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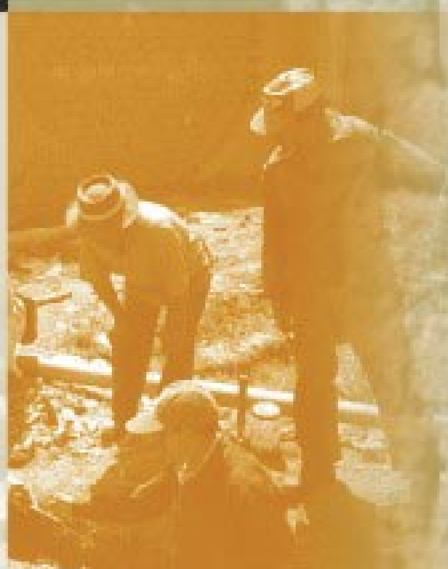
Condominial Water and Sewerage Systems

Costs of Implementation of the Model



EL ALTO - BOLIVIA / PILOT PROJECT

VIVIEN FOSTER
WORLD BANK

Vice Ministry of Basic Services

Swedish International Development Cooperation Agency

ECONOMIC AND FINANCIAL EVALUATION

Water and
Sanitation
Program

Water and Sewerage Systems

Report written by: Vivien Foster – The World Bank.

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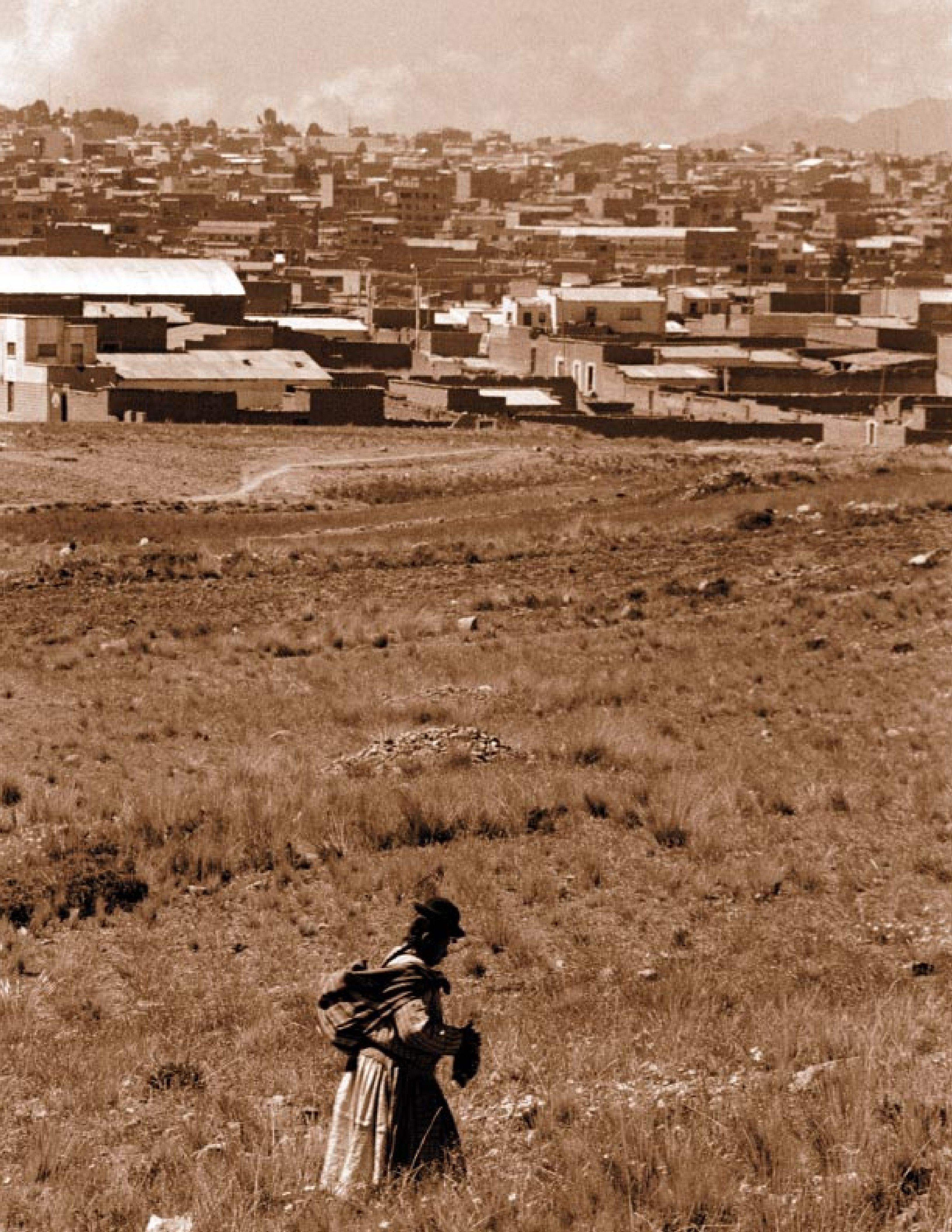


EL ALTO - BOLIVIA / PILOT PROJECT

CONTENTS

Executive Summary

This paper undertakes the economic and financial evaluation of the El Alto Pilot Project (EAPP), a pilot project aimed at transferring the condominial water and sewerage system from Brazil to Bolivia and testing its applicability in the context of private sector participation in service provision. Since its inception in 1998, the EAPP has provided condominial water connections to 1,977 households in eight neighborhoods of El Alto, and condominial sewerage connections to 4,050 households in nine neighborhoods of El Alto. According to recent statistics, about 60% of these households live below the poverty line with an average daily income per capita of US$0.80.

To what extent are the results of the El Alto pilot relevant beyond Bolivia? The peculiar cultural, geographical and social circumstances of El Alto make it—if anything—an acid test for the condominial approach. In particular, a number of factors which have served to limit the benefits of the condominial system in Bolivia would not necessarily be present in other contexts to the same degree. Examples include the exceptionally low levels of consumption of households, and the difficulties experienced in inducing them to switch to modern hygiene practices for a variety of cultural reasons. Consequently, the results of the evaluation should be regarded as specific to the El Alto context, even though in qualitative terms they are indicative of what can generally be achieved through the condominial approach.

The pilot project experimented with a number of different components including:

- innovative engineering design of networks;
- community participation in network construction and maintenance;
- hygiene education to support the installation of household facilities;
- micro-credit lines to finance the construction of bathrooms.

Many of these components are mutually reinforcing and formed part of an integrated concept in the El Alto project. Nonetheless, both in principle as in practice, it is possible to apply these components independently of each other. Hence, for analytical purposes it proves convenient to provide an independent evaluation of each.

Engineering design

The purpose of the innovative engineering design is to reduce the length, diameter and depth of the network required by routing the distribution pipes across pavements and/or backyards. Analysis of the EAPP experience suggests that savings in the length and diameter of pipes are of the order of 10%-20%, while savings in the volume of soil excavation as a result of shallower trenches are of the order of 45%-75%. These physical savings translate into overall financial savings of the order of 24% for the sewerage service and 40% for the water service when the condominial engineering design is implemented using conventional contractors. This is consistent with recent experience from Brasilia which suggests savings of 20% for condominial sewerage systems without community participation (Neder, 2001).

Community participation

Community participation brings a number of advantages, among them is a further reduction in connection costs as a result of training local residents to construct and maintain their own condominial branches. Community participation reduced the network costs by a further 26% for the sewerage service and 10% for the water service. Thus, the overall savings achievable by implementing the condominial engineering design with community labor come to around 50% for each of the two services. However, community participation also introduces costs of social intermediation for the water company of around US$8 per connection, and requires each participating household to give-up about a week of its time valued at around US$20. When these costs are taken into account, the overall cost advantage of the condominial design with community participation falls slightly from 50% to 40% for both services. Considering the balance between marginal costs and benefits, community participation has a benefit cost ratio of 2.2 for the sewerage service suggesting that it is very worthwhile. However, in the case of the water service the benefit cost ratio is only 1.0, since in this case the cost savings come primarily from the engineering design.

There is also some evidence suggesting that community participation increases the proportion of households that connect to the sewerage network once it is built from 66% to 75%. The effect of this is to increase the overall cost saving of the approach from around 40% to 45%.

Hygiene education

The purpose of the hygiene education component was to provide moral and technical support for households to adopt modern hygiene practices, in particular by helping them to construct their own bathrooms and associated facilities. Without such investments within the home, a sewerage connection brings little or no benefit to households, and has been shown to have virtually no impact on water consumption.

In neighborhoods where hygiene education activities had been performed the probability that any given household had constructed a bathroom increased from 38% to 73%, and the range of water-using installations in the household (showers, kitchen sinks, etc.) increased markedly. Households with bathrooms were found to consume, on average, two cubic meters more per month than households without bathrooms, which is to say an increase of 30% on average consumption in households without bathrooms of 5.4 cubic meters per month. Households receiving hygiene education were also found to significantly reduce insanitary practices (Canelli, 2001). After the project, the percentage of households throwing out used water into the streets fell from 77% to 58%. Households recycling water within the home fell from 36% to 25%.

The cost of hygiene education to the utility works out at around US$13 per household, while the cost of bathroom construction to the household was estimated at US$443. Given the relatively small absolute value of the consumption increase, and the low level of tariffs for low volume consumers, hygiene education is not at present a commercially attractive proposition for a private utility in El Alto. The estimated consumer surplus increase from the additional consumption ranges from US$253-US$470 depending on the discount rate used. This suggests that bathroom construction is only marginally attractive to households. However, it is important to stress that these modest benefits for hygiene education are largely an artifact of the exceptionally low levels of water consumption in El Alto. With the much larger consumption increases that could easily be anticipated in other locations, the proposition would start to look much more attractive both from the utility's and the customer's perspectives.

Micro-credit line

The purpose of the micro-credit line was to help households finance the US$400 worth of materials required to construct a fully-equipped bathroom. Overall, 25% of households applied for credit, and 19% had their applications approved. The available evidence suggests that those households applying for credit tended to have above average incomes. While the provision of credit undoubtedly eased the payment of the costs for beneficiary households, statistically there is no evidence to suggest that bathroom construction rates were significantly higher in neighborhoods were micro-credit had been offered. The micro-credit line was dropped at an early stage of the project.

Overall, these results suggest the following conclusion. The engineering design component alone produced significant savings of 24% for sewerage and 40% for water. The community participation component further increased the savings available for the sewerage service to 40%, but did not have any net effect on the cost reductions available for the water service. The hygiene education component had a very substantial effect on household behavior, but the size of the benefits was more modest than might be expected owing to very abstemious water consumption practices peculiar to El Alto. Evidence on the micro-credit facility suggests that it probably was not all that effective in reaching the poorest households.

The results reported above are given from the perspective of an 'enlightened policy maker' who takes all financial and economic costs fully into account. However, the considerable divergence between tariff structure and underlying cost structures in the AISA concession contract appears to distort the way in which the utility and its consumers perceive the advantages of the condominial system.

- From the utility's perspective, it is difficult to make categorical statements about the profitability of making condominial as opposed to conventional connections. Although current connection charges mandated by the concession contract are substantially lower than the estimated average cost of making a connection, it is not known to what extent part of the costs of network expansion have in fact been built into the use of service tariff. However, one point that is clear is that there does not appear to be any incentive for the utility to engage in hygiene education since the additional costs are not recouped through the connection charge, and the resulting increases in water consumption—though significant—are not large enough to take consumers out of the loss-making low volume tariff band. If charges were fully cost-reflective the utility would be indifferent between conventional and condominial systems, but would still only have an incentive to undertake hygiene education as long as the consumption increase was large enough to justify the cost of the initial investment.

- From the consumer's perspective, households receiving water and sewerage services by the condominial method saved US$19 and US$80 respectively in terms of connection charges, an aggregate value equivalent to 80% of monthly household income. However, when the opportunity cost of the household's time is fully accounted for, the saving disappears for the water service and for the sewerage service is reduced to US$58 (or about 50% of monthly household income). If connection charges were more closely aligned with underlying cost, households would spend more on obtaining a condominial connection than they do at present, but the savings relative to the conventional system would also be larger. They would increase to US$109 for water and US$126 for sewerage (together equivalent to nearly 200% of monthly household income). As before, when the opportunity costs of time are taken into account, the savings are somewhat reduced to US$90 for water and US$104 for sewerage (in total equivalent to 160% of household income).

1. Introduction

The purpose of this report is to conduct an economic and financial evaluation of the El Alto Pilot Project (EAPP) for condominial water and sewerage systems in Bolivia. The report does not however directly consider the technical performance of the systems, or the social impacts of the projects which are being treated in parallel evaluations.

Condominial water and sewerage systems were pioneered in Brazil during the 1980s as a way of bringing piped sanitation services within the economic reach of poor households (Watson, 1995). The 'condominial approach' has two defining features.

- The first is the use of innovative engineering techniques. By routing water and sewerage networks across pavements and yards instead of down the center of streets, the condominial approach leads to substantial economies in the length, depth and diameter of the pipes.
- The second is the integration of social and engineering work. By involving communities in the construction and maintenance of the condominial networks, further cost reductions are achieved. Moreover, the interaction with the community during the execution of the works provides opportunities to impart hygiene education and to influence water consumption habits in a variety of ways.

In July 1997, the Government of Bolivia granted a 30 year concession contract for the provision of water and sewerage services to the adjacent cities of La Paz and El Alto. The concession contract was awarded to Aguas del Illimani (AISA), a consortium led by Lyonnaise des Eaux. A major objective of the concession contract was to improve access to water and sewerage services in El Alto. The expansion targets for the first four years of the concession in El Alto included reaching 100% water coverage and making 38,000 new sewerage connections. However, the very high levels of poverty in El Alto raised concerns about the affordability of the new water and sewerage services. This prompted a search for ways to reduce the cost of serving low income households, and led the Bolivian authorities to consider the potential use of the condominial approach.

Shortly after the award of the concession contract in July 1997 a tripartite agreement was reached between the Government of Bolivia (GoB), the private utility (AISA) and the Water and Sanitation Program (WSP).

- The GoB agreed to relax its technical standard which, as currently written, would legally preclude the use of the condominial approach.
- With the endorsement of the regulatory agency, AISA agreed to use the condominial approach to meet a proportion of its expansion targets in El Alto.
- While the WSP—thanks to support from the Swedish International Development Cooperation Agency (SIDA)—agreed to finance the research and training activities required to transfer and adapt the condominial system from Brazil to Bolivia.

Although condominial systems have been successfully deployed in a number of cities around Brazil, the EAPP is believed to represent the first attempt to export the approach to another country with very different socioeconomic and sectoral conditions. Furthermore, the Brazilian experience of condominial systems has always been in the context of public sector service provision. The EAPP applies the model, for the first time, in the context of private sector participation. It therefore provides an opportunity to establish whether the social work component of the methodology is compatible with the *modus operandi* of a private utility. For both of these reasons, the experience is of interest not only in Bolivia, but to other countries who may wish to experiment with the condominial system.

This report is organized as follows.
- Section 2 provides a more complete description of the EAPP.
- Section 3 describes the methodological framework for the evaluation.
- Section 4 estimates the cost differences between conventional and condominial systems.
- Section 5 examines how the condominial approach affects household water consumption.
- Section 6 draws out the main conclusions of the evaluation.

2. Description of the El Alto Pilot Project

This section provides a more detailed description of the EAPP project, describing the setting in which it takes place, the nature and phasing of the neighborhoods affected by the project and the scope of the associated interventions. It concludes by providing a more nuanced definition of what is meant by the condominial approach.

Project setting

The setting for the EAPP is the city of El Alto located at 4,100 meters above sea level on the Bolivian altiplano[1], adjacent to La Paz and home to 600,000 people. The city has been described as the 'Aymara capital of the world', in recognition of the fact that 80% of its population belong to the Aymara ethnic group, and that Aymara beliefs and customs are strongly observed.

The city has grown-up from nothing during the last 30 years (and more especially during the last 10 years) as a result of large scale urban-rural migration. However, many of the inhabitants retain strong links with the countryside, spending a proportion of each year back in their villages where they continue to take part in agricultural activities. For a considerable proportion of the population, El Alto thus represents a way of combining urban and rural livelihoods. While in the city, most people earn their living by street vending or informal micro-enterprises, as there is very little organized large scale industry. Many inhabitants of El Alto spend most of their waking hours in La Paz where most of the economic opportunities are, hence El Alto is something of a 'dormitory city'.

The recent creation and rapid growth of the city has created a coverage deficit, particular for sanitation. Sewerage coverage in El Alto, estimated at 30% - 45%, lags significantly behind that in La Paz, estimated at 66%.

However, the high levels of poverty make expansion of services particularly challenging: average income in El Alto is less than half of that in La Paz, with 60% of the population living under the poverty line (Table 2-1).

Table 2-1 Poverty statistics for La Paz and El Alto

	La Paz	El Alto
Income (US$/month)		
Per capita	51.32	24.36
Per household	256.60	121.79
Poverty lines (US$/per capita/month)		
Extreme poverty	26.05	
Poverty	42.92	
Poverty rates (%)		
Extreme poverty	27.53	41.16
Poverty	48.37	59.47

All of these characteristics combine to make El Alto a unique location, and raise a number of critical issues for the expansion of water and sanitation services (Table 2-2).

- First, the religious beliefs of the Aymara people preclude certain forms of modern hygiene. For example, latrines and septic tanks would be regarded as unacceptable to many because they involve the burial of feces in the ground, which is considered both dangerous and sacrilegious. However, piped sewerage does not create conflict with traditional beliefs, basically because it returns feces to surface water courses.
- Second, the geographic location means that temperatures are unusually cold for a tropical location. This means that water use, in particular for personal washing, is exceptionally low; on average just under six cubic meters per household per month or about 40 liters per capita per day. Furthermore, the climate, low oxygen levels and high levels of ultraviolet radiation create an unusually sterile environment, so that the links between hygiene and health are not as strong as they usually are in tropical locations.
- Third, the largely rural origins of the population and the continued links with the countryside, make many people reluctant to adapt to modern urban lifestyles. People are accustomed to obtaining their water directly from nature, and returning their feces directly to nature. They are not used to living with piped water and sewerage, and the older people in particular are not always attracted to doing so.

The peculiar cultural, geographical and social circumstances of El Alto make it—if anything—an acid test for the condominial approach. In particular, a number of factors which have served to limit the benefits of the condominial system in Bolivia would not necessarily be present in other contexts to the same degree. Examples include the exceptionally low levels of consumption by households, and the difficulties experienced in

Table 2-2 Local idiosyncrasies of relevance to the project

Aspect	Local characteristics	Implications for water and sanitation services
Cultural	80% of the population of El Alto belongs to the Aymara ethnic group, with strong traditional religious beliefs:	- Latrines and septic tanks are not a culturally viable option for sanitation.
	- The earth mother (*pachamama*) is venerated as an important deity.	- Burial of feces in the earth is regarded as sacrilegious.
	- Evil spirits reside in the depths of the earth and can escape through holes in the ground.	- Creation of holes in the ground for the disposal of feces is regarded as dangerous.
	- Possession of another person's feces gives power of witchcraft over them.	- There is a preference for anonymous disposal of feces in scattered locations.
Geographic	El Alto is located at an altitude of 4,100m above sea level, which means that:	
	- Overnight temperatures fall to freezing year round.	- Hot water is needed for showering. - Health outcomes are less sensitive to hygiene practices than they would be in a warmer climate. - General water use tends to be lower than in warmer climates.
	- Low temperatures, low oxygen levels, and high levels of ultraviolet radiation combine to reduce bacterial activity in the local environment.	
Social	El Alto is a city that has been created in the last 10 years as a result of rural-urban migration, hence:	
	- Most of the residents are recent arrivals from rural areas.	- People have limited experience of modern sanitation practices.
	- Many of the residents maintain strong links with the rural areas, dividing their time between agricultural activities in the countryside and commercial activities in the city.	- Difficulty of coordinating projects requiring agreement between neighbors, given seasonal migrations and many absentee landlords.

inducing them to switch to modern hygiene practices for a variety of cultural reasons. It is particularly important to bear these local idiosyncrasies in mind when drawing inferences about the relevance of the El Alto experience to other locations in Bolivia, Latin America or beyond, where many of these conditions are unlikely to apply.

Timing of the Pilot Project

The EAPP encompasses a number of different neighborhoods of El Alto, as well as some of the poorer neighborhoods of La Paz (Caja Ferroviaria, El Rosal Lloreta, and Kupini). The implementation of the project can be divided into two partially overlapping phases (Table 2-3).

Phase One, which was the pilot proper, ran from November 1998 to February 2000 and encompassed six different neighborhoods: Huayna Potosí, Villa Ingenio, Caja Ferroviaria, San Juan de Río Seco, Oro Negro, Jichusirca. During this phase, a team of WSP consultants had overall responsibility for the project sites. The team, which combined Brazilian condominial experts with Bolivian counterparts, undertook the design of the condominial networks, and the training of local social workers and AISA engineers, as well as supervision of the overall process.

The Phase One sites were covered in two waves. The two projects covered in the first wave, Huayna Potosí and Villa Ingenio, provided the basic learning experience. This is reflected in the relatively long duration of these projects, which took on average about eight months from start to finish. The four neighborhoods covered in the second wave, on the other hand, were executed much more rapidly, taking on average just under four months to complete.

Phase Two, which ran from October 1999 to November 2000, was the first stage of scale-up. A key change between Phase One and Phase Two was that AISA began to take overall responsibility for implementing the condominial methodology, while the WSP team played a much more limited advisory role. Five further neighborhoods have been added under this phase: Villa Ingenio (a different part of the original Phase One neighborhood), El Ingenio, Germán Busch, El Rosal Lloreta, and Kupini. These projects have taken, on average, just over five months each to complete.

Services provided

The nature of the services provided differs by pilot neighborhood (Table 2-4), depending on their original service endowment. Some of the pilot neighborhoods—Huayna Potosí, Oro Negro and

Table 2-3 Phasing of pilots by neighborhood

	1998: o n d; 1999: j f m a m j j a s o n d; 2000: j f m a m j j a s o n d
Phase One	
Huayna Potosí	199 days
Villa Ingenio (D-II)	279 days
Caja Ferroviaria	168 days
San Juan de Río Seco	105 days
Oro Negro	119 days
Jichusirca	74 days
Phase Two	
Villa Ingenio (UV-4)	113 days
El Ingenio	203 days
Germán Busch	160 days
El Rosal Lloreta	175 days
Kupini II	130 days

Kupini—already had a conventional water supply. Hence, the pilot was limited to adding a condominial sewerage service. Elsewhere, condominial water and sewerage systems were simultaneously provided. The only exception is Jichusirca, where only water was provided.

Condominial approach

The EAPP incorporated a number of different innovative components. Many of these components are mutually reinforcing and formed part of an integrated concept in the El Alto project. Nonetheless, both in principle as in practice, it is possible to apply these components independently of each other. Hence, for analytical purposes it proves convenient to provide an independent evaluation of each.

- Engineering design component: This refers to a modification of conventional design so that networks are routed along sidewalks or private yards, rather than down the middle of roads. This allows for savings to be made in the length, depth and diameter of pipes. If this approach is implemented directly by the utility, without the community participation component, then networks must generally be confined to sidewalks to facilitate access during construction and subsequent access for maintenance. However, for topographical reasons, it may not always be feasible to confine the networks to the sidewalks. To the extent that the network has to cross through private yards, community participation becomes indispensable because of the problems of access.

- Community participation component: This means that the responsibility for constructing and maintaining the branches ('ramales') of the condominial network is entirely delegated to the community. The operator employs a team of social workers to engage with the community and to train them for these activities. Community involvement helps to improve the acceptability of the infrastructure, promoting network connections, and provides an entry point for imparting hygiene education. Moreover, since the labor is provided free of charge, the financial costs of doing the works is reduced. However, against this must be set the additional cost of the social workers required to facilitate this process. Within topographical constraints, the community are allowed to choose whether the condominial network should pass along the sidewalk or through their private yards. It is important to note that, community participation does not necessarily entail routing through private yards, however routing

Table 2-4 Characteristics of pilot by neighborhoods

	Water Service		Sewerage Service	
	Before	**After**	**Before**	**After**
Phase One				
Huayna Potosí	Conventional		Nothing	Condominial
Villa Ingenio (D-II)	Nothing	Condominial	Nothing	Condominial
Caja Ferroviaria	Nothing	Condominial	Nothing	Condominial
San Juan de Río Seco	Mixed*	Mixed**	Nothing	Condominial
Oro Negro	Conventional		Nothing	Condominial
Jichusirca	Nothing	Condominial	Nothing	
Phase Two				
Villa Ingenio (UV-4)	Nothing	Condominial	Nothing	Condominial
El Ingenio	Nothing	Condominial	Nothing	Condominial
Germán Busch	Nothing	Condominial	Nothing	Condominial
El Rosal Lloejeta	Nothing	Condominial	Nothing	Condominial
Kupini II	Conventional		Nothing	Condominial

*Some households had no water and others had conventional water connections.
** Those with conventional connections retained them and the others obtained condominial connections.

through private yards necessarily entails community participation (Table 2-5). In the case of EAPP only the neighborhoods of Huayna Potosí and Villa Ingenio (and partially Caja Ferroviaria) have used yard routings of the condominial branches. In all other neighborhoods, the branches were routed across the sidewalks.

- Hygiene education component: The process of community engagement needed for the construction of condominial networks can also be used to enter into a wider dialogue about water use. The nature of this dialogue is likely to vary with the context. In the case of El Alto, a key issue was the very low awareness of hygiene issues and limited exposure to modern sanitation facilities. Hence, considerable emphasis was placed on teaching households about the connection between water and health, and providing them with moral and technical support for the construction of their own bathrooms and other household facilities such as kitchen and laundry sinks. The education also attempted to discourage undesirable practices, such as disposing of waste water into the streets, or recycling it within the household.

- Micro-credit facility: This refers to the incorporation of a micro-credit facility for the construction of bathrooms. The micro-credit was seen as a valuable complement to the hygiene education, since there is little point in encouraging households to build bathrooms if they cannot afford to do so.

Table 2-5 Possible permutations

Network Routing	With Community Participation	Without Community Participation
Public sidewalks	Possible	Possible
Private yards	Possible	Impossible

Table 2-6 Permutations of the condominial approach by neighborhood

	Engineering	Participation	Education	Credit
Phase One				
Huayna Potosí	✓	✓	✓	✓
Villa Ingenio (D-II)	✓	✓	✓	✓
Caja Ferroviaria	✓	✓	✓	
San Juan de Río Seco	✓	✓	✓	
Oro Negro	✓	✓	✓	
Jichusirca	✓	✓		
Phase Two				
Villa Ingenio (UV-4)	✓			
El Ingenio	✓	✓		
Germán Busch	✓	✓		
El Rosal Lloreta	✓			
Kupini II	✓			

These four components are conceptually distinct and can be packaged in a variety of different ways. What is commonly referred to in the literature as the condominial model combines the engineering component with the community participation component. However, it is also possible to apply the engineering approach in isolation of the other interventions, while hygiene education and micro-credit facilities can readily be incorporated into a program involving community participation.

Under the EAPP, different combinations of these four components were tried in different neighborhoods (Table 2-6). During Phase One, a comprehensive approach was taken. All project sites included a community participation component[2], and educational activities in support of bathroom construction were conducted everywhere except Jichusirca, where they were not relevant owing to the absence of sewerage service. In addition, a micro-credit line was provided for households in the first two pilot sites at Huayna Potosí and Villa Ingenio.

Since the inception of Phase Two, the approach has changed considerably. Most of the Phase Two sites have limited themselves to the engineering component[3]. Only in El Ingenio and Germán Busch has community participation been applied. The educational component has also largely been cut back. The reason for this was that the government's own social investment fund (FNDR) is introducing a program to provide free bathrooms to households in El Alto, making the educational component as conceived in Phase One somewhat redundant.

3. Evaluation Methodology

This section outlines the evaluation methodology that will be used in this study. It begins by establishing the conventional system as the benchmark against which the relative costs and benefits of the condominial system will be measured. The section goes on to define the various perspectives from which the evaluation can be performed, and explains the relevance of each to the current exercise.

Condominial versus conventional

In order to evaluate an intervention such as the EAPP it is necessary to have a clear counterfactual, that is, to establish what alternative system the condominial system is being compared against. In the context of El Alto, the relevant counterfactual is clearly the conventional water and sewerage system, since AISA was contractually obliged to connect the households in the project area and would have done so using conventional technologies had the EAPP not been undertaken.

The evaluation will therefore concentrate on a comparison of the costs and benefits of condominial versus conventional technologies for water and sewerage provision. The implication of this is that it is only necessary to focus on those costs and benefits that differ between the two systems. To this end, Table 3-1 highlights those areas where differences arise between the two systems, and also indicates how these differences vary according to the four components of the condominial approach identified in the preceding section.

In many respects, the two systems are quite similar. For example, the costs of water and sewage treatment, as well as the costs of billing and administration, are essentially the same across the two systems and hence need not be considered in the evaluation. Similarly, on the benefits side of the equation, the environmental impact of the two systems is very similar since this depends on the level of sewage treatment applied which is not contingent on the nature of the upstream distribution network.

However, key differences do arise in three areas:

- The first key difference is the cost of water and sewerage distribution networks. Relative to the conventional approach, costs are reduced by applying the condominial engineering design to the distribution network. Further cost reductions are achieved by means of community participation, because the beneficiaries supply their own labor for the construction of the condominial branches. Moreover, when it comes to operating costs of the distribution network, the condominial system reduces costs

Table 3-1 Comparison between conventional projects and EAPP

	EAPP				Conventional
	Engineering	Participation	Education	Credit	
Costs					
Capital expenditure					
(a) Water / sewage treatment	No Difference				
(b) Water / sewerage distribution network	Medium	Low	Low	Low	High
Operating and maintenance costs					
(a) Billing and administration	No Difference				
(b) Water / sewage treatment	No Difference				
(c) Water / sewerage distribution network	High	Low	Low	Low	High
Social intermediation	Low	Medium	High	High	Low
Benefits					
Consumption impact	Low	Low	High	High	Low
Environmental impact	No Difference				

to the extent that there is community participation in the maintenance of the condominial branches.

- The second area where the two systems differ is the cost of social intermediation. Significant costs of social intermediation only begin to be incurred when community participation is introduced. These increase further if a component of hygiene education (and possibly micro-credit) is introduced. The important point to note is that the variations with the lowest engineering costs also tend to be those with the highest costs of social intermediation. Hence, a trade-off is introduced and the key question becomes whether the additional social intermediation required to organize community participation is justified by the associated reduction in the costs of constructing and operating the network.

- The third key difference between the two systems is the impact on household water consumption. Where hygiene education (and possibly micro-credit facilities) are introduced into the condominial package, it becomes possible to have an impact on the construction of bathrooms and other household water installations, which in turn affects household water consumption. This has both social payoffs in the form of improved hygiene and financial payoffs in the form of higher utility revenues. However, as before, the permutations with the highest consumption impact are also those with the highest costs of social intermediation. Once again, an important trade-off is introduced, namely whether the higher costs of social intervention are justified in terms of the higher resulting levels of water consumption.

The evaluation exercise will therefore focus on two aspects.

- The *cost differences* that arise between the conventional and condominial systems in terms of network expansion and social intermediation.
- The *consumption differential* that exists between the conventional and condominial systems as a result of hygiene education activities.

As far as possible, the cost and consumption impacts of each of the four different components of the condominial approach—engineering design, community participation, hygiene education and micro-credit—will be separately identified. *All costs and benefits will be measured relative to the conventional baseline.*

Different analytical perspectives

The costs and benefits of the condominial system can be assessed from a variety of perspectives: that of the utility, that of the water consumer, and finally the social perspective.

Utility's perspective

In order to simplify, it is assumed that the private operator is primarily concerned with profit maximization, or at the very least breaking even subject to the constraints placed by its contractual obligations. From this perspective, the key issue is the relative profitability of the conventional and condominial systems, and hence the differing cost and revenue streams which they generate.

In theory—if the tariff structure perfectly reflected the differing costs of service provision under the two systems—the profit margin on water consumed from either type of connection would be identical and the utility would be indifferent between the two technologies, except in so far as the overall level of water consumption was greater under one system than the other. The profit impact of selecting the condominial over the conventional system would then simply be equal to the profit margin on each unit of water sold multiplied by the consumption differential.

Although a definitive analysis of the full cost and tariff structure of the utility lies beyond the scope of the present study, there are a number of reasons to think that current tariff structure may not be very closely aligned with the structure of costs, even for conventional systems.

- First, it is not clear how the current connection charges mandated by the concession contract relate to the actual cost of making connections The charges established in the concession contract of US$155 and US$180 for water and sewerage respectively, fall substantially short of the average connection costs of US$229 and US$276 reported by the utility. However, this does not necessarily mean that the utility is not covering the costs of network expansion since these may be partially recovered from the general use of service tariff.

- Second, the tariff structure does not incorporate a fixed charge to cover the administrative costs of meter reading and billing. According to AISA, these costs amount to approximately US$1 per month. Given that the charge for the first cubic meters of water consumption is US$0.22, the implication is that households which consume less than five cubic meters per month do not even generate enough revenue to cover billing costs (Table 3-2).

- Third, the rising block tariff structure is such that households with low levels of water consumption are not profitable to serve. The exact breakeven level of consumption depends on the true cost per cubic meter of water and sewerage services, a number that is not currently known. However, there is little doubt that it must be higher than the rate for the first band of domestic consumption which currently stands at US$0.22. For example, the tariff study undertaken immediately prior to privatization estimated an average cost for the water service of US$0.56 (Uzin, 1996). If this were the true average cost of water, a domestic customer would have to consume more than 350 cubic meters of water per month before the revenue generated would cover the cost of providing the service. Clearly, one would expect the average cost of water (and hence the breakeven level of water consumption) to have fallen as a result of the efficiency gains produced by the privatization process. However, the exact extent of these efficiency gains is not known at this point.

- Fourth, there is no separate tariff for the sewerage service. That is to say that there is a unified tariff that is supposed to cover the cost of both services, and which is paid by all customers regardless of whether they receive the sewerage service. The implication of this is that as the number of sewerage connections expands the utility's costs increase without any concomitant growth in revenues. The average cost of water of US$0.56 reported above relates to the water service only. If the (unknown) costs of the sewerage service were added in, the breakeven consumption level would increase further.

- Finally, since condominial systems were not contemplated under the original concession contract their existence is not reflected in the original tariff structure. A differentiated connection charge has now been introduced so that customers connected under the condominial system enjoy a price reduction to reflect the lower costs of the system. However, there is at present no differentiation in the use of service tariff paid by condominial customers who take responsibility for maintaining their own network branches.

For all of these reasons, the profit margins on the two types of connections are not necessarily the same, and may not even be positive. Hence, in order to assess the profit impact of the technology choice it is necessary to take costs and revenues fully into account.

To summarize, the net benefits to the utility (*NBU*) of the condominial system (*D*) are equal to the difference in the profit margin of the two technologies—where the profit margin is defined as the difference between the connection charge (*CC*) and the corresponding costs of connection (*C*)—plus the profit margin on the additional revenues (*P*) generated as a result of higher consumption under the condominial system. The exact costs and revenues generated by the condominial system will, of course, depend on the exact variant of the approach that is used. In particular, community participation and hygiene education components will tend to have higher associated costs but could be expected to lead to higher service revenues.

$$NBU_D = (CC_D - C_D) - (CC_V - C_V) + (P_D - P_V)$$

Consumer's perspective

The consumer's perspective differs from that of the utility in three key respects.

- First, the consumer perceives the financial cost of materials and labor through the utility's service charges. To the extent that tariff structures may not be perfectly aligned with cost structures, as noted above, the consumer's perception of these costs may differ from that of the utility. Given the difficulties with the current tariff structure identified above, the evaluation will be conducted using two parallel scenarios. The first will reflect current reality and using the existing tariff structure. The second will reflect an ideal case and assume that tariffs perfectly reflect costs.

Table 3-2 Tariff structure for AISA

Consumption category (m^3/month)			Tariff
Domestic	Commercial	Industrial	(US$/$m^3$)
1-30			0.22
31-150			0.44
151-300	1-20		0.66
>301	>21	>1	1.18

- Second, the condominial approach is intensive in the use of a household's time. Households contribute their time and labor not only for the construction of the condominial branches, but also through their attendance of the workshops and community gatherings that form part of the condominial process. No financial cost is incurred since the utility does not pay households for their participation. However, unless household members are completely idle, there is likely to be an opportunity cost to their time which should be taken into account from an economic perspective.

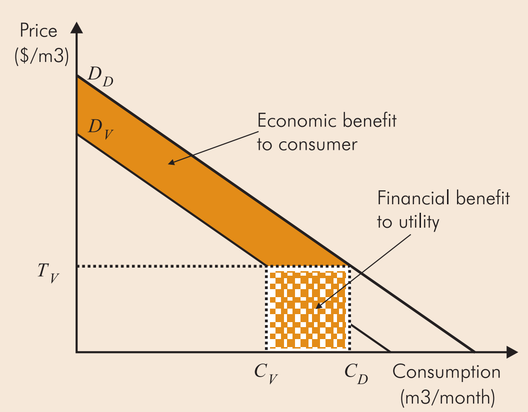
The question of what rate to use to value household time is a difficult and controversial one. One approach is to value the household's time according to the market cost of hiring somebody to perform the same activity. For example, to value the cost of a household's time in constructing the condominial branches at the wage that is paid to a construction laborer; a rate of US$6 per day. However, this is probably not the correct approach in this context. The reason is that the rate used should reflect the value of a household's time *to the household itself*. Hence, this rate would only be appropriate if the household would have been able to use the time dedicated to the condominial project to undertake activities generating US$6 per day.

For a number of reasons, it seems unlikely that this would be the case. First, the minimum wage in Bolivia is US$2.50 per day. Second, the average per capita earnings for workers living in El Alto is US$4.14 per day[4]. Third, the household members participating in the condominial project would not necessarily be the income earners. Anecdotal evidence gathered from site visits suggests that women played an important role in the construction works. A number of women remarked that this was because their husbands would have had to sacrifice wages if they had taken time off work. The opportunity cost of time for those who are not working, is much harder to gauge since it depends on the nature of the household activities they perform. For the purposes of the analysis, the minimum wage of US$2.50 per day will be used as an indicative value of household time.

- Third, the impact of increased water consumption is measured not by the additional revenues to the utility but rather by the increase in consumer surplus; which represents the welfare a household obtains from consuming water over and above the price it pays.

The difference between these two concepts can be illustrated graphically in Figure 3-1, where the line D_V represents household demand for water under the conventional system. A condominial approach incorporating hygiene education or promotion of bathroom construction will increase household preferences for water consumption leading to higher consumption of water at all prices, and an outward shift of the demand curve to the higher line D_D. Within this framework, the hatched square area represents the increased financial revenues to the water utility of which a small component will be the profit margin, whereas the solid trapezium shaped area represents the higher consumer surplus obtained by the household. It is important to note that the change in consumer surplus may be larger or smaller than the increase in utility revenues depending on the specific parameters of the demand curve. However, the two are unlikely to be the same.

Figure 3-1 Difference between economic and financial benefits



To summarize, the net benefits to the consumer (*NBC*) of the condominial system (*D*) are equal to the associated savings in the connection charge (*CC*), minus the opportunity cost of time (*OC*) devoted to the condominial process, plus the greater consumer surplus (*CS*) resulting from higher levels of consumption. Once again, it is important to note that the extent of these benefits will depend on the exact form of the condominial approach that is adopted. For example, when the engineering component alone is applied, the only impact will be the reduction in connection charge. When the community participation component is applied the connection charge differential will increase but the opportunity cost of time will also come into play. Finally, when hygiene education activities are conducted, a change in the consumer surplus can additionally be expected.

$$NBC_D = (CC_V - CC_D) - OC_D + (CS_D - CS_V)$$

Social perspective

The social perspective is the most holistic, taking costs and benefits to both utility and customer into account. Thus the net benefits to society (*NBS*) of the condominial system (*D*) are simply the sum of the net benefits to the utility and the consumer. The connection charges drop out of this equation since what is a cost to the consumer is a benefit to the utility. Hence, from a social perspective what matters is the underlying investment cost differential between the two systems (*C*), taking into account the opportunity cost of time absorbed by community participation (*OC*). To this must be added the additional profits (*R*) accruing to the utility from additional water consumption and the additional consumer surplus (*CS*) experienced by the consumer from the same.

$$NBS_D = (C_V - C_D - OC_D) + (R_D - R_V) + (CS_D - CS_V)$$

Comparison

Finally, for the purposes of clarity, the key differences between the evaluation methodology from the three different perspectives are summarized in the table. Essentially, the utility's perspective considers financial costs, connection charges and subsequent profits from higher revenues. The consumer's perspective considers connection charges, the opportunity cost of time and subsequent increases in consumer surplus. While, the social perspective considers financial and opportunity costs and both additional profits and gains in consumer surplus.

Table 3-3 Comparison between analytical perspectives

	Utility	Consumer	Social
Cost of distribution networks			
Financial costs of materials and labor	✓	×	✓
Utility connection and service charges	✓	✓	×
Opportunity cost of household time in construction works	×	✓	✓
Benefits of water consumption			
Profits accruing to the utility	✓	×	✓
Consumer surplus	×	✓	✓

4. Cost Differentials

This section presents an estimate of the cost savings of condominial systems relative to conventional ones, considering both financial costs and economic costs (such as the value of time). Separate treatment is given to network costs and the costs of social intermediation. Under each heading, the financial and economic perspectives are separately considered.

Financial costs

Network costs

Investment costs

The financial costs of the network expansion can be broken down into two components; labor and materials.

- First, even when the condominial branches are constructed by the community, labor must still be contracted to undertake the upstream network extension and reinforcement. The costing of this component is straightforward because the figures can be taken directly from the contract invoices and the corresponding payment records in the utility's database.

- Second, materials are needed to complete both the condominial branches and the upstream extensions. In both cases, materials are provided from the utility's storage depot. Physical withdrawals from the depot are registered on a corresponding materials balance sheet. However, this documentation is not always complete. Furthermore, the unit cost for each type of material will depend on when it was purchased by the utility which may have been some time before the construction works. For both of these reasons, the values taken for the cost of materials are based largely on estimates that were undertaken by staff at the water utility and members of the WSP consultant team. Since these estimates were independently performed they are not identical, but are broadly consistent in most cases.

The average financial costs per water and sewerage connection for each pilot site are presented in the figures below (supporting tables can be found in the Annex). For Phase One, where two sets of cost estimates are available the uncertainty range between the two estimates is shown as a 'fuzzy' area in the figures. For Phase Two, only the utility's cost estimates are available and thus a single point estimate is given. Unfortunately, cost estimates are not available for all of the Phase Two sites, and in particular for those neighborhoods where the condominial approach was applied without community participation. The reason is that these projects incorporated lengthy sewerage outfalls whose cost could not be fully separated out in order to produce cost estimates comparable to those presented for other sites[5]. Finally, the Germán Busch pilot was still in progress at the time when the research for this study was carried out, hence the numbers given represent budgetary estimates as opposed to outturn costs.

It is important to note that all figures are expressed as cost per *connection*, as opposed to cost per *plot*. In all the project neighborhoods the rate of connection to the new network was less than 100%. This is largely due to the fact that on average only 80% of the plots in any given neighborhood were occupied full-time. The remaining 20% consist of undeveloped plots, or plots that are only occupied for part of the year. The overall connection rate was 75%, however among fully occupied plots the rate rises to 97%. Furthermore, the connection rates achieved by the EAPP for the water service (35%-80%) tend to be lower than for sewerage (70%-100%) reflecting the fact that some households already had prior access to piped water. These uncon-

Figure 4-1 Financial cost comparison for sewerage service

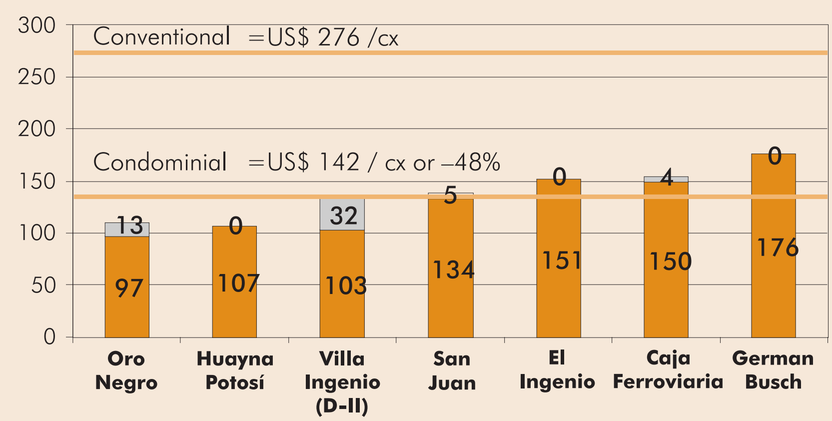
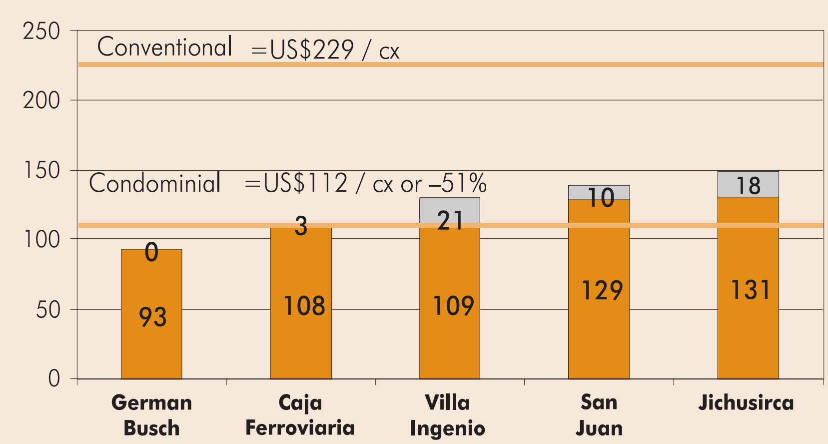


Figure 4-2 Financial cost comparison for water service



nected lots clearly added to the cost of network expansion, but did not result in an immediate connection. The costs per plot follow the same general pattern as the costs per connection, but on average are 33% higher given that 75% of households connect.

The cost estimates presented below are based on the assumption that the same proportion of households connect to the network regardless of whether a conventional or condominial system is provided. However, there is some evidence that connection rates may be higher in condominial than conventional systems, perhaps owing to the greater involvement and ownership experienced by the community. For example, in 3 de Mayo (a control neighborhood recently connected to the conventional sewerage network) only 66% of households made a connection (Cannelli, 2001), compared to an average of 75% across the condominial neighborhoods. To the extent that such a difference exists, the costs per connection given for conventional sewerage would tend to be understated and hence the cost savings of the condominial approach would also be understated.

It was not straightforward to come-up with unit cost figures for conventional sewerage against which to compare the costs of the condominial systems. There has been only one conventional sewerage project in El Alto, in a neighborhood known as Brasil. This project resulted in a cost of US$240 per connection. However, it was based on the use of cement pipes which are considerably less expensive than the PVC pipes used in the EAPP sites and hence as a point of comparison it is too low. Moreover, the fact that it is a single site cost estimate as opposed to an average of several sites does not make it an ideal reference point, since it may be distorted by site-specific idiosyncrasies. AISA has also done five conventional sewerage projects in low income neighborhoods in La Paz, that perch on the steep cliffs or 'laderas' surrounding the city. The average cost per conventional sewerage connection for these neighborhoods has been in the range US$265 to US$410, with an average of US$310[6]. However, the topographical conditions of the 'laderas' are very different to those found in El Alto and hence these sites do not provide an appropriate point of comparison with the EAPP sites.

In conclusion, historic experience with conventional sewerage projects in La Paz and El Alto does not appear to provide the necessary cost comparator for the EAPP sites. All that can reliably be deduced from this experience is that the cost per connection for conventional sewerage in El Alto would probably lie somewhere in the range US$240 to US$310. Therefore the approach adopted was to take as a reference point the average estimated connection cost of conventional sewerage for those Phase One neighborhoods where detailed cost estimates had been undertaken. This led to an estimated cost per conventional sewerage connection of US$276, which—in fact—turns out to be consistent with the range defined above.

In the case of water, conventional services have been provided in three neighborhoods in El Alto, with connection costs ranging from US$140 to US$216, and an overall average of US$194. This average is similar, but slightly lower than, the average of US$229 obtained from the Phase One EAPP neighborhoods where conventional water service cost estimates were made. For the sake of consistency with the method used for the sewerage service, this second number is used in making the cost comparisons reported in the figures below.

The main results are as follows.

- For sewerage services, the average cost per connection with community participation is US$142, with a range from US$107 to US$176 depending on the neighborhood. The range of uncertainty in Phase One cost estimates is small in relation with the variations in unit costs across project sites. Overall, this represents an average cost saving of US$134 (or 48%) on the corresponding cost of a conventional sewerage connection which stands at US$276.

- For water services, the general pattern of results is very similar. The average cost per connection is US$112, with a range from US$93 to US$149 depending on the neighborhood. Once again, the uncertainty ranges in Phase One estimates are small in relation to the unit cost variations across pilot neighborhoods. These results suggest an average reduction of US$117, equivalent to 51% of the cost of a conventional water connection which stands at US$229.

In summary, the overall pattern of results is that the condominial approach approximately halves the financial costs of network expansion for both water and sewerage systems when the community participates in the construction process. These savings are broadly consistent with those reported for condominial systems in Brazil. For example, Bakalian *et al*. (1988) find cost savings of around 40% for sewerage in Brazil. While, a recent survey of 10 years of experience with condominial sewers in Brasilia, concluded that cost savings had been of the order of 40%-50% (Luduvice *et al*., 2001). Larger savings have been reported in some cases; such as the city of Petrolina where reductions of 60%-80% have been reported (Watson, 1994).

Figure 4-3 Breakdown of cost savings for sewerage service

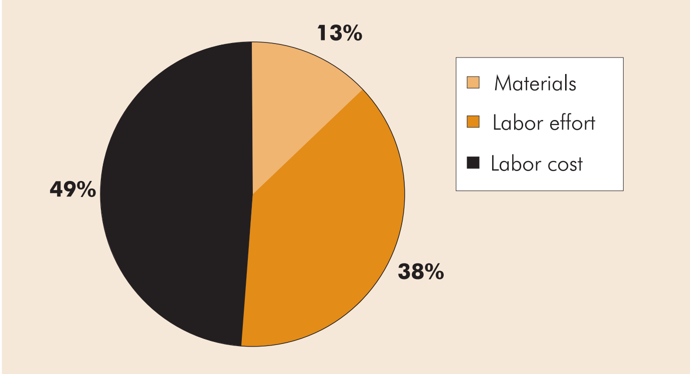
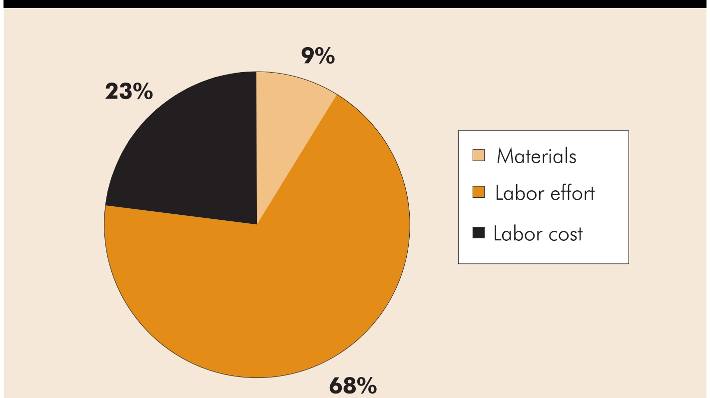


Figure 4-4 Breakdown of cost savings for water service



Breakdown of cost savings

The cost savings observed with the condominial model potentially come from three different sources. First, the savings in the cost of materials as a result of the shorter length and narrower diameter of the pipes. Second, the savings in labor effort resulting from the shorter and shallower trenches that can be used in the condominial case. Third, the savings in labor costs that arise from community participation. The first two of these are available when the condominial approach is applied without community participation, whereas the third is directly attributable to the community's volunteer labor.

By breaking down the cost savings experienced in the EAPP neighborhoods, it is possible to quantify the relative importance of these three factors (Figures 4-3 and 4-4). The main results are as follows.

- Materials savings are relatively modest, accounting for only 10% of the overall cost reduction. There are two explanations for this. First, materials account for less than half of the total costs of conventional systems (36% for sewerage and 47% for water). Second, the physical savings made in the length and diameter of pipes are comparatively small; of the order of 10%-20%.

- Conversely, labor savings account for around 90% of the total cost reduction. As before, this reflects the fact that labor represents a higher share of the total costs of conventional systems (64% for sewerage and 53% for water). Moreover, the physical savings in the volume of soil to be excavated are substantial, at 45% for water and 75% for sewerage.

- The breakdown of labor savings between labor effort and labor cost varies substantially across services. Labor cost savings dominate for the sewerage service, while labor effort savings dominate for the water service.

From these results, it is possible to infer that the condominial design applied without community participation would have led to cost savings of 24% for the sewerage service and 40% for the water service. These results are consistent with recent estimates reported by Aguas del Illimani for a new project site in El Alto called Mallasilla. The Mallasilla cost estimates suggest savings of 22% for the condominial approach without community participation, as against 42% with community participation. They are also consistent with evidence from CAESB, the water utility of Brasilia, which reports cost savings of the order of 20% for sewerage systems without community participation (Neder, 2001).

Impact of connection rates

The cost savings estimated above are based on the implicit assumption that the proportion of households connecting to a sewerage network will be the same regardless of whether a conventional or condominial approach is adopted. There is some evidence to suggest that this may not be the case. Neighborhoods that formed part of the EAPP achieved an average sewerage connection rate of 75%, whereas in a control neighborhood (3 de Mayo) the sewerage connection rate was 66%. The fact that there was only a single control neighborhood makes it difficult to know how much weight to attach to this result. However, if the effect of this differential in connection rates is factored into the calculation of cost savings, the overall cost saving from condominial sewerage increases from around 40% to 45%.

Operating and maintenance costs

In theory, the condominial system with community participation should also have the effect of reducing the operating and maintenance costs of the sewerage network. However, in practice this is very difficult to quantify. One reason for this is simply the difficulty of disaggregating company cost data to the level required to identify differences in maintenance costs over relatively small segments of the network. A second reason is the nature of maintenance activities. Particularly in the case of sewerage, maintenance on the finer branches of the distribution network tends to be reactive and consequently infrequent. It would therefore be necessary to track highly disaggregated cost data over a fairly long period of time in order to be able to identify such differences.

In the case of El Alto, both problems are pertinent. On the one hand, historically there has not been separate accounting between water and sewerage systems in La Paz and El Alto, let alone disaggregated information for the sewerage service. AISA is required to introduce separate water and sewerage accounting under the terms of the concession, however more disaggregated information is not yet available. On the other hand, the very recent arrival of the condominial system in El Alto means that insufficient time has accumulated to be able to establish the long term average annual maintenance costs.

Unfortunately, the literature on the Brazilian experience is not very conclusive on this subject. Bakalian *et al*. (1988) were unable to obtain any data to document the maintenance cost differential. Watson (1994) reports some maintenance data for the city of Petrolina, which shows that the maintenance cost saving to the utility when customers maintain their own sewers is less than 10%. Watson also reports that while tariff reductions of around 50% are typical for condominial neighborhoods in Brazil, this is an 'ad hoc' reduction that is not based on a scientific comparison of maintenance costs. For the case of Brasilia, Luduvice *et al*. (2001) report that the number of maintenance visits per kilometer of sewer per month is similar between condominial and conventional systems, but that the cost per maintenance visit is substantially higher for conventional systems. Overall, they find that maintenance costs are around 70% lower for condominial systems. The current practice in Brasilia is for condominial customers to receive a discount of around 40% on their sewerage bills relative to conventional customers.

Costs of social intermediation

The preceding discussion considered only the cost of network expansion. However, the condominial system also entails significant costs in social intermediation, which need to be taken into account in estimating the full financial cost.

The social work required for the condominial method was contracted out during Phases One and Two of the project (Table 4-1). The first contract, relating to the neighborhoods of Huayna Potosí and Villa Ingenio, was awarded to an NGO: CIEC. Owing to the high costs of the services provided by CIEC, the remainder of the Phase One neighborhoods were contracted to ESUE, a private company formed by a number of social workers previously employed by CIEC who had participated in the original pilots. ESUE was also awarded the contract for the Phase Two neighborhood, El Ingenio. However, in the case of Germán Busch, AISA preferred to enter into individual contracts with four social workers who were former employees of ESUE, and hence had experience from earlier pilot neighborhoods. As regards the future, AISA has decided that from henceforth it will use its own in-house staff for the social intermediation activities.

The costs of social intermediation can be divided into two categories. On the one hand, there is the cost of the contracted social workers. On the other hand, the cost of the WSP (Phase One) or AISA (Phase Two onwards) staff responsible for supervising the work of the contractors must also be taken into account.

Table 4-2 summarizes the evidence regarding the costs of the contracted social workers. The comparison between neighborhoods is complicated by various factors.

Table 4-1 Contracting of social work

Contractor	Value	Projets Covered
CIEC	US$65,072	Huayna Potosí Villa Ingenio D-II
ESUE	US$71,000	Caja Ferroviaria San Juan de Río Seco Oro Negro Jichusirca
ESUE	US$21,000	El Ingenio
Individual	US$7,897	Germán Busch

Table 4-2 Costs of social intermediation

	Man-days per connection	Cost per man-day US$	Cost per connection US$
Phase One			
Water only			
- Jichusirca	0.7	19	14
Sewerage only			
- Huayna Potosí	11.9	28	334
- Oro Negro	1.4	19	28
Water and sewerage			
- Villa Ingenio D-II	2.4	28	68
- Caja Ferroviaria	2.9	19	55
- San Juan de Río Seco	1.6	19	32
Phase Two			
Water and sewerage			
- El Ingenio U-IV	0.9	19	17
- Germán Busch	0.6	19	12

- First, there is a learning effect which implies that the first neighborhood to be covered (Huayna Potosí) has a very high number of man-days of social intermediation per connection (11.9).
- Second, the man-days of social intermediation per connection also vary according to whether water, sewerage, or both services were being provided to the community.
- Third, the cost per man-day in the first contract (awarded to CIEC for Huayna Potosí and Villa Ingenio) at US$28 per man-day is substantially higher than the cost of US$19 per man-day found in subsequent contracts.
- Fourth, the social intermediation conducted under Phase One had a strong hygiene education component. This activity was substantially scaled down in Phase Two, due to the fact that the Bolivian government began to provide subsidies to households in El Alto to construct their own bathrooms.

Taking all of these factors into consideration, the following conclusions appear to emerge from Table 4-2. Under Phase One, the average number of man-days per connection after the learning experience of Huayna Potosí, is 2.3. Taking the lower rate of US$19 as the cost per man-day, this works out at US$44 per household connected to both water and sewerage services. The costs for connections to a single service are substantially lower. Namely, US$13 per connection for water (based on Jichusirca) and US$26 per connection for sewerage (based on Oro Negro). The cost per sewerage connection is about twice as high as per water connection. This cost differential is largely attributable to the fact that households receiving sewerage received additional support from social workers in order to help them to construct bathrooms. From this it may be inferred that the 'bathroom support' component cost around US$13 per household.

The costs of social intermediation under Phase Two, at an average US$15 per household connected to both water and sewerage services, are almost a third of the costs registered under Phase One. These differences are due to number of factors, including learning effects, a more cost-conscious approach to supervision by AISA, and a substantial reduction in the scope of the social work due to the exclusion of the bathroom support component.

For the purposes of this evaluation exercise the US$15 cost will be used because it embodies the full learning effects accumulated during the various pilots. This value averaged across the two services works out at about US$8 per household per service. Given the absence of Phase Two experience with hygiene education, the Phase One estimate of US$13 per household will have to be used, even though it seems likely that this cost would have reduced somewhat in Phase Two as efficiency levels improved.

It is important to note that these costs of social intervention do not take into account the costs of WSP consultants involved in the EAPP, which came to just under US$720,000 over the three year period of the project: 1998-2000. These costs are evidently high in relation to the sum of around US$1 million invested in the physical networks, and particularly in relation to the US$0.7 million that in aggregate was saved as a result of providing condominial rather than conventional sewers.

However, to attempt to allocate these costs to individual connections made in the project would be misleading. Essentially, these represent an investment in the transfer of the condominial know-how from Brazil to Bolivia, entailing the adaptation of the approach to the local context, the training of local professionals in the implementation of the methodology, and a number of monitoring and evaluation and dissemination activities. As can be seen the costs of this transfer are substantial, but they should be amortized across all future condominial connections in Bolivia and not simply those carried out in the EAPP. It is estimated that of the total expenditure under the WSP program 55% corresponds to the adaptation process, 25% to the training process, and 20% to other activities such as monitoring, evaluation and dissemination among others[7] .

Summary of financial costs

Table 4-3 below summarizes the financial costs of conventional versus condominial water and sewerage services. Condominial systems lead to savings in network expansion costs of around 50% for both water and sewerage. The costs of the social intermediation required to engage community participation prove to be modest in relation to the associated cost savings. The overall cost advantage of condominial systems is reduced to around 45% when social intermediation is taken into account.

Economic costs

Network costs

The financial costs reported above are estimated from the perspective of the water utility. In order to move from financial to economic costs it is necessary to shift to the customers perspective. This entails two changes.

- First, it is necessary to incorporate the opportunity cost of the time devoted to the construction of the condominial networks.
- Second, the monetary cost of the connection to the consumer is the connection charge as opposed to the costs reported in the preceding section.

Opportunity cost of time

In order to value the opportunity cost of time for community participation, two different approaches will be used.

- The first is an activity based approach, which was applied to the Phase One sites by the WSP team. The idea is to list the tasks that were performed by the community at each project site and then to scale down the commercial unit cost of these activities by the ratio between the community's value of time (US$2.50 per day as derived above) and the daily wage of a construction worker (US$6 per day as noted above). The results of this approach suggest that the value of community time is about US$12 for a water connection and US$16 for a sewerage connection (Table 4-4).

- The alternative approach is to estimate, based on field observations, the total number of man-days that each beneficiary was putting into the construction of the condominial networks, to which can be applied the daily value of time. The results are US$15 per water connection and US$17 per sewerage connection (Table 4-5).

Given that the two approaches give reasonably consistent values, average values of US$14 per water connection and US$17 per sewerage connection, will be adopted in the subsequent analysis.

Over and above the time contributed for construction of condominial networks, it is estimated that routine maintenance of condominial branches undertaken by households takes approximately 8 hours per month, equivalent to a value of around US$2 (Programa de Agua y Saneamiento, 2001).

Table 4-3 Summary of financial costs (US$)

	Water		Sewerage	
	Conventional	Condominial	Conventional	Condominial
Network expansion	229	112	276	142
Social intermediation	0	8	0	8
Total	229	120	276	150

Table 4-4 Activity based costing (US$)

	Water	Sewerage
Huayna Potosí	–	11
Villa Ingenio (D-II)	16	14
Caja Ferroviaria	8	12
San Juan de Río Seco	6	21
Oro Negro	–	21
Jichusirca	13	–
Average	12	16

Table 4-5 Time based costing

	Water		Sewerage	
	Days	US$	Days	US$
Preparatory work	0.50		0.50	
Digging of trenches	4.00		4.00	
Laying of pipes	0.65		0.65	
Laying of septic chambers	–		0.70	
Refill of trenches	1.00		1.00	
Total	6.15	15.38	6.85	17.13

Connection charges

Connection charges are reported in Table 4-6. Following the experience of Phase One, AISA has introduced a standard differentiated connection charge for condominial water and sewerage services. These currently stand at US$100 for each of the two services, although in practice the water connection charge includes an additional US$36 to cover the cost of the water meter. For the consumer, this represents a saving of US$19 (or 16%) in the case of water and US$80 (or 44%) in the case of sewerage. However, there is no charge reduction for condominial connections undertaken without community participation.

Finally, since these charges are nonetheless high in relation to household income, AISA allows households to pay the connection charge in monthly installments over a two year period. The interest rate applied to these monthly installments is 13% per annum. This is approximately half of the minimum interest rate charged by local micro-finance institutions.

Table 4-6 Connection charges

	Water (US$)	Sewerage (US$)
Original Concession Contract	119*	180
Currently		
Condominial with community participation	100*	100
Condominial without community participation	119*	180
Conventional	119*	180

*For purposes of comparison the US$36 cost of the meter has been excluded.

Table 4-7 Opportunity cost of social intermediation

	Duration (hours)	Attendance (hours)	Value of Time (US$)
Workshops			
Presentation of project	3.00	2.25	
Presentation of network design	6.00	4.50	
Training for construction work	3.00	2.25	
Regulations of condominia	3.00	2.25	
Maintanance techniques	3.00	2.25	
Hygiene habits	3.00	2.25	
Construction of bathrooms	3.00	2.25	
House Visits			
Construction of network	6.00	4.50	
Construction of bathrooms	4.00	3.00	
Total time			
Construction of network	24.00	18.00	4.50
Construction of bathrooms	10.00	7.50	1.88
Overall	34.00	25.50	6.38

Costs of social intermediation

Just as the time devoted by the community to the construction of condominial networks has an opportunity cost, so does the time devoted by the community to participating in the activities relating to the social intermediation process.

Table 4-7 lists all of the different workshops and house visits that are involved in the implementation of the condominial approach together with the estimated duration of each. The figures show that the social intermediation associated with community participation in the construction of condominial networks, can absorb 24 hours per household, over the 3-6 month duration of the project. The inclusion of hygiene education and 'bathroom support' activities add a further 10 hours to the participation of each household. According to household survey data collected by the WSP team, each event was actually attended by around 75% of participating households.

The opportunity cost of this time is valued using the rate of US$2.50 per day (or US$0.25 per hour) established above. On this basis, the overall opportunity cost of social intermediation comes close to US$5 for participation associated with the construction of the network, and US$2 for activities relating to hygiene education and bathroom support. Arguably the opportunity cost of time attaching to social intermediation activities is lower than that relating to the construction of condominial branches. The reason is that workshops and house visits were typically conducted outside of normal working hours, that is to say in the evenings and weekends.

Costs of intra-household investments

In order to be able to benefit from a sewerage connection, households need to construct a bathroom of their own. The bathrooms constructed by households in the project area are typically built from scratch, and involve the construction of an independent out-house containing a toilet, hand basin and electric shower. The level of sophistication of these facilities varies considerably across households. However, the average cost of constructing a bathroom is estimated to be of the order of US$440 (Table 4-8). This overall cost can be broken down into US$400 for materials and about US$40 for labor, which it is assumed will be supplied by the household itself.

This represents a very substantial cost for households in the project area. Indeed, it is about twice as high as the sewerage connection charge and is equivalent to about one month of average household income. In order to ensure that this did not create a financial barrier for households to benefit from the sewerage connection, the project included a micro-credit line to provide loans for bathroom construction.

A second tier bank, FUNDAPRO, offered to provide up to US$500,000 of capital for the micro-credit scheme. Following a bidding process, the retailing of the loans was contracted to Caja Los Andes (CLA), a micro-credit institution with an established brand name in the project area. This was the first time that CLA had offered loans to households specifically for utility services.

CLA was willing to supply loans to households with a good credit history as long as certain basic financial conditions were met. In particular, the value of the loan should not exceed 70% of the household's assets. As a special inducement to households, CLA was willing to consider owner occupied housing as collateral; a departure from its standard procedure of considering only movable assets (such as televisions, furniture, etc.). In addition, the monthly repayment should not exceed 70% of the value of the household's surplus income defined as income minus an estimated living cost of the order of US$20-US$30 per person per month to cover food, basic services, transport, education, health and contingencies.

As a further inducement to households, CLA offered terms of 1.92% interest per month on loans made under the project, which represents a significant discount on their standard rates of 2.50% per month. The implications for monthly repayment charges on typical terms of up to 36 months are illustrated in Table 4-9.

In spite of these preferential terms, the level of participation from households was lower than expected. Some 25% of Phase One households

Table 4-8 Average cost of bathroom construction

	Average Installation Costs (US$)		
	Materials	**Labor***	**Total**
Phase One			
Huayna Potosí	412	40	452
Villa Ingenio (D-II)	284	40	324
Caja Ferroviaria	520	40	560
San Juan de Río Seco	310	40	350
Oro Negro	480	40	520
Jichusirca	–	–	–
Overall	**401**	**40**	**441**

Source: estimates of WSP team members based on non-random sampling of households
*Based on 16 man-days of labor valued at US$2.50 per day.

Table 4-9 Reference table for cost of debt servicing

Principal (US$)	Montly repayment (US$) for a term of				
	12 months	**18 months**	**24 months**	**30 months**	**36 months**
200	18.82	13.25	10.48	8.83	7.75
250	23.52	16.56	13.10	11.04	9.68
300	28.23	19.87	15.72	13.25	11.62
350	32.93	23.18	18.34	15.46	13.56

Source: Caja Los Andes, La Paz, Bolivia.

applied for credit, of which 75% met with the CLA creditworthiness conditions. However, this overall average conceals significant variation between the two Phase One neighborhoods, with more than 50% of households in Huayna Potosí applying for a loan, as against fewer than 20% of households in Villa Ingenio (Table 4-10). Overall, only US$43,000 of the original capital could be placed, less than 10% of the total originally earmarked for the project. Owing to relatively low levels of participation in the Phase One neighborhoods, the micro-credit line was suspended from Phase Two onwards.

The average borrowing household had a monthly income of US$562 (see table and figure). This value is well above the poverty line and extreme poverty lines reported in Table 2-1 above. As reported there, about 60% of the population of El Alto live in poverty and 40% in extreme poverty. By contrast, less than 25% of borrowers live below the poverty line and less than 15%

below the extreme poverty line. The absence of income data for non-borrowing households makes it difficult to draw rigorous conclusions. Nevertheless, these comparisons in combination with the other economic characteristics of participating households (high rates of home ownership and significant surpluses of income over out-goings), suggest that take-up of loans was concentrated disproportionately among non-poor households. This finding is consistent with a recent study of micro-credit institutions in Bolivia, which notes that their clients tend to be people living close to the poverty line as opposed to those living below it (Navajas *et al*., 2000). The same study finds that among Bolivian micro-credit institutions, CLA reaches a lower proportion of the poorest than some of its competitors.

Participating households on average borrowed a principal of US$407, with a term of 32 months. As a result, they incurred monthly repayment charges of US$14.21; equivalent to 6.2% of income or 35.3% of surplus income (after netting out basic living costs). The principal to asset ratio for the average borrowing household was 21.9%. About 86% of households were able to take advantage of the possibility of using their house as collateral. The average value of the dwellings occupied by borrowing households was estimated by CLA to be of the order of US$4,291. However, the value of the collateral that could be raised by non-owner occupiers was substantially lower at US$566[8].

A number of reasons have been advanced to explain the lower than expected take-up of the micro-credit line.

- The first possible explanation relates to the way in which the loans were administered. CLA delegated the marketing of the credit line to the project social workers, who were evidently not

Table 4-10 Take-up of loans by neighborhood

	Huayna Potosí		Villa Ingenio		Total	
	#	%	#	%	#	%
Obtained credit	25	39.7	28	13.0	53	19.1
Refused credit	9	14.3	8	3.7	17	6.1
Managed without	29	46.0	179	83.3	208	74.8
Total	63	100.0	215	100.0	278	100.0

Source: Caja Los Andes, La Paz, Bolivia

Table 4-11 Characteristics of borrowing households

	Income US$	Out-goings US$	Surplus ratio	Home ownership	Value of home US$	Value of other collateral US$
Average	561.87	513.59	16.3%	86.0%	4,290.56	566.38
Quartiles						
- First	158.93	124.49	6.7%	–	1,844.50	439.18
- Second	326.23	298.58	12.6%	–	2,439.18	459.14
- Third	754.34	690.36	23.6%	–	6,469.28	895.42
Range						
- Minimum	78.98	48.07	2.9%	–	1,356.24	302.82
- Maximum	3,458.45	3,278.52	45.3%	–	8,413.27	940.44

Source: Caja Los Andes, La Paz, Bolivia specialists in this field. CLA participation was limited to sending along its own representatives about once per week to process credit applications. The company hypothesizes that higher penetration rates might have been achieved had a dedicated team of company representatives been assigned to the project[9].

- The second possible explanation relates to the preferences of the local people. According to the experience of CLA[10], Aymara people prefer to use any wealth they may accumulate to make investments in real estate or to finance community festivities. They are less inclined to spend money on improving personal comfort levels, for example by constructing a bathroom. Furthermore, given that a bathroom does not yield a direct financial return people may be unwilling to go into debt in order to finance it.

- The third possible explanation relates to the existence of alternative finance mechanisms. The Aymara people often prefer to make use of their own traditional financing mechanisms, such as the 'pasanaco', because these do not entail the explicit payment of interest. The 'pasanaco' is an arrangement whereby a group of people—typically relatives or friends—pay a regular amount into a common fund; every so many months the entire value of the fund falls to one of them for their discretionary use.

- The fourth possible explanation relates to the wider economic and financial conditions in the country at the time of the project. Bolivia was entering an economic downturn at around the time the micro-credit scheme was being advanced, which brought about a fall in household incomes. Furthermore, the country had also just come through a consumer credit crisis caused by aggressive marketing of loans by a number of institutions. Both factors may have made consumers more wary of participating in the credit scheme.

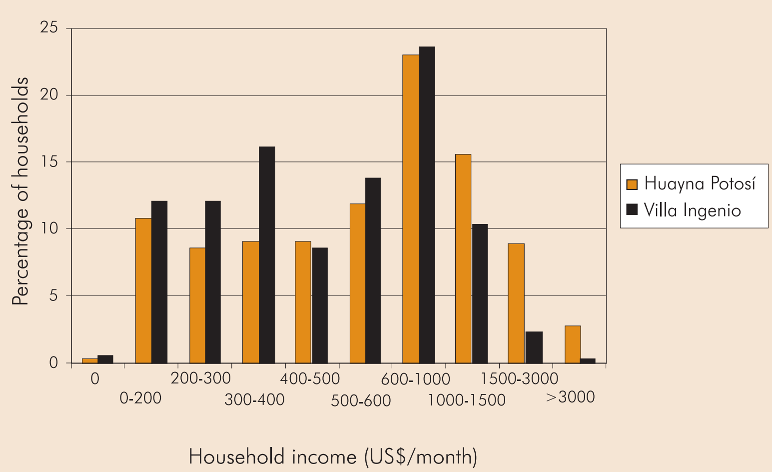
It is not possible to say which of these four factors was the most important factor behind the relatively low rate of take-up for the loans.

Summary of economic costs

Table 4-13 below summarizes the economic costs of conventional versus condominial water and sewerage services. Two separate sets of results are reported.

- The first is based on connection charges as they currently stand, and hence reflects the

Figure 4-5 **Income distribution of households participating in micro-credit scheme**



real experience of households.

- The second is based on connection charges as they would be if they truly reflected the financial costs estimated above.

The first set of results show that, from the consumer's perspective, there is currently no real advantage to taking a condominial water connection. The reason is that the reduction in the connection charge (from US$119 to US$100) is not large enough to offset the opportunity cost of time involved in participation which comes to US$19. On the sewerage side, however, there is a cost advantage of about US$60, equivalent to a reduction of over 30%.

The second set of results show that, when charges are adjusted to cost-reflective levels, condominial water connections do lead to a US$90 saving equivalent to a reduction of around 40%. The saving for condominial sewerage connections is over US$100, again equivalent to a reduction of around 40%.

Finally, at an estimated total of US$443, the time and money costs of bathroom construction are high in relation to those relating to the expansion of the network. When these are factored in, the full cost of the sewerage service under the hygiene education variant rises to US$628.

Table 4-12 Characteristics of credits granted

	Principal (US$)	Term (months)	Repayment (US$)	Principal to asset ratio (%)	Repayment to income ratio (%)	Repayment to surplus ratio (%)
Average	406.84	32	14.21	21.9	6.2	35.3
Quartiles						
- First	305.00	20	10.04	7.6	2.0	24.9
- Second	402.50	28	11.62	14.9	4.2	30.1
- Third	500.00	44	17.80	24.5	8.9	43.1
Range						
- Minimum	100.00	13	6.67	5.3	0.4	5.7
- Maximum	950.00	53	30.77	104.4	24.7	89.7

Source: Caja Los Andes, La Paz, Bolivia

Table 4-13 Summary of economic costs (US$)

	Water		Sewerage	
	Conventional	Condominial	Conventional	Condominial
Actual charges				
- Connection charge	119*	100*	180	100
- Network expansion	0	14	0	17
- Social intermediation	0	5	0	5
Total	119	119	180	122
Cost-reflective charges				
- Connection charge	229	120	276	150
- Network expansion	0	14	0	17
- Social intermediation	0	5	0	5
Total	229	139	276	172

*Excludes US$36 cost of meter.

5. Consumption Differentials

As well as leading to savings in the costs of network expansion and maintenance, the condominial system may also lead to higher levels of water consumption, thereby increasing the revenues of the water utility and the welfare of the water consumer. The consumption effect is thought to come from the hygiene education component of the social intermediation activity, which supported households in the construction of a bathroom and related household installations (such as kitchen sinks). This section first tries to isolate the consumption differential attributable to the condominial approach, and then goes on to value this differential both from the financial and the economic perspectives.

Estimating the consumption differential

The analysis of consumption is based on household survey data collected by the WSP team on the complete sample of beneficiary households from Phase One, plus a 'control' neighborhood in El Alto (3 de Mayo) which receives conventional as opposed to condominial water and sewerage services. The WSP survey collected information on a wide range of household characteristics, including—of particular interest for this purpose—water-related installations within the household. On the basis of the utility's customer code, it was subsequently possible to match individual households in the WSP database with those in AISA's billing database, so that a series of monthly water consumption readings could also be incorporated into the dataset.

There are two stages to the process of determining the consumption differential attributable to the condominial approach.

- First, it is necessary to establish to what extent the inclusion of a hygiene education component in the condominial approach increased the rate of construction of bathrooms and related household installations.
- Second, it is necessary to establish to what extent these bathrooms and related installations increased household water consumption on average.

Impact on household installations

Table 5-1 compares the prevalence of water-related household installations in the EAPP neighborhoods, with that in the control neighborhood (3 de Mayo). Although the coverage of domestic installations varies substantially across condominial neighborhoods, by a range of up to 30%, all condominial neighborhoods have higher rates of coverage of water-using facilities than the households in 3 de Mayo (Figure 5-1). Thus, bathroom construction is on average 35% higher in the condominial neighborhoods than in 3 de Mayo. Moreover, while the only installation that households in 3 de Mayo have is a water closet, a significant proportion of households in the condominial neighborhoods have installed other water-related facilities such as hand basins, showers, kitchen sinks and laundry sinks.

The regression model reported in Table 5-2 aims to uncover some of the factors that might explain the variation in bathroom construction rates across neighborhoods within the condominial pilot. Curiously, the availability of a micro-credit facility does not appear to have had a significant effect on the rate of bathroom construction. However, the following three factors seem to have been important.

- First, when a house is continually, as opposed to occasionally, inhabited the probability of constructing a bathroom increases by 0.55.
- Second, providing water and sewerage service simultaneously raises the probability of bathroom construction by 0.33, as against

Table 5-1 Coverage of water-related installations in households with sewerage

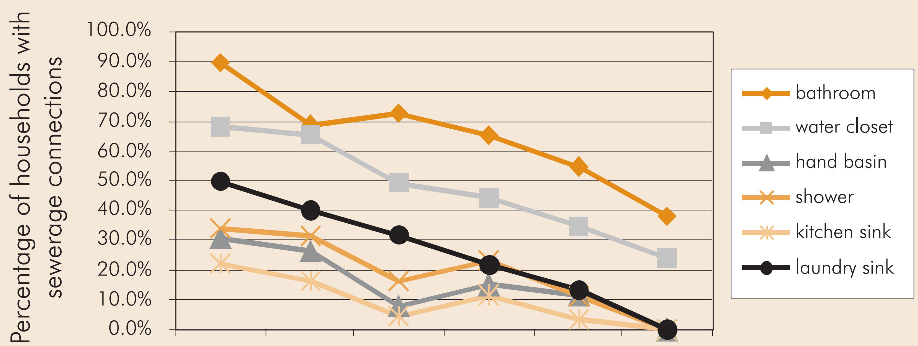
	Condominial Neighborhoods					Averages		
	Huayna Potosí	**Villa Ingenio**	**Caja Ferroviaria**	**San Juan**	**Oro Negro**	**Condominial**	**Conventional (3 de Mayo)**	**Differential**
Bathroom	68.5	72.5	89.2	54.6	65.3	73.2	38.0	+35.2
Installations								
- Water closet	65.2	49.2	68.1	34.9	44.1	52.6	24.0	+28.6
- Hand basin	26.1	8.1	30.7	11.8	15.0	17.8	0.0	+17.8
- Shower	31.5	16.2	34.0	11.2	23.7	23.7	0.0	+23.7
- Kitchen sink	16.3	4.5	22.6	3.3	12.0	12.2	0.0	+12.2
- Laundry sink	40.2	31.7	49.7	13.2	21.9	32.7	0.0	+32.7

Table 5-2 Results of regression model for probability of bathroom construction*

	Coefficient	**Standard error**	**T-statistic**	**Significant at 95% level?**	**Impact on probability of bathroom construction**
Household size	0.03	0.02	1.66	No	–
Always inhabited	1.35	0.15	8.89	Yes	+0.55
Combined water and sewerage	0.81	0.08	10.02	Yes	+0.33
Intensity of social work	0.09	0.02	5.31	Yes	+0.04
Availability of microcredit	-0.11	0.10	-1.09	No	–
Constant	-2.03	0.14	-14.00	No	–
Regression parameters					
Observations	1292				
Log likelihood function	-754.38				
Adjusted R squared	0.15				
Chi-squared statistic (5)	271.55				

*Regression is performed only on those households who have sewerage service.

Figure 5-1 **Prevalence of water related installations in households with sewerage connections**



neighborhoods that had already had the water service for some time before the sewerage service was extended.

- Third, the intensity of social work (measured in terms of days per connection) also had a significant effect. An extra day of social work per connection raises the probability of bathroom construction by 0.04.

In summary, households in condominial neighborhoods raised their chances of constructing a bathroom on average by 35%. The intensity of social work appears to have been an important reason for this. However, it is not the only one. Factors such as the joint provision of water and sewerage services may have had a larger role to play.

Impact on water consumption

The household database indicates that monthly water consumption in El Alto is very low by international standards, with the average household taking 5.91 cubic meters per month, equivalent to just under 40 liters per capita per day. Indeed, almost 50% of households consume less than 5 cubic meters per month (Figure 5-2). To put this in context, an often used international benchmark for subsistence consumption is 120 liters per capita per day (equivalent to 18 cubic meters per month). However, fewer than 3% of households in El Alto consume above this level.

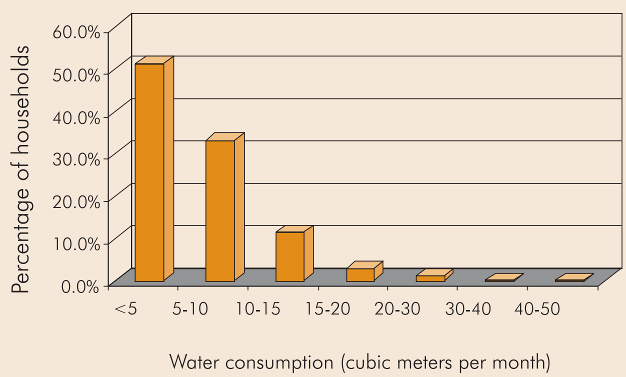
This section considers the extent to which households with bathrooms registered higher water consumption than households without bathrooms. On the basis of the available data, there are two possible ways of capturing this consumption differential.

- *Time series approach*: In the two neighborhoods (Huayna Potosí and Oro Negro) that had had the water service for some time before the sewerage service, it is possible to compare how water consumption *for the same household* changes when sewerage arrives and in particular when a bathroom is installed.
- *Cross-sectional approach*: Elsewhere, water and sewerage services were provided simultaneously, and hence no before and after comparisons are possible. However, since the sample contains a significant number of households which have water services but lack sewerage services, it is possible to make cross-sectional comparisons between the two.

The time-series analysis is reported in Table 5-3. In order to minimize as far as possible the distortion created by short-run seasonal fluctuations, the water consumption variable used for the purposes of comparison is a six month average[11]. That is to say that the average monthly consumption in the six months immediately after the arrival of the sewerage service, is compared with the average monthly consumption for the same six month period during the year preceding the arrival of the sewerage service. In order to isolate the effect of bathroom construction, separate comparisons are undertaken for households with and without bathrooms.

The results indicate that—in both neighborhoods—as might be expected, households that did not construct bathrooms saw no significant change in their water consumption following the arrival of the sewerage service[12]. However, consumption did increase significantly in households that constructed their own bathrooms[13]. In Huayna Potosí, households who constructed bathrooms were consuming on average two cubic meters per month more than they did beforehand, a growth of over 30%. In Oro Negro, the differential is somewhat smaller at 0.6 cubic meters per month, equivalent to growth of 8%.

Figure 5-2 Consumption histogram



Turning to cross-sectional evidence, Table 5-4 illustrates the consumption differentials between households with different installations. Consumption is measured as the monthly average over the period April to August 2000, which was the longest period for which consumption data was consistently available in all of the pilot neighborhoods. The pattern of results is quite consistent with that found in the time-series analysis. The difference in water consumption between households without sewerage and those

Table 5-3 Average consumption before and after sewerage

	Observations	Mean	Standard error	95% confidence interval	
				Lower bound	Upper bound
Huayna Potosí					
(a) Sewerage connections without bathrooms					
Before	21	6.70	0.55	5.56	7.84
After	21	6.60	0.74	5.06	8.14
Difference	21	-0.10	0.69	-1.54	1.35
(b) Sewerage connections with bathrooms					
Before	46	6.57	0.44	5.68	7.46
Afer	46	8.62	0.73	7.15	10.08
Difference	46	2.05	0.57	0.90	3.20
Oro Negro					
(a) Sewerage connections without bathrooms					
Before	173	6.89	0.37	6.16	7.62
After	173	6.79	0.35	6.10	7.47
Difference	173	-0.10	0.26	-0.61	0.41
(b) Sewerage connections with bathrooms					
Before	110	7.40	0.39	6.62	8.17
After	110	8.01	0.45	7.11	8.91
Difference	110	0.61	0.30	0.01	1.21

that have sewerage but have not constructed bathrooms is about one cubic meter per month; but is only just statistically significant[14]. Households with bathrooms, consume on average 1.9 cubic meters per month more than households with sewerage but without bathrooms. The difference is statistically significant[15].

The remainder of Table 5-4, explores the impact of specific sanitary installations on monthly water consumption. Thus, for example, households with a water closet consume on average two cubic meters per month more than households without one. In the case of handbasins, showers, kitchen sinks and laundry sinks, the differential is at least three cubic meters per month. However, these simple averages are misleading because there is a high correlation between households that have water closets and households that have showers and other installations. In order to isolate the contribution of specific sanitary installations, multiple regression techniques are required that control simultaneously for the presence of all of these devices.

To this end, Table 5-5 presents the results of a linear regression model that succeeds in explaining 32% of the variation in average monthly water consumption across households in terms of a range of explanatory variables. There are only two types of variables that appear to have a significant effect. The first type are variables relating to habitation and household size. In particular, it is found that each additional household member adds on average about half a cubic meter per month to the total consumption of the household. The second type are variables relating to household installations. Households with a shower on average consume one cubic meter a month over and above households that do not have a shower. A similar differential is found for the presence of a laundry sink, while a kitchen sink adds about one and a half cubic meters to monthly household consumption.

As interesting as the variables that prove to be significant in this model are those that do not turn out to be significant. For example, it is striking that the presence of a water closet does not appear to add significantly to household water consumption. Nonetheless, this result accords with discussions held with households in the field, who stated that they thought it extravagant to flush the toilet with clean water and therefore tended to recycle water from other uses for this purpose. The fact that the presence of sewerage does not have any significant effect on household water consumption merely confirms the result reported above, that what matters is not the sewer itself but the number of household installations to which it is connected. A similar argument explains the absence of any statistically significant effect for the presence of a bathroom. The bathroom itself is no more than a room, what matters for water consumption are the facilities that it contains.

Impact on waste water behavior

Households receiving hygiene education were also found to significantly reduce insanitary practices. The percentage throwing out used water into the streets fell from 77% before the project to 58% thereafter, and the percentage recycling water within the home fell from 36% to 25% (Cannelli, 2001). Unfortunately, it is not straightforward to put a monetary value on these behavioral changes. However, they are unquestionably important in terms of bringing about improvements in environmental quality and human health.

Valuing the consumption differential

The balance of evidence reported above suggests that in neighborhoods where the hygiene education component of the condominial approach were applied, the average impact on consumption was 0.7 cubic meters per month[16], or an average increase of about 10%[17]. In this section, the value of this consumption increment is estimated both from the utility's and the consumer's perspective.

Financial perspective

As outlined in Section 3, under the current tariff structure, households consuming less than 20 cubic meters per month (which is to say about 99% of households in El Alto) pay a tariff of

Table 5-4 Average consumption for different user categories

	Observations	Mean	Standard error	95% confidence interval	
				Lower bound	Upper bound
By type of household					
Without sewerage	285	4.48	0.23	4.02	4.94
With sewerage but without bathroom	435	5.41	0.23	4.97	5.85
With sewerage and bathroom	446	7.33	0.24	6.86	7.80
By presence of water closet					
Without	424	5.11	0.23	4.65	5.56
With	495	7.19	0.22	6.76	7.63
By presence of hand basin					
Without	743	5.42	0.14	5.14	5.71
With	188	8.46	0.41	7.67	9.25
By presence of shower					
Without	689	5.43	0.14	4.96	5.52
With	242	8.50	0.36	7.79	9.20
By presence of kitchen sink					
Without	795	5.49	0.14	5.22	5.77
With	136	9.11	0.52	8.09	10.13
By presence of laundry sink					
Without	569	5.19	0.15	4.90	5.48
With	292	8.09	0.32	7.45	8.72

Table 5-5 Results of regression model for water consumption

	Coefficient	Standard error	T-statistic	Significant at 95% level?	Consumption impact (m3/month)
Habitation					
Household size	0.08	0.01	9.99	Yes	+0.49 m^3/person
Always inhabited[a]	0.30	0.11	2.64	Yes	+1.74m^3
Sometimes inhabited[a]	0.06	0.12	0.47		
Services					
Sewerage	-0.03	0.13	-0.26		
Condominial water	-0.02	0.13	-0.13		
Water-related installations					
Bathroom	0.10	0.07	1.33		
WC[b]	0.03	0.08	0.33		
Silla Turca[b]	0.01	0.11	0.02		
Latrine[b]	0.25	0.30	0.83		
Hand basin	0.056	0.08	0.75		
Shower	0.17	0.07	2.41	Yes	+1.00m^3
Kitchen sink	0.25	0.08	3.30	Yes	+1.47m^3
Laundry sink	0.18	0.06	2.86	Yes	+1.08m^3
Neighborhood					
Huayna Potosí[c]	0.09	0.27	0.34		
Villa Ingenio[c]	0.31	0.54	0.56		
Caja Ferroviaria[c]	-0.37	0.26	-1.26		
San Juan de Río Seco[c]	-0.11	0.27	-0.39		
Oro Negro[c]	-0.05	0.26	-0.20		
Jichusirca[c]	-0.18	0.31	-0.58		
Constant	0.87	0.28	3.10	Yes	–
Regression parameters					
Observations		1114			
Adjusted R squared		0.32			
F-statistic (19, 1094)		28.07			

[a] Defined relative to the baseline category of an unconstructed lot.
[b] Defined relative to the baseline category of no toilet facility of any kind.
[c] Defined relative to the baseline category of the neighborhood 3 de Mayo, a control area with no project interventions.

US$0.22 that almost certainly falls short of the average cost of service provision. While the true efficient average cost of the company is currently unknown, estimates produced at the time of privatization put the value at US$0.56. Using this value purely as an illustrative point of reference, AISA could be losing up to US$0.34 per cubic meter of consumption in the first consumption band. Hence, under the current regime, the increases in consumption produced by the hygiene education program—because they are not large enough to take households into a higher tariff band—only serve to increase the losses that AISA experiences from connecting consumers in El Alto.

If on the other hand, the tariff structure reflected the true average cost of service provision, the hygiene education activities could be expected to increase the utility's revenues—and hence potentially profits—by around 10%. However, without knowing the true average cost of the service or the utility's profit margin and discount rate, it is not possible to put an absolute monetary value on this benefit. Again, purely as an illustration, if the true average cost of water were US$0.56 and the company's profit margin and discount rate were 15%, a 0.7 cubic meter per month increase in consumption would translate into a profit increase in perpetuity valued at around US$5.

Economic perspective

Irrespective of the tariff structure, the hygiene education component leads to a change in consumer preferences that increases the amount of water demanded at every price. As a result, households experience an increase in consumer surplus. The monetary value of this increase depends on the price elasticity of demand, a parameter that is unknown for the pilot area. In order to take the analysis further, some relatively heroic assumptions will therefore have to be made about the functional form of the demand curve.

By identifying two points on the demand curve, it is possible to recover the parameters of a linear demand function. The point representing current consumption of 6.6 cubic meters per month at a price of US$0.22 per cubic meter is already known. Komives (1999) reports some approximate estimates of price and quantity of water used by consumers without piped supplies, finding that households relying on tankered supplies pay US$3.64 per cubic meter and consume 2 cubic meters per month. If one is willing to accept that these two points lie on the same demand curve and that the demand function is linear, then it is possible to proceed with the consumer surplus analysis[18].

The monthly increase in consumer surplus for the linear demand curve defined by the above two points turns out to be US$2.74 (or US$32.92 on an annual basis)[19]. In order to calculate the welfare gain, it is necessary to take the present value of this change in consumer surplus. Unfortunately, the discount rate of households in El Alto is not known. However, it is known that only a minority of households were willing to borrow money from CLA at 26% per annum, while a majority were willing to pay AISA an interest rate of 13% in order to spread the cost of connection charges. It therefore seems plausible to say that household discount rates lie closer to 13% than 26%.

At a discount rate of 13%, the present value of the increment in consumer surplus in perpetuity works out at US$253. It is important to note that this is considerably lower than the investment of US$441 required to construct a bathroom. Indeed, it was found that the consumer surplus from bathroom construction only starts to exceed the start-up costs at discount rates below 7.5%.

As noted in passing, this analysis is subject to numerous limitations and hence the results should be treated with considerable caution. Perhaps the main message to be drawn is that the changes in consumer surplus appear to be of a similar order of magnitude to the investments required to construct the bathroom, and hence that the conclusion is highly sensitive to assumptions made about the discount rate over plausible ranges of its possible value. This suggests that from the household's perspective bathroom construction represents neither a huge gain nor a huge loss, but rather something of a marginal decision. This finding is in fact consistent with the ambivalence encountered among local residents during the course of the hygiene education activities (recall Table 5-1).

6. Evaluation

This section brings together all of the preceding results and uses them to conduct an evaluation of the EAPP. As well as considering both the relative costs and benefits of condominial and conventional systems, the marginal costs and benefits of the various additional components such as community participation and hygiene education are also given separate consideration. The results are presented from the social perspective, as well as the private perspectives of the utility and the consumer.

Social perspective

The evaluation begins by considering the virtues of the condominial system from a social perspective, that is to say, taking all costs and benefits into account regardless of the party to which they accrue. This perspective is appropriate to an 'enlightened policy maker' and is helpful in providing a holistic picture of the condominial approach.

The main results are summarized in Figures 6-1 and 6-2 (see Table A3 of the Annex for underlying figures). The pattern is very similar for both services. Network savings costs of around 50% are achieved, but these fall to 40% once the costs of social intermediation and the opportunity cost of community time are fully accounted for. Overall, the absolute saving is of the order of US$100 per connection. It is also interesting to note that the opportunity cost of community time is more than twice as large as the cost of social intermediation, although both are small in relation to network expansion costs. These findings suggest that the condominial approach is very worthwhile from a social perspective.

In addition to making this overall comparison between conventional and condominial systems, it is important to compare the variants of the condominial system with each other in order to establish the balance of marginal costs and benefits. Two comparisons are particularly important.

First, it is interesting to examine the marginal costs and benefits of the community participation component (Table 6-1). As noted above, community participation is responsible for 49% of the network expansion savings for the sewerage service (equivalent to US$66 per connection) and 23% of the network expansion savings for the water service (equivalent to US$27 per connection). In the case of the sewerage service, these savings are large in relation to the costs of social intermediation and community participation, leading to a benefit cost ratio in excess of two. This suggests that community participation is extremely worthwhile in the case of the sewerage service. The results for the water service are less favorable, since the benefits are smaller and barely offset the additional costs, with a resulting benefit-cost ratio close to unity.

The second comparison is between the versions with and without the hygiene education and related bathroom support activities (Table 6-2). The hygiene education activities cost an additional US$13 per household to undertake, and take-up US$2 of household time. The construction of the bathroom itself costs US$441. Thus the overall cost of the investment is US$456. These activities were found to increase the proportion of households constructing bathrooms by 35% and to increase water consumption in households with bathrooms by about two cubic meters per month. Hence, the overall effect of this is to raise consumption by 0.7 cubic meters per month on average in the neighborhoods affected.

Even assuming cost-reflective tariffs, the present value of the profit margin on this additional consumption amounts to very little for the utility. The gains in consumer surplus are larger by about two orders of magnitude. However, whether they are large enough to compensate for the substantial costs of investing in a bathroom depends critically on assumptions made about the discount rate. The overall conclusion is that hygiene promotion is not at all attractive to the utility, but is potentially attractive to the household.

Given the exceptionally low levels of water consumption in El Alto, it seems likely that bathroom promotion campaigns in other locations would potentially lead to much larger increases in household water consumption. An increase of 10 cubic meters per month, for example, would more than compensate the bathroom investment even at the 13% discount rate. It would also start to make the investment look attractive to the utility.

Utility's perspective

The preceding section considered the comparison between conventional and condominial sys-

Figure 6-1 Social evaluation of condominial sewerage service

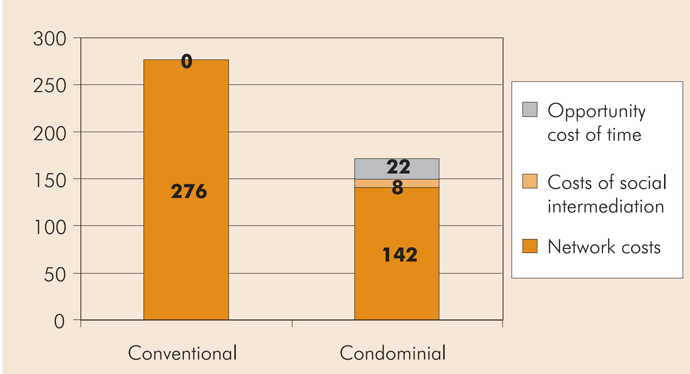


Figure 6-2 Social evaluation of condominial water service

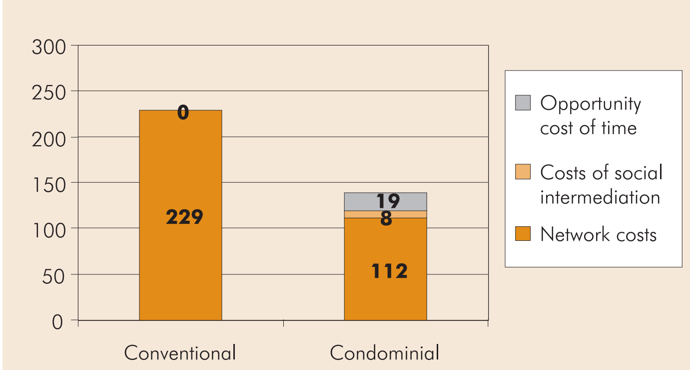


Table 6-1 Marginal benefit-cost analysis of community participation

	Benefits	Costs	Benefit-Cost Ratio
Water	27	27	1.0
Sewerage	66	30	2.2

Table 6-2 Marginal benefit-cost analysis of hygiene promotion

	Benefits		Costs	Benefit-Cost Ratio	
Discount Rate	**7%**	**13%**	**US$**	**7%**	**13%**
Customer	470	253	443	1.1	0.6
Utility	5*	5*	13	0.4	0.4
Total	472	255	456	1.1	0.6

*This value is obtained by applying the average cost tariff of US$0.56 (estimated in 1997) to the expected consumption increment of 0.7m^3 per month, annualizing it, and taking the present value in perpetuity.

Figure 6-3 Utility's perspective on condominial sewerage service (US$)

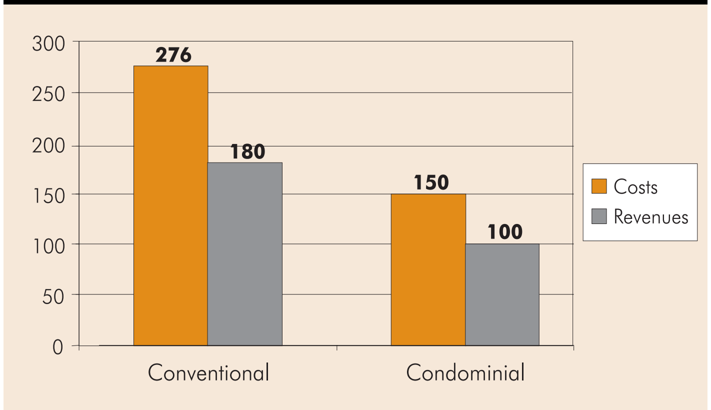
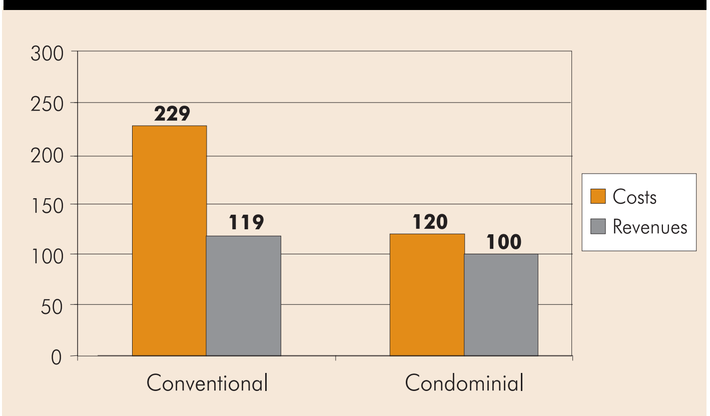


Figure 6-4 Utility's perspective on condominial water service (US$)



tems from a social perspective. However, in order for a system to be implemented, it needs to be attractive not only from a social perspective, but from the narrower individual perspectives of the participating parties. To this end, this section adopts the perspective of a privately managed utility, assuming that the utility is primarily concerned about the impact of alternative systems on profitability.

The following conclusions emerge.

- First, in practice, it is very difficult to assess the profit impact of making new connections. Although the connection charges allowed in the concession contract are substantially lower than the average costs of connection estimated in the present study (Figures 6-3 y 6-4), this does not necessarily mean that the utility is failing to recover the costs of connection since these may have been incorporated into the general tariff level.
- Second, although part of the cost of network expansions may have been incorporated into the average user tariff, the very large size of the subsistence block means that new customers are not commercially attractive because they fall in the lowest tariff band or US$0.22 per meter, compared with the last published estimate of the average cost of service which was US$0.56 per cubic meter (Uzin, 1996), the higher consumption levels of condominial customers cost the utility US$36 per year but bring in only US$14 per year of revenue since they fall in the lowest tariff band of US$0.22 per cubic meter. Hence, serving the newly connected customers is a loss-making proposition.
- Third, under the current tariff structure, there is no incentive whatsoever for the utility to undertake the hygiene education component. This is so for two reasons. On the one hand, hygiene education increases the costs of connection by US$13 without any concomitant increase in the connection charge. On the other hand, although hygiene education leads to higher water consumption the increases are not large enough to take households into a higher tariff band; and higher water consumption in the first tariff band only leads to higher losses.

These conclusions would change completely if the tariff structure were brought in line with the underlying structure of costs. If this were the case, the utility would be indifferent to the cost savings of the condominial approach since the *profitability* of both types of connections would—by design—be identical. Furthermore, it would also be profitable to provide service to low volume consumers. However, as noted above, due to the relatively small increases in consumption resulting from the hygiene education activities, these would remain unattractive to the utility unless the associated costs could be recovered from the consumer in the connection charge.

Consumer's perspective

This section adopts the perspective of a consumer facing a choice between conventional and condominial systems, and between alternative variants of the condominial system (see Figures 6-5 y 6-6 and underlying figures in Table A5 of the Annex). Separate results are reported for the current structure of charges and a hypothetical alternative where charges reflect the underlying structure of costs. The main conclusions are as follows.

- First, the current tariff structure offers the consumer no cost advantage from the condominial water service and substantially attenuates the cost advantage available from the condominial sewerage service. The total savings currently available to households, at US$58 are nonetheless significant representing 50% of the average monthly household income in El Alto.

- Second, if charges for condominial systems were made fully cost-reflective, households would stand to make significant gains. The overall saving on the water system would be close to 40% for both water and sewerage services. The total value of the savings from opting for condominial water and sewerage connections would come to US$194, which is equivalent to 160% of the average monthly household income in El Alto.

Figure 6-5 **Customer's perspective on condominial sewerage service (US$)**

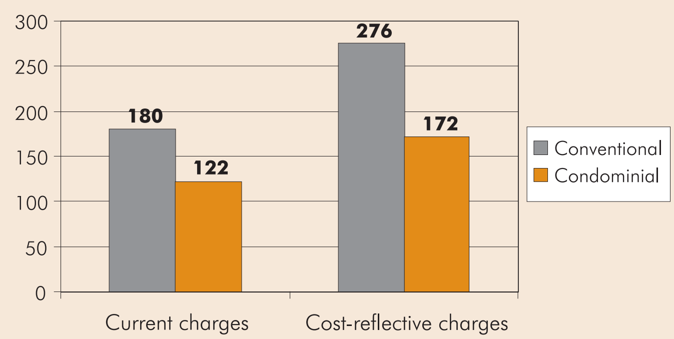
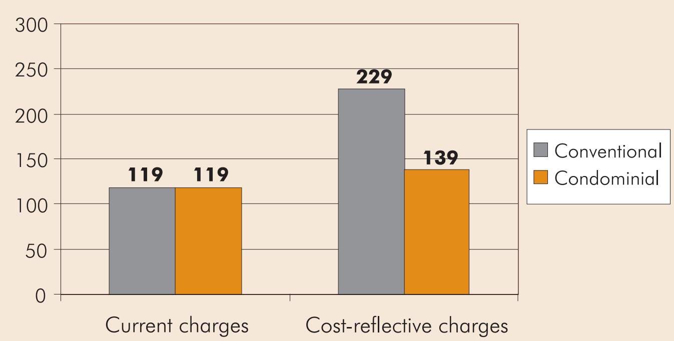


Figure 6-6 **Customer's perspective on condominial water service (US$)**



7. Conclusions

This paper undertakes the economic and financial valuation of the EAPP, a pilot project aimed at transferring the condominial water and sewerage system from Brazil to Bolivia and testing its applicability in the context of private sector participation in service provision. Since its inception in 1998, the EAPP has provided condominial water connections to 1,977 households in eight neighborhoods of El Alto, and condominial sewerage connections to 4,050 households in nine neighborhoods of El Alto.
According to recent statistics, about 60% of these households live below the poverty line with an average daily income per capita of US$0.80.

To what extent are the results of the El Alto pilot relevant beyond Bolivia? The peculiar cultural, geographical and social circumstances of El Alto make it—if anything—an acid test for the condominial approach. In particular, a number of factors which have served to limit the benefits of the condominial system in Bolivia would not necessarily be present in other contexts to the same degree. Examples include the exceptionally low levels of consumption by households, and the difficulties experienced in inducing them to switch to modern hygiene practices, for a variety of cultural reasons. Consequently, the results of the evaluation should be regarded as specific to the El Alto context, even though in qualitative terms they are indicative of what can generally be achieved through the condominial approach.

The pilot project experimented with a number of different components including:

- innovative engineering design of networks;
- community participation in network construction and maintenance;
- hygiene education to support the installation of household facilities;
- micro-credit lines to finance the construction of bathrooms.

Many of these components are mutually reinforcing and formed part of an integrated concept in the El Alto project. Nonetheless, both in principle as in practice, it is possible to apply these components independently of each other. Hence, for analytical purposes it proves convenient to provide an independent evaluation of each.

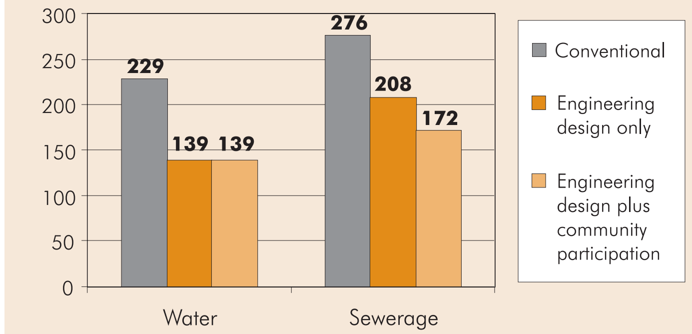
Engineering design

The purpose of the innovative engineering design is to reduce the length, diameter and depth of the network required by routing the distribution pipes across pavements and/or backyards. Analysis of the EAPP experience suggests that savings in the length and diameter of pipes are of the order of 10%-20%, while savings in the volume of soil excavation as a result of shallower trenches are of the order of 45%-75%. These physical savings translate into overall financial savings of the order of 24% for the sewerage service and 40% for the water service when the condominial engineering design is implemented using conventional contractors. This is consistent with recent experience from Brasilia which suggests savings of 20% for condominial sewerage systems without community participation (Neder, 2001).

Community participation

Community participation brings a number of advantages, among them is a further reduction in connection costs as a result of training local residents to construct and maintain their own condominial branches. Community participation reduced the network costs by a further 26% for the sewerage service and 10% for the water service. Thus, the overall savings achievable by implementing the condominial engineering design with community labor come to around 50% for each of the two services. However, community participation also introduces costs of social intermediation for the water company of around US$8 per connection, and requires each participating household to give-up about a week of its time valued at around US$20. When these costs are taken into account, the overall cost advantage of the condominial design with community participation falls slightly from 50% to 40% for both services. Considering the balance between marginal costs and benefits, community participation has a benefit cost ratio of 2.2 for the sewerage service suggesting that it is very worthwhile. However, in the case of the water service the benefit cost ratio is only 1.0, since in this case the cost savings come primarily from the engineering design.

Figure 7-1 **Cost comparison (US$)**



There is also some evidence suggesting that community participation increases the proportion of households that connect to the sewerage network once it is built from 66% to 75%. The effect of this is to increase the overall cost saving of the approach from around 40% to 45%.

Hygiene education

The purpose of the hygiene education component was to provide moral and technical support for households to adopt modern hygiene practices, in particular by helping them to construct their own bathrooms and associated facilities. Without such investments within the home, a sewerage connection brings little or no benefit to households, and has been shown to have virtually no impact on water consumption. In neighborhoods where hygiene education activities had been performed the probability that any given household had constructed a bathroom increased from 38% to 73%, and the range of water-using installations in the household (showers, kitchen sinks, etc.) increased markedly. Households with bathrooms were found to consume, on average two cubic meters more per month than households without bathrooms, which is to say an increase of 30% on average consumption in households without bathrooms of 5.4 cubic meters per month. Households receiving hygiene education were also found to significantly reduce insanitary practices (Canelli, 2001). The percentage throwing out used water into the streets fell from 77% before the project to 58% thereafter. While the percentage recycling water within the home fell from 36% to 25%.

The cost of hygiene education to the utility works out at around US$13 per household, while the cost of bathroom construction to the household was estimated at US$443. Given the relatively small absolute value of the consumption increase, and the low level of tariffs for low volume consumers, hygiene education is not at present a commercially attractive proposition for a private utility in El Alto. The estimated consumer surplus increase from the additional consumption ranges from US$253-US$470 depending on the discount rate used. This suggests that bathroom construction is only marginally attractive to households. However, it is important to stress that these modest benefits for hygiene education are largely an artifact of the exceptionally low levels of water consumption in El Alto. With the much larger consumption increases that could easily be anticipated in other locations, the proposition would start to look much more attractive both from the utility's and the customer's perspectives.

Micro-credit line

The purpose of the micro-credit line was to help households finance the US$400 worth of materials required to construct a fully-equipped bathroom. Overall, 25% of households applied for credit, and 19% had their applications approved. The available evidence suggests that those households applying for credit tended to have above average incomes. While the provision of credit undoubtedly eased the payment of the costs for beneficiary households, statistically there is no evidence to suggest that bathroom construction rates were significantly higher in neighborhoods were micro-credit had been offered. The micro-credit line was dropped at an early stage of the project.

Overall, these results suggest the following conclusion. The engineering design component alone produced significant savings of 24% for sewerage and 40% for water. The community participation component further increased the savings available for the sewerage service to 40%, but did not have any net effect on the cost reductions available for the water service. The hygiene education component had a very substantial effect on household behaviour, but the size of the benefits was more modest than might be expected owing to very abstemious water consumption practices peculiar to El Alto. Evidence on the micro-credit facility suggests that it probably was not all that effective in reaching the poorest households.

The results reported above are given from the perspective of an 'enlightened policy maker' who takes all financial and economic costs fully into account. However, the considerable divergence between tariff structure and underlying cost structures in the AISA concession contract appears to distort the way in which the utility and its consumers perceive the advantages of the condominial system.

- From the utility's perspective, it is difficult to make categorical statements about the profitability of making condominial as opposed to conventional connections. Although current connection charges mandated by the concession contract are substantially lower than the estimated average cost of making a connection. It is not known to what extent part of the costs of network expansion have in fact been built into the use of service tariff. However, one point that is clear is that there does not appear to be any incentive for the utility to engage in hygiene education since the additional costs are not recouped through the connection charge, and the resulting increases in water consumption—though significant—are not large enough to take consumers out of the loss-making low volume tariff band. If charges were fully cost-reflective the utility would be indifferent between conventional and condominial systems, but would still only have an incentive to undertake hygiene education as long as the consumption increase was large enough to justify the cost of the initial investment.

- From the consumer's perspective, households receiving water and sewerage services by the condominial method saved US$19 and US$80 respectively in terms of connection charges, an aggregate value equivalent to 80% of monthly household income. However, when the opportunity cost of the household's time is fully accounted for, the saving disappears for the water service and for the sewerage service is reduced to US$58 (or about 50% of monthly household income). If connection charges were more closely aligned with underlying cost, households would spend more on obtaining a condominial connection than they do at present, but the savings relative to the conventional system would also be larger. They would increase to US$109 for water and US$126 for sewerage (together equivalent to nearly 200% of monthly household income). As before, when the opportunity costs of time are taken into account, the savings are somewhat reduced to US$90 for water and US$104 for sewerage (in total equivalent to 160% of household income).

Notes

[1] *Local term referring to an arid high altitude plateau.*

[2] *In Spanish, this approach is described as 'con gestión compartida'.*

[3] *In Spanish, this approach is described as 'sin gestión compartida'.*

[4] *This is based on data for average earnings of workers in El Alto from the 1999 Encuesta de Hogares, which are just under $100 per month. The average number of hours worked per week is 50, which is taken to represent 6 days of work per week, or 24 days over the month. Hence, the average daily wage is just over $4.14.*

[5] *This problem affected the projects at Villa Ingenio (UV-4), El Rosal Lloreta and Kupini II.*

[6] *The average relates to the following neighborhoods: Alta Ciudadela (Parts I and II), Huacataqui, and Bartolina Sisa, This average excludes one exceptionally difficult neighborhood, Peña Azul, where the cost per connection proved to be as high as US$811. Including this neighborhood in the calculation, raises the average cost per connection to US$403.*

[7] *This breakdown is made by considering the roles of different team members. The training of local professionals in the design and implementation of condominial systems was largely undertaken by Adela Martínez, Mery Quitón, Fernando Inchauste and Alfonso Nueva. Whereas, the adaptation of the approach together with the 'training of the trainers' was undertaken primarily by Luiz Lobo (Team Leader)*

[8] *However, non-owner occupying households also took out smaller loans. The average loan for this group was US$366, putting the principal asset ratio for this category at 64.2%.*

[9] *This comment is based on an interview with Claudio Parra, Regional Manager for CLA in El Alto.*

[10] *This comment is based on an interview with Pedro Arriola, General Manager of CLA.*

[11] *To fully remove the effects of seasonality a full year's average before and after would have been ideal. However, there was not sufficient data after the event to permit this. By looking at the same six month period, at least one can be sure that the differential is due to the presence of a bathroom rather than to varying consumption patterns at different times of year. Nonetheless, the size of the differential will not necessarily be constant across the year.*

[12] *This can be inferred from the fact that the confidence interval for the difference between consumption before and after the arrival of sewerage spans the value zero.*

[13] *This can be inferred from the fact that the confidence interval for the difference between consumption before and after the arrival of sewerage does not span the value zero.*

[14] *The confidence intervals for the two consumption levels almost overlap. The upper bound for households without sewerage is 4.94 cubic meters per month, while the lower bound for households with sewerage but without bathrooms is 4.97. This difference is just significant at the 95% confidence level, but would not be at the 99% confidence level.*

[15] *This can be inferred from the distance that exists between the upper bound of the first confidence interval (5.85) and the lower bound of the second confidence interval (6.86).*

[16] *This figure can be arrived at in a number of ways. First, the rate of bathroom construction is 35% higher when hygiene education is applied, and the presence of a bathroom on average adds 1.9 (cross-sectional) to 2.0 (time-series Huayna Potosí) cubic meters per month to consumption. Thus, the overall effect is (0.35*1.95) = 0.68 cubic meters per month. Alternatively, the installations that add significantly to water consumption are the shower, the laundry sink and the kitchen sink. The coverage of these installations is respectively 24%, 33% and 12% higher in neighborhoods receiving hygiene education, and the consumption differential is on average 1 cubic meter, 1 cubic meter and 1.5 cubic meters. Thus, the overall effect is (1*0.24+1*0.33+1.5*0.12) = 0.75 cubic meters per month. This result is consistent with the preceding one.*

[17] *That is to say that in about 35% of households consumption rises by about 30%, so that overall consumption rises by about 10%.*

[18] *Evidently, both of these assumptions are highly questionable. On the one hand, a tankered supply is so different in nature from an in-house connection that the two points are unlikely to be on the same demand function. On the other hand, there is no reason why the demand function should be linear; although, neither is there any a priori reason to expect it to be anything else.*

[19] *The linear demand curve resulting from these two points has an elasticity of only –0.04 at the current price of water. Since this value is implausibly low, some sensitivity analysis was performed by lowering the price of tankered water until the price elasticity rose to a more 'typical' range (–0.3 to –0.7). Fortunately, the increase in consumer surplus is very robust to these variations, remaining in the interval $2-$3 per month.*

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Cost Annex

Table A1 Financial costs per sewerage connection

	Cost (US$)						Cost difference	
	Condominial			Conventional*			Absolute	Relative
	lower	middle	upper	lower	middle	upper	(US$)	(%)
Phase One								
Huayna Potosí		107			276		-169	-61.3
Villa Ingenio (D-II)	103	119	135	272	277	282	-158	-57.1
Caja Ferroviaria	150	152	154		221		-69	-31.1
San Juan de Río Seco	134	137	139	329	332	336	-196	-58.9
Oro Negro	97	104	110	256	275	295	-172	-62.4
Phase Two								
El Ingenio		151			276		-125	-45.4
Germán Busch*		176			276		-100	-36.3
Overall average		142			276		-129	-47.6

*It is important to note that the numbers in these rows and columns are budgetary estimates as opposed to outturn costs.

Table A2 Financial costs per water connection

	Cost (US$)						Cost Difference	
	Condominial			Conventional*			Absolute	Relative
	lower	middle	upper	lower	middle	upper	(US$)	(%)
Phase One								
Villa Ingenio (D-II)	109	120	130	193	233	273	-113	-48.6
Caja Ferroviaria	108	110	111		240		-131	-54.4
San Juan de Río Seco	129	134	139		233		-100	-42.7
Jichusirca	131	140	149	199	208	216	-68	-32.5
Phase Two								
Germán Busch*		93			229		-136	-59.2
Averages		112			229		-117	-50.9

*It is important to note that the numbers in these rows and columns are budgetary estimates as opposed to outturn costs.

Table A3 Evaluation results from a social perspective

	Water		Sewerage	
	Conventional	Condominial	Conventional	Condominial
Absolute Values				
Costs (US$)				
- Network expansion	229	112	276	142
- Plus social intermediation	0	120	0	150
- Plus opportunity cost of time	0	139	0	172
Absolute Differences				
Cost savings (US$)				
- Network expansion	–	-117	–	-134
- Plus social intermediation	–	-109	–	-126
- Plus opportunity cost of time	–	-90	–	-104
Percentage Differences				
Cost savings (%)				
- Network expansion	–	-51	–	-49
- Plus social intermediation	–	-48	–	-46
- Plus opportunity cost of time	–	-39	–	-38

Table A4 Evaluation results from the utility's perspective

	Water		Sewerage	
	Conventional	Condominial	Conventional	Condominial
Connection				
Costs	229	120	276	150
- Revenues	119*	100*	180	100
- Profit impact	-110	-20	-96	-50
Consumption (annual)				
Costs*	36	36	36	36
- Revenues	14	14	14	14
- Profit impact	-22	-22	-22	-22

*This is the US$120 financial cost of the connection minus the US$36 cost of the meter.
These are based on the average cost tariff of US$0.56 (estimated in 1997).

Table A5	Results of evaluation from the consumer's perspective			
	Water		Sewerage	
	Conventional	Condominial	Conventional	Condominial
Absolute Values				
Actual charges				
- Monetary cost	119*	100*	180	100
- Full cost	119	119	180	122
Cost-reflective charges				
- Monetary cost	229	120	276	150
- Full cost	229	139	276	172
Absolute Differences				
Actual charges				
- Monetary cost	–	-19	–	-80
- Full cost	–	0	–	-58
Cost-reflective charges				
- Monetary cost	–	-109	–	-126
- Full cost	–	-90	–	-104
Percentage Differences				
Actual charges				
- Monetary cost	–	-16	–	-44
- Full cost	–	0	–	-32
Cost-reflective charges				
- Monetary cost	–	-48	–	-46
- Full cost	–	-39	–	-38

*The US$36 cost of the meter has been subtracted from the current connection charge in order to make this comparison consistent.