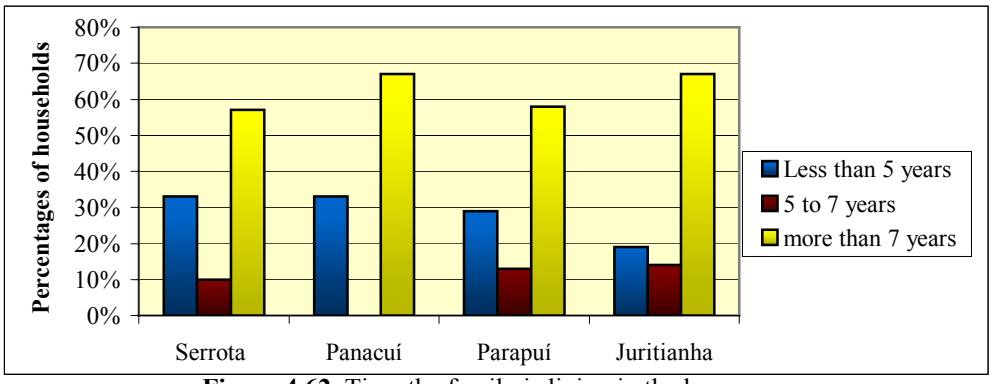


Figure 4.62. Time the family is living in the house

The monthly income for the households was not determined due to the characteristics of these rural villages (the great majority of families have no formal jobs and many of them live from domestic agriculture and fishing). This would have required a more detailed survey, which took into account not only cash incomes but also the cash equivalents of subsistence farming.

- **Section II –Water Supply**

In general, the water supply in the four districts was of a yard tap level and problems with the reliability of the systems were only associated with failures in the electricity supply.

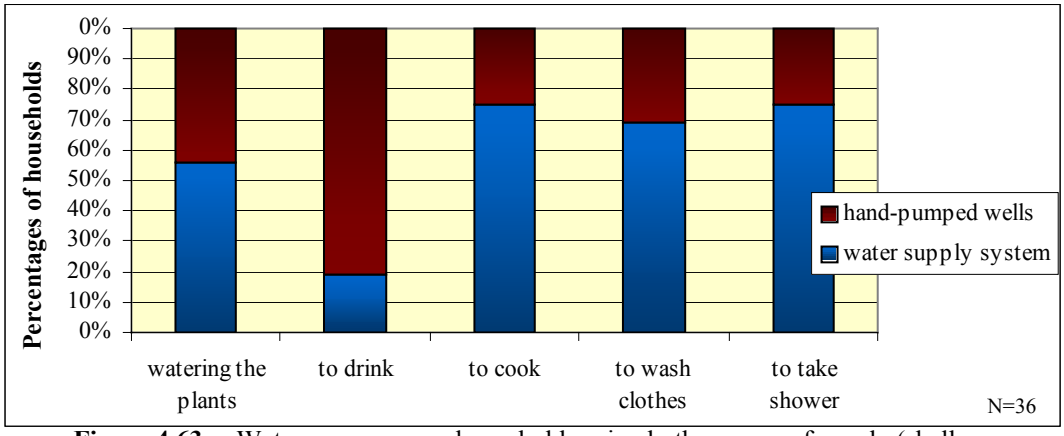


Figure 4.63. – Water usage among households using both sources of supply (shallow wells and treated water from the programme) in the district of Juritianha.

In the district of Juritianha (where householders also consumed hand-pumped water from shallow wells), 6% of the households were consuming water only from the wells, 42% were using solely the water supplied by the programme and 53% of the households were using both the water from the programme and water from the wells. As

shown in Figure 4.63, the majority (81%) of the households that were consuming water from both sources preferred to drink the water from the wells and more than 56% used the treated water for watering their garden plants.

- **Section III – Technology Usage, Functioning and Satisfaction**
  - **Technology usage**

The sanitation systems serve 100% of the households in the districts of Serrota and Juritianha, and the Serrota system had the highest number of households served by septic tanks instead of sewers (Figure 4.64).

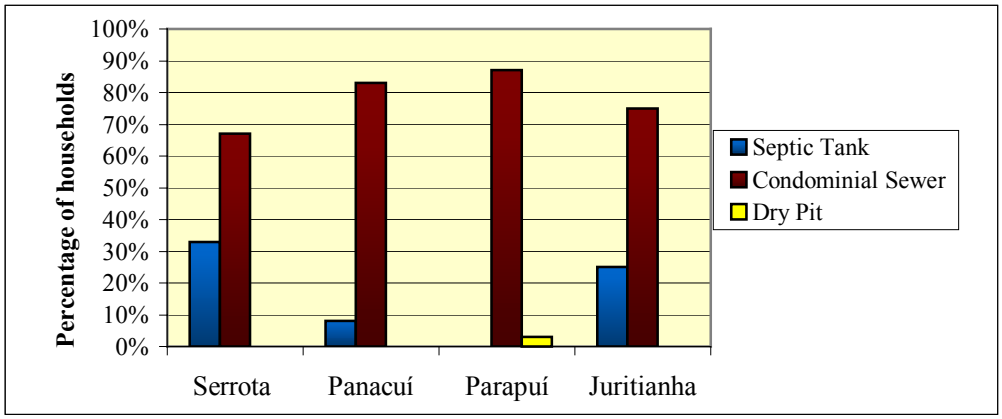


Figure 4.64 – Sanitation solutions used by householders

Regarding the utilisation of the facilities, more than 83% of the householders declared that the whole family uses the bathrooms built by the programme. In Juritianha, this percentage was 100%, as shown in Figure 4.65.

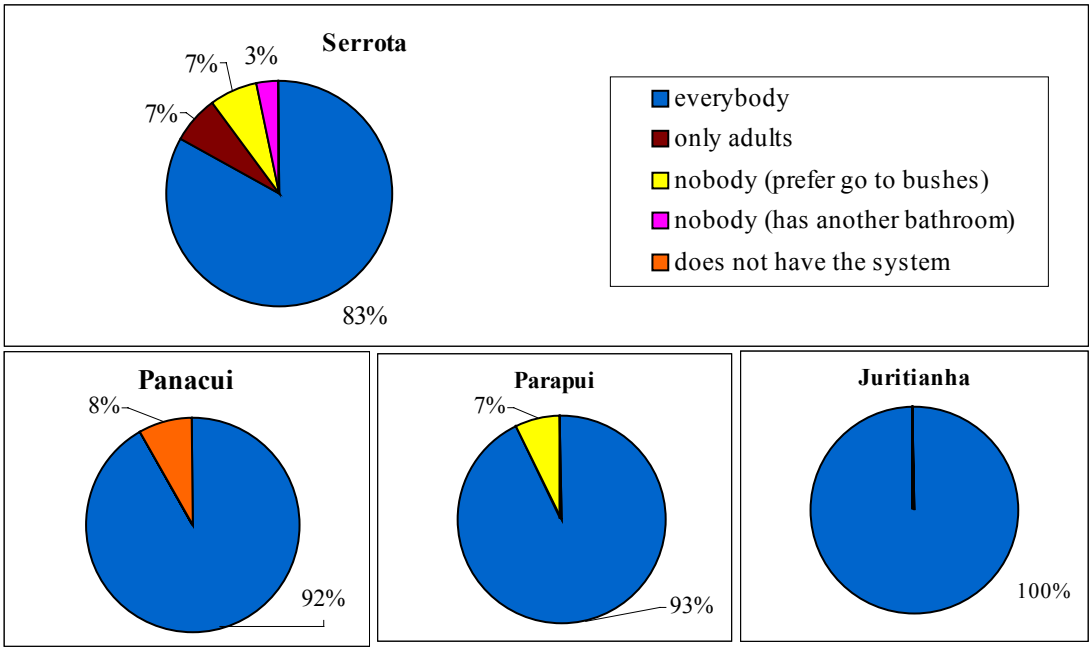


Figure 4.65. Usage of the sanitation facilities

- **Technology functioning**

According to the householders, the occurrence of failures in the condominial sewerage systems was not frequent. As shown in Figure 4.66, more than 70% of the users in the four districts never had any problem.

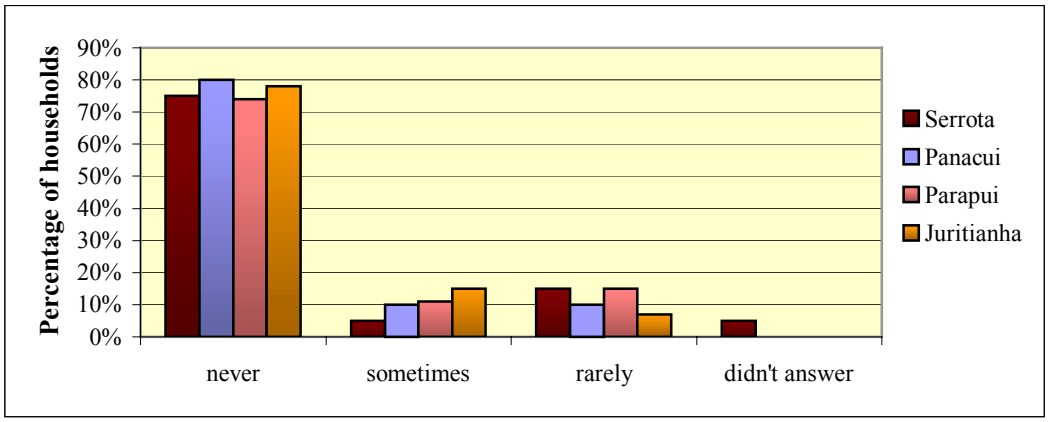


Figure 4.66. Frequency of sewers operational problem

Regarding the functioning of the septic tanks, 20% of the users in Serrota said that the facility had failures "sometimes" and 10% said that problems occur "rarely". The remaining 70% of septic tank users in Serrota and the users from the other districts said that problems "never" occurred.

In the sewerage systems, the type of problems reported was of blockage in the condominial sewers and in the household connections (Figure 4.67).

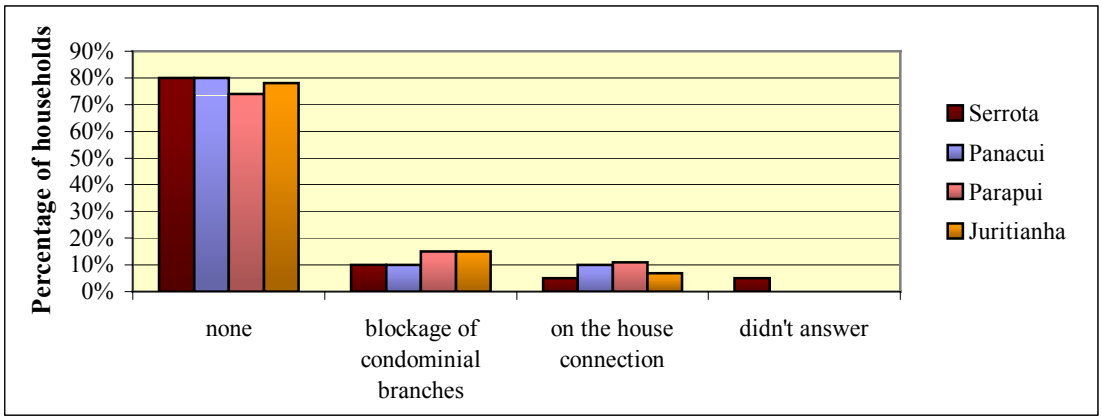


Figure 4.67. Type of operational problems in the sewerage systems

About who solves the problems that may occur with the sanitation systems, the great majority of householders (between 73 and 80%) answered that it was the local operator. Nevertheless, in Juritianha, 20% of the householders said that they did not know who was supposed to do this (Figure 4.68).

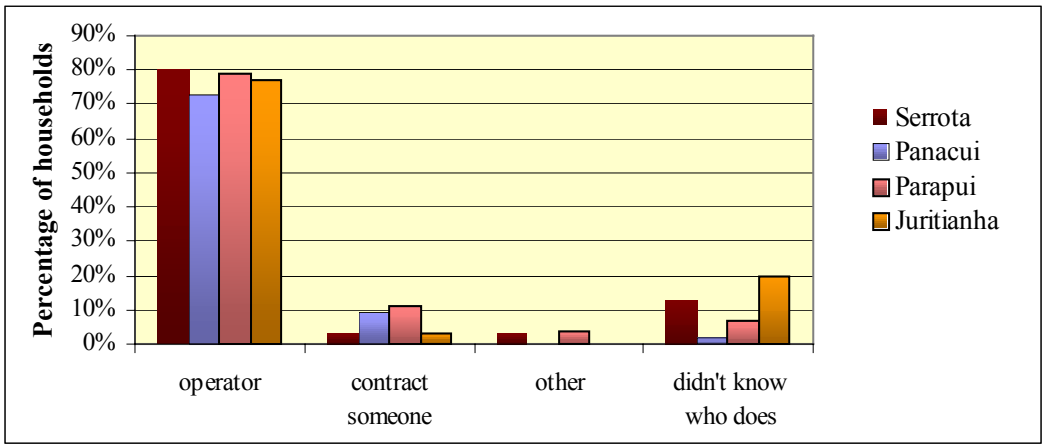


Figure 4.68. Person responsible for the maintenance of the sanitation system.

Among the householders that have requested the services of the operator, the great majority reported an attendance in less than 24 hours (Figure 4.69).

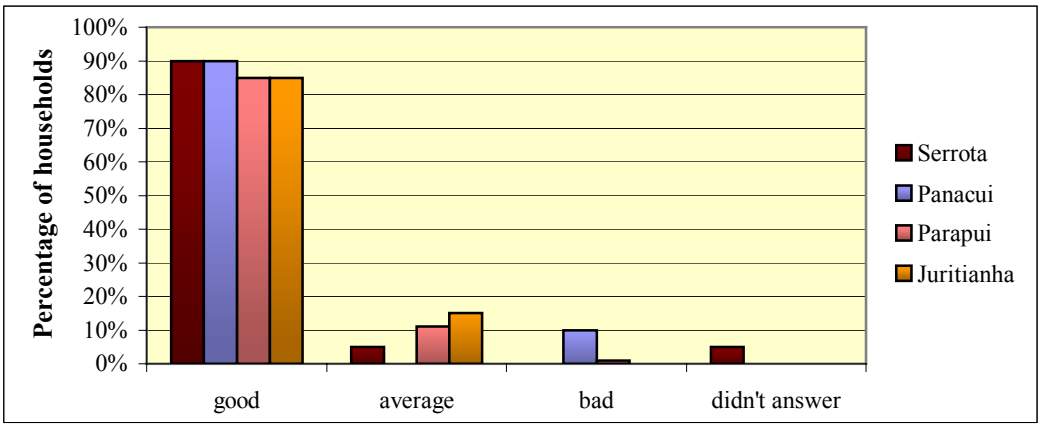


Figure 4.69. Time for the operator to attend a user's request for maintenance services.

- **Technology Satisfaction**

According to 85 to 90% of the households in the districts studied, the condominial sewerage was considered a good system (Figure 4.70).

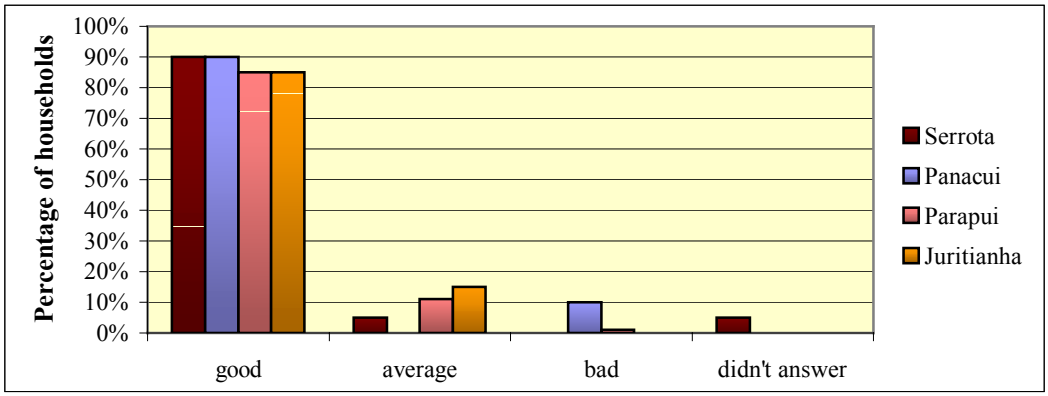


Figure 4.70. – Level of user satisfaction with the condominial sewerage system.

Among householders from the two districts with higher percentage of septic tank users (Serrota and Juritianha), the level of satisfaction was also relatively high: 60% for those from Serrota and 100% for those from Juritianha.

Finally, the values charged for the system was, in general, considered to be reasonable by the householders of the four districts (Figure 4.71).

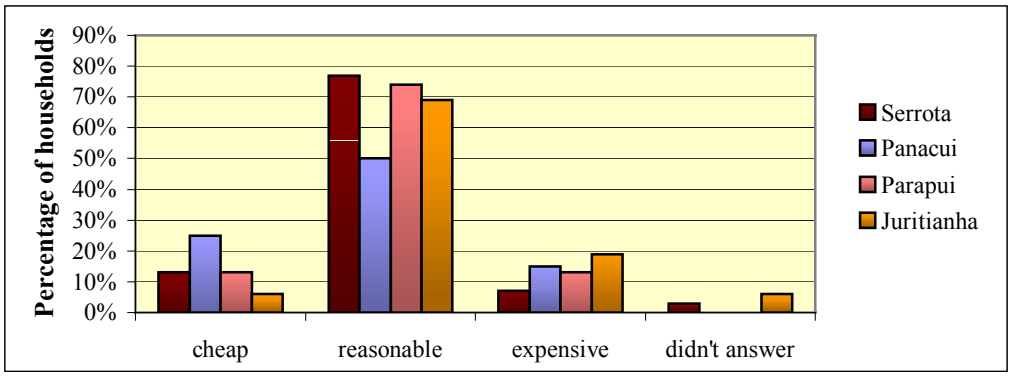


Figure 4.71. – Amount of money paid by the users.

❑ Section IV – Health and Educational Programmes

As already mentioned, this sanitation programme also had socio-educational activities, which focused on the appropriate usage of the new facilities, on the improvement of personal hygiene and on the empowerment of the community associations. However, when asked about educational messages the households in the four districts seemed to remember more the messages from a health programme from the Federal Government than those of the sanitation programme (Figure 4.72).

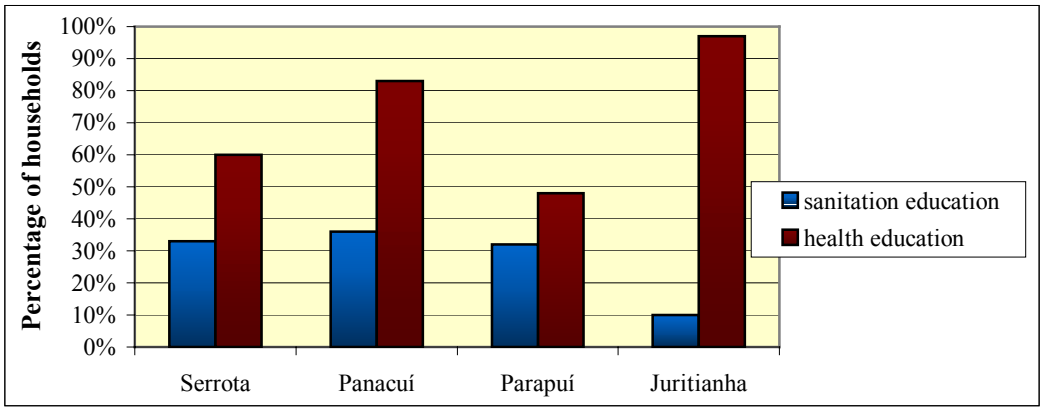


Figure 4.72. – Householders that remember educational messages from the sanitation programme and from the health programme.

Although the general feeling when visiting the communities was that improvements were still needed to the householders' personal hygiene practices, good health practices have started to be noticed. The following sequence of photographs exemplifies this (Plates 4.76-4.78).

Plate 4.76. – Household storage of drinking water.

Plate 4.77. – Children playing in the street (having few clothes, but wearing shoes).

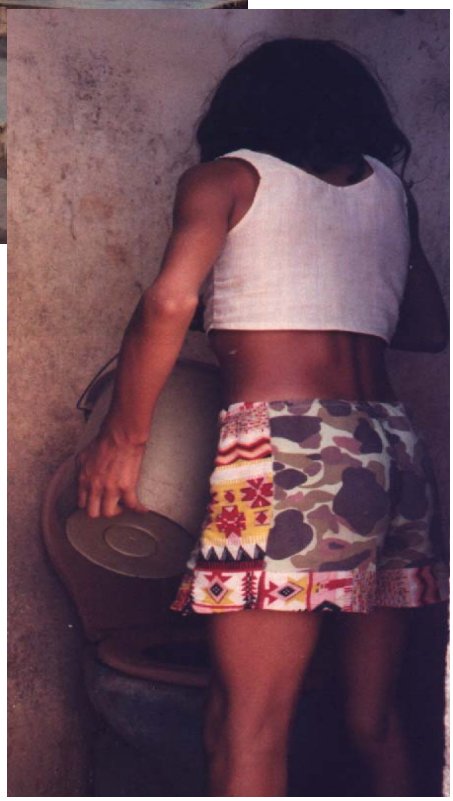


Plate 4.78. – A girl cleaning the toilet bowl.