2004

Putting Participation in Context: An Evaluation of Urban Sanitation in Brazil

Earthea Nance

PUTTING PARTICIPATION IN CONTEXT: AN EVALUATION OF URBAN SANITATION IN BRAZIL

A DISSERTATION
SUBMITTED TO THE DEPARTMENT OF
CIVIL AND ENVIRONMENTAL ENGINEERING
AND THE COMMITTEE ON GRADUATE STUDIES
OF STANFORD UNIVERSITY
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

Earthea B. Nance

May 2004

I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

Leonard Ortolano, Ph.D., Principal Advisor

I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

James O. Leckie, Ph.D.

I certify that I have read this dissertation and that, in my opinion, it is fully adequate in scope and quality as a dissertation for the degree of Doctor of Philosophy.

Clifford Barnett, Ph.D.

Approved for the University Committee on Graduate Studies.

Abstract

In this dissertation, I examined the performance of condominial sewer projects in two Brazilian cities. My research objectives were to investigate the impact of participation on condominial sewer project performance, and to identify the key factors that enabled good performance. I used qualitative research methods and analyzed six condominial sewer projects as case studies. Primary data were obtained during a ten-month period of fieldwork in the capital cities of Natal and Recife, Brazil. The dissertation produced two sets of results. In the first set of results, project performance was: 1) positively associated with the participation of beneficiaries in project mobilizing and project decisions; and 2) not positively associated with participation in project construction and maintenance work. Although beneficiaries did participate in project construction and maintenance work, these categories of participation were not positively associated with project performance. These results, which are contrary to what was anticipated based on the literature, suggested that other variables were more significant in influencing project outcomes.

In the second set of results, two other factors were associated with project performance: 1) the alignment of interests among elected officials and implementing agencies in support of the project; and 2) the ability of communities to influence elected officials and implementing agencies to support the project (e.g., by delivering large blocks of votes). In Recife, good project performance was more likely when elected officials and sewer agencies provided consistent support for a particular project, when communities organized in order to exert influence on the officials and agencies who controlled sewer

services, and when residents participated in project mobilizing and decisions. In Natal, good project performance was associated with the alignment of interests and with participation in project mobilizing and project decisions. Given Brazil's continuing efforts to decentralize its sanitation sector, and given the country's historic use of infrastructure projects as elements of political patronage, the proposed framework provides an appropriate basis for understanding what factors enable good performance in the urban sanitation sector.

Acknowledgments

I thank the Department of Civil and Environmental Engineering at Stanford University for providing the most supportive and stimulating environment for doctoral studies I can imagine. I am most grateful to my principal advisor and mentor, Dr. Leonard Ortolano, Professor of Civil and Environmental Engineering. Thank you, Len, for inspiring me with your passionate teaching and intensely interesting courses. Thank you for being patient and kind, and for your enduring support through this long journey. And thank you for opening the door to Brazil.

My faculty advisors also contributed greatly to my experience in the doctoral program and to my dissertation research. I am thankful for the guidance and encouragement I received from Dr. James O. Leckie, Stanford Department of Civil and Environmental Engineering. I am grateful to Dr. Clifford Barnett, Stanford Department of Anthropological Sciences, for offering me many years of thoughtful advice, friendly critique, and a fresh perspective. I thank Dr. Kathleen Morrison, Stanford Center for Latin American Studies, for encouraging me and for her contributions as a member of my dissertation defense committee.

I thank Dr. Carl Gotsch, Stanford Institute for International Studies, for generously serving as the University Chair of my dissertation defense committee. I also thank Dr. Andrea Klimpt, Stanford Department of Anthropology, who served on my dissertation qualifying exam committee, reviewed my dissertation proposal, and taught me about writing proposals and conducting field research. I thank the late Dr. John Wirth, Stanford Department of History, for sharing his knowledge and passion about Brazil and for teaching me to appreciate the historical perspective. I am indebted to the late Karen Van den Dool, Stanford Department of Spanish and Portuguese, for teaching me Portuguese in spite of everything.

I thank Stanford University and the Department of Civil and Environmental Engineering for supporting my graduate studies with Frances Goodrich Fellowships during my 1991/1992 and 1993/1994 academic years. I thank the US Department of Education for providing me with a Foreign Language and Area Studies Fellowship to study Brazil during my 1992/1993 academic year. I thank the Stanford Institute for International Studies for supporting my dissertation research with a travel grant in 1994 and with a dissertation writing grant in my 1995/1996 academic year. I thank the Buck Foundation for providing a research grant for the fieldwork portion of my dissertation research during the 1994-1995 academic year. I thank Stanford University for providing dissertation writing support with a John K. Vennard Fellowship during my 1996/1997 academic year. And I thank my former employer, Lawrence Livermore National Laboratory, for providing flexibility and paid time off during the final stage of dissertation writing in my 2003/2004 academic year.

I thank the Water and Sanitation Division of the World Bank for providing me with two summer internships that readied me for international research. My wonderful experiences there really helped launch the fieldwork in Brazil, and I give special thanks to John Briscoe, Harvey Garn, Vijay Jagannathan, Alex Bakalian, and Albert Wright for mentoring me while I was at the Bank. I am indebted to Gabrielle Watson for generously sharing her knowledge about condominial sewers with me.

I am especially grateful for the kindness and support I received from Ellen Raber, Department Head of the Environmental Protection Department at Lawrence Livermore National Laboratory. I also thank my supervisors and colleagues at the Lab for applying gentle pressure for me to finish my dissertation while I was working there. Special thanks to Harry Galles, Janet Hauber, Al DiSabatino, Robert Fischer, Leonard Gray, Brian Anderson, Dianne Gates-Anderson, Diane Spencer, and Sabre Coleman.

I appreciate the good work of the research assistants who assisted me during the fieldwork phase of the research. Thank you Dulcineide Marinho Cesar, Claudete Marcelino da Silva, Isis Freire, Silvania Maria Oliveira Diniz, Ilka Leandra Cruz, Andrea Oliveira da Fonseca, and Ilma Alves da Cruz Pinto for conducting the household censuses, taking notes at focus group meetings, distributing invitations, and performing the bulk of the household interviews. Thank you Edson Barbosa Silva for translating my interview guides and other research materials into Portuguese and for our wonderful conversations about Brazil. I thank Gustavo and Paula Valente for their tremendous assistance during the data analysis and dissertation writing phases of the research. I thank Carol Dickinson for providing exceptional assistance with the typing and bibliography.

I thank the professional staffs and public officials of Recife and Natal who made it possible for me to conduct this research, who helped arrange housing and other support for me during my fieldwork, and who inspired me with their tireless efforts to expand access to sanitation services in Brazil. I especially thank my Brazilian sponsor, Professor Cicero Onofre de Andrade Neto of the Federal University of Rio Grande do Norte, and my principal hosts, Jose Carlos Rodrigues de Melo in Recife and Maria Geny Formiga de Farias in Natal. In keeping with the ethical practice of protecting the privacy of human subjects involved in research, many of the Brazilians who made important contributions to this dissertation must remain anonymous. I thank all of the Brazilian residents who contributed to this dissertation by participating in focus groups, household interviews, and informal interviews. Thank you for literally opening your doors to me and my research assistants.

I thank my cherished Stanford colleagues for your friendship and your brilliance. Thank you Rafik Hirji, Ann Steinneman, Barbara Sinkule, Rick Gelting, Xiaoying Ma, Kim Warren, Alnoor Ebrahim, Ernesto Sanchez Trianna, Greg Browder, Nicole Carter, Jimin Zhao, Katherine Kao Cushing, Stephanie Ohshita, and Mara Warwick. I also thank my new colleagues for making my final year at Stanford wonderful. Thank you Hongyan He, Jiang Ru, Daniel Rutherford, Elizabeth Richards, Veena Srinivasan, Xeuhua Zhang, Cheng Chang, Kirsten Oleson, and Rebeca Hwang.

I also thank many dear friends who provided moral support and a social life during the early years of my doctoral studies. Thank you Luisah Teish, David Wilson, Uzuri Amini, Vance Williams, Xochipalla Maes-Valdez, Ayannakai Nalo, Keven Noel Amherd, Sauda Birch, Lulit Taka, Anna Gruver, Sylvia Warren, and Samantha Black. Thanks to my brothers Ahtio Nance and Antwahn Nance for always believing in me, and thanks to my late father, Raymond Lester Nance, Jr., for inspiring me to travel to other countries. I am deeply grateful to my husband, Janvier Mugisha Bubanje, and two children, Ntwari and Mutoni, for their support even as they endured endless nights without me during the long road of writing.

Modupe Egun · *Moferefun Obatala* · *Ibase Osun*

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

ACRONYMS AND ABBREVIATIONS

BNDES – National Bank of Economic and Social Development (*Banco Nacional de Desenvolvimento Econômico e Social*)

BNH – National Housing Bank (*Banco Nacional de Habitacao*)

CAERN – North Rio Grand State Water and Sanitation Agency (*Companhia de Aguas e Esgotos do Rio Grande do Norte*)

CBO – Community-Based Organization

CEF – Federal Bank of Brazil (*Caixa Economica Federal*)

CHESF – San Francisco River Basin Hydroelectric Agency (*Companhia Hidro Elétrica do São Francisco)*

COHAB – Pernambuco State Housing Agency (*Companhia Habitacional de Pernambuco*)

COMPESA – Pernambuco State Water and Sanitation Agency (*Companhia Pernambucana de Saneamento*)

EMLURB – Recife Urban Cleanup Agency (*Empresa Municipal de Limpeza Urbana*)

EMOPER – Pernambuco State Public Works Agency (*Empresa de Obras de Pernambuco*)

FIDEM – Municipal Development Foundation (*Fundacao de Desenvolvimento Municipal*)

GME – COMPESA Metropolitan Sewage Department (*Gerencia Metropolitana de Esgotos de COMPESA*)

IBGE – Brazilian Census Bureau (*Instituto Brasileiro de Geographica e Estatistica)*

IDB – Inter-American Development Bank

NGO – Non-Governmental Organization

OBRAS – Recife Public Works Agency (*Empresa de Obras da Cidade do Recife*)

PAHO – Pan American Health Organization

PCR – Recife Municipal Government (*Prefeitura da Cidade do Recife*)

PFL – Party of the Liberal Front (conservative/right) (*Partido de Frente Liberal*)

PLANASA – National Sanitation Plan *(Plano Nacional de Saneamento)*

PMDB – Party of the Brazilian Democratic Movement (center) (*Partido de Movimento de Democratica Brasileiro*)

PNAD – IBGE National Household Sample Survey (*Pesquisa Nacional por Amostra de Domicilios*)

PSB – Brazilian Socialist Party (independent/left) (*Partido Socialista Brasileiro*)

PSDB – Party of Brazilian Social Democracy (social democratic/center left) (*Partido de Socialista Democracia Brasileiro)*

RMR – Recife Metropolitan Region (*Regiao Metropolitao da Cidade do Recife*)

RPA – Political-Administrative Region (*Regiao Politico-Administrativo*)

SPI – Sewer Performance Index

SUDENE – Northeast Regional Development Agency (*Superintendencias do Desenvolvimento do Nordeste*)

SUMOV – Natal Public Works and Transit Agency (*Superintendencia Municipal de Obras e Viacao do Prefeitura do Natal)*

UNDP – United Nations Development Program

URB – Recife Urban Planning Agency (*Empresa de Planejamento Urbano do Recife*)

URBANA – Natal Urbanization Agency (*Empresa da Urbanizacao do Natal*)

US – United States

USAID – United States Agency for International Development

WHO – World Health Organization

Chapter 1

Introduction

The World Health Organization (WHO) estimates that 40 percent of the world's population (2.4 billion people) were living without sewage disposal facilities in 2000[1]. Inadequate sanitation is linked to intestinal parasitic infections, schistosomiasis, and diarrheal diseases that kill over 2.2 million people per year worldwide[2]. Brazil is a case in point, where just over half of urban households were connected to sewers in 2001[3], and where diarrheal disease is among the main causes of mortality and morbidity in children under five years of age[4]. In this chapter, I introduce Brazil's sanitation problem (Section 1.1), review the existing literature (Section 1.2), describe the intended audience for this dissertation (Section 1.3), and present the statement of purpose and the research questions (Section 1.4). This dissertation explores the social, political, and technical factors that may have contributed to successful implementation of simplified sewer projects in Recife and Natal, Brazil. I also seek to explain the relationship between participation and project performance. The simplified sewer projects studied are called *condominial* sewers.

1.1 The Sanitation Problem in Brazil

The term *sanitation* refers to "services or systems of collection, transportation, treatment, and sanitary disposal of wastewater, excreta, or other waste."[5] *Sewerage* is a "system of pipes for wastewater collection and removal"[6] commonly referred to as a sewer. In the following sections, I describe Brazil's sanitation problem, with an emphasis on sewerage.

1.1.1 Technical Aspects of the Sanitation Problem

In 1999, the Pan American Health Organization (PAHO) estimated that 81.7 percent of the Brazilian population resided in urban areas[7]. The majority of urban homes were constructed without underground sewer infrastructure such as pipes, manholes, and pump stations. In some instances, homes were constructed below the elevation of the street, in flood plains, or in other poorly drained areas, which makes sewage collection more technically challenging and which may require the provision of pavement and drainage in addition to a sewer system. Without careful engineering and without the provision of complementary infrastructure such as pavement and drainage, the operational effectiveness of sewer systems in poorly drained areas can be significantly jeopardized.

Some urban residents do not have piped water or indoor bathrooms, so the provision of a sewer system to these households must be accompanied by the provision of piped water and bathrooms, which increases the scope and cost of a sewer project. If water is only supplied a few days per week rather than daily (which is the case in many poor urban Brazilian neighborhoods), and if bathrooms are not plumbed or connected to the sewer, then the operational benefits of the sewer system, in terms of improved public health and environmental quality, are not realized. Some urban neighborhoods have irregular housing layouts, indistinct blocks, narrow unpaved pathways instead of streets, and no public rights-of way. These characteristics impede the installation of conventional sewer lines, and preclude access by conventional sewer construction equipment and sewer maintenance trucks. In these situations, conventional sewers are either never constructed or, if constructed, they function poorly because they cannot be properly maintained. The variety of physical situations represented by the neighborhoods of Brazil give rise to a series of technical challenges, many of which cannot be resolved using conventional sewer technology.

1.1.2 Financial Aspects of the Sanitation Problem

The high capital and maintenance costs of conventional sewage collection and treatment systems pose another challenge. Conventional sewers are expensive as a result of the high design standards. Capital costs for conventional sewers in Brazil range from $150 to $300 per capita (1988 US dollars), not including house connection, treatment, maintenance, and disposal costs[8]. Historically, Brazilian agencies responsible for water and sanitation have had limited public resources available for the construction of new sewer infrastructure. The majority of the Brazilian population cannot afford the fees associated with conventional sewer service, and when fees are heavily subsidized the financial shortfall can ultimately contribute to inadequate public investment in sewer system expansion, sewage treatment, and sewer system maintenance.

Another obstacle is the lack of market forces to stimulate private investment in sewer infrastructure. Historically, private firms have had little incentive to enter into markets for public goods like sewer systems. The financial incentive for market-run conventional sewer service has been too low to attract large-scale investment, and the financial cost of state-run conventional sewer service in Brazil has been too high to be sustained[9].

1.1.3 Social Aspects of the Sanitation Problem

Residents may not be educated about the relationship between sewer systems and disease[10]. Unless people have this knowledge, it is generally difficult to stimulate public demand for sewer infrastructure. Demand for sanitary sewers tends to increase as urban population density increases, as water supply increases, and as income increases[11]. Residents also may not express demand for sanitary sewers until their demands for other higher-priority services (e.g., land tenure, electricity, and water) have been satisfied[12].

Some residents may not want to interact with government officials out of fear of eviction, mistrust, or apathy based on previous project failures[13]. Residents may also think that a new system will be too expensive or that user fees will change each time a new official is elected[14]. As long as each household finds individual disposal solutions, community-level problems such as public health may have to reach crisis levels before they are widely perceived, and even then the demand for sanitation may be based on desires for privacy and convenience rather than public or personal health. For these reasons, sewer projects must often be accompanied by educational and promotional campaigns to change habit patterns[15].

The significance of these technical, social, and financial challenges in Brazil is reflected in three overall results: 1) generally low rates of sewer coverage (i.e., the percent of population with access to sanitary sewers), 2) generally poor performing sewer systems, and 3) a geographic patchwork of sewer service sharply differentiated by income, with higher income areas receiving the limited services that are available and lower income areas remaining unserved and relying on individual solutions (e.g., leachpits, cesspools, septic tanks, gutters, and open ditches). The inability of either markets or states to provide and adequately maintain sewer service to a majority of the Brazilian population threatens public health. Though preventable, sanitation-related diseases such as cholera, typhoid, dysentery, malaria, and diarrhea kill thousands of people per year in Brazil. Unsanitary conditions significantly impair people's – especially children's – quality of life, their environment, and their health.

1.1.4 The Limits to Conventional Solutions

The following features characterize conventional sewer systems:

- Houses face the street and are laid out regularly on city blocks;
- Houses are connected individually to a sewer located in the street;
- Streets are paved and of ample width to allow vehicle access by personnel who maintain the sewer lines;
- Relatively large-diameter sewer pipes are installed at conservative design slopes and depths;
- Suitable equipment and materials are available to construct and maintain the system; and,

- The collected sewage is discharged to a suitable destination, such as a wastewater treatment plant.

Many cities in developing countries, including Brazil, have not yet developed the physical or financial capacity to support this level of development for the entire population[16]. As a consequence, conventional sewers in Brazil mainly serve wealthier neighborhoods that have the conditions to support conventional sewer systems. The Brazilian Census Bureau (IBGE) reported that, in 2001, 86 percent of households with incomes of 5 or more minimum salaries per capita had adequate sanitation[17]. Conversely, only 38 percent of extremely poor households (i.e. with incomes of 0.5 or less minimum salaries per capita) had adequate sanitation. Since 62 percent of Brazilian workers earn only two minimum salaries or less[18], appropriate sanitation solutions must address the physical, social, and financial constraints faced by the majority of the population. Experience shows that even when these obstacles are overcome, the outcome of a sewer project may not be successful. When conventional sewers are installed in low-income areas of Brazil, residents may choose *not* to connect because of the expense, because of the lack of a perceived benefit, and because connection to a sewer system is not required.

Two examples of this phenomenon are the neighborhoods of Rocas and Santos Reis in Natal, Brazil. In 1978, funding became available and a conventional sewer was planned in each of these poor neighborhoods. But because residents could neither afford to hook up to the condominial sewer nor pay the monthly fee, few residents signed up for a sewer connection. It became a foregone conclusion that, if constructed, the project would have been unpopular and unsuccessful. Like the majority of poor residents in many developing country cities, the unsewered residents of Rocas and Santos Reis had relied on individual solutions to dispose of gray water (i.e., the wash water from sinks, bathtubs, and floor drains) and sewage. Because residents lacked adequate sewer service, they faced precarious public health conditions and high death rates from sanitation-related diseases.

The experiences of Rocas and Santos Reis demonstrate that the mere expansion of the sewer system is a necessary, but not sufficient, element of project success. Other important aspects of project success include the number of house connections realized, user satisfaction, health impacts, and environmental improvements. The most successful projects positively transform some of the basic conditions of the communities in which they are installed. The sanitation problem is not likely to be solved merely by expanding conventional sewers to the unserved population, because this approach has not been shown to be feasible under the current conditions in Brazil.

1.1.5 Condominial Sewers: An Appropriate Solution

To overcome many of the obstacles associated with implementing conventional sewers, Brazil addressed its sanitation problem by simplifying sewer technology, reducing system costs, and trying new service delivery approaches that incorporated participation. Their approach, called *condominial* sewers, envisioned a new role for project beneficiaries in the implementation of projects, along with the traditional roles of government and private organizations. Roles for beneficiaries included mobilizing community demand, forming user groups, constructing indoor bathrooms, constructing house connections, and becoming knowledgeable about how to operate and maintain their system. The role of local or state government included project financing, implementation, billing, and user education. Private involvement included the traditional types of firms: material suppliers, construction contractors, engineering consultants, and plumbers.

The condominial sewer approach was Brazil's response to the need for an appropriate sewer technology and implementation method to reach unserved populations. The key reasons for the development and adoption of condominial sewers in Brazil were: a) the high cost of conventional sewer technology, b) low household connection rates to conventional sewer systems because of a lack of participation, and c) users' desire for a flexible sewage solution that could be upgraded to a conventional sewer as incomes rose[19]. Political conditions for innovating with condominial sewer technology became more favorable following Brazil's democratic transition of the 1980s. The populist politicians that emerged during democratization could readily integrate participation into their platforms. Moreover, the previous period (1970s and early 1980s) of water and sanitation investment in mostly affluent communities made possible the subsequent investments in low income communities (late 1980s and 1990s).

Condominial sewers are a feasible alternative to conventional sewers in developing countries. The technology is characterized by inexpensive materials, shallow excavations, small diameters, and modest slopes. Condominial sewer systems are located in backyards, front yards, and sidewalks to serve groups of homes (or blocks) collectively. Collective service reduces the overall length of sewer pipe needed and allows sewer service to homes in unplanned areas that lack distinct blocks or paved streets. This alternative design results in significant capital cost savings compared to conventional sewers. Capital costs for condominial sewers in Brazil range from $50 to $150 per capita (1994 US dollars)[20]. Condominial sewer installation often relies on the active participation of beneficiaries in design, construction, and maintenance, which has the potential to reduce operating costs.

1.2. A Brief Review of the Literature

1.2.1 The Participation Approach

In this section, I introduce the literature on participation, project performance, and the impact of participation on project performance. I also present information about participation and performance in condominial sewers, and I identify the gaps in knowledge. Participation has emerged as a general principle important to the outcome of public infrastructure projects, especially rural water supply and irrigation projects[21]. A consensus in the literature is that development projects are more successful when they are implemented with a more localized planning process and a bottom-up approach that includes participation[22]. In 1994, the World Bank stated that:

> The importance of participation in effective delivery of local public goods is well recognized. . . . A 1985 World Bank review of 25 projects (mostly in agriculture and rural development) five to ten years after completion found that participation by beneficiaries and grass-roots institutions was a key factor in those projects' long-term success. . . . This experience has not been unique to World Bank projects; it is mirrored by other development agencies. Statistical analysis reinforces the impression from project reviews – a 1987 analysis of recent World Bank projects and a 1990 analysis of USAID-funded projects found strong evidence for the importance of participation. (World Bank, 1994:76)

Participation is known by several names in the literature, including community participation, popular participation, citizen participation, people's participation, user participation, project participation, beneficiary involvement, stakeholder involvement, community self-help, etc. Many definitions of participation exist. According to Narayan (1994:3), participation is "a voluntary process by which people . . . influence or control the decisions that affect them[23]." Studies by Korten (1980) and Ostrom, et. al. (1993) have shown that the quality of interactions between project beneficiaries and implementing agencies can influence project outcome. I envision three general categories of participation:

1. Beneficiaries participate by making contributions of money or labor to a project (i.e., self-helping);
2. Beneficiaries mobilize themselves for participation in the project and/or the agency mobilizes residents for the project (i.e., mobilizing); and
3. Beneficiaries participate by their involvement in project decisions (i.e., decision-making).

Other observers have made similar categorizations of participation. Oakley (1991) divided the concept of participation into contributions, organization, and empowerment of beneficiaries. In the World Bank's (1994) view:

> There are three keys to using participation to improve project performance: involve the beneficiaries directly, seek their early consensus on the project, and mobilize cash or in-kind contributions from them. (World Bank, 1994:76)

A participation approach may include aspects of both agency-initiated and beneficiary-initiated activities. Implementing agencies can develop participation programs in which the agency determines the activities available for beneficiary involvement. Also, residents may organize themselves to carry out self-directed activities or to request service from the responsible agency or official. Hypothetically, the benefits of participation include:

- A better match between user needs and project outputs;
- A heightened sense of ownership among beneficiaries;
- Increased access to sewer coverage by poor residents;
- Enhanced accountability between authorities and beneficiaries; and
- Increased community capacity (e.g., organizing skills) and empowerment.

1.2.2 Condominial Sewer Performance

The introduction of condominial sewer technology challenged the state and local agencies in Brazil that were responsible for implementation. Some agencies adopted condominial sewers with considerable success, while others strongly resisted the technology or the participation approach. Among opponents, condominial sewerage was perceived as an unwanted reduction of technical standards, a low performing technology that brought in fewer fees than conventional sewers, and an unproven participation approach that required a new set of skills for traditional engineering-focused organizations. In practice, there were great variations in the implementation approaches used and in the performance outcomes realized. Some projects functioned very well, while others functioned poorly or failed completely. The general suggestion made by Brazilian practitioners was that projects with participation tended to perform better.

Because of the relaxed design and construction standards of condominial sewers, and because residents are often responsible for constructing some part of the system, condominial sewer performance is an important issue. When condominial sewers perform poorly, the public health risk from sanitation-related disease can be as high as in areas that lack a sewer system. Photo 1-1 vividly illustrates the consequences of poor sewer performance. The photo shows that residents have reverted to the use of an open ditch for sewage disposal. A manhole cover for the inoperable condominial sewer and a water supply standpipe can be seen in the path of the sewage ditch.

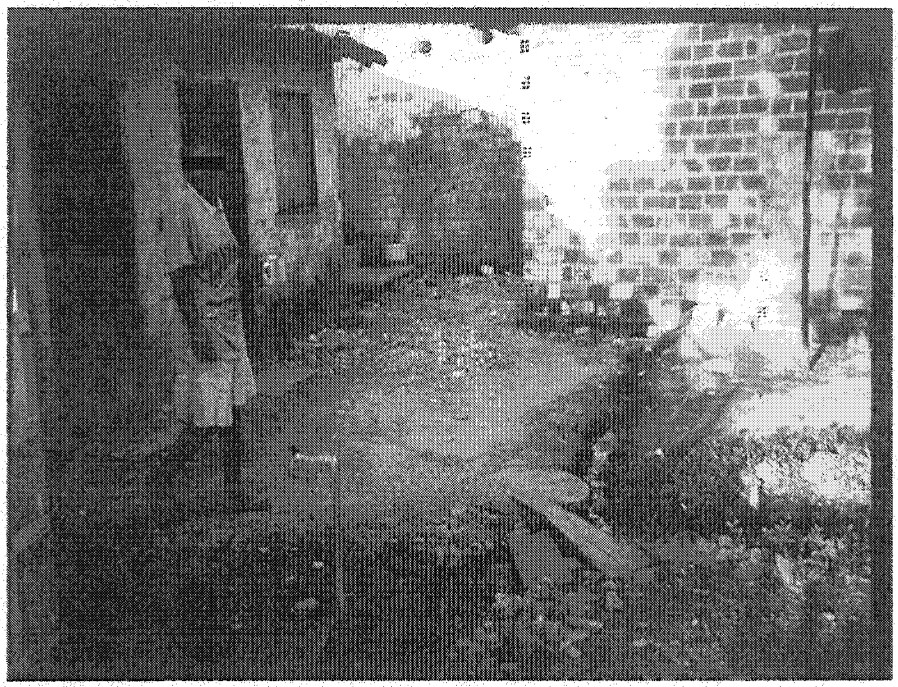


Photo 1-1. The consequences of poor performance of a condominial sewer system in Brazil.
Source: Photograph taken by the author, 1995.

There are a number of explanations for the success and failure of condominial sewer projects, based on the experiences of condominial sewer officials, engineers, and other practitioners from Brazil. A sample of statements by condominial sewer practitioners is presented in Table 1-1. The long list of factors in Table 1-1 suggests a high level of complexity in the relationships between causal factors and project outcome. No single factor explains project outcome. There is also no established framework or strategy for prioritizing the numerous factors that are possibly associated with project outcome. Some project outcomes may even be situational or path dependent - the result of a unique set of conditions and actions that are not generalizable. Often, condominial sewer project outcomes mirror the social order from which they emerge. The least successful projects tend to be located in neighborhoods that have the most obstacles.

Table 1-1. Some factors associated with poor project performance mentioned by condominial sewer practitioners from Recife and Natal, Brazil.

Examples of Statements by Condominial Sewer Practitioners About the Factors Associated with Poor Performance
"Low Income Beneficiaries"
"Inadequate Drainage/Bad Topography"
"Lack of Functioning of the Public Trunk Sewer"
"Engineers Unfamiliar with Condominial Technology"
"Users' Lack of Demand for Sewers"
"Engineers Opposed to the Technology or to Participation"
"Users' Lack of Education on How to Use the System"
"Public Agencies Don't Take Responsibility for Sewer Maintenance"
"Users Don't Take Responsibility for Sewer Maintenance"
"Users Don't Re-Cement Manhole Lids Closed After Opening Them"
"Users Push Blockages Downstream Instead of Removing Them"
"Poor Quality of Construction"
"Poor Quality of Maintenance"
"Lack of User Participation"
"Inadequate Design"
"Misuse of the System by Users"
"Modification or Damage of the System by Users"
"No Satisfactory Destination for the Collected Sewage"

Sources: Multiple informants, interviews by author, 1994-1995, Recife and Natal, transcripts.

1.2.3 Participation and Performance

The literature on participation contains a number of studies investigating the link between participation and project outcome. One study by Narayan (1994 and 1995) applied a multivariate regression analysis to test the hypothesis that participation was correlated with better performance in 121 rural water projects[24]. Using participation and performance data from project evaluation reports written by large international lenders, Narayan concluded:

> Participation remains the single most important factor contributing to [rural water] project effectiveness. To maximize the benefits of participation, participation must be treated as a continuous process, with participation important throughout [the project cycle]. Participation is not effective when limited to later stages [of the project cycle]. (Narayan, 1995)

Despite steps taken by Narayan (1994 and 1995) to ensure reliability and validity, the study was criticized by World Bank staff and other researchers because the source data were considered biased[25]. Finsterbusch (1989) conducted a comprehensive evaluation of 52 multi-sector projects funded by large international donors, and concluded the following:

> Participation is not always necessary or helpful. It has much greater benefits in some contexts than in others. Participation variables have modest correlations with project effectiveness, and the contribution of participation to project effectiveness increases with progression through the stages of the project, from design to maintenance. The main benefit of participation appears to be the building of community capacity. (Finsterbusch, 1989)

A comprehensive study by Cabrera (1995) of 22 rural water and sanitation projects in Latin America that were funded by humanitarian organizations concluded the following:

> One of the most significant lessons learned found in the evaluations is that the water and sanitation projects are very efficient for organizing, motivating, and achieving participation. In the few evaluations where the degrees of participation in the different stages of a project were studied in depth, there is agreement regarding the need for more involvement of the community in all aspects of the process. (Cabrera, 1995:5)

Although all three studies found participation to be beneficial, the authors' conclusions varied as to *why* participation was beneficial. Narayan found a strong association between participation and project success, and argued that the main benefit of participation was improved project performance. Finsterbusch found only modest associations between participation and project success, and concluded that the main benefit of participation was increased community capacity. Cabrera (1995) recommended more participation in all aspects of project implementation to increase community capacity, which was the main benefit of participation found in the study. There is not a consensus among these three studies on the benefits of participation. No general conclusion about participation can be drawn from these three comprehensive studies, except that there *is* agreement that participation in project implementation is beneficial.

While there are no studies available on participation and performance for condominial sewers, anecdotal information from Brazilian engineers and project staff suggests a possible association between participation and performance in condominial sewer projects. One representative quote comes from the division manager of a state-level sewer agency who defines condominial sewers in terms of participation:

> Physically, it [refers to condominial sewers] is defined as a low cost system. Philosophically, it is defined by the participation of residents among themselves and by the public agency's actions to stimulate this participation. (Informant 121, CAERN division manager, interview by author, 1 June 1995, Natal, transcript)

My survey of the condominial sewer literature reveals that 1) some Brazilian agencies adopted participation in implementing condominial sewers while others did not, and 2) the performance outcome of condominial sewers was a mix of success and failure. Notwithstanding this range of outcome and the numerous potential causal factors, most condominial sewer practitioners I interviewed attributed good performance to good participation. Table 1-2 provides a sample of statements by Brazilian condominial sewer practitioners about the perceived impacts of participation. The main point to draw from these statements is the wide range of benefits attributed to participation.

Condominial sewers are deserving of formal study because of their potential for addressing widespread sanitation problems in developing countries. They provide ideal case studies for examining the conditions in which participation might contribute to project success. Despite the promotion of participation and appropriate technology in development programs worldwide, and despite the expansion of the condominial approach throughout Brazil, engineers and evaluators have found a number of problems associated with participatory service delivery. Prominent among these issues is the perception that the participation approach has not been adequately evaluated in relation to project outcome.

1.2.4 What is Missing from the Literature

One comment I have about the above-mentioned studies by Narayan (1994 and 1995), Finsterbusch (1989), and Cabrera (1995) is the lack of apparent objectivity in the

Table 1-2. Some impacts of participation mentioned by condominial sewer practitioners from Recife and Natal, Brazil.

Examples of Statements by Condominial Sewer Practitioners About the Impacts of Participation
"Participation reduces project installation costs."
"Residents need to discuss with and respect their neighbors when the system plugs up."
"Need to orient the residents because they don't know how to use the condominial sewer system."
"Residents should buy the materials for the part of the system within their lot because this gives more value to the project for the resident."
"Condominial sewer users have more responsibility because if they plug their pipe they harm their neighbors."
"Residents are responsible for construction and maintenance of the collective part of the sewer system and their house connection."
"Government cannot build the collective and private parts of the sewer system without participation from residents."
"Residents need to negotiate with their neighbors to resolve collective problems."
"Residents are responsible for maintenance of the condominial and private parts of the sewer."
"Lack of orientation and participation leads to misuse of the system by residents."
"The system is only viable for users who know how to use it."

Sources: Multiple informants, interviews by author, 1994-1995, Recife and Natal, transcripts.

measurement of participation. As many studies do, these three studies relied on subjective grading of participation – typically conducted by researcher(s) who read dozens of project evaluation reports and arrived at conclusions about the quality and quantity of participation in each project – without adequate documentation of how measurements of participation were made. This lack of transparency in the analysis, and the subjectivity involved in measuring participation contribute to a general criticism of subjectivity, which can reduce the persuasive impact of the conclusions.

A further criticism with the methodology of these three studies is the potential for bias in the main source of data: project evaluation reports written by project proponents. There is often an unseen incentive for project evaluations to show participation only in a positive light, which raises the question of possible bias in project evaluations prepared by proponents of a project[26]. The reasons for this are twofold. First of all, project proponents usually adopt a development approach that guides their work, and most recent development approaches have recommended participation as beneficial. There could be an incentive to show the correctness of their development approach within project evaluation reports, which would simultaneously provide a good impression of the proponent, or there may be an incentive to "jump on the bandwagon" of participation because it is the current fashion in development discourse. Second, project proponents may overestimate the success of their own projects. There could be an incentive for proponents to write glowingly about the performance of their projects in order to justify past or future funding, or to avoid scrutiny or negative publicity that would stop the flow of funding.

Whether or not there is bias on the participation variable or bias on the outcome variable, the question of possible bias certainly cannot be ignored when evaluations are prepared by project proponents. The potential for bias in no way suggests that the three studies presented here reached the wrong conclusions. But neither can the potential for bias be ignored. This situation reveals the need for an improvement in the methodologies for measuring participation and project outcome.

Completely missing from the literature are studies examining the relationship between participation and performance in the sanitation sector. There are no project-level case studies examining this relationship for condominial sewers. Watson's (1993) study addresses this relationship in general, but the unit of analysis was the city (not the project), and no measure of project performance was provided. Very few studies present explicit measures of the participation and performance variables, and the studies that are available all address rural water supply projects (e.g., Narayan, 1994 and 1995; Prokopy, 2002; and Gelting, 1995). I found no study that measured the different dimensions of participation in urban sanitation projects, and no study that analyzed the association of each dimension of participation with performance. Also missing from the literature is a discussion of the role of participation within the local social and political context so that the relative significance of participation can be judged compared to other factors that influence project performance.

1.3 Who Should Read this Dissertation

I prepared this dissertation with two specific audiences in mind: condominial sewer practitioners and sustainable infrastructure development policy makers. Practitioners may find this dissertation useful because I evaluate condominial sewer project implementation and performance from a different perspective than their own. I also hope that policy makers involved in sustainable infrastructure development find it useful to ascertain the effects of sewer development policy at the neighborhood and project level. This dissertation may also be useful to other researchers interested in the relationship between participation and project performance in the urban sanitation sector; to international aid and lending organizations interested in achieving maximum benefit from the funds they provide for condominial sewer projects; and to non-governmental organizations interested in supporting urban communities through the infrastructure implementation process.

1.4 Research Purpose and Research Questions

This dissertation addresses Brazil's sanitation problem from a research perspective, with a focus on understanding the significance of participation and evaluating condominial sewer project outcome. The overall purpose of this dissertation is to discern the conditions that led to success or failure in six condominial sewer case study projects in Brazil, and to make contributions to theory based on the results of the case analyses. Understanding why some urban sewer projects are more effective than others is important for at least two fundamental reasons. First, knowledge of what brings about success contributes to overcoming the numerous obstacles to urban sewer development that exist in developing countries. More knowledge can help stakeholders and decision-makers improve sanitation policy and better target the available resources. Second, the case studies presented in this dissertation contribute new data to the case study literature. The starting point for my research is the hypothesis that participation is positively associated with project performance. Six condominial sewer projects are examined in detail and in the context of their respective cities during the time period of Brazil's democratic transition. My research objective was to explain the factors that contributed to project success or failure. Two questions guided the dissertation. What were the key factors that shaped project performance? How did participation affect project performance?

---

[1]WHO, 2000.
[2]WHO, 2000; and Esrey, et. al., 1991.
[3]IBGE, 2001.
[4]PAHO, 1998.
[5]Soares, 2001:17.
[6]Soares, 2001:16.
[7]PAHO, 1999.
[8]Bakalian, et. al., 1994:19.
[9]World Bank, 1994:22-25.
[10]Sinnatamby, 1983.
[11]Briscoe and Garn, 1995.
[12]Briscoe and Garn, 1995.
[13]Elmendorf and Buckles, 1980.
[14]Gorell, 1990.
[15]Annis and Hakim, 1988.
[16]Sinnatamby, 1990:146-147; and Bakalian and Jagannathan, 1991.
[17]IBGE/PNAD, 2001:8. A "*salario minimo*" in Brazil is the minimum wage, in *reais* (Brazilian dollars), accumulated over one month.
[18]IBGE, 2001.
[19]Bakalian and Jagannathan, 1991.
[20]Bakalian, et. al., 1994:19.
[21]Gelting, 1995; Narayan, 1994; Narayan, 1995; World Bank, 1994:76; and Prokopy, 2002:22.

[22]Korten and Alfonso, 1985; Bryant and White, 1982; and Wright, 1997.
[23]Narayan, 1995:7.
[24]Narayan, 1995.
[25]Prokopy, 2002; and Harvey A. Garn, economic advisor to the World Bank, personal communication with author, July 1994, Washington, D.C.
[26]Harvey A. Garn, economic advisor to the World Bank, personal communication with author, July 1994, Washington, D.C.

Chapter 2

Innovating with Condominial Sewer Technology

Brazilian engineers introduced condominial sewers in the 1980s as a low-cost alternative to conventional sewers. The principles of simplified sewer technology and participation are combined in the condominial sewer approach. The purpose of this chapter is to define and describe condominial sewers as they have been implemented in Brazil. In this chapter, I introduce the technology (Section 2.1), present typical condominial sewer engineering standards and design criteria (Section 2.2), discuss the participation of residents in condominial sewer projects (Section 2.3), and describe the application of condominial sewers in Brazil (Section 2.4). I conclude that condominial sewer technology is a viable alternative to conventional sewerage and is an innovative solution to the technical, financial, and social challenges of sanitation in Brazil.

2.1 Introduction to Condominial Sewers

Before describing condominial sewers, a brief explanation of conventional sewers is appropriate. In a conventional sewer network, each house is connected to a public sewer located in the street. Because conventional sewers are buried under the public street, the sewer structure must be strong enough and the installation deep enough so that vehicle loads do not crush the sewer pipe. The typical boundary between the public and private parts of a conventional sewer system is the "pipe cleanout" at each house. Homeowners are usually responsible for their individual house connections and for internal plumbing up to the point of the pipe cleanout. A public sewer authority is usually responsible for the parts of the sewer system located in public rights-of-way, which are downstream of the pipe cleanout.

The high quality and typically excellent performance of conventional sewers is a result of conservative design standards that are expensive to achieve. Because of their high cost, conventional sewers are provided exclusively to higher income residents in Brazil. Costs start at approximately $200 per capita (in 1992 US dollars) for conventional sewers alone and approximately $1000 per capita for conventional sewers plus treatment[1]. Conventional sewer systems are often too costly for low-income areas.

The majority of Brazil's residents live in homes that are unsewered, so the installation of a sewer system is often a retrofit and not new construction. The existing layouts of homes and streets can present significant challenges to the design of sewer retrofit projects. Physical limitations combined with the financial constraints inherent in a developing country can create conditions in which conventional sewers are infeasible, making condominial sewers an attractive alternative.

Because different users are willing to pay different prices and receive different levels of service, it is appropriate for sewer technology to have a range of service levels and prices. Traditional onsite sanitation solutions (e.g., leachpits, cesspools, septic tanks, and open ditches) offer low performance at a low price, but they are generally accessible to most of the Brazilian population[2]. In contrast, conventional sewers provide high performance at a high price, but with limited access. Condominial sewer technology offers two levels of service in between these two extremes. The "sidewalk" condominial sewer layout connects households to a sewer pipe located in the sidewalk, pathway, or lane. The "backyard" or "front yard" condominial sewer layout connects households to a sewer pipe located in privately-owned yards. The three primary features of condominial sewers are relaxed sewer design standards (and the lower costs that result), installation of sewers on private property (in the backyard and front yard layouts), and participation in project implementation.

Figure 2-1 compares typical piping layouts for condominial and conventional sewers in a planned housing settlement (i.e., a city block). Under a conventional sewer piping layout, houses discharge individually to a public sewer in the street. Piping layouts for backyard and front yard condominial sewers involve a common collection pipe for each group of homes or each city block, which in turn discharges to a public sewer in the street or other disposal destination (e.g., local septic tank, storm drain, and river). In the sidewalk condominial sewer layout, the collection pipe is on public property – in the sidewalk – and houses discharge individually to the sidewalk sewer.

The typical boundary between the public and private parts of a condominial sewer system is the most downstream cleanout box, through which all of the wastewater collected from the block flows. Prior to this point, the system is on private property (except in the sidewalk layout). The system is on public property downstream from this point.

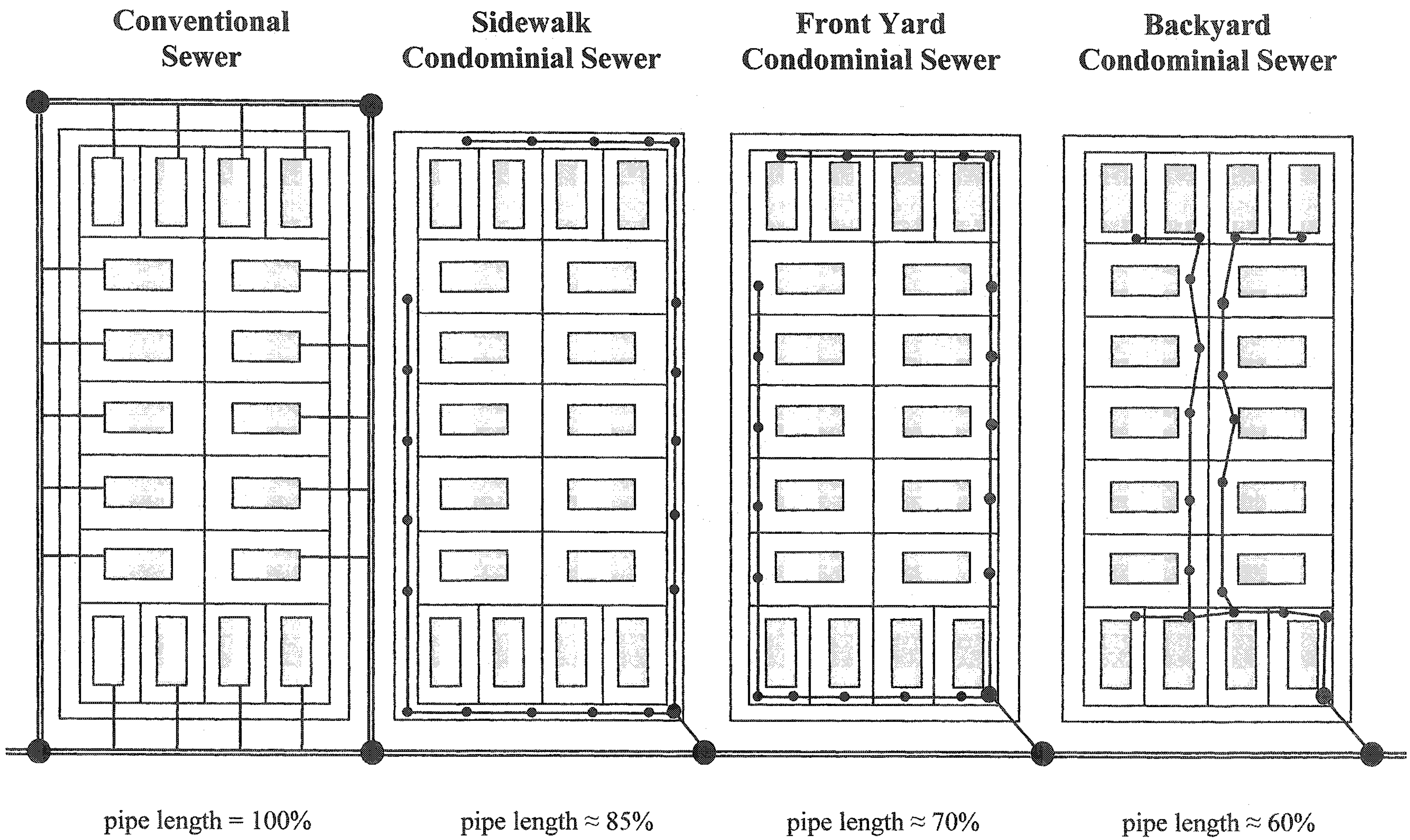


Figure 2-1. Typical piping layouts for conventional and condominial sewer systems.

Compared to conventional sewerage, condominial sewerage requires significantly less pipe, which lowers installation costs (see Figure 2-1 for a comparison of relative pipe lengths).

When the common collection pipe is installed in the backyards of homes, the overall length of sewer pipe is minimized, resulting in the lowest cost layout. When the common collection pipe is installed in the front yard or sidewalk area of homes, overall pipe length and installation costs are somewhat higher compared to the backyard layout, but costs are still significantly lower than the piping requirements of conventional sewerage.

Overall, the installation cost of condominial sewers ranges from 50 to 80 percent of the installation cost of conventional sewers[3]. These capital costs are often spread out over several years to make condominial sewer systems affordable to more residents. The monthly fee charged to Brazilian households for ongoing maintenance of a conventional sewer is typically 100 percent of the household water bill. Typical monthly fees for condominial sewers in Recife and Natal are 80% of the water bill for the sidewalk layout, and 40% of the water bill for the backyard or front yard layout.

The rationale behind this fee structure is that more of the sewer system is located on private property under the backyard and front yard layouts. Therefore, project beneficiaries are responsible for maintaining these parts of the sewer system. Because the private parts of the condominial sewer theoretically do not receive maintenance service by the public sewer authority, lower fees are charged to beneficiaries of backyard and front yard systems. Beneficiaries of sidewalk condominial sewers are charged higher fees because more of their system is located on public property. However, because the sidewalk sewer is not as costly as a conventional sewer, its fee is somewhat lower. The condominial sewer fee structure is not based on true maintenance costs. Setting maintenance fees as a percentage of the water bill puts the ongoing cost of sewers in perspective for consumers who are familiar with the costs of water service. But this fee system ignores the fact that sewer systems are often more costly to maintain than water systems[4].

It is very difficult to estimate the true cost of installed condominial sewer projects in Brazil because many of the projects were installed during an era of severe inflation. Brazil has experienced some of the highest inflation of any country, with inflation rates as high as 2,489% in 1993[5]. From 1985 to 1994, the average inflation rate in Brazil was 1,018%[6]. During this time, the price of a project would be re-calculated each month because the value of the Brazilian dollar was constantly changing, and by the end of a typical project no one really knew its true cost. Heavy government subsidization of condominial sewer materials and monthly fees further complicates the estimation of true costs. Costs vary widely depending on the discharge location and on whether sewage pumping and treatment is included. Capital costs for condominial sewers range from $48 to $123 per capita (in 1993 US dollars) for projects in several Brazilian cities[7].

2.2 *Engineering Standards and Design Criteria*

Conventional engineering standards and design criteria are relaxed (or simplified) for condominial sewers. For this reason, condominial sewers are also called "simplified" sewers, "shallow" sewers, or "low-cost" sewers. Condominial sewers are characterized by inexpensive pipe materials, shallow excavations, small diameter pipes, modest slopes, and by their applicability to either planned or unplanned housing settlements. Because condominial sewers can be located in yards, sidewalks, pathways, lanes, or alleys instead of streets, the sewer pipes are not expected to support vehicle loads and they can be installed in shallower excavations with lower cost materials. Moreover, smaller overall lengths of pipe are needed to serve a given number of homes with a condominial sewer, as discussed previously. Condominial sewer pipe diameters are smaller than typical conventional designs. The standard diameter of a condominial sewer pipe is 100 millimeters (mm), although 150 mm diameter is also used in some locations. The standard diameter of conventional sewer pipe is 150 to 200 mm. These relaxed design standards yield significant cost savings.

Table 2-1 shows a comparison of typical design criteria for condominial sewers and conventional sewers. Sinnatamby (1990) cites sewer field studies that found no association between flatter slopes and the frequency of blockages, and he concludes that "shallow sewer design seeks to maximize the frequency of [sewage] discharges to increase the efficiency with which solids are transported in small diameter pipes."[8]

Table 2-1. Typical design criteria for condominial sewers compared to those of conventional sewers[a, d].

Design Item	Typical Condominial Sewer Design Standards	Typical Conventional Sewer Design Standards
Design Period	15 - 20 years	25 - 50 years
Peaking Factor (unitless)	1.8	2.0 - 3.3
Minimum Self-Cleaning Velocity	Not typically used	0.5 – 0.6 m/s
Maximum Velocity	4 m/s	3 – 6 m/s
Minimum Tractive Tension[b]	0.1 kg/m^2 or 1 Pa	Not typically used
Minimum Flow Depth	0.20 x diameter	0.20 x diameter
Maximum Flow Depth	0.75 x diameter	0.75 x diameter
Minimum Design Flow	100-120 L/day/person	1500 L/day/person
Minimum Depth of Sewer	0.60 – 1.5 m	1.8 m
Minimum Depth of House Connection	0.4 m	0.8 m
Minimum Diameter	100 mm (house connections and block sewers) 150 mm (block collectors and trunk sewers)	150 - 200 mm
Minimum Slope	0.5% – 0.6% (0.005 – 0.006 m/m)	1.0% – 1.4% (0.01 – 0.014 m/m)
Maximum Manhole Spacing	(c)	100 – 180 m
Minimum Manhole Diameter	0.6 – 0.9 m	1.5 m

Continued…

Table 2-1. Continued.

Design Item	Typical Condominial Sewer Design Standards	Typical Conventional Sewer Design Standards
Typical Number of Homes per Collective Sewer or Street Lateral	10-60 homes for 100 mm diameter at min. slope and min. tractive tension	20 homes for 100 mm diameter at min. slope and min. velocity
Maximum Length of Pipe per Collective Sewer	400 m for 100 mm diameter at min. slope	Not typically used

Sources: Bakalian, et. al., 1994; Mara and Guimaraes, 1999; WPCF, 1982; Sinnatamby, 1990:147-148; Informant 76, CAERN social worker, interview by author, 11 April 1995, Natal; and Informant 77, CAERN civil engineer, interview by author, 25 May 1995, Natal.
a. The Manning formula is used in both condominial and conventional sewer design.
b. Minimum tractive tension is also known as minimum tractive force or critical boundary shear stress.
c. Fewer manholes are used in condominial sewer systems; most manholes are replaced by cleanout boxes (also known as inspection chambers).
d. m = meters; m^2 = square meters; s = seconds; kg = kilograms; L = liters; mm = millimeters, Pa = Pascal.

In their technical review of design criteria for simplified, shallow, and condominial sewers, Bakalian, et al. conclude that the use of flatter slopes and the relaxation of other sewer design standards to achieve cost savings does not, perforce, mean a substandard design. Rather, Bakalian, et al. report that simplified sewers represent a rational alternative "based on sound engineering principles without sacrificing quality or lowering the level of service."[9] In other words, there is no technical reason to believe that condominial sewers should perform poorly just because they are based on relaxed design standards. Nevertheless, Bakalian, et al. (1994) do acknowledge that sewer professionals expect simplified sewers to have lower levels of performance and increased maintenance requirements, probably due to poor workmanship and misuse[10].

The installation of condominial sewers is considerably different from conventional sewer installation. Conventional sewers are typically installed in advance of homes and streets, and individual connections to the conventional sewer are usually installed as homes are built. The government or the developer can build trunk sewers without any input from the residents, and when the resident installs a conventional house connection to the trunk sewer it is simply a matter of connecting their individual house to the existing sewer pipe. Existing neighborhoods can be retrofitted with conventional sewers that are installed in public streets to allow direct access by each and every home. An existing neighborhood also can be retrofitted with a condominial sewer installed on private property that collects sewage from groups of homes before discharging to the public sewer in the street.

Condominial sewers are typically made of either small diameter, inexpensive polyvinyl-chloride (PVC) or unvitrified clay pipe. Clay pipes are generally prone to more installation problems because they are manufactured in short sections (in 70-90 centimeter lengths for 100 millimeter diameter pipe[11]) and are subject to cracking and chipping at the joints. However, because of its durability and resistance to corrosion, clay pipe is the most commonly used condominial sewer construction material. Clay pipe is best used in areas with well-drained sandy soils and a low water table, and for this reason clay pipe is the norm in the City of Natal. In areas with poorly-drained soils and a high water table, PVC pipe offers a better alternative because it is manufactured in longer sections (in 6 meter lengths for 100 millimeter diameter pipe[12]) and has fewer joints and tighter joint connections, thus minimizing the problems of infiltration and inflow[13]. Both PVC and clay pipes have been used in the City of Recife, which has a higher water table than Natal. Photo 2-1 shows typical condominial sewer construction materials used in Recife and Natal. Photo 2-2 shows a typical household cleanout box installed in a backyard condominial sewer.

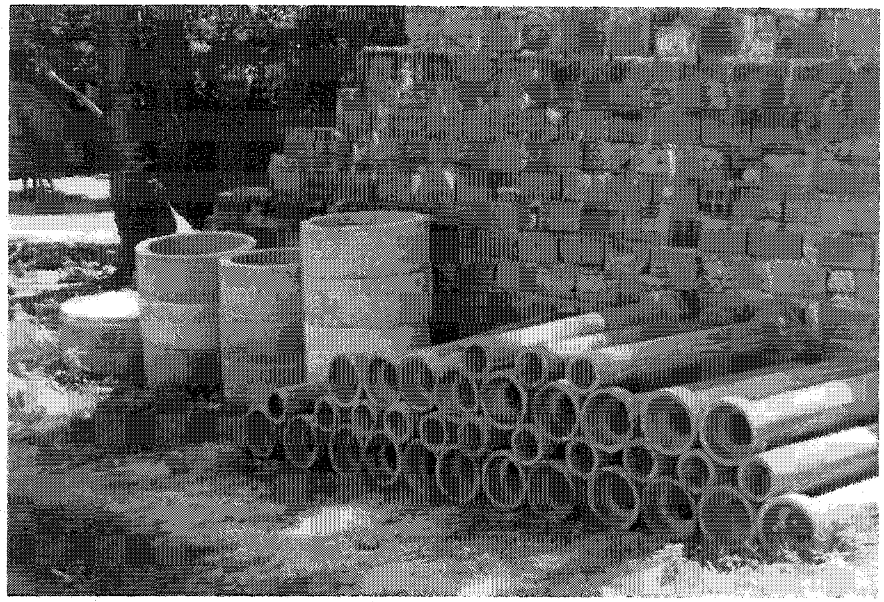


Photo 2-1. Typical condominial sewer construction materials: clay pipes and concrete cleanout boxes. (Source: Photograph taken by the author, 1995).

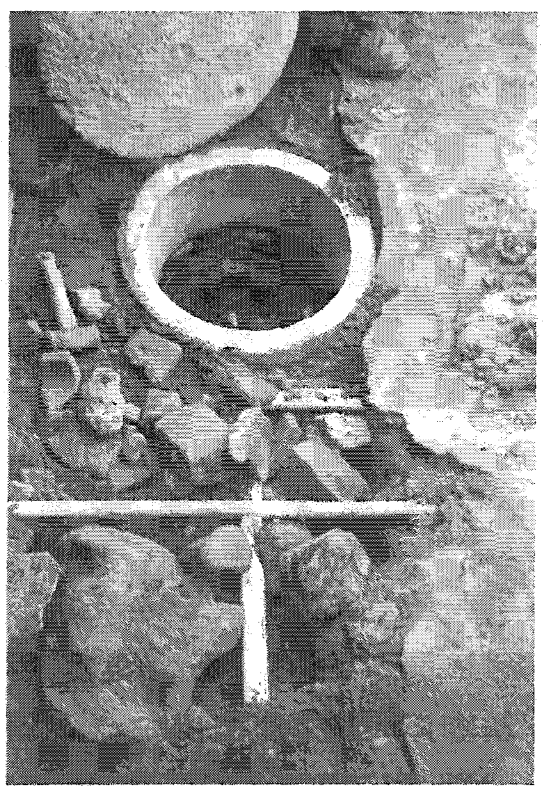


Photo 2-2. Typical installed cleanout box for a backyard condominial sewer system in Brazil. (Source: Photograph taken by the author, 1995).

Clay pipe is less expensive to buy and more durable than PVC pipes, but clay pipe is usually more expensive to install than PVC pipe. The short lengths of clay pipe generate more joints and more opportunities for error in laying the short lengths of pipe at a constant slope. Nevertheless, the total cost (purchase price plus installation cost) of PVC pipe tends to exceed the total cost of clay pipe[14], and so clay pipe is more commonly used for condominial sewers. For house connections however, residents usually choose PVC because of its availability and ease of use.

2.3 Participation in Condominial Sewers

Participation is a fundamental feature of condominial sewers. The importance of participation in condominial sewer technology is apparent in the following statement by a condominial sewer engineer from Recife:

> It's not the physical part that defines a condominial sewer. It's the involvement of the community that is 'condominial.' A conventional layout can be a condominial sewer if the people choose the layout and pay the costs. The method of access to the public sewer is the community's decision. (Informant 1, engineering consultant, former Recife official, and former state official, interview by author, 2 and 13 March 1995, Recife)

While trunk sewers are in the interest of the public at-large, condominial sewers are in the collective interest of the group of homes served. The government usually cannot build a condominial sewer on private land without some agreement from the residents whose homes are already there. There is no traditional legal control (law or right-of-way) that allows the government to build on private land or that prohibits residents from constructing on top of a condominial sewer system located on their property. Condominial sewers thus rely on informal arrangements among the residents comprising the group of homes served by the condominial sewer. Traditional legal controls are replaced with informal agreements in condominial sewers. These "relaxed" legal controls can be expected to increase the risk of poor performance, especially if residents are responsible for constructing and/or maintaining the condominial part of the sewer system.

In both condominial and conventional sewers, the construction and maintenance of public trunk sewers is in the public interest and the construction and maintenance of house connections is in the private interest of residents. As a result, the government usually constructs and maintains trunk sewers, and homeowners construct and maintain their house connections. The condominial sewer lies between the home and the street, so the government typically constructs the condominial sewer in consultation with residents, and residents are expected to maintain the condominial sewer.

Experience has shown that merely providing a conventional sewer in a poor area does not result in a significant percentage of residents connecting to that sewer, even if the sewer is installed directly in front of homes. Lessons from conventional sewer projects in two poor neighborhoods of Natal (Rocas and Santos Reis) reveal that residents did not connect primarily because of high costs and because of low demand for a sanitary sewer. The implementation approach for condominial sewers tackles this problem by seeking input and feedback from residents about their specific needs and limitations. Resident input and feedback is not a traditional part of the implementation approach for conventional sewers.

The design differences between conventional and condominial sewers further contribute to the need for increased interaction between service providers and beneficiaries. Condominial sewers often involve residents in selecting the route for the common collection pipe on private property within each block. Residents are also frequently involved in deciding the final sewer layout on their block (or other private property) and in deciding what level of condominial sewer service – backyard, front yard, or sidewalk – they collectively prefer and can afford. As more of the sewer system is located on private property, there is an increase in the use of resident involvement in decision-making because project beneficiaries are the best ones to make decisions about their private property. Even when residents do not have legal title to their plot (such as in a squatter settlement, shantytown, or slum) they often prefer to decide how their plot will be utilized.

The only departure from this situation is the sidewalk condominial layout (also called a "conventional sidewalk" sewer or an "individual" condominial sewer). In this layout, the sewer is located in a public right-of-way, so beneficiaries are usually not involved in decisions about the layout of piping in the sidewalk. They may be involved in decisions about their household sewer connections, however.

In theory, residents are typically responsible for maintaining the condominial sewer on their block and for constructing and maintaining their individual house connections. In some projects, residents may also be expected to contribute to construction of the condominial sewer. The three condominial sewer layouts that have evolved (backyard, front yard, and sidewalk) represent different expectations about the degree of resident involvement in maintenance. With backyard condominial sewers, neighbors on each block may be expected to assume collective responsibility for maintaining and cleaning the common collection pipe. This is the lowest-cost option. For front yard and sidewalk condominial sewers, the local government or sewer authority may assume some maintenance responsibility because the condominial sewer is more accessible and (in the sidewalk layout) is not located on private property.

Unlike conventional sewerage, an individual home on a condominial sewer route can create blockages and other problems for its closely interconnected neighbors. This is especially true for the backyard and front yard layouts that link homes together with small diameter pipes and less so for the sidewalk layout, in which homes are not directly interconnected. The proper functioning of a condominial sewer can depend on the usage practices of multiple residents and on informal agreements for collective maintenance by the interconnected households.

2.4 Condominial Sewer Implementation in Brazil

Before the development of condominial sewers in Brazil, relaxed sewer design and construction standards had been practiced under the concept of "simplified" sewerage, and the idea of installing collective sewers in yards, alleys, and pathways had originally been tried in India[15]. The use of participation had been previously established as a beneficial aspect of rural water development in many developing countries. Condominial sewerage brought these two practices together. Jose Carlos Rodrigues de Melo, a Brazilian civil engineer, is credited with introducing condominial sewers to Brazil and for successfully encouraging and promoting the technology. Among sanitation professionals in Brazil, Melo is known as the "father" of the condominial sewer approach. Several other Brazilian civil engineers were also at the forefront of promoting and implementing condominial sewers.

Much of the initial innovation and research on condominial sewers was conducted in the State of Rio Grande do Norte by the state water and sanitation agency (*Companhia de Aguas e Esgotos do Rio Grande do Norte*, or CAERN) in consultation with professors from the Federal University of Rio Grande do Norte (*Universidade Federal do Rio Grande do Norte*, or UFRN). Starting in 1980, CAERN initiated pilot projects of condominial sewer technology in the capital city of Natal and in several interior towns (e.g., Currais Novos, Parelhas, and Goianinha). The results of these initial condominial sewer projects were published in a doctoral dissertation[16], in five volumes of research reports by CAERN, and in engineering conference proceedings and professional journals.

These initial studies helped engineers develop rational design standards for condominial sewers, and established participation as a key part of the condominial sewer implementation approach.

During these early experiments with condominial sewers, the World Bank was supportive of implementing the new technology in Natal. However, proposals for implementing condominial sewer technology in Recife were not as well received. Instead of immediately funding condominial sewers, the World Bank initially funded experimental household septic tanks in Recife. Residents received these septic tanks as part of the Word Bank-funded Recife Program. At the same time, CAERN experimented with condominial sewers in Natal with funds primarily from the World Bank. The outcome of the household septic tanks in Recife was generally unsuccessful, while the condominial sewers in Natal showed great promise. This outcome led to Recife finding more support from the World Bank for implementing condominial sewers.

Brazilian practitioners of condominial sewer projects hold a variety of viewpoints on what constitutes a condominial sewer and on which elements are most important. In Tables 2-2 and 2-3, I summarize the range of viewpoints expressed during interviews with numerous condominial sewer practitioners from Recife and Natal, respectively.

The majority of practitioners defined condominial sewers primarily as a participatory process and not as a technology, per se. Others focused on the low-cost or simplified nature of the technology, and still others focused on its location on private property. In

Table 2-2. Some viewpoints on the definition of condominial sewers from practitioners in Recife.

How Would You Define a Condominial Sewer?
"It's not the physical part that defines a condominial sewer. It's the involvement of the community that is 'condominial.' A conventional layout can be a condominial sewer if the people choose the layout and pay the costs. The method of access to the public sewer is the community's decision."
"A collective decision by the residents about how sewage will be collected from their block, with the physical form of the pipe connections being a consequence of the type of block or housing layout."
"...low-cost, shallow depth, and the community acting as a collective. If the collective exists, then a condominial sewer exists, whatever the layout."
"A collection pipe within housing lots where part of the maintenance is the residents' responsibility. In condominial sewers the cleanout boxes are located behind the lots."
"...sewage from an area is collected and disposed of into a public sewer. A low-cost system with collective maintenance and interconnected homes."
"An alternative to serve the population at a lower cost, with shallow pipe depths resulting in reduced maintenance costs compared to conventional sewers."
"If it's an independent connection, it's not a condominial sewer... In every type of sewer design the resident is responsible for their house connection. The only difference for condominial sewers is that the house connection is interconnected to someone else's house."
"A way to divide the costs between residents and government."
"A more economical alternative that requires participation and orientation of the users during implementation."
"A rational and logical solution where people work together to solve sewage problems. It's the *condominio*."
"Participation - a way of combining the forces of residents and the implementing agency. Everybody works together towards the sewer system; the sewer agency does not do everything for the residents."
"The *condominio*, or collective relationship. A collective relationship between residents and the implementing agency, and a collective connection between homes and the sewer infrastructure."
"If the residents build it, contract it, or pay the City to build it then it's a condominial sewer no matter what is the layout. They are also responsible for maintenance."
"Condominial sewerage is not a new technology; it's a new relationship between users and government and among the collectivity of the users themselves."
"It's not a condominial sewer if the homes are not interconnected."

Sources: Informants 1, 3, 7, 9, 12, 29, 30, 31, 59, 100, 101, and 103; condominial sewer practitioners; interviews by author; 1994-1995; Recife.
a. *Condominio* refers to a user group that is thought to form among the residents who share a common collection pipe within a block or group of homes.

Table 2-3. Some viewpoints on the definition of condominial sewers from practitioners in Natal.

How Would You Define a Condominial Sewer?
"A simple system that serves one block, that removes sewage from the homes, and that includes participation of the residents. You can have a sewer in the street and it can be a condominial sewer if the people participate and if it is the simplest way to serve all the houses. In Rio de Janeiro, they designed a condominial sewer attached to the walls of favela homes. In Natal, we use backyard condominial sewers because it is the custom, not because this is the definition of a condominial sewer."
"For a poor area it is a deficient system. It's not viable because low-income residents do not know how to use the sewer system. The system is only viable for users who know how to use it. In the interior of the state it is viable for all areas, rich and poor. But in the city it is only viable for the middle class and above."
"Condominial sewers permit full service to all independent of differences in income. Some think condominial sewers are a solution only for the poor, but I don't agree."
"Physically, it is defined as a low cost system. Philosophically, it is defined by the participation of residents among themselves and by the public agency's actions to stimulate this participation."
"Condominial is a system in which the unit of collection is the block, whereas in a conventional system the unit of collection is the house."
"A sanitary sewer system that requires participation of the residents, and that also has homes interconnected in the backyard, in the front yard, or on the sidewalk. It must have participation because we have to enter the private property of the resident and because one resident can harm others."
"A form of sanitary sewerage that brings awareness to the population, promoting everyone to participate in the system. This is fundamental: participation."
"The major difference is the philosophy. The first thing that's done is to contact the community and see if they want a condominial sewer. In conventional sewers the whole project is designed without ever contacting residents. They don't find out about the project until they see construction happening."
"It follows the objective of health. . . . To the extent that you are really attending to and serving the people, you are resolving the health problems. . . . The resolution of sewer problems for the whole community, and not just for individuals, is a condominial solution."
"A collective system with cleanout boxes located inside the lot or yard, and where the homes are interconnected to the same pipe. The word 'collective' signifies participation of the users because one user can cause problems for others."

Sources: Informants 75, 76, 77, 78, 87, 89, 96, 120, 121, and 122; condominial sewer practitioners; interviews by author; 1994-1995; Natal.

practice, the definition of condominial sewers is flexible, and individual practitioners give different weights to these three features of condominial sewer technology; i.e., participation, relaxed design standards, and location on private property.

According to the state water and sanitation agency that serves Natal (CAERN), a conventional sewer exists when every street has a sewer pipe, so that each household can build an individual connection when they are ready[17]. A conventional sewer system serves houses rather than blocks. Condominial sewerage is based on an initial project philosophy adopted during the planning stage, in which every block does not have a sewer pipe because condominial sewers serve blocks instead of homes. From experience, CAERN has learned that if they install a sewer (conventional or condominial) without notifying, educating, and mobilizing residents, then few residents actually connect due to low demand. CAERN notifies residents in advance to gauge their interest in connecting to the sewer and to create interest in the sewer service.

Applying the condominial approach on a grand scale, CAERN designs and lays out public trunk sewers with the assumption that every block will eventually want to connect. The public trunk sewers are only extended to the tip of each block. CAERN then performs a second round of communication, mobilization, and education of residents in order to lay out the on-block condominial sewers based on which houses want to connect. This second round of participation is conducted block by block throughout the project area. Residents who want individual connections to the public trunk sewer must pay CAERN to extend the nearest public trunk sewer to the front of their house (quite an expense) and then pay for their own connection.

Under CAERN's interpretation, both conventional and condominial sewers can make use of any pipe material, pipe slope, and pipe diameter that is appropriate for the design needs of the site. The choice of materials does not define a condominial sewer; however, within-block condominial sewers do typically use flatter slopes and smaller diameters as the norm. For the public trunk sewer, CAERN may make use of conventional manholes where system depth requires them, or may use smaller cleanout boxes where possible, to reduce overall system costs. Based on CAERN's interpretation, Natal's only true conventional sewer is the antique conventional sewer system of the 1940s, which was built by the United States. Since that time, all new sewer construction in Natal has been based on the condominial approach described above.

Condominial sewer systems may involve the use of local pump stations (as needed for proper flow) and community septic tanks (for localized treatment of the collected sewage). In other instances, sewage collected by condominial sewer systems is routed to a centralized or regional wastewater treatment plant. In Brazil, all of the collected sewage is not necessarily treated by wastewater treatment plants; some may be discharged to (or interconnected with) the storm drainage system, resulting in untreated sewage being discharged to local surface waters. In 1995, sewer agency staff in Recife estimated that only about 24 percent of the population was connected to the public sewer system[18] and only 20 percent of the collected sewage was treated prior to discharge.

In his review of low-cost sewer technologies, Azevedo-Netto (1992) identified condominial sewers in over 40 towns in Brazil; however, a complete listing of these towns and the range of sewer performance was not provided[19]. The World Bank (1992) estimated that hundreds of thousands of Brazilians were using condominial sewers as of 1992, and that most of these had been installed in the Northeast (NE) region of Brazil[20]. Table 2-4 presents a list of Brazilian cities with condominial sewers, as of 1994, compiled from a variety of sources. As shown in this table, most cities that have implemented condominial sewers are located in the Northeast (NE) region of Brazil.

When condominial sewers began to be used in Brazil in the early 1980's, most practitioners (e.g., sewer agency staff, engineering consultants) in support of the technology thought condominial sewers would be primarily targeted to the poor. But by 1995, many condominial sewer practitioners believed the technology could serve everyone, rich and poor[21]. As a design innovation and a new approach to infrastructure service provision, condominial sewerage increases the feasibility of providing basic sanitary sewers to unserved neighborhoods. However, preliminary evidence from completed condominial sewer projects suggests that the new technology alone has not resulted in widespread and consistent success.

Table 2-4. Brazilian cities with condominial sewerage as of 1994[a].

Region of Brazil[b]	City, State	City Population (1992)	No. of Projects	No. of Homes Served	Start Up Year	Ongoing Projects?	Overall Performance
SE	Rio de Janeiro, Rio de Janeiro	5,473,909	n/a	n/a	n/a	Yes	n/a
NE	Salvador, Bahia	2,072,058	n/a	n/a	n/a	n/a	n/a
NE	Fortaleza, Ceara	1,765,794	n/a	n/a	n/a	Yes	n/a
CW	Brasilia, Distrito Federal	1,513,500	8	12,000	1990	n/a	Excellent
NE	Recife, Pernambuco	1,297,000	20	8,000	1986	Yes	Poor
NE	Natal, Rio Grande do Norte	606,500	8	11,800	1980	Yes	Good
CW	Cuiaba, Mato Grosso	401,000	9	8,500	1986	Yes	Poor
CW	Dourados, MS	n/a	n/a	n/a	n/a	Yes	n/a
S	Joinville, Santa Catarina	333,900	1	450	1986	Yes	Good
S	Fatima, Santa Catarina	n/a	n/a	n/a	n/a	n/a	n/a
SE	Niteroi, Rio de Janeiro	n/a	n/a	n/a	n/a	Yes	n/a
SE	Baixada Fluminense, Rio de Janeiro	n/a	n/a	n/a	n/a	n/a	n/a
NE	Petrolina, Pernambuco	125,400	12	11,400	1983	Yes	Excellent

Continued…

Table 2-4. Continued.

Region of Brazil[b]	City, State	City Population (1992)	No. of Projects	No. of Homes Served	Start Up Year	Ongoing Projects?	Overall Performance
NE	Petrolandia, Pernambuco	n/a	n/a	n/a	n/a	n/a	n/a
NE	Parnamirim, Rio Grande do Norte	n/a	n/a	n/a	n/a	n/a	n/a
NE	Currais Novos, Rio Grande do Norte	n/a	n/a	n/a	n/a	n/a	n/a
NE	Sao Tome, Rio Grande do Norte	n/a	n/a	n/a	n/a	n/a	n/a
NE	Parelhas, Rio Grande do Norte	16,150	n/a	n/a	n/a	n/a	n/a
NE	Itapissuma, Pernambuco	14,000	2	400	1986	Yes	Excellent
NE	Sape, PA	55,000	n/a	n/a	n/a	n/a	n/a
NE	Juazeiro do Norte, Ceara	n/a	n/a	n/a	n/a	Yes	n/a

Sources: Watson (1993:4), Azevedo-Netto (1992:49), Mejia, *et al.* (1993:3), IBGE (1992), and Watson (1992).

a. Information for all projects was not available. The abbreviation "n/a" indicates not available.

b. SE = southwest, NE = northeast, CW = central west, and S = south.

In some instances, condominial sewers have been implemented with resident involvement in planning, construction, and/or maintenance. In other instances, sewer authorities and municipal agencies have implemented condominial sewers without the participation of beneficiaries. Among the approximately two dozen Brazilian cities that have installed condominial sewers, several implementation approaches have been tried and there are successful and unsuccessful outcomes. Anecdotal reports from condominial sewer practitioners converge on the idea that projects are more successful when beneficiaries participate in project implementation, and that those projects lacking adequate participation are less successful[22]. However, there is no standard method for evaluating condominial sewer performance or for comparing projects. Likewise, participation has not been systematically evaluated with regard to its impact on the outcome of condominial sewer projects, nor has the significance of participation been put in perspective compared to other factors that affect project outcome. The remainder of this dissertation formally addresses these questions.

---

[1]Azevedo-Netto, 1992:48; and World Bank, 1992:107.
[2]In this dissertation, the term "cesspool" refers to a simple onsite pit to which waste is disposed with or without water. Cesspools are typically used to store the waste from simple pit latrines. The term "leachpit" (also known as a soakage pit or a soakaway) refers to a brick-lined onsite pit that permits the seepage of wastewater into the surrounding ground. The term "septic tank" refers to an onsite, watertight, underground settling tank constructed so that solids are collected and wastewater flows through to a leachpit, drainage field, or sewer system. (Sinnatamby, 1990:131-145).
[3]Bakalian, et. al., 1994; Azevedo-Netto, 1992:48; World Bank, 1992:108; Wright and Bakalian, 1990; and Santos and Gazen, 1987:5.
[4]Informant 12, COMPESA engineer, interview by author, 10 March 1995, Recife, transcript.
[5]Mainwaring, 1999:90.
[6]Mainwaring, 1999:90.
[7]Mejia, et. al., 1993. Based on 4.39 people per household for the project areas studied in this dissertation (IBGE, 1991), this range in per capita cost is equivalent to a range of $211 to $540 per connection (in 1993 US dollars).
[8]Sinnatamby, 1990:148.
[9]Bakalian, et. al., 1994:23.

[10]Bakalian, et. al., 1994:23; and Sinnatamby, 1990:148.
[11]Informant 100, president of an engineering company, interview by author, 19 March 1995, Recife, transcript.
[12]Informant 100, president of an engineering company, interview by author, 19 March 1995, Recife, transcript.
[13]As defined by Corbitt (1990:6.62), infiltration is "the groundwater which leaks into the sewer system generally through deteriorated and/or defective pipes, joints, connections, and manholes. . . . Inflow is the storm water which directly enters the sewer system after rainfall from such sources as flooded manhole covers, yard and roof drain connections, and cross-connections with a storm sewer." (Corbitt, 1990:6.62).
[14]Informant 100, president of an engineering company, interview by author, 19 March 1995, Recife, transcript.
[15]Informant 89, CAERN senior maintenance technician, interview by author, 19 May 1995, Natal, transcript.
[16]Sinnatamby, 1983.
[17]Informant 78, CAERN sewer design division chief, interview by author, 2 May 1995, Natal, transcript.
[18]Informant 29, COMPESA operation and maintenance coordinator, interview by author, 6 December 1994, Recife, transcript.
[19]Azevedo-Netto, 1992:49.
[20]World Bank, 1992:107.
[21]Informant 31, consulting engineer, interview by author, 3 March 1995, Recife, transcript.
[22]Informant 121, CAERN sewer construction division manager, interview by author, 1 June 1995, Natal, transcript; Informant 29, COMPESA operation and maintenance coordinator, interview by author, 6 December 1994, Recife, transcript; Informant 4, sociologist, former EMLURB staff member, former director of a condominial program, interview by author, 2 December 1994, Recife, transcript; Informant 31, consulting engineer, interview by author, 3 March 1995, Recife, transcript; and Luis Baltar, EMOPER, to Sergio Pimentel, COMPESA, 1 June 1988, letter attached to COMPESA Memorandum CM 110/88 – DT 26/88, 10 June 1988, Recife.

Chapter 3

Research Methods

Condominial sewer technology in Brazil was initiated in 1980. The technology is still emerging and few research studies have been published. Knowing this led me to consider carefully the best research methodology for exploring the implementation process and investigating the relationship between project performance and the participation of project beneficiaries. In this chapter I present my rationale for selecting a qualitative research approach (Section 3.1); describe how I selected the research sites, the case study projects, and the study participants (Section 3.2); describe the sources and procedures I used to gather data (Section 3.3); describe how I analyzed the data (Section 3.4); and present the strategies I used to manage reliability, validity, and bias (Section 3.5). The research methodology is primarily qualitative. Even though some statistical methods are applied to the participation and performance variables, the measurement of these variables is based on qualitative data.

3.1 Rationale for Selecting a Qualitative Research Approach

I selected a qualitative research approach for two reasons. First, a qualitative approach allowed me to fully explore the implementation process by gathering in-depth information on the experiences of condominial sewer practitioners and beneficiaries in the context of specific projects. In my view, a qualitative approach provided higher quality data than a purely quantitative approach. In a qualitative design I could focus on gathering primary data on a few projects, whereas in a quantitative design I would have to mine secondary data sources for information on a large sample of projects. Based on my discussions with World Bank staff, other researchers, and condominial sewer practitioners, and based on my reconnaissance visits to condominial sewer implementing agencies in Brazil, I learned that very few, if any, reliable secondary data sources were available. I concluded that, for this topic, a detailed and exploratory examination of implementation was best achieved with a qualitative research approach.

Condominial sewer technology is relatively new and not intensely studied. At the beginning of my research, I did not know what the important variables were, so the need for knowledge and understanding to unfold throughout the dissertation was critical. This led to my second reason for adopting a qualitative research approach. The emerging design approach of qualitative research would allow me to discover other variables (beyond participation) that were important to the condominial sewer implementation process. As my exploration of implementation evolved within a qualitative research design, I would be able to identify additional phenomena that influenced, mediated, or confounded the implementation process. I concluded that a qualitative research design was the best approach for keeping my inquiry open. To summarize, I selected a qualitative research approach because of the newness of my research topic and because of the exploratory nature of my research questions.

There are several types of qualitative inquiry to choose from, including case-based, ethnographic, grounded theory, phenomenological, etc[1]. I selected a case-based qualitative strategy for this dissertation because I was primarily interested in exploring condominial sewer projects in-depth, and because projects could be readily bounded – temporally, spatially, and by activity – into discrete cases. From reading other studies that had only focused on project implementation at the city level, the policy level, or the program level, I realized that with these policy and program units of analysis one could not examine in detail the aspects of implementation that were internal to each project (internal characteristics). Without detailed project level information, one could not identify which factors caused some projects to perform better than others.

I was also interested in exploring the two cities in which my case study projects were located so that I could identify important factors that were external to each project's implementation process (external characteristics). Like projects, cities can also be considered case studies of experiences bounded by time, space, and activity. My approach was to use comparative micro-analysis of projects as well as comparative macro-analysis of cities to discover the external and internal factors that impacted project implementation. Knowledge about internal characteristics, such as participation in the project, could be useful for explaining the performance of individual projects. Knowledge about external characteristics, such as political factors operating at the city level, could be useful for explaining patterns of performance among multiple projects in and between cities. My strategy was based on the assumption that gathering data at both the project and the city level were important for achieving a complete picture of implementation.

Thus far, I have explained my rationale for selecting a qualitative research approach. Although this dissertation is primarily qualitative, I did utilize some simple, non-parametric statistical methods in the measurement and analysis of the participation and performance variables. The following three specific aspects of my research were well-suited to this quasi-quantitative approach:

1. Participation – I developed indexes to measure various aspects of participation of project beneficiaries and to categorize case study projects based on their (ordinal) level of participation.
2. Performance – I developed an index to measure project performance and used non-parametric statistical tests to categorize case study projects based on their (ordinal) level of performance.
3. Association Between Participation and Performance – I used graphical analysis to evaluate the possible association between the participation and performance variables.

The use of these quantitative methods complemented the qualitative case study descriptions, facilitated comparison among the case study projects, and supported the main argument of the dissertation, which was qualitative in nature.

3.2 Sample Selection

I obtained data on three types of samples: research sites (i.e., cities), case study projects, and participants. My decision-making criteria for selecting samples are described in the following sub-sections.

3.2.1 Research Site Selection Criteria

One of the first steps in designing my research was to create a list of all known condominial sewer projects in Brazil (see Chapter 2, Table 2-5). To make efficient use of time and funds available for field research, I limited the dissertation to two cities with experience in implementing condominial sewer projects. My selection criteria for choosing the two cities are presented in Table 3-1.

The two research sites that were selected using these criteria were both located in the Northeast region of Brazil. The Northeast region is historically the poorest region in Brazil, as evidenced by the average monthly income data presented in Table 3-2. The average monthly income in the Northeast is only slightly above the poverty line of one minimum salary. In Brazil, one minimum salary is similar to the minimum wage in the United States, except that a minimum salary is per month, not per hour. Experience with condominial sewers in the Northeast has been the most widespread and the most successful[2].

Because the Northeast is the poorest region in Brazil, low-cost technologies such as condominial sewerage are particularly appropriate. Therefore, I chose the Northeast as the geographical region from which to select case study cities. Maps of Brazil showing state boundaries and capital cities are presented in Figure 3-1 and Figure 3-2.

Table 3-1. Criteria used to select research sites.

Research Site Selection Criteria
1. City officials and agency staff must be willing to cooperate in the study.
2. There must be a variety of information sources available to conduct case studies, and there must be available access to project staff and beneficiaries of the projects.
3. The two selected cities must be located within one geographical region of Brazil to eliminate the need to account for regional differences in cultural, socio-economic, and political factors.
4. Each city must be a medium or large city (based on population) with a relatively large number of condominial sewer beneficiaries to avoid the idiosyncrasies associated with implementation in small towns or mega-cities.
5. Each city must have at least five years experience with condominial sewers so that the implementing agency(s) is not in the first stages of learning about the technology and so that there is enough experience from which to draw.
6. Each city must have at least five condominial sewer projects at different stages of implementation so that there are several projects from which to choose.

Table 3-2. Average monthly income per person in minimum salaries for Brazil, by region[a], from 1989 to 1999.

Year	Total	N	NE	SE	S	CW
1989	2.4	2.5	1.2	3.0	2.4	2.7
1990	2.0	2.2	1.0	2.4	2.0	2.3
1992	1.7	1.4	0.9	2.1	2.0	1.8
1993	1.9	1.6	1.0	2.3	2.2	2.0
1995	2.4	2.1	1.3	3.0	2.7	2.4
1996	2.4	2.0	1.3	3.1	2.7	2.4
1997	2.4	2.0	1.3	3.1	2.7	2.6
1998	2.4	1.9	1.4	3.0	2.7	2.6
1999	2.3	1.8	1.3	2.8	2.6	2.4
10-year Average[b]	2.21	1.94	1.19	2.76	2.44	2.36

Source: IBGE PNAD, 1999, (www.ibge.gov.br/english/estatistica/populacao/trabalhoerendimento/pnad99/sintese/tab7_1_15.shtm).

a. N = Old Urban North region; NE = Northeast region; SE = Southeast region; S = South region; CW = Old Central West region

b. My calculations using IBGE data.

Figure 3-1. Brazil in relation to other South American countries, with capital cities. Source: Courtesy of The General Libraries, The University of Texas at Austin.

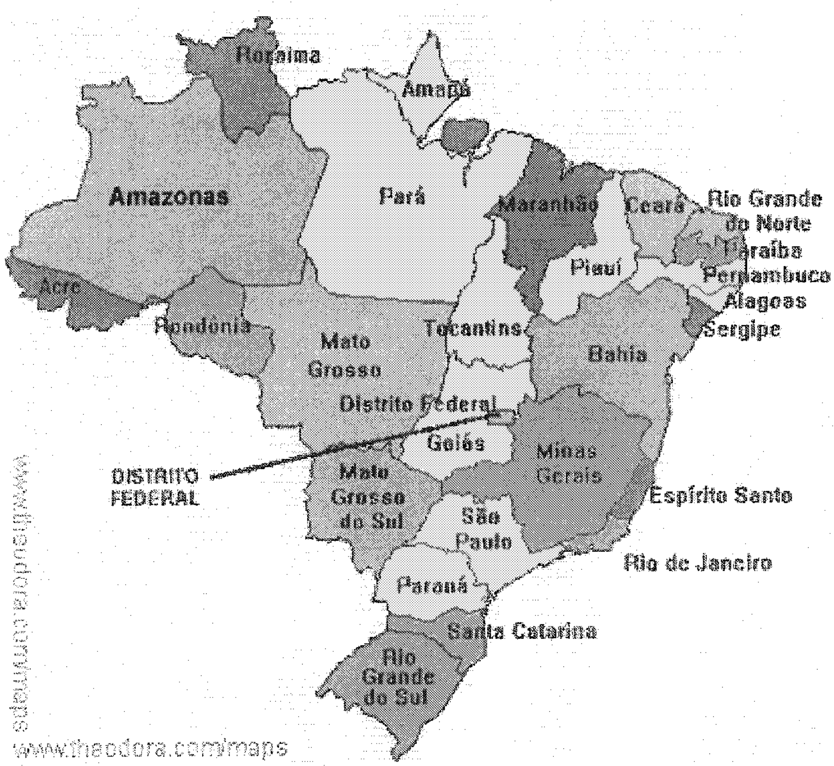


Figure 3-2. The states and federal district of Brazil.
Source: Map courtesy of www.theodora.com/maps, used with permission.

The fourth selection criteria in Table 3-1 states that the two cities must be medium-sized cities (over 100,000 people) or large cities (over 500,000 people). The Northeast cities of Petrolina, Recife, Natal, Fortaleza, Juazeiro do Norte, and Salvador all meet this criterion. However, only Recife, Natal, and Petrolina meet the fifth and sixth criteria; that is, five years of experience with condominial sewers and five or more projects in various stages of implementation (see Table 3-1). The interior town of Petrolina is considerably smaller and more rural than the urban, capital cities of Recife and Natal, both located on the coast. During a reconnaissance visit to Recife and Natal in May, 1994, I confirmed that Recife and Natal met the criteria. Although Recife is larger than Natal, each city has well over 10,000 condominial sewer connections. Because Natal and Recife satisfied all six of my selection criteria, I chose them as my two research sites.

Recife and Natal are capital cities in Brazil's Northeast region that are both over 450 years old; but despite their proximity it would be a mistake to assume no variation in condominial sewer implementation existed between the two cities. The different historical and political-economic conditions of each city produced different local contexts for implementation. Natal has only really developed in the last 50 years, so the city has a more modern appearance than Recife. Most of Recife's growth and development took place hundreds of years ago. Recife has a class of very wealthy people as a result of its international port and sugar cane, coffee, cotton, and tobacco economies. This wealth has historically attracted the rural poor to immigrate to Recife from the interior and from other states in the Northeast region. Natal does not have this level of wealth, but it still has poverty. Many of Natal's poorest people live in favelas on the periphery of the city, while in Recife the poor live within the city itself as well as on the urban fringe. Table 3-3 shows that Recife has ten times more favela households than Natal, even though the population in Recife is only twice that of Natal.

Table 3-3. Census data on the numbers of permanent private households and favela households in the cities of Recife and Natal.

City	Population in 2000	Permanent Private Households in 2000	Favela Households in 2000	Percent of Households that are Favelas[a]
Recife	1,422,905	376,022	154,280[b]	29.1%
Natal	712,317	177,783	13,030	6.83%

Source: IBGE, 2003 (www.IBGE.gov.br).
a. My calculations using IBGE data.
b. The figure for favela households in Recife is for the year 1999.

Compared to Natal, Recife is surrounded by a larger metropolitan community that includes the cities of Olinda and Jaboatao. Recife is larger in land area and population, and is more economically developed. Some condominial sewer agency staff in Natal reported that Recife was "more politically advanced" than Natal in terms of people recognizing their rights, mobilizing to meet the basic needs of their communities, and joining political parties[3]. With respect to condominial sewer technology, agency staff reported that Natal was "more evolved" than Recife[4].

Like Recife, Natal is built on a river floodplain, but Natal does not have flat topography, a high water table, and poor soil conditions as Recife does. Natal also has a drier climate than Recife. Consequently, Natal's drainage problems are not nearly on the scale of the drainage problems in Recife. In both cities, but in Recife especially, interconnections between storm drains and sanitary sewers result in a great volume of untreated sewage. Both Natal and Recife suffer from a severe shortage of sewage treatment capacity, and both cities only treat a paltry percentage of the total sewage collected. Both cities exhibit a pattern in which the better performing sewer systems tend to be located in neighborhoods with higher average incomes, and the worst performing projects tend to be located in the poorer neighborhoods; however, there are some exceptions to this pattern. With regard to sewer expansion from the late 1980s to the mid 1990s, sewer connections (conventional and condominial) in Natal grew by 18 percent while sewer connections in Recife grew by 11 percent[5].

Population data for the selected cities, their states, and the country of Brazil are presented in Table 3-4. Based on these population data, 18% to 26% of the state populations in Pernambuco and Rio Grando do Norte have resided in the capital cities of Recife and Natal, respectively, over the past two decades. During the past ten years, Recife has had approximately twice the population of Natal.

3.2.2 Case Study Selection Criteria

My fundamental objective in choosing cases was to select examples that illustrated the diversity of implementation experiences and project outcomes that were known to exist. Examining both failure and success provides an opportunity to learn from contrast. I had time and resources to study only three or four projects in depth in each of the two cities.

Table 3-4. Population of the research site cities, their associated states, and the country of Brazil from 1980 to 2000.

Year	Brazil (million)	Pernambuco (million)	Recife (million)	Rio Grande do Norte (million)	Natal (million)
1980	121.286	6.142	1.184 (19%)[a]	1.898	0.3766 (20%)
1991	151.152	7.128	1.298 (18%)	2.416	0.6069 (25%)
1996	161.365	7.399	1.346 (18%)	2.559	0.6560 (26%)
2000	172.860	7.911	1.422 (18%)	2.771	0.7094 (26%)

Source: Populstat, 1999/2003 (www.library.uu.nl/wesp/populstat/Americas/brazilp.htm and www.library.uu.nl/wesp/populstat/Americas/brazilc.htm).
a. My calculations using Populstat data.

Selection of these case study projects could only be done in the field due to the lack of information available outside of Brazil (beyond the information presented in Chapter 2, Table 2-5).

When I was in the field, I created a census of condominial sewer projects in each city that was much more complete and detailed than Table 2-5. Each census was based on discussions with engineers, maintenance personnel, and other staff of city and state implementing agencies who had knowledge about the scope of condominial sewer projects in their city. Table 3-5 presents the census of condominial projects in Recife, and Table 3-6 presents the census for Natal.

Table 3-5. Condominial sewer systems in Recife as of March, 1995.

Condominial Sewer System	No. of Connections[a]	Implementing Agency[b]	Maintenance Agency[b]
Coque	240	URB, 1987/1994	COMPESA
Coelhos	117	URB, 1986	COMPESA
Joao de Barros	340	URB, 1995	COMPESA
Alto Santa Izabel	500	URB/ COMPESA, 1992	COMPESA
Afogados	(d)	URB/ COMPESA	COMPESA
Brasilit	(d)	URB/ COMPESA	COMPESA
Campo Grande	(d)	URB/ COMPESA	COMPESA
Vila Tamarineira	130	URB, 1993	COMPESA
Apipucos	125	URB, 1988/1994	COMPESA
Vila Santa Luzia	1700	URB, 1983	COMPESA
Barbalho	300	URB, 1990	COMPESA
Vila Santa Marta	174	URB, 1987	COMPESA
Skylab I	275	URB, 1987	COMPESA
Aritana	38	URB, 1987	COMPESA
Gleba 14	155	URB, 1990	COMPESA
Roda de Fogo	3100	URB, 1990	COMPESA
Vila Sao Miguel	(c)	URB 1995	COMPESA
Coronel Frabiciano	87	URB, 1986/1993	COMPESA
Entra-a-Pulso	35	URB, 1986/1993	COMPESA
Vila Teimosinho	147	URB, 1989	COMPESA
Mangueira	(c)	URB 1995	COMPESA
Joao Xavier Pedrosa	91	EMLURB, 1988	COMPESA
Alderico Pereira Rego	10	EMLURB, 1988	COMPESA
Jardim Beberibe	30	EMLURB/ COMPESA, 1988	COMPESA
Vila Jorge Pimenta	350	EMLURB, 1988	COMPESA
Cajueiro	440	EMLURB, 1988	COMPESA
Abdias de Oliveira	212	EMLURB, 1986	COMPESA

Continued...

Table 3-5. Continued.

Condominial Sewer System	No. of Connections[a]	Implementing Agency[b]	Maintenance Agency[b]
Ind. Paulo Alimonda	25	EMLURB, 1987	COMPESA
Rio Jiquia	31	EMLURB, 1989	COMPESA
Skylab II	135	EMLURB, 1987	COMPESA
Brasilandia	63	EMLURB, 1988	COMPESA
Ruth Moura	19	EMLURB, 1989	COMPESA
Avare/Tupinare	65	EMLURB, 1988	COMPESA
Rua Metodio Maranhao	120	EMLURB, 1988	COMPESA
Olegario Mariano	13	EMLURB, 1990	COMPESA
Vietna	(d)	EMLURB, 1988	COMPESA
Vila Nossa Senhora Fatima	35	EMLURB, 1988	COMPESA
Vila Burity	269	EMLURB/ COMPESA, 1987	COMPESA
Planeta dos Macacos	20	EMLURB/ COMPESA, 1988	COMPESA
Vila Cardeal Silva	(d)	EMLURB/ COMPESA, 1990	COMPESA
Nova Trento	19	COMPESA/ EMLURB, 1990/1991	COMPESA
Elpidio Branco	90	COMPESA/ EMLURB, 1990	COMPESA
Jose da Bomba	40	COMPESA/ EMLURB, 1988	COMPESA
Cacimbao	80	COMPESA/ URB, 1987/1991	COMPESA
Burity (Alto COHAB)	1528	COHAB, 1990	COMPESA
Ambole	1	COHAB, 1990	COMPESA
PE. Henrique	(d)	COHAB, 1994	COMPESA
Lot. Mel. Gonc. da Luz	56	COHAB, 1988	COMPESA
Conjunto 27 Novembro	6500	COHAB, 1988	COMPESA

Sources: *Quadro Resumo – Esgoto Condominial*, EMLURB, March 8, 1995; and EMLURB, URB, COHAB, and COMPESA staffs, interviews by author, 1994-1995, Recife, transcripts.

a. The numbers of connections are estimates only.

b. Abbreviations used for Recife are as follows:

URB – Urbanization Agency (Empresa de Urbanizacao)
EMLURB – Urban Cleanup Agency (Empresa Municipal de Limpeza Urbana)
COMPESA – State Water and Sanitation Agency (Companhia do Pernambuco de Saneamento)
COHAB – State Housing Agency (Companhia de Habitacao do Pernambuco)

c. Project was being implemented at the time of this fieldwork.

d. Number of connections was not available.

Table 3-6. Condominial sewer systems in Natal as of May, 1995.

Condominial Sewer System	No. of Connections or Blocks Served[a]	Implementing Agency[b]	Maintenance Agency[b]
Petropolis	10 blocks	CAERN	CAERN
Basin A – Rocas, Santos Reis (pilot project)	3000 connections 86 blocks	CAERN, 1986	CAERN
Basin A – Areia Preta, Mae Luiza	(d)	CAERN, 1995	CAERN
Basin C - Lagoa Seca	1000 connections 15 blocks	CAERN, 1988	CAERN
Basin C – Tirol	6 blocks	CAERN, 1988	CAERN
Basin D - Bairro Nordeste	23 blocks in 1989 31 blocks in 1994	CAERN, 1989/1994	CAERN
Basin D - Bairro Quintas (population 27,500) (area 446 hectares)	900 connections 54 blocks in 1989 5500 connections 70 blocks in 1994	CAERN, 1989/1994	CAERN
Basin D – Alecrim	4 blocks	CAERN	CAERN
Basin E - Bairro Nordeste	31 blocks	CAERN	CAERN
Basin E - Bairro Quintas	7000 connections 70 blocks	CAERN, 1987	CAERN
Basin E - Bom Pastor	20 blocks	CAERN, 1987	CAERN
Basin E - Dix-Sept Rosado	6 blocks in 1989 26 blocks in 1995	CAERN, 1989/1995	CAERN
Basin F - Bom Pastor	(d)	CAERN	CAERN
Basin G - Nova Descoberta (pilot project)	1000 connections 7 blocks	CAERN	CAERN
Basin G - Morro Branco (pilot project)	(d)	CAERN	CAERN
Basin H - Dix-Sept Rosado	(d)	CAERN, 1995	CAERN
Basin I - Nazare	(c)	CAERN	CAERN
Basin I - Esperanza	(c)	CAERN	CAERN
Basin K - Felipe Camarao (pilot project)	100 connections 4 blocks	CAERN	CAERN

Sources: CAERN project reports; and CAERN staff, interviews by author, 1995, Natal, transcripts.

a. The numbers of connections and blocks are estimates only.

b. Abbreviations used for Natal are as follows:
CAERN – State Water and Sanitation Agency (*Companhia de Agua e Esgoto do Rio Grande do Norte*)

c. Project was being implemented at the time of this fieldwork.

d. Number of connections was not available.

My strategy for selecting projects as case studies was to identify a small number of polar cases (*i.e.*, the "best" and the "worst" projects) in terms of project participation and performance. In the field, I learned that identifying the best and worst projects was not straightforward. Some projects were identified as best *and* worst by different informants. Faced with these conflicting opinions, I developed the following criteria for selecting polar cases in each city (see Table 3-7). At this stage of my research, participation and performance were loosely defined in a qualitative sense. Good participation was characterized by adequate levels of interest and involvement by beneficiaries in the agency's participation program. Bad (or no) participation meant lack of an agency participation program and lack of interest and involvement by beneficiaries. Good performance was characterized by adequate sewer functioning. Bad performance meant regular system failures and high levels of complaints from users.

Table 3-7. Criteria used to select case study projects.

Case Selection Criteria
1. Develop a census of all existing condominial projects for each city and a list of agency staff that know the most about each project.
2. Interview engineers, maintenance staff, and social science staff one-by-one, asking each person to identify the best and worst projects in their city (or to identify the best and worst projects from a list of projects).
3. Visit the named project sites to develop preliminary knowledge about the projects.
4. Compile and analyze the information obtained. Eliminate projects judged best and worst and projects with ambiguous outcomes.
5. Select a set of polar projects that represents both good and bad performance and both good and bad participation, to the degree possible.

During the selection process, I found that for some projects there was widespread agreement on performance and participation outcomes. These were the set of projects from which I selected my case studies. Tables 3-8 and 3-9 summarize the "best" and "worst" projects based on staff responses in Recife and Natal, respectively. These tables show that staff opinions were mixed and sometimes conflicting. These differences may have been caused by personal differences in the definitions of performance and participation as well as differences in staff project knowledge. Among Recife staff, slightly more projects were judged to be bad performers (12) than good performers (10), and more projects were judged to have good participation (15) than bad participation (9) (see Table 3-8). Among Natal staff, slightly more projects were judged to be good performers (10) than bad performers (8), and more projects were judged to have good participation (12) than bad participation (5) (see Table 3-9).

When asked in the context of an informal interview about all of the projects in their city, most staff (with the exception of some maintenance staff) had no difficulty and needed little prompting in identifying successful and unsuccessful projects or, when presented with a list of projects, had no difficulty placing projects from the list into good and bad categories. However, when subsequently asked to rate three or four specific projects (which I had selected) on a 5-point scale in the context of a semi-structured interview, most engineering staff responded that they did not have enough knowledge of actual project performance to provide an answer.

Table 3-8. Characterization of Recife condominial sewer project performance and participation by seven agency staff members[a].

Condominial Sewer System	Performance		Participation	
	Good	Bad	Good	Bad or None
Jardim Beberibe	1		1	
Jardim Sao Paulo	2		1	
Jose da Bomba	3	1	1	
Vila Sao Miguel	3	2		1
Burity Alto	1			1
Rio Jiqui	1		1	
Entra-a-Pulso	2		1	
Alto Santa Isabel	1			1
Abdias de Oliveira	2	1	1	
Vila Burity	2		1	
Vila Jorge Pimenta		5		1
Brasilandia		1	1	
Barbalho		2		1
Vila Nossa Senhora Fatima		1	1	
Vila Cardeal Silva		1		
Coronel Fabriciano		1	1	
Cacimbao		1		1
Roda da Fogo		2		1
Cajueiro		1	1	
Joao Xavier Pedrosa			1	
Alderico Pereira Rego			1	
Ind. Paulo Alimonda			1	
Ruth Moura				1
Avare/Tupinare			1	
Olegario Mariano				1
Total Projects	10	12	15	9

Sources: COMPESA, URB, and EMLURB staffs, interviews by author, 1994-1995, Recife, transcripts.
a. Blank spaces indicate categories for which a project was not selected by agency staff.

Table 3-9. Characterization of Natal condominial sewer project performance and participation by five agency staff members[a].

Condominial Sewer System	Performance		Participation	
	Good	Bad	Good	Bad or None
Petropolis	1		1	
Santos Reis	1	1	1	
Tirol	4		1	1
Lagoa Seca	2			2
Rocas		5	1	
Quintas E		2	1	1
Nordeste E	1	1	1	
Morro Branco	3			
Alecrim	1		1	
Nordeste D	1		1	
Quintas D (Phase 1)		2	1	
Dix-Sept Rosado E	1	1	1	
Bom Pastor E		1	1	
Bom Pastor F		1		
Nova Descoberta	1		1	1
Felipe Camarao				1
Total Projects	10	8	12	5

Sources: CAERN staff members, interviews by author, May 1995, Natal, transcripts.
a. Blank spaces indicate categories for which a project was not selected by agency staff.

The maintenance staff, in general, had a much more detailed and nuanced perspective on performance than the engineering, management, or social science staff. Some maintenance staff found it difficult to group projects by performance level in the context of an informal interview. They reported that condominial sewer technology had more problems compared to conventional sewers, and that older condominial sewer projects had the most problems of all. Maintenance staff saw sewer performance as a function of topography, quality of construction, project size, user education level, user income level, technology type, and system age, and they had conflicting opinions about which of these problems was most important.

Most staff interviewed believed misuse by users was the worst problem of all for condominial sewers[6]. One staff member remarked that "just one uneducated person can cause problems for all the others[7]". Other staff lamented the problems created during design and construction as being the most irresolvable of problems[8]. Rather than reducing their opinion of project performance into "good" and "bad" categories, maintenance staff generally preferred to describe the array of problems for each neighborhood, taking into account a variety of characteristics that impacted the amount of maintenance required. These kinds of responses reveal the wide spectrum of possible definitions for the performance variable and the numerous variables potentially affecting performance.

There was, however, widespread agreement by all staff about which projects were the very worst performers. But even when staff generally agreed on the performance level of a particular project, their judgments may have been for different reasons. Some staff believed performance was "good" if project implementation was simply completed. Other staff considered performance as "good" if the project served a large number of people. Others judged performance as "good" based on how the system actually functioned. Similarly, some staff determined that a project had good participation based on high levels of participation during the *implementation* phase, while other staff rated the same project as having bad participation based on low levels of participation in the project *maintenance*. For still other projects, there was no clear reason why they were ranked best and worst by different individuals.

These issues present the possibility of high sampling and measurement error for two of the variables of interest (participation and performance). Consequently, the staff judgments used in this case study selection method did not constitute the final conclusions about project participation and performance. Rather, I used these staff judgments as a pre-screening step. I found that selecting polar case studies based on a compilation of informed judgments from local implementing agency staff provided a flawed but workable preliminary case selection method. This finding also confirmed my suspicion that more detailed definitions of the project participation and performance variables were needed.

My method for selecting cases from staff judgments was as follows. I categorized the information in Tables 3-8 and 3-9 into three groups: projects unanimously judged "good," projects unanimously judged "bad," and "ambiguous" projects that were judged both good and bad or that were not mentioned. These project groups are presented in Table 3-10. From this list I selected six polar cases, which included projects with both good and bad participation as well as good and bad performance.

Table 3-10. Initial categorization of condominial sewer projects in Recife and Natal based on the judgments of agency staff.

	Good Participation	**Ambiguous Participation**	**Bad or No Participation**
Good Performance	*Alecrim* *Nordeste D* Jardim Beberibe Jardim Sao Paulo Rio Jiqui Entra-a-Pulso Vila Burity	*Tirol* *Morro Branco* *Nova Descoberta*	*Lagoa Seca* Burity Alto Alto Santa Isabel
Ambiguous Performance	*Santos Reis* *Nordeste E* *Dix-Sept Rosado E* Jose da Bomba Abdias de Oliveira Joao Xavier Pedrosa Alderico Pereira Rego Ind. Paulo Alimonda Avare/Tupinare		*Felipe Camarao* Vila Sao Miguel Ruth Moura Olegario Mariano
Bad Performance	*Rocas* *Quintas D* *Bom Pastor E* Brasilandia Vila N. S. Fatima Coronel Fabriciano Cajueiro	*Quintas E* *Bom Pastor F* Vila Cardeal Silva	Vila Jorge Pimenta Barbalho Cacimbao Roda da Fogo

Note: Underlined projects are in Recife; projects in *italics* are in Natal. Text in the corner cells indicates polar projects from which case studies were selected.

Table 3-10 reveals that, based on these cumulative staff judgments, there is no obvious association between participation and performance. Of the 13 "good" performing projects, 7 had good participation and 6 had ambiguous, bad, or no participation. Of the 14 bad performing projects, 7 had good participation and 7 had ambiguous, bad or no participation. A slight majority of projects (23 out of 40) had good participation in the opinion of knowledgeable staff, but performance was equally distributed among all three categories. These trends in perception appear to be similar for both cities based on the information in Table 3-10. Yet many of these very same individuals each independently reported that in their experience participation was critical to successful project outcome, especially for poor beneficiaries. It appears that participation alone may not be sufficient to explain project performance, yet participation remains important to the discussion condominial sewer implementation.

In selecting polar cases, I ignored all ambiguous projects. I assigned pseudonyms to the six selected cases to maintain resident and neighborhood anonymity and to comply with the ethics and privacy requirements of the Stanford Human Subjects Committee. Three projects from each city were selected as case studies: Cases R1, R2, and R3 from Recife, and Cases N1, N2, and N3 from Natal. Table 3-11 presents additional information about the six selected cases, including the agencies responsible for project implementation and maintenance.

3.2.3 Variations in Income

The six selected case studies were comparable in terms of country region (all in Northeast Brazil), city type (all in coastal state capitals), project initiation date (all in 1987-88), and project type (all condominial sewer projects). The average income level of each case study area is worth noting, because marked differences in income level could confound the results of a comparison across cases[9]. I used average household income (i.e., the combined income of all members of a household) as a proxy measure of socio-economic level for each case study project[10].

Table 3-11. Additional information about the six selected case study projects.

Case	City, State	Implementation Period	Implementing Agency	Maintenance Agency
R1	Recife, PE	1986-1988	City Public Works Agency (EMLURB)	State Water and Sanitation Agency (COMPESA)
R2	Recife, PE	1987-1992	City Urban Planning Agency (URB)	State Water and Sanitation Agency (COMPESA)
R3	Recife, PE	1987-1990	State Housing Agency (COHAB)	State Water and Sanitation Agency (COMPESA)
N1	Natal, RN	1987	State Water and Sanitation Agency (CAERN)	State Water and Sanitation Agency (CAERN)
N2	Natal, RN	1986-89[a]	State Water and Sanitation Agency (CAERN)	State Water and Sanitation Agency (CAERN)
N3	Natal, RN	1986-89[a]	State Water and Sanitation Agency (CAERN)	State Water and Sanitation Agency (CAERN)

(a). After a 5-year period of paralysis, these two projects were continued in 1994 to complete the remainder of the blocks in the sewer basin. Only those blocks that were completed in the 1986-89 time period were included in this dissertation. For more details, see Chapter 6 (Sections 6.5.2 and 6.5.3) and Appendix F.

Disaggregated census data on population and income for the six case study neighborhoods were obtained from the Brazilian Census (*Instituicao do Brasil de Geografia e Economia*, or IBGE). Census data are usually the only reliable information on income level available at the preliminary case selection stage, even though this information may not be disaggregated at the project level[11]. Table 3-12 provides my estimate of income levels for urban households in the Northeast region of Brazil, based on the distribution of income in 2000.

Table 3-12. Estimate of household income levels using average monthly income per household, in minimum salaries, for urban households in the Northeast region of Brazil in 2000.

Income per Household in Minimum Salaries per Month	No. of Households in 2000	Percent of Total Households[a]	Estimated Household Income Level[b]
No income	758,514	8.37%	no income
Up to 1	1,922,329	21.21%	indigent[c]
More than 1 up to 3	3,194,140	35.25%	poor[c]
More than 3 up to 5	1,262,249	13.93%	low income
More than 5 up to 10	1,046,545	11.55%	middle income[d]
More than 10	878,806	9.70%	high income

Source: IBGE Censo Demografico, <http://www.ibge.gov.br/home/estatistica/populacao/censo2000/trabalho_rendimento/tabela_regioes.shtm?c=2>, (2000).
a. My calculations using IBGE data.
b. My characterization of income level was informed by the work of Rocha (1997) and World Bank (2003). The poverty line in Brazil is often difficult to determine. The cost of a "food basket" (*cesta basica*) of basic foodstuffs for one month is typically set as the poverty line (Power and Roberts, 2000:248), however, several other methods for determining the poverty line are also in use (Rocha, 1997:4). A *cesta basica* for a family of four cost 2.37 minimum salaries in Natal as of April 2001 (Escoda, et. al, 2001:5).
c. In Brazil, indigent and poor people often live in shantytowns or squatter settlements called *favelas*, thus the people are commonly referred to as *favelados*. People who inhabited favelas in Recife in the early 1980s earned up to 3 minimum salaries per household, but the great majority of Recife's favela dwellers earned between 1 and 2 minimum salaries per household (Prefeitura da Cidade do Recife, 1983:4).
d. The middle income category can be further divided into three sub-categories: 1) lower middle income (more than 5 up to 6 minimum salaries), middle middle income (more than 6 up to 9 minimum salaries), and upper middle income (more than 9 up to 10 minimum salaries).

Based on the approach cited in World Bank publications for Brazilian development, households with incomes of 2 minimum salaries or less are considered living in poverty, and households with incomes of 1 minimum salary or less are considered living in extreme poverty[12]. One Brazilian reported that "low" incomes are perceived to be in the range of 2 to 5 minimum salaries per household, "middle" incomes range from 5 to 8 minimum salaries per household, and "high" incomes are greater than 8 minimum salaries per household[13]. Table 3-12 reveals that in 2000 approximately 65% of Northeast urban households were poor, indigent, or had no income; and that 30% of households reported no income or less than 1 minimum salary per household.

Table 3-13 presents household and income data for the six case study project areas and neighborhoods. The data in Table 3-13 reveal that average household incomes for the case study areas ranged from poor to high income. None of the case study project areas were considered favelas at the time of my fieldwork (1994-1995); however, the case R3 area had been a favela prior to the condominial sewer project. From the information provided in Tables 3-12 and 3-13, I estimate that, in 1995, Case R3 was poor, Cases R2 and N2 were low income, Case N3 was lower middle income, Case R1 was middle income, and Case N1 was high income.

3.2.4 Study Participants

Participants of this study included residents living in the case study project areas; project managers, engineers, social scientists and maintenance staff of the implementing agencies; elected officials, and appointed agency directors involved in planning and funding case study projects; other relevant personnel such as selected employees of consulting companies and construction companies who worked as contractors of the implementing

Table 3-13. Number of households and average incomes for the neighborhoods (*bairros*) that correspond to the six case study project areas.

Case	Greater Neighborhood (1991 Census Data)			Case Study Project Area (1995 Interview Data)			Estimated Household Income Levels for the Case Study Project Areas[c]
	Number of Households	Average People per Household	Average Monthly Income per *Head of Household* (in minimum salaries[a])	Number of Households	Average People per Household	Average Monthly Income per *Household* (in minimum salaries[b])	
R1	7,127	4.31	3.16	293	4.53	7.69	middle income
R2	6,122	4.34	1.81	158	4.46	3.34	low income
R3	2,517	4.49	2.16	1,349	4.70	2.46	poor
N1	3,155	4.31	6.27	384	4.66	10.08	high income
N2	2,705	4.45	2.23	757	4.67	3.07	low income
N3	7,936	4.43	1.95	964	3.80	5.17	lower middle income

Sources: IBGE, 1991; and project area residents, interviews by author, 1995, Recife and Natal, transcripts.
a. One minimum salary in October 1991 was Cr$36,161.60 per month (in cruzeiros) (IBGE, 1991). Brazil's currency subsequently changed to the "cruzeiro real" in July 1993, and then to the "real" in July 1994.
b. Interviews with residents in Cases R1, R2, and R3 were initiated in March 1995, and interviews with residents in Cases N1, N2, and N3 were initiated in May 1995. The local minimum salary during these time periods varied from 70 to 100 Brazilian reais (R$70-100) per month for 6 hours per day of work, roughly the equivalent of 70-100 US dollars (US$70-100) per month at that time, based on the local foreign exchange rate. Wages were adjusted frequently in Brazil as a result of dramatic increases in inflation throughout the 1980s and early 1990s (Keck, 1989:268; and Mainwaring, 1999:90). Typically, there was a lag between the date of an official wage adjustment and the date on which workers' paychecks reflected the adjustment. For the purposes of estimating household income levels, an average minimum salary of R$100 per month was chosen for all six case studies.
c. These are my estimates based on the information in Table 3-12.

agency; and condominial sewer specialists from Brazil, the World Bank, and elsewhere. Throughout this dissertation, the term "staff" is used to refer to employees of a public implementing agency (agency staff). The term "practitioner" is used more generally to refer to professional individuals involved in the implementation of condominial sewer projects, including agency staff, consulting engineers, and construction contractors. The terms "users" and "beneficiaries" are employed interchangeably to refer to residents whose households are connected to condominial sewer systems. The generic term "residents" is used more generally to refer to users and non-users alike who reside in the project area. The term "officials" refers to both elected and appointed people in leadership and executive positions. The term "expert sub-group" refers to specific categories of practitioners, such as participation staff, engineering staff, or maintenance staff.

Residents living in the case study areas were selected at random to participate in the study. These include residents who lived in the project area before and during project implementation (original dwellers), residents who moved into the project area after implementation, residents connected to the condominial sewer (users or beneficiaries), residents not connected to the condominial sewer, residents who participated in project implementation, and residents who did not participate.

Engineers, social scientists, and maintenance personnel were not selected at random. They were selected based upon their experience, knowledge, and involvement in the case study projects as employees of local water and sewer agencies or as condominial sewer practitioners. In some cases, I located former employees of an agency and included them in the study because of their critical roles in the implementation of a specific case study project. Agency managers and local officials were selected based on their key roles, decision-making responsibility, and broad view of condominial sewer implementation in the context of their city. When possible, employees of the private consulting and construction companies who designed or built case study projects were selected as participants. Also, I met several experts on condominial sewers and participation while I was in Brazil for extended fieldwork and while I was in Washington, D.C. as a World Bank intern. These subject matter experts, while not formal participants in this study, are referenced as appropriate throughout the dissertation.

Sample Size Determination. The target number of resident households selected for in-depth interviews was determined using the formula for computing sample size shown in Equation 3-1[14].

$$\text{Sample Size} = \frac{X^2 \cdot N \cdot P(1-P)}{C^2(N-1) + X^2 \cdot P(1-P)} \qquad \textbf{Equation 3-1}$$

where: X^2 = Chi-Squared for 1 degree of freedom at 90% probability = 2.7055

N = Population Size

P = Population Parameter[15] = 0.5

C = Confidence Interval

Bernard (1994) recommended this formula to anthropologists and other researchers who take samples from small populations and use ethnographic or other qualitative data to supplement statistical results[16]. Since the researcher's overall confidence in the results is based on a combination of qualitative and statistical data, smaller sample sizes and wider confidence intervals may be used with this formula. Because I adopted a qualitative research design, Equation 3-1 was applicable for estimating the minimum number of households that should be interviewed so that the interview results would be fairly representative of the case study area. I also selected a 90% level of significance (ρ = 0.10) for this dissertation, following the recommendation by Bernard (1994) for qualitative research in which some statistics are used[17]. The target sample sizes and minimum confidence intervals for each case are presented in Table 3-14.

The number of homes interviewed in each case study area varied from a low of 158 to a high of 1349. At the time of my fieldwork in 1994-1995, the combined number of homes in all six project areas was 3905 (1800 in Recife and 2105 in Natal). Of these, in-depth interviews were conducted with 264 households (133 households interviewed in Recife and 131 households interviewed in Natal). The number of households interviewed exceeded the calculated sample size targets for each case study. With these actual sample sizes, confidence intervals ranging from ±10.5 to ±13.5 percent were determined based on a ρ=0.10 level of significance. These sample sizes were appropriate for determining gross differences among the cases, which was my goal. Therefore, small differences in results (*e.g.,* less than ±13.5%) were not considered significant.

Table 3-14. Target sample sizes and confidence intervals (C) for the six selected case study projects in Recife and Natal.

Case	Total Homes in Project Area	Target Sample Size at C=±15% (ρ=0.10)	Number of Homes Interviewed	Actual Confidence Interval (ρ=0.10)
R1	293	27	33	±13.5%
R2	158	25	41	±11.0%
R3	1349	29	59	±10.5%
N1	384	28	39	±12.5%
N2	757	29	46	±11.8%
N3	964	29	46	±11.9%

3.3 Data Gathering

During a ten-month period of fieldwork in Recife and Natal (from October 1994 to July 1995), three main types of evidence were collected for the six case studies: records, observations, and interview data. These data sources and the procedures used to gather data are described in the following sections.

3.3.1 Records

The records collected included project documents, maps, engineering drawings, reports, memoranda, and journal articles related to the case studies. Archival records collected included data from the census bureau (population, income, etc.) and computer records from the water and sanitation companies (number of connections, billing records for water and sewer service, etc.)[18]. Many photographs were also taken of the case study project areas.

3.3.2 Observations

Direct observations involved inspecting project sites, attending meetings, and systematically observing local conditions and activities. Project site inspections included a) inspections of street sewer manholes and neighborhood conditions; b) inspections of condominial sewer manholes and cleanout boxes located in sidewalks, front yards, alleys, and backyards; and c) inspections of household fixtures, sewer connections, and cleanout boxes located in homes and yards, and other onsite conditions.

3.3.3 Instruments

Five different interview guides were developed for use in semi-structured interviews. None of the interview guides was designed to be completed by the respondent; rather, they were designed to guide the researcher through an interview with the respondent about their experience and knowledge. The interview guides included open-ended questions, exploratory questions, rating questions, and checklists. Several multiple choice, nominal (yes/no), and ordinal (rating scales from 1 to 3 or 1 to 5) questions were also included to provide a basis for quantification. Each interview guide was used for a different population group, as shown in Table 3-15. The interview guides and response codes are presented in Appendix A.

3.3.4 Procedures

I wrote all of the interview guides in English and had them reviewed by the Stanford Human Subjects Committee prior to using them in the field. Because all of the interviewing had to be conducted in Brazilian Portuguese, I addressed translation as follows. I had every document associated with the residents translated from English to Portuguese by a professional Brazilian translator who was also fluent in English. These documents included the resident interview guides, the flyers that announced my research project, invitations to focus groups, and consent forms. Because of the possibility that residents could have low levels of education and because of the lay public's general lack of knowledge about the topic, I used a professional translator to improve comprehension by residents. Each resident would be interviewed only once, so I wanted to minimize language problems. I reviewed the translated documents for quality and accuracy, and I tested the first draft of the resident interview guides on a subset of residents and revised it as necessary. This testing was done in both cities.

I also had the first draft of the interview guides for the expert subgroups (for officials, engineering staff, maintenance staff, and participation staff) professionally translated. I made subsequent revisions and added a few questions to the expert subgroup interview

Table 3-15. Interview guides used for different groups of participants.

Interview guide	Participant Group
Resident Interview Guide	Randomly-selected households located in each case study project area, many of whom were beneficiaries.
Engineering Staff Interview Guide	Engineers, project managers, and other staff who played central roles in planning, designing, and constructing each case study project.
Officials Interview Guide	Agency directors, elected officials, and appointed officials from implementing agency(s), city government, and/or state government.
Maintenance Staff Interview Guide	Operators and technicians who were involved in operating and maintaining case study projects.
Participation Staff Interview Guide	Social scientists, engineers, and other staff who were involved in participation activities, such as holding meetings with case study beneficiaries.

guides myself without additional assistance from the translator. I felt comfortable doing this because these subjects had specialized knowledge about their topics and technical comprehension was not an issue as it was with residents. Also, I typically conducted several informal interviews with the expert subjects before using the interview guide to conduct a formal interview. As a result of frequent contact over weeks and months, my communication with expert subgroups was relatively trouble-free, and, in most cases, there had been plenty of opportunity to work out language issues in advance of the formal interview.

I hired research assistants to assist me in implementing the residential interview guides. In both cities, I selected research assistants who met the following qualifications: a) were graduates of the local vocational school who had majored in sanitation, b) had previously interned with the local sewer agency, c) were recommended by agency staff, and d) had previous work experience in the participation activities of condominial projects. I used these criteria to maximize the reliability and qualifications of my research assistants. Individuals with future job prospects with the sewer agency were targeted. Even though much of our communication was verbal, I had the documents I used to interact with research assistants professionally translated. These documents included training materials and work contracts. I prepared the selected research assistants by conducting a training session where I provided an overview of my research project, reviewed the intent of all of the questions for residents, handed out written material about the research and their tasks, and oriented them to the case study project areas where they would be working. Each research assistant signed a work contract that outlined the scope and time period of their work, expectations, conditions, and terms of pay.

Before any of the door-to door interviewing took place, I had to establish the boundaries of each case study project and develop a census of all the households in each project area. Accurate maps were typically not available, so basic information had to be established in the field. I numbered the homes for each case and then selected homes to be interviewed using a random number table. I also randomly selected an alternate home for each selected home in case no one was available at the first home, and I added 10 percent more homes to improve the chances of ending up with the target sample size. These additional homes were also selected at random. I developed case study project area maps and divided up the homes among the research assistants and myself. I had four research assistants in each city.

For each case study area, I established a home (or other location) that served as a safe house for me and the research assistants. I often selected the home of a community leader. Establishing a safe house served a practical purpose (i.e., providing a meeting location), but it was also needed for security reasons in neighborhoods that had gang activity or other safety concerns. All the research assistants were young females in their early twenties, and none lived in the case study areas. Security issues had to be addressed so that everyone would be comfortable with the work. This comfort level was achieved in every case study area. Transportation issues also had to be addressed because of the low incomes of the research assistants. As part of the work contract, I provided bus tickets in advance so that the research assistants could get to the case study project sites reliably.

To announce my presence and the nature of my research activities, I passed information to residents by word-of-mouth through community leaders and I posted fliers throughout each neighborhood. In some of the case study areas, I conducted focus groups with residents. During the focus groups, my research assistants took notes. The focus groups were also recorded. The residential interview phase took approximately six weeks in each city. The work in this phase included mapping the project area, conducting a house census in the field, conducting focus groups (optional), randomly selecting households, testing the interview guides on a subset of residents, identifying and interviewing community leaders, and interviewing residents. Residential interviewing ended when each research assistant had conducted either the requisite number of interviews, or as many as could be practically conducted during the contract period. Each residential interview took 30 to 60 minutes to complete. Research assistants were paid at the completion of the work, based on completing a requisite number of interview guides (approximately 50 each) satisfactorily.

Expert subgroups of engineers, social scientists, maintenance staff, managers, and officials were not selected at random. Instead, I identified an initial group of knowledgeable individuals and, over time, I used these initial informants to find additional informants with specific knowledge. I used techniques known as snowball sampling and purposive sampling, described by Huck (2000) as follows:

> [In] purposive samples [members of] a large group of potential subjects must meet certain criteria established by the researcher because of the nature of the questions to be answered by the investigation. A snowball sample is like a two-stage purposive sample. First, the researcher locates a part of the desired sample by turning to a set of individuals who possess certain characteristics deemed important by the researcher. Then, those individuals are asked to help complete the sample by going out and recruiting [other individuals] who possess the needed characteristics. (Huck, 2000:123, 126)

I conducted all of the expert subgroup interviews myself, without the use of research assistants. Interview guides were not followed as closely for the expert subgroup interviews as they were for the resident interviews. Rather, individual questions were included or ignored depending on what was appropriate for the expert's area of knowledge and experience. Also, expert subgroup interviews were not conducted during an intense interview period as was done for the resident interviews. Rather, expert subgroup interviews were conducted at convenient times throughout my 5-month long stay in each city.

In Recife, I spent a great deal of time at several different implementing agencies (both city and state agencies), but in Natal I only had to focus on one primary implementing agency (the state agency). In addition to conducting semi-structured interviews with expert subgroups, I conducted many informal interviews with these and other informants, the results of which I recorded daily in field notes.

The privacy of all informants was maintained throughout the study[19]. No quotations were attributed to any individual informant who participated in the study and each informant was given a pseudonym (e.g., Informant 73).

3.4 Data Analysis

3.4.1 Quantitative Data Analysis

I hired a research assistant to support the data entry phase of the research. There was a significant amount of information (in Portuguese) that had to be transferred from the interview guides into several Microsoft Excel spreadsheets. This work required someone with spreadsheet development skills, fluency in English and Brazilian Portuguese, and some basic knowledge of sanitary sewer systems. The person I selected was a native Brazilian who was also fluent in English and lived in the United States. This research assistant had a civil engineering degree and was proficient in Excel as a result of his employment at a Microsoft contractor company.

I oriented the research assistant to my research project, described the scope of work, and prepared a work contract. I provided a set of codes for each interview guide (see Appendix A) so that interview questions could be converted into numbered categories (e.g., No = 1, Yes = 2). The research assistant read the answers in Portuguese and entered the appropriate code into the spreadsheet. To check the quality and accuracy of the research assistant's work, I checked random sections of the spreadsheets, I compared the research assistant's scores to scores I had determined on a sample of interview guides, and I had some questions scored twice by the research assistant (at different times) so I could compare the results. I spent a lot of time going over the proper coding of the questions with the research assistant. The data entry process took approximately 100 hours (of the research assistant's time) for all of the interview guides associated with the six case studies.

Criteria were developed for selecting specific interview questions from the spreadsheet, and empirical methods were developed for measuring and comparing participation and condominial sewer performance (Appendices B, C, and D). The selected questions were analyzed quantitatively using simple indexing methods, graphical analysis, and non-parametric statistics. I provide a description of the performance analysis method in

Appendix C, and I describe the participation analysis method in Appendix D. Each description includes an example application of the method using a subset of data from one of the cases. My objective was to condense large amounts of qualitative information in a manner that would facilitate the comparison of cases in terms of participation and performance. Gross differences in the performance of projects were identified and projects were grouped using non-parametric statistics. Graphical analysis was then used to reveal a possible association between participation and performance (Chapter 7).

3.4.2 Qualitative Data Analysis

The remainder of the data analysis phase consisted of qualitative analysis of the open-ended interview responses, project documents, historical evidence, and case study observations. Qualitative analysis included identifying broad characteristics of the Brazilian context that affected condominial sewer implementation (Chapter 4), determining the important factors within each city that impacted project implementation (Chapters 5 and 6), and preparing detailed descriptions of the case studies (Appendices E and F). I conducted a comparative macro-analysis of the two cities, as well as within-case and between-case micro-analyses (Chapter 7). Overall, I used an inductive approach to create an explanatory framework of project implementation based on the significant factors that I had identified (Chapters 7 and 8). This framework was then tested on an additional case study project.

3.5 *Reliability, Validity, and Bias*

The variety of data gathering instruments I used allowed me to obtain a great deal of information from a variety of viewpoints. However, because my research was based primarily on perceptual (i.e., the perceptions of residents and agency staff) and observational data (i.e., my own direct observations) obtained in natural settings, rather than on experimental data obtained under controlled conditions, I used a number of strategies throughout the research process to maximize the reliability and validity of my findings and to minimize bias.

3.5.1 Strategies to Improve Reliability

Creswell (2003) argues that reliability (the consistency with which results are achieved with repeated application of a research measure) and generalizability (the validity of applying results to situations external to the original study) do not have major roles in qualitative research[20]. As Creswell states, "data is interpreted in regard to the particulars of a case rather than generalizations"[21]. Accordingly, the results of this dissertation were not intended to be generalized to situations other than the cases and cities studied. The credibility of this dissertation depends heavily on the *internal* reliability of the information gathered. I depended on this information to draw out the key qualitative themes and variables, and to form lines of reasoning about the relationships between variables that are the basis of the dissertation. I took the following steps to enhance the internal reliability of the information used in this dissertation.

1. To enhance the reliability of my measure of *participation*, I included within the measure the use of an established, well-cited scale that previous research had proved reliable: the participation intensity scale developed by Paul (1987)[22]. I also triangulated the results of this scale with two other sources of data: responses from residents and responses from agency staff who had implemented the participation program (i.e., participation staff) to several questions about participation. The average response from each group was combined with the previously mentioned measure (equally weighted) to achieve the overall measure of participation. These same steps were performed for each of several categories of participation: project mobilizing, project decisions, project construction, and project maintenance.

2. To enhance the reliability of my measure of *project performance*, I measured the performance variable twice. For the first measurement, I interviewed agency staff informally (see Section 3.2.2). For the second measurement, I interviewed agency staff formally and noted the differences in results. I also triangulated my performance measure with information provided by residents, engineers, maintenance staff, and direct observation. In addition, I split the data in half to measure performance with two different sets of data, and I found no statistically

significant difference in the groupings of the cases measured with both sets of data.

3. To enhance the reliability of the *resident interviews* in both cities, I did the following. I provided orientation and training to the research assistants prior to the interview period, including discussing the interview questions with them at length to reach agreement on the intent of each question. I had them conduct practice interviews. I also reviewed their completed interview guides at different times in the 6-week interview period and re-directed their efforts as necessary to ensure consistency.

4. To enhance the *representativeness* of the resident interview data, I used probability sampling techniques to select a sample of households to be interviewed. These techniques included formal establishment of the sampling frame, random selection of households, and establishment of a target sample size. A probability sample is considered representative when the size of the randomly-selected sample provides the desired level of accuracy (the level of significance for this dissertation is $\rho=0.10$) and when the sample adequately accounts for the heterogeneity of the population and the size of the phenomena being investigated[23]. For my resident samples to be representative of the total population of households in the project area, a minimum number of residences were sampled at random for each case. I calculated minimum sample sizes (using Equation 3-1) to determine the target number of resident interviews desired for

each project area. Then, after administering as many interview guides as feasible (given the procedures previously outlined), I used a sample size validity check to determine the degree to which the data were representative as indicated by the confidence interval[24].

3.5.2 Strategies to Improve Validity

Validity is the degree to which an empirical measure or operational definition adequately and accurately measures a concept[25]. As Creswell (2003) states, "validity is seen as a strength of qualitative research"[26]. The prolonged fieldwork and rich, thick description of qualitative research greatly enhances the credibility, authenticity, and validity of measures. In addition to applying a qualitative methodology, I took the following steps to enhance the various dimensions of validity in this dissertation.

1. Face validity exists when the content of an empirical measure (e.g., an interview question, a type of observation, application of an existing record) represents the desired concept in a manner that most people would agree with[27]. In Bernard's words, "Face validity is simply looking at the operational indicators of a concept and deciding whether or not, on the face of it, the indicators make sense."[28] To enhance the face validity of the data I obtained by interview questions, I hired a professional translator to translate all of my research questions from English to Brazilian Portuguese. I also field-tested the resident interview questions to ensure the wording was understandable and consistent with everyday language. To

further enhance face validity, I included more than one question on certain topics so that the interviewer (i.e., myself or my research assistants) could compare the answers to check if the content of the question was clear to the informant. Additional face validity checks of the questions that made up participation and project performance measures were made during the dissertation review process by my faculty advisors and colleagues.

2. Content validity (also called content matching) exists when an empirical measure includes all the dimensions and ranges of meaning of a concept[29]. To cover all of the dimensions of participation, I used the results of 31 questions and observations to measure four different categories of participation (see Appendix D). To cover all of the dimensions of project performance, I used the results of 27 questions and observations to measure two aspects of performance (see Appendix C).

3. Construct validity exists when an empirical measure relates logically to other variables in a theoretical sense, which suggests that the concepts were measured properly[30]. Construct validity depends on the "the collective judgment of the scientific community," which forms the criterion against which the validity of new measures are compared[31]. I did three things to enhance construct validity in this dissertation. First, I used indicators that had been developed and tested by other researchers as a starting point for developing measures of my two main variables (i.e., participation and performance). In constructing my participation

variable, I reviewed, critiqued, and was guided by the work of Oakley (1991), Moser (1983), Paul (1987), Narayan (1994), Metsch and Veney (1973), Finsterbusch and Van Wicklin (1987), and others. Similarly, my construction of the performance variable was informed by my review of the definitions and measures of infrastructure performance presented by Abbott (1996), Narayan (1994), Yepes (1993), Reader, et. al. (1983), Janssens, et. al. (1996), EPA (1991), Sullivan, et. al. (1977), and others. By basing my variables on measures from the literature that were found to be valid in the context of other studies, I enhanced the construct validity of my variables.

Second, I compared the results of my variables to the expectations of local experts (i.e., agency staff). Prior to actually measuring participation and performance, I obtained an initial view of the relative levels of participation and performance to be expected for each project. I did this by undertaking a series of informal interviews with agency staff. For example, as a result of my initial interviews, I expected case study projects R1 and R3 to score significantly higher than project R2 on the performance variable. My performance scores ultimately followed this expectation and, as a result, I was confident that I had developed a valid construct for the performance variable.

Third, I compared the relationship between my variables to the expected relationship from other studies (including studies by Narayan (1994), Finsterbusch and Van Wicklin (1987), Korten (1980), Korten and Alfonso (1985), and Bryant and White (1982)), that had shown, both qualitatively and quantitatively, a positive association between participation and performance. Two of my participation measures (i.e., participation in mobilizing and participation in decision-making) were positively associated with performance in the manner expected from existing theory and from the findings of other researchers. These results offer evidence of construct validity for these two participation measures and for the performance measure.

Unexpectedly, however, two additional participation measures (i.e., participation in construction and participation in maintenance) were not positively correlated with performance. This finding raises a concern about whether the latter two measures were properly constructed. If the latter two measures were properly constructed (i.e., if they had high construct validity), then the resulting lack of correlation with performance is a surprising and important finding. If these measures were not properly constructed, then the resulting lack of correlation can simply be explained by low construct validity of the measures.

Several conditions increase the possibility that these constructs were valid: a) turnover of residents between the time of construction and the time of my interviews was accounted for in the scores for participation in construction, and b) information from the rich case study details revealed that the residents did not receive construction support from the implementing agency, and that the maintenance performed by residents was not adequate to overcome the system's design and construction flaws. Additionally, the explanation presented later in the dissertation (see Chapter 9) explains *why* good performance was not dependent on these measures for the cases studied. This approach enhances the likelihood that valid constructs were used, even though all of the expected relationships were not found.

4. Statistical conclusion validity exists when a measure meets the relevant statistical assumptions and rules, and when accurate inferences can be drawn from the statistic[32]. For example, the Chi-Squared statistic is only valid for data sets with an expected frequency count (N_p) greater than or equal to about 2 to 5, where N_p is the expected frequency count when the null hypothesis is true[33] (see Chapter 7 and Appendix B). To ensure statistical conclusion validity, I performed the appropriate statistical validity checks to make sure I had selected the proper statistic for the data being analyzed.

3.5.3 Strategies to Reduce Bias

Bias can be present in everything from the language of interview questions and the format of sampling to the preconceptions of the researcher and study participants. I took the following steps to reduce bias in this dissertation.

1. I reduced potential bias in the case studies by selecting cases that corresponded to polar attributes of the main variables of interest (successful and unsuccessful

project performance, and the participation or non-participation of project beneficiaries).

2. I reduced potential biases in interview questions and interview responses by triangulating my data sources as much as possible. To carry out this triangulation, data for each variable were obtained from a variety of sources (from residents, engineering staff, maintenance staff, officials, direct observation, and project records). My variables thus represented a composite viewpoint, not the viewpoint of any single source.

3. For the expert subgroup questions and direct observations (both of which were non-probability samples from small populations), I reduced potential researcher bias in question selection by a) using all of the available data from these sources without regard for the minimum response rate, and b) including negative or contrary responses and observations, even when this information ran counter to the main argument of the dissertation. One example of this was the existence of different perceptions by engineers and maintenance staff on the level of performance. Any internal inconsistencies that may have existed between or within groups were acknowledged (because they reflected reality), and were included in the cumulative result.

4. For resident interview questions (which were probability samples from the project area populations), I reduced potential researcher bias in question selection by

using a non-biased selection criterion based on minimum response rate, not based on the content of the answer. Instead of throwing portions of the data away or choosing not to use certain questions because of result, I used all of the questions that met the minimum response rate. I set minimum response rate equal to the "expected frequency," which is the number of responses divided by the degrees of freedom for the question, plus one. I selected a minimum acceptable expected frequency of 3.0. According to Huck (2000), an expected frequency of 3.0 falls within the range of validity for using Chi-Squared tests[34].

In this chapter, I have described the overall research design for this dissertation. In the next chapter, I introduce the context of urban infrastructure development in Brazil during the years leading up to and including the case study implementation period.

---

[1]Creswell, 2003:90; and Patton, 2002.
[2]Gabrielle Watson, consultant to the World Bank, personal communication with author, July 1993, Washington, D.C.
[3]Informant 79, CAERN technical staff, interview by author, 24 April 1995, Natal, transcript; and Informant 76, CAERN social worker, interview by author, 10 May 1995, Natal, transcript.
[4]Informant 31, consulting engineer, interview by author, 3 March 1995, Recife, transcript.
[5]COMPESA, 1995; and CAERN, 1995.
[6]Informants 76, 89, 96, 87, 78, 84, and 121, CAERN staff, interviews by author, 1995, Natal, transcripts.
[7]Informant 121, CAERN sewer construction division manager, interview by author, 1 June 1995, Natal, transcript.
[8]Informant 88, CAERN condominial sewer technician, interview by author, 11 May 1995, Natal, transcript.
[9]Several condominial sewer practitioners in Recife and Natal reported that the socio-economic level of project beneficiaries was directly related to project performance (for example, Informant 1, engineering consultant, former Recife official, and former state official, interview by author, 1 December 1994, Recife, transcript; and Informant 76, CAERN social worker, interview by author, 5 May 1995, Natal, transcript).
[10]According to the Brazil Census Bureau, "indicators related to the familial nucleus may help a more comprehensive analysis of the socio-economic situation. . . . A relevant indicator, for example, is the income earned together by family members."
(IBGE, www.ibge.gov.br/english/presidencia/noticias/12062003indic2002.shtm, 3 March 2004: 11-12).
[11]Practitioner judgments about the socio-economic level of residents in each project area were also obtained. Practitioners used the following categories to represent socio-economic level: "poor," "lower middle class," "middle class," and "upper middle class." However, their judgments were not utilized for two reasons. First, the practitioners were selected based on their expertise in implementing condominial

sewer projects and their first-hand knowledge of project performance and participation. These practitioners were not necessarily subject matter experts in local socio-economic levels, so I considered their judgments about socio-economic levels to be less reliable, and I did not have the resources to identify and interview experts on the topic. Second, as an external researcher I could not accurately interpret the significance of the categories they used.

[12]World Bank, 2003.

[13]Gustavo Valente, Brazilian citizen and civil engineer, personal communication with author, November 2003, Tracy, CA.

[14]Bernard, 1994:77.

[15]Bernard, 1994.

[16]Bernard, 1994.

[17]Bernard, 1994.

[18]Although I sought public health data for this dissertation, the data that were available were not disaggregated at the household, project, or neighborhood level, and so they could not be used to differentiate the impacts of different case study projects.

[19]All subjects, regardless of which interview guide was used, gave prior consent for their anonymous participation in this dissertation as required by the Stanford University Human Subjects Committee. In almost all cases informants signed a consent form. In cases of illiteracy, informants "signed" by providing a thumb print. In a few cases, informants read the consent form and gave oral consent because they did not want to provide a signature.

[20]Creswell, 2003:195.

[21]Creswell, 2003:199.

[22]Paul, 1987.

[23]Huck, 2000:73-74.

[24]A sample size check could not be applied to the expert subgroups nor to the number of cases selected because, in these instances, statistically significant samples did not exist. Only a limited number of knowledgeable agency staff were available, and only a limited number of projects existed that met the selection criteria. Consequently, these samples were chosen using non-probability methods.

[25]Babbie, 1992:132.

[26]Creswell, 2003:195.

[27]Babbie, 1992: 132.

[28]Bernard, 1994:40.

[29]Babbie, 1992:133.

[30]Babbie, 1992:133.

[31]Bernard; 1994:42-43.

[32]Creswell, 2003: 171.

[33]Hinton, 2001; and Huck, 2000.

[34]Huck, 2000:635.

Chapter 4

The Brazilian Context for Urban Service Provision

Brazil's transition to democracy constitutes a major change of lasting historical significance. Grassroots popular movements and political liberalization during the late 1970s and early 1980s resulted in the decentralization of urban service provision, and extension of urban services (e.g., water and sanitation) to previously unserved areas. The appearance of condominial sewers coincided with Brazil's democratic transition. This fact alone raises a number of questions. What forces motivated implementing agencies to innovate so they could start serving the poor? What types of citizen activity emerged? Did urban service outcomes improve? These questions are important because in Brazil a significant portion of the population lives in poverty and without basic services like sewers.

This chapter explores the context in which condominial sewers began to be implemented in Recife and Natal, Brazil during the 1980s and 1990s. I introduce Brazil's democratic transition (Section 4.1); describe the issues surrounding the delivery of urban services in an emerging democracy (Section 4.2); and discuss the challenges of serving the urban poor (Section 4.3). Historically, Brazilian water and sanitation agencies were unable to provide basic sanitation services to the majority of residents. I describe how the conditions for providing sanitation services changed during the political opening, and I identify the incentives that motivated some implementing agencies to innovate with new sewer technology and participation approaches.

Four themes emerge in this chapter:

1. The shifting interests of state and local elected officials and implementing agencies affected the implementation and outcome of individual condominial sewer projects differently;
2. As citizens in a new democratic process, and as participants in a new project participation process, residents gained wider possibilities for exerting influence on the implementation and outcome of condominial sewer projects;
3. The "condominial" approach to sewer service delivery, which combined appropriate technology and participation, increased the possibility for extending sewer service to poor Brazilian communities; and
4. The performance outcome of condominial sewer projects was judged subjectively by project stakeholders (i.e., beneficiaries, engineers, maintenance staff, agency officials, etc.), and some projects with poorly functioning physical works were still considered to have elements of success.

4.1 Brazil's Political Opening

The provision of potable water in Brazil steadily increased through the 1970s, although by no means to a level where all of Brazil had access to it. By the early 1980s, many urban neighborhoods still lacked adequate infrastructure and other urban services. Even middle-income residents who owned their homes did not routinely have a full complement of reliable urban services. Starting in the 1980s, there was a surge of urban service provision in Brazil, including drainage, water supply, and sanitary sewer services[1]. This increased service provision coincided with what is frequently called Brazil's "political opening." The term "political opening" refers to the transition from authoritarianism to democracy in Brazil, a transition in which previously closed political positions became open to civilians by direct popular vote. The terms "political opening," "democratization," "transition to democracy," and the Brazilian term *abertura* (which literally means "opening") are used interchangeably in this dissertation.

Brazil's political opening was initiated by the military in 1974 under President Geisel's administration. This democratization process is characterized well by Hagopian and Mainwaring:

> The transition toward democracy in Brazil was not abrupt nor did it represent a clean break from the military government. Key civilian figures in the authoritarian regime, after a certain point, did not resist the regime change but joined the opposition bandwagon in order to retain their positions and influence in the new government...The circumstances under which opponents to military governance rose make it questionable how much of a reform program they can put into practice (Hagopian and Mainwaring, 1987:3, 6).

The democratic transition continued into the 1980s, with the first democratic gubernatorial elections being held in 1982, and ratification of a new Brazilian Constitution in 1988. These events represent a change in the general political-economic context in Brazil, and this change had significant implications for the provision of urban services.

One of the implications of the political opening was increased responsiveness by some government agencies toward serving previously unserved communities. A good example of the impact of the political opening on agency responsiveness is the emergence of *condominial* sewer technology that was expressly designed to respond to the variety of conditions and housing layouts in Brazilian neighborhoods. Before the political opening, conventional sewers had been used almost exclusively, resulting in service to only about 25 percent of the urban population. Officials had claimed that not enough funds were available to extend urban services and that most poor neighborhoods could not be served for legal and technical reasons (e.g., lack of legal tenure or lack of vehicular access into the neighborhood). These financial, legal, and engineering constraints effectively blocked service provision to many neighborhoods[2].

After the political opening, innovative municipal agencies in Recife set up programs in which organized residents could have their streets paved and receive condominial sewer services. Recife's municipal agencies tended to implement small-scale projects in numerous neighborhoods, since they did not have the resources or staff to provide citywide service to all unserved neighborhoods. In Natal, a responsive state agency implemented larger-scale condominial sewer projects.

In general, the implementation of innovative sewer services in Recife and Natal occurred after the election or appointment of a reformist official (e.g., Major Jarbas Vasconcelos in Recife in 1985, and Director Josemar Azevedo in Natal in 1982), and after the formation, within the implementing agency, of a progressive group of professionals that was interested in trying new ways of providing sewer services (e.g., EMLURB staff in Recife, and CAERN's condominial subgroup in Natal). After the political opening, politicians and agencies were more responsive to popular needs for basic urban infrastructure (including sewers) and were willing to experiment with ways of lowering engineering standards and acquiring land tenure for squatters.

In both Recife and Natal, increases in the provision of urban services accompanied the transition to democracy. This turning point was especially important for poor residents who had, in the past, relied exclusively on clientelistic politics that were exploitive of the poor. As defined by Gay, clientelism is "the distribution (or promise) of resources – public or private – by power seekers or holders in return for votes[3]. Although the terms "clientelism" and "patronage" have very similar meanings, there is a subtle but notable difference between these terms. Clientelism has an exploitive character because it is a transaction between the powerful and the powerless[4]. The term "patronage", however, refers to similar transactions with officials without the blatantly oppressive aspect.

Before the political opening, poor residents typically relied on clientelistic transactions in which they tended to receive small, one-time benefits. Continuing urban services were rarely provided under clientistic practices because of the private, informal nature of the transaction – institutionalized services were not typically included in clientele transactions. The political opening provided a possible opportunity to change the character of the relationship between poor residents (who were now enfranchised and mobilized) and politicians (many of whom were now more responsive to popular needs). Despite the opportunity, this change did not happen, as Mainwaring explains quite well:

> In Brazil, clientelism and patronage have not been unique to authoritarian or democratic governments. However, the reliance of government leaders on patronage and clientelism expanded after 1979...The difficulty parties have had in retaining support from one election to the next underscores the low level of legitimacy that they enjoy...In clientelistic polities, most citizens do not believe in parties on the basis of conviction, but rather adhere to them for instrumental reasons, often for immediate material gain. But support on the basis on material favors is not legitimacy...A second liability of clientelistic political systems is their predominantly elitist character...A third problem of widespread clientelism between 1979 and 1994 was its negative impact on the public sector...A final problem of clientelism is its deleterious effect on social programs for the poor. (Mainwaring, 1999:200, 208, 210, 213).

Clientelism and patronage became even more entrenched in the 1980s and 1990s, and the expansion of urban services to previously unserved groups occurred as a result of clientelistic and patronage exchanges with communities that were now better organized to deliver votes.

4.1.1 Poverty and Wealth

Among the many unique and interesting features of Brazil, one of the most noticeable is the stark contrast between poverty and wealth in urban areas. The poorest urban residents often have no choice but to settle - sometimes illegally - on the most marginal lands and construct their own shelters. Shantytowns and squatter settlements in Brazil, known as *favelas,* are the result of poverty and a lack of affordable housing. Favelas are characterized by high population density, low-income levels, lack of legal land tenure, low standards of construction, and lack of formal urban services[5]. It is estimated that from the late 1960s to the early 1980s, one third of Rio de Janeiro's population lived in favelas[6]. In 1993, 60 million people out of a total Brazilian population of 150 million lived in favelas and slums, and of these, 12 million had no residence[7].

Favelas first appeared in Rio de Janeiro in the early twentieth century. In the late 1890s soldiers who had conducted the massacre in Canudos returned from the Northeast region and constructed temporary shacks on Providencia Hill, waiting to receive their compensation. Canudos had been a thriving backlands town in Northeast Bahia since 1893. Canudos residents survived a series of military campaigns, but the town was destroyed by federal troops in 1897. The objective of the Canudos invasions was to regain federal control of the town[8]. The soldiers changed the name of Providencia Hill to *Morro da Favela* (or Squatter Settlement Hill) and upon leaving sold their shacks to the poor, which created the first known favela in Rio de Janeiro[9]. Additional squatter settlements continued to grow in all major Brazilian cities, especially during the post-war population explosion of the 1940s[10].

In the decades following World War II, official government policy in Brazil was to prevent new favelas and eliminate old ones. It was only after the military takeover in 1964 that the government could begin to muster the power and resources to implement these goals (Perlman, 1981:169). One result was that, in 1973, the city of Rio de Janeiro planned to eliminate all favelas within ten years[11]. Governments of Brazil had always exhibited strong authoritarian tendencies. These tendencies were expressed to their fullest in the two-decade reign of Brazil's repressive military government from 1964 to 1984. The repressive climate of the 1960s and 1970s included the prohibition of individual freedoms, "disappearances," the use of torture, and favela-eradication programs. The military regime also guided Brazil toward unprecedented economic growth, culminating in the so-called economic miracle of 1968-1974. Unfortunately, this economic boom meant increasing income concentration and poverty[12], and it was soon followed by sharp economic decline, hyperinflation, and massive foreign debt.

Amazingly, both the richest and poorest people of Latin America live in Brazil. One source reported that 44% of Latin America's poor lived in Brazil, based on the findings of the World Bank[13]. The World Bank reported that the income of the 40% poorest families in Brazil was lower than that of the equivalent percentage in any other country, and that the income of the 20% richest families in Brazil was higher than that of the equivalent percentage in any other country[14]. As Hoffman (1989) puts it, Brazil is consistently "in the highest range of inequality" of all countries in the world[15]. In 1980, 50 percent of the poorest people in Brazil earned only 13 percent of the total income, while 46 percent of the total income went to the richest 10 percent of Brazilians[16]. Moreover, the extreme maldistribution of land, which has not changed significantly in the last seven decades, is an important factor in the Brazilian problem of inequitable distribution.[17] In 2001, approximately 62% of the Brazilian population had an income of two minimum salaries or less – an income range that represents the poverty level[18].

Regional disparities in Brazil continued to worsen with the increasing urbanization and industrialization of the twentieth century. Brazilians in the Southeast states (including Sao Paulo) experienced the highest average incomes and the lowest relative level of inequality, while the Northeast region – the historical center of Brazil's slave economy – continued to have the highest degree of inequality and the lowest average incomes[19]. In the 1970s, inequality decreased and average family incomes increased in the Southeast region, but in the Northeast inequality worsened and average family incomes dropped during the same period[20]. The economic disparities between the Northeast region and the rest of Brazil are also reflected in the statistics on access to water and sanitation, as shown in Table 4-1. Because of these great regional imbalances, countrywide generalizations tend to be inaccurate for Brazil.

Table 4-1. Regional disparities in access to piped water supply and sewer services between the Northeast region and the rest of Brazil in 1999.

Region	Percent of Households with Access to Piped Water	Percent of Households with Access to Sewers
Northeast	58.7%	22.6%
Brazil	76.1%	52.8%

Source: IBGE, 1999.

By the late 1980s, over 70 percent of Brazil's population lived in urban areas, where the proliferation of favelas was common[21]. Much of this urbanization was the result of mass migrations of the landless poor from rural areas into the cities[22]. Urban population growth without corresponding increases in urban services results in poor public health and a degraded environment. Without adequate water supply and sanitary sewers, there is a higher risk of death from sanitation-related diseases such as cholera, typhoid, and dysentery[23]. The consequences of a lack of access to affordable infrastructure services resulted in conditions where raw sewage was simply discharged into open ditches (*valas negras*) in many Brazilian favelas and other low-income areas. "*Valas negras*" is the Brazilian term for open ditches that carry sewage through areas that lack sewer systems.

The extent to which sanitation is inadequate directly affects public health and economic productivity. Regarding the former, diseases can quickly reach epidemic proportions in the unsanitary conditions of most high-density urban neighborhoods and favelas. For example, cholera spread rapidly throughout Latin America in the early 1990s, and favela residents were at highest risk. Cholera first reached epidemic levels in Peru and then spread to the Northeast region of Brazil. Subsequently, the disease spread to Brazil's South and Southeast regions[24]. By 1994, a total of 378,488 people had been stricken with cholera throughout Latin America, with 150,000 cases and 1700 deaths reported in Brazil[25]. Regarding economic productivity, sanitation-related health problems resulting from the lack of water supply and sanitary sewerage means that some unserved residents are unable to participate in income-generating activities that could contribute to their own welfare and to society[26]. Clearly, investment in basic infrastructure is not only an investment in public health but can also enhance economic productivity.

4.1.2 Towns, Cities, and States

The democratic transition allowed more progressive politicians to be elected at the local level, to address local concerns, and to improve democratic accountability[27]. Demographic change during the 1980s (i.e., urbanization, population growth, and rural-urban migration) also increased the voting power and prominence of cities and urban voters[28]. The fiscal decentralization of the 1988 Brazilian Constitution further empowered municipalities. As Samuel states,

> Under the 1988 constitution, . . . municipalities gained legal status as federal entities. . . . Municipalities also gained exclusive authority to organize and provide local public services, . . . to organize municipal zoning laws, and to legislate and develop urban development plans. . . . Brazilian municipalities also gained significant new resources under the 1988 constitution, mostly in the form of revenue transfers from state and federal governments. . . . The post-1988 fiscal decentralization has provided municipalities with an unprecedented degree of political autonomy because nearly all-fiscal transfers continue to be made automatically. (Samuels, 2000:82-83)

Capital cities were usually more independent from the state, in an economic and political sense, than interior towns. Mayors of capital cities were not necessarily in the same political party as the state governor. The prominence of mayors increased during the democratic transition, and then dependence on state governors lessened. The political tension between capital city mayors and state governors, combined with other characteristics of the new democratic political system (e.g., the emergence of a large number of weak political parties and the high turnover of political officials) contributed to instability in election outcomes from one election to the next, especially, in capital city mayoral elections following the democratic transition[29].

The introduction of popular elections and political parties did not eliminate reliance on traditional patterns of clientelism and patronage, especially for people located in Northeast interior towns that were typically more dependent on the state than large urban cities. Interior town mayors were elected, but the voters often supported and voted for candidates because of whom the candidate was, not necessarily because of their political party. Interior town mayors were more often in the same political party as the state governor, because having ties to the governor and being in the same political party strengthened the mayor's own power base. But whether they were in the same political party or not, the interior mayors each received a quota of funding from the governor to fund the city government. Because poor people in the interior were in a more dependent position, the city government was effectively a local arm of the state government. The interior mayors looked to the state government (and the governor) for assistance and they developed and nurtured their relationship with the state to maintain that assistance. Large urban cities also received a quota of funding, but were more likely able to supplement this quota with a self-generated tax base[30].

The dependence of interior residents on local officials and city government, and the dependence of interior city governments on state government, was a result of historic factors as well as the agricultural boom and bust cycle. When the agricultural economy was good, agricultural jobs were available and agriculture-related manufacturing and industrial jobs were available in the interior towns and cities. Dependence of interior residents on city government lessened during these boom periods. But when the boom ended, the unemployed in interior cities immigrated in droves to capital cities such as Recife and Natal. The State of Pernambuco has been through several agricultural boom and bust eras, including highs and lows in sugar cane, coffee, cotton, and tobacco output, as well as recurring cycles of severe drought. The level of dependence of interior residents varied from town to town, depending on the size of the population and on the local economic situation.

The political-economic situation in urban capital cities was different. For example, the capital cities of Natal and (especially) Recife had an industrial base that created and attracted more stable and diversified employment than was possible in the agriculturally based interior. Even though Natal was not an industrial giant by any means (e.g., its port and railroad are miniscule compared to Recife's), it was an urban area and therefore it did not suffer from the boom and bust cycles of the agriculture-dependent interior. Nor did Recife and Natal suffer as much from droughts because of their location along the Brazilian coast.

There were also differences in population size and the source of votes between the capital cities and the interior towns. Because the combined population of the interior was usually much greater than the population of the capital city, the majority of a governor's votes likely came from the interior, which obligated the governor to focus his or her efforts there. Capital city mayors, however, only received votes from the population living in the capital city. Capital city mayors often had to compete with interior town mayors for discretionary state funds, and they had to protect the capital city's resources from being diverted to the interior by the state governor.

The federal redistribution of finance away from states and toward municipalities that occurred during the transition to democracy further contributed to the tension between city and state levels of government (the impact of this redistribution on condominial sewer development is discussed in more detail in Section 4.2.3). Depending on the balance of power between the capital city and the state government, the interests of a capital city mayor and a state governor could be far apart or they could be perfectly aligned. As a consequence, there were variations in the ability of different cities and states to coordinate the implementation of policies, programs, and infrastructure projects. In chapter 5, I will show how this lack of coordination had a tremendous impact on condominial sewer projects in Recife during the 1980s and early 1990s.

After democratization, the local political conditions that enabled urban service provision began to change significantly with each election cycle[31]. An election could bring a period of stability if the mayor and state governor were in the same political party, or a period of instability if the mayor and governor were in opposing parties. The level of stability was also affected by the city's level of dependence on the state, among other factors. For example, in the state of Pernambuco, the capital city of Recife was quite powerful compared to the state government. For periods of time during the 1980s and early 1990s, the Recife city government and the Pernambuco state water and sanitation agency did not cooperate (see Chapter 5, Section 5.2.2). Conversely, in the state of Rio Grande do Norte, the capital city of Natal was relatively less powerful compared to its state government. The Natal city government continued to cooperate with and rely on its state water and sanitation agency throughout the 1980s and early 1990s (see Chapter 6, Section 6.2).

4.2 Urban Service Provision in an Emerging Democracy

In the previous section, I introduced Brazil's political opening. In this section, I focus on the impact of Brazil's political opening on the provision of urban services, including condominial sewers.

4.2.1 Grassroots Movements

Part of Brazil's transition period included what Gerschman (1993) calls a "sanitation movement," which consisted of grassroots popular movements of poor residents, and middle-class movements of health workers and doctors who protested, demonstrated, mobilized, lobbied, and otherwise struggled for better public health policies, programs, and facilities[32]. The term "grassroots popular movements," a subset of urban social movements, refers to mobilization of the popular classes (i.e., the poor and working class)[33]. Public health problems, rapid urbanization, the growing lack of urban services, and the political opening of the early 1980s motivated numerous popular and middle-class movements that focused on health issues. The influence of the sanitation movement corresponded with the new attitudes involving the urbanization and integration of favelas into society, as opposed to their demolition[34]. The sanitation movement also set the stage for the emergence of new attitudes about conventional sewer technology. Before the sanitation movement, conventional sewer technology was accepted as the primary sewerage solution. After the sanitation movement, sewer agency officials and engineers throughout Brazil began to question the appropriateness of conventional sewer technology and showed a willingness to experiment with condominal sewers.

Rather than organizing the sanitation movement around class, poor Brazilian residents tended to organize around residential location (i.e., neighborhoods)[35]. Residents formed community-based organizations that demanded water, sewer, and other urban services from elected officials and government agencies. They used a variety of tactics in their struggles for service. Tactics among CBOs included[36]:

- Mobilizing large numbers of residents;
- Conducting sit-ins;
- Protesting at the doorsteps of government agencies;
- Signing petitions;
- Submitting complaints;
- Inviting government representatives to tour their neighborhoods to witness living conditions;
- Using the threat of mass protest to force negotiation;
- Negotiating with officials in small groups;

- Prioritizing needs and focusing on each one in sequence; and
- Targeting specific demands to appropriate agencies.

Although grassroots mobilizing alone did not result in change within local and state implementing agencies, it did play at least three important roles: 1) mobilizing allowed residents to express their basic needs (e.g., for water supply, sewers, etc.) to reformist officials; 2) mobilizing allowed residents to direct grassroots pressure to implementing agencies; and 3) mobilizing triggered implementing agencies to collaborate with residents to seek viable service solutions[37].

Watson (1992) identified a general trend in the mobilizing tactics used by favela associations in Sao Paulo during the decade of the 1980s[38]. The tactics used were solely oppositional at first, but became more collaborative by the end of the 1980s. Oppositional tactics were used initially to pressure government agencies and to provide a constituency for opposition candidates. But successful implementation of actual projects required collaboration between residents and the implementing agency to formulate local solutions and to negotiate agreements among favela residents[39]. Rather than seeing this collaboration as a weakness or as cooptation by the state, Watson argues that it was an effective strategy for favela associations in Sao Paulo. Watson's conclusions on this point contradict the view that increased populism and clientelism are evidence of the weakness and cooptability of grassroots popular movements. Support for Watson's interpretation can be found in the following statement by Mainwaring (1989):

> Although it is important for social movements to avoid becoming a servile instrument of parties or politicians, it is also important that they influence political parties and the State. What is sometimes portrayed as cooptation may be good judgment on the part of movement leaders. . . . A discussion of autonomy/cooptation should therefore focus on trade-offs rather than simply positing the importance of "autonomy" in some undefined sense. (Mainwaring, 1989:188)

In my opinion, Watson's and Mainwaring's interpretations are more persuasive than a simple cooptation-by-the-state argument.

Even more important than the mobilizing tactics used by different community-based organizations was the political rationale behind their organizing activity. Prior to the democratic transition, community-based organizations in poor neighborhoods were integrated into local-level clientelistic politics, in which large populations of poor residents that were organized at the neighborhood level served as inexpensive sources of votes for politicians[40]. The clientele system was, and still is, deeply entrenched throughout Brazil. Even though clientelism exploited the poor and perpetuated their dependent and powerless situation, it provided advantages for both the patron and the client[41]. The community received desperately needed services – usually right around election time – and the politician gained a block of votes. Larger neighborhoods had more potential votes and thus had more influence, so they were in a better position to bargain for better services.

Community organizing was necessary so that the president of the community association could assess the most pressing needs of the residents and announce which politician was to receive everyone's vote. Clientele-oriented organizing activities functioned to reduce transaction costs for the patron, and transferred most of the benefits of empowerment to the community president, whose local prestige and power depended on his or her deal-making ability. The community benefited from this arrangement by receiving neighborhood improvements. However, most of these improvements were one-time gifts rather than long-term services[42].

Clientelism tended to flourish most in local-level politics (not state-level politics). It was not until the democratic transition that the possibility for new forms of community organizing and party politics emerged at the local level[43]. Rather than voting for candidates based on an optimal transaction, democracy-oriented neighborhoods organized to vote for the political party that would represent their needs more broadly. As documented by Gay (1990) for Rio de Janeiro, this new rationale for grassroots organizing in the 1980s was successful in bringing long term urban services (e.g., condominial sewers) to the poor in a much more emancipatory and less-exploitive fashion.

Conversely, Mainwaring and others have noted that the transition period resulted in *increased* clientelism and populism, which were aimed at pacifying and demobilizing grassroots popular movements[44]. In theory, democracy allows poor residents to participate in the political process without being exploited. However, because the clientele system promises to bring immediate benefits to the community, to the community president, and to the politician, the temptation to fall back on clientelism is strong for everyone involved. This is why this system is so difficult to change. Gay distinguishes populism from clientelism as follows:

> Populism represents an appeal by political elites to popular discontent with the distribution of power in society. In a sense, populism is simply a more sophisticated form of clientelism in that both represent strategies for the political incorporation of the masses. But although populism is essentially an exchange of "votes for patronage" in that the distribution of benefits is calculated on the basis of what is necessary for consolidating political power, populism is less transactional and more ideological than clientelism (Gay, 1990:116).

Despite the practical success of the sanitation movement, some social movement theorists argue that grassroots popular movements are unlikely to have a lasting impact in Brazil. Boschi found that participation in mobilizing activities increased the participation of residents in the electoral process, that the grassroots movements brought pressure for more democratic, pluralistic social interactions, and that these new social patterns weakened the long-standing clientele system[45]. However, the legitimacy of grassroots organizations as political actors and the institutionalization of permanent channels of access did not occur for at least two reasons: 1) community organizing was based on specific, transitory demands; and 2) grassroots popular movements tended to become captured by the government. In Boschi's words,

> [The] process from the "bottom up" does not occur in isolation; what was coming from the "top down" had important effects in limiting the new social forces' potential to institutionalize a new order. . . . The institutional impact that these movements can have is much less than appears at first glance judging by the [limited] extent of the phenomenon on the national scene. (Boschi, 1984:73, 203)

Community mobilizing that revolves around specific services is considered a transitory demand. Once the service is provided, the demand goes away and the incentive to mobilize disappears. Grassroots organizations that centered their mobilizing activities around attracting new urban services, while sometimes effective in a practical sense, thereby limited their ability to make more permanent changes as a social movement. The capture, or cooptation, of grassroots movements by government was another factor that limited the strength of the movement.

4.2.2 Popular Elections

Popular elections also influenced the provision of condominial sewer and other urban services in Brazil. Prior to 1982, state governors were appointed by the President of Brazil. But since 1982, state governors have been directly elected by popular vote. The popular election of city mayors started in 1985. The policies and programs of reform politicians created pressure to improve and expand urban services. For example, in the state of Pernambuco, opposition candidate Miguel Arraes won the 1987 gubernatorial election and subsequently enacted policies and programs to serve his political base, which largely consisted of poor and working class people.

Prior to popular elections, agency directors did not have the political space to take proactive steps to expand urban services. Service provision had been largely clientelistic and exploitive, or merely a reaction to large mobilizations and immediate political pressure[46]. As the democratic transition proceeded and as populist politicians were elected to office, there were periods of proactive implementation of urban services initiated from within government agencies. These periods of proactive implementation were accompanied by the election of populist politicians who supported the proposals of progressive technical staffs within government agencies. The democratic transition also led to the potential for wide swings in political administrations with each election cycle which, in some locations, resulted in discontinuity in support for urban service projects from one administration to the next.

4.2.3 Institutional Arrangements

Under President Medici's administration of the early 1970s, Brazil adopted a state-owned enterprise institutional model for its water and sanitation sector. This resulted in the creation of large state agencies directly funded by the federal government that specialized in the implementation of water and sanitation infrastructure in each state. Under these institutional arrangements, project decision-making was centralized at the state level.

Most of the water and sanitation investment of the 1970s and 1980s came from Brazil's National Sanitation Plan (*Plano Nacional de Saneamento*, or PLANASA), funded by the National Housing Bank (*Banco Nacional de Habitacao*, or BNH). From 1970 to 1989 (i.e., the "PLANASA era"), PLANASA provided R$11.3 billion in federal funding to state water and sanitation agencies for infrastructure projects throughout Brazil[47]. The majority of PLANASA-era funds supported water development, since popular demand for water projects was higher than demand for sanitation projects. Other funds from international donors and lending agencies (such as the World Bank) were also channeled through the BNH for distribution to state water and sanitation agencies and to municipalities that implemented the projects. Many of the original condominial sewer projects in Brazil were PLANASA/BNH-funded projects in which the World Bank provided a portion of the funds.

Table 4-2 presents estimates of the percentage of the Brazilian population with access to water and sewer service from 1970 to 1999. These estimates illustrate that great increases in water and sewer access were made in the PLANASA era, and that investments in sewers lagged behind investments in water. Most of these investments did not reach the poor, however. Silva, et. al., (1996) concludes that Brazil's sanitation development policy was limited to "formal, legitimate urban areas"[48], and Parlatore (undated) states that:

> Despite PLANASA's major achievements, the institution failed to accomplish universal service, especially in the poorest regions . . . in the North and Northeast. . . . Rural-urban migration grew considerably during the period in which PLANASA was in effect, causing rapid and disorderly growth at the outskirts of medium and large cities and making it increasingly difficult and expensive to provide water supply and sewerage services in such areas. (Parlatore, undated: 4-5)

The institutional arrangements set up in the 1970s administration included federal rules declaring that municipal governments had control over local water and sanitation development. The great majority of Brazilian cities subcontracted out their water and sanitation development by signing 20-year contracts with the state-owned water and sanitation agencies. These contracts assigned to water and sanitation agencies the responsibility to provide infrastructure services, but some cities were more dependent on the state agencies than others. Because the agencies were state-owned, they were often

Table 4-2. Estimated access to piped water supply and sanitary sewer services in Brazil from 1970 to 1999.

Year	Access to Piped Water	Access to Sewers
1970	55 – 60% (percentage of population)	22% (percentage of population)
1980	72% (percentage of population)	21%[a] (percentage of population) 43% (percentage of households)
1991	86% (percentage of population)	49% (percentage of population)
1995	91%[b] (percentage of population)	66%[b] (percentage of population)
1999	83.9% (percentage of population) 76.1% (percentage of households)	41.2% (percentage of population) 52.8% (percentage of households)

Sources: Parlatore, undated; IBGE, 1999; IBGE PNAD, 1999; World Bank, 1994; and Cardoso, 1989: 305.

a. Due to a lack of available data, the figures for 1980 are access to sanitation (sewer or septic tank) from the World Bank (1994) and Cardoso (1989: 305).

b. The inconsistent pattern of improvement in water and sewer access between 1995 and 1999 indicates the possibility of a high level of error in establishing how much of the population is being served at any given time. PAHO/WHO (2001:44) reported that Brazil's 1995 water and sewer access estimates were likely too high due to errors in population estimates.

politically tied to the governor of their state. The water and sanitation agencies were affected by political differences between state governors (to whom they were directly tied) and urban capital city mayors (with whom they had contracts). While small, rural interior towns tended to be in a position of dependence on the state agencies, large and wealthy capital cities had some capacity to act independently and went through periods in which they competed with the state with regard to water and sanitation policy and program implementation. As state governors moved funds away from the urban centers and toward the more needy interior, capital cities either enhanced their relationship with the state or made attempts to develop their own water and sanitation sector (i.e., they provided services independently).

In the 1988 Brazilian Constitution, the system for financing public infrastructure was changed from a highly centralized to a largely decentralized financing scheme[49]. In preparation for the democratic transition, the BNH was reconstituted as the Federal Bank of Brazil (*Caixa Economica Federal*, or CEF) in 1986. Under the new decentralized financing scheme, federal money for local infrastructure services (including World Bank loans, etc.) would be distributed directly to municipalities rather than through the state water and sanitation agencies. This new arrangement would, effectively, alter the balance of power between cities and state agencies. Municipalities would be able to build and manage their own sewer projects, hire private companies, or hire the state water and sanitation agency to implement, operate, and maintain city sewer services. An engineer with Natal's municipal urbanization agency (URBANA) described the impact of these changes as follows:

> During the dictatorship, everything was concentrated and centralized, and CAERN did everything. Then this all changed and things became decentralized in 1988. Part of this process included deciding what responsibilities would be transferred to the municipalities and what CAERN would continue doing. . . . The problem is that the City wants CAERN to do more and CAERN wants the City to do more. Another problem is that all of the technical staff and expertise is in CAERN. (Informant 120, URBANA civil engineer, interview by author, 25 May 1994, Natal, transcript)

The new decentralized finance arrangements were put into practice by President Itamar in the early 1990s. Since that time, cities have been able to acquire their own funds and implement condominial sewer projects without involving the state water and sanitation agencies, and state agencies have had to obtain an agreement with a city government before they could receive project money. In essence, the state agencies now had to market their services to city governments, sometimes in competition with private companies. Once again, the evolving balance of power between capital cities and the state has implications for the implementation of water and sanitation services.

This change in finance rules did not significantly stall condominial sewer development in Recife, because four agencies – two municipal-level and two state-level – were involved in implementing condominial sewers in Recife. Recife's municipal agencies were prepared to apply for funds on their own, and Recife's state agencies were prepared to seek new sources of funding. As a result, condominial sewers continued to be implemented in Recife throughout the 1985 to 1995 period, even by regimes that did not initially embrace the technology. Recife's multiple implementing agencies, operating at both the municipal and state levels of government, gave the City a degree of resiliency to changes in the rules governing public finance. This was in contrast to the City of Natal, whose dependence on a single, state level sewer agency (i.e., CAERN) contributed to that city's vulnerability to finance rule changes by the federal government. When funding was decentralized from state governments to municipal governments, CAERN lost direct access to funding and, for a period, condominial sewer implementation came to a halt in Natal.

4.2.4 The Transition to Condominial Sewers

Figures 4-2, 4-3, and 4-4 illustrate the modest increases in water and sewer connections made in Recife and Natal during the years following the democratic transition[50]. Measured as the number of connections per 1,000 households, Recife added approximately 73 water connections, 12 condominial sewer connections, and –9 conventional sewer connections per 1,000 households during the 1987 to 1994 period (shown graphically in Figures 4-2, 4-3, and 4-4). The rate of expansion of conventional sewer connections was negative because it was slower than the rate of population growth. In the 1990 to 1995 period, Natal added approximately 46 water connections, 12 condominial sewer connections, and –4 conventional sewer connections per 1,000 households (also shown in Figure 4-2, 4-3, and 4-4).

These rates of expansion in the number of connections indicate that Recife was adding water connections at a slightly faster rate than Natal, and that increases in water connections outpaced the respective population growth in each city during this period[51]. The data reveal that Natal had slightly more water connections per household than Recife at that time[52]. Conventional sewer expansion was insignificant in both cities during this period because of the end of the PLANASA era of federal investments in water and sanitation. Neither city's rate of conventional sewer expansion exceeded the rate of population growth.

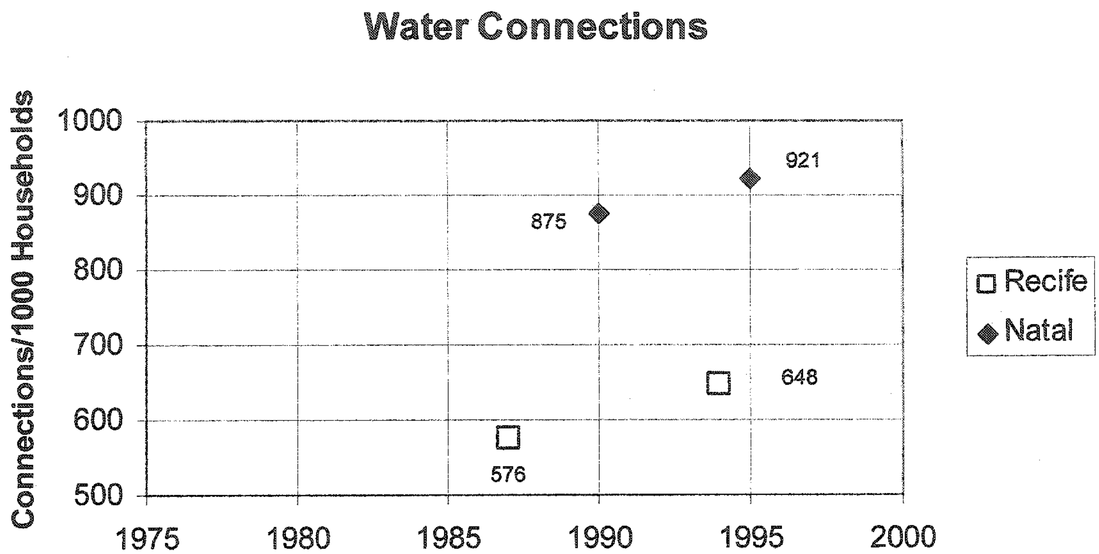


Figure 4-1. Estimated expansion of water connections per thousand households in Recife (from 1987 to 1994) and Natal (from 1990 to 1995)[a].

Sources: My calculations using connection data from COMPESA (1994) and CAERN (1995); city household data from IBGE-Malha (1997); and city population data from Populstat (2003).

a. These time periods reflect the first year that computerized records were kept in Recife (1987) and Natal (1990), and the year for which data on water connections were available during my fieldwork in Recife (1994/1995) and Natal (1995).

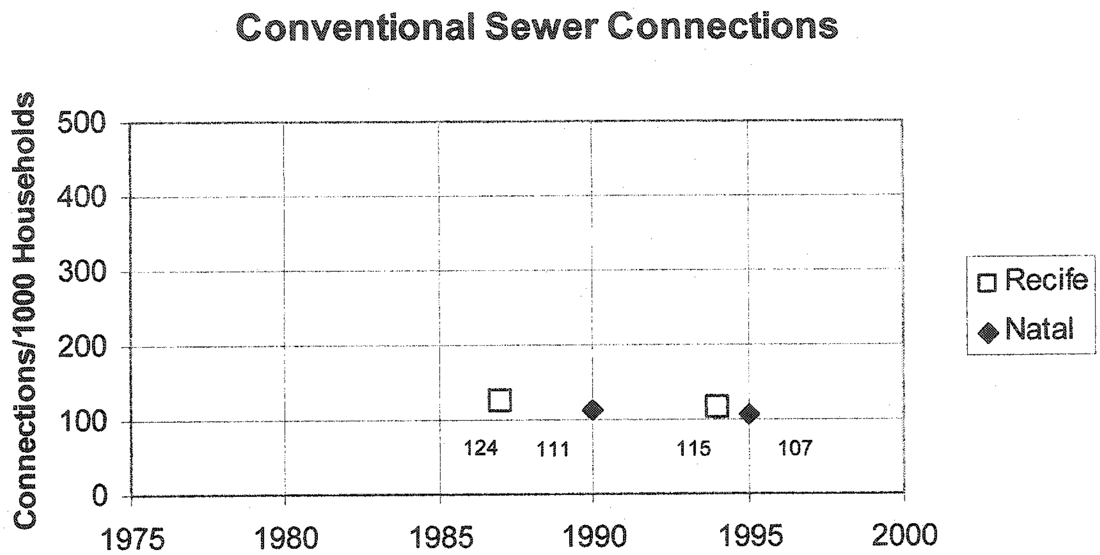


Figure 4-2. Estimated expansion of conventional sewer connections per thousand households in Recife (from 1987 to 1994) and Natal (from 1990 to 1995)[a].

Sources: My calculations using connection data from COMPESA (1994) and CAERN (1995); city household data from IBGE-Malha (1997); and city population data from Populstat (2003).

a. These time periods reflect the first year that computerized records were kept in Recife (1987) and Natal (1990), and the year for which data on conventional sewer connections were available during my fieldwork in Recife (1994/1995) and Natal (1995).

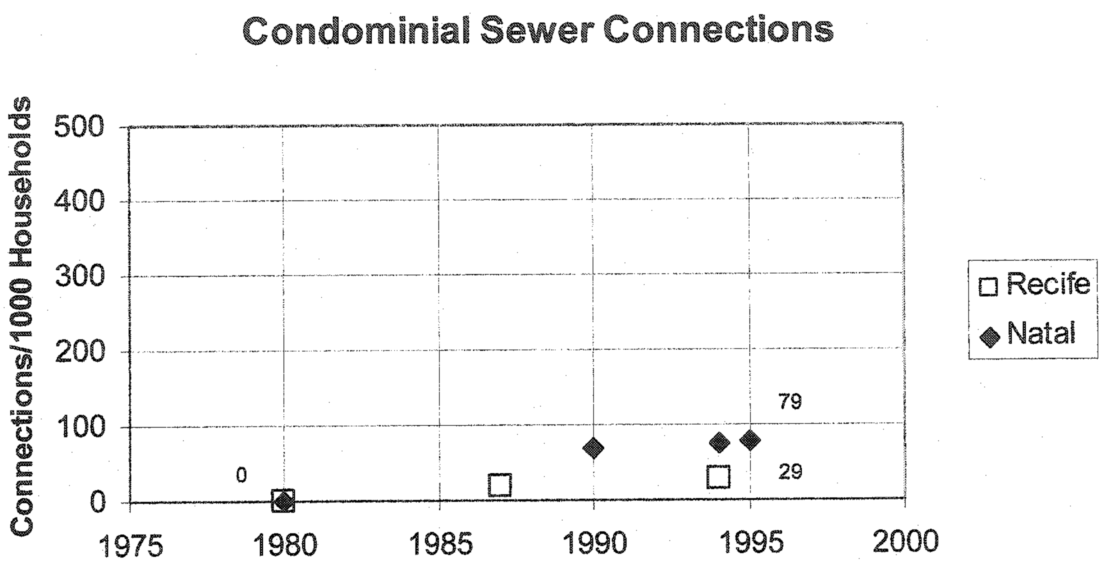


Figure 4-3. Estimated expansion of condominial sewer connections per thousand households in Recife (from 1980 to 1994) and Natal (from 1980 to 1995)[a].

Sources: My calculations using connection data from COMPESA (1994) and CAERN (1995); city household data from IBGE-Malha (1997); and city population data from Populstat (2003).

a. These time periods reflect the first year that condominial sewer implementation began in Natal (1980), and the year for which data on condominial sewer connections were available during my fieldwork in Recife (1994/1995) and Natal (1995).

Recife and Natal increased their condominial sewer connections at nearly equal rates during the 1990s. However, Natal had more condominial sewer connections per household than Recife because Natal had begun implementing condominial sewers in the early 1980s, approximately five years before Recife. The increases in sewer connections in Recife and Natal, although modest, consisted almost entirely of condominial sewer connections. Whereas few (if any) conventional sewer systems had been installed in favelas, poor, or low income neighborhoods during the PLANASA era, the transition to condominial sewer technology allowed both Recife and Natal to begin extending sewerage to previously unserved populations.

4.3 The Challenge of Providing Urban Services to the Poor

Targeting urban services to poor, unserved residents presents considerable challenges to implementing agencies. The technical difficulties associated with serving the poor (e.g., unplanned housing layouts, flooded neighborhood locations, etc.) are confounded by weak institutions, lack of resources, ineffective approaches, and the historically disenfranchised nature of low-income populations[53].

The historic difficulties that government agencies have had in expanding urban services to the low-income segments of the population can be understood, in part, by the contradiction between the needs of low-income communities and the standard operating practices of large, specialized, state-owned agencies. While large, centrally-managed organizations (e.g., state-owned water and sanitation agencies) can take advantage of economies-of-scale by providing standardized services over large areas, they are typically incapable of responding to local needs and low-income populations. Because smaller, decentralized organizations (e.g., non-governmental organizations (NGOs), community-based organizations (CBOs), and municipal level agencies) are better positioned to respond to local needs, they are more likely to embrace innovative and low-cost approaches that meet the needs of low-income residents[54].

The operations of large agencies are based on highly standardized procedures employed by technical professionals who may be – because of their training and because of the incentives they face – biased toward conventional approaches and high technical standards. With respect to sewer service in Brazil, conventional sewer technology largely has not met the needs of low-income communities. Conventional sewers are generally not appropriate for low-income communities (e.g., favelas), because they are costly, require vehicular access by maintenance staff, and require wide streets and regular housing layouts[55]. Brazil's large, specialized water and sanitation agencies developed the capacity to implement conventional sewer facilities. Most agency professionals were not experienced in the installation of unconventional, low-cost sewer systems. Many agency engineers considered unconventional systems unacceptable, because they did not comply with industry standards. Wide differences between the socio-economic status of agency professionals and low-income beneficiaries made it difficult for state agency staffs to understand local needs and propose viable solutions[56].

The lack of public-sector resources and private-sector support for water and sanitation were additional constraints to successful urban service provision in low income areas. Historically, the resources available for water and sanitation services in Brazil were very limited due to the developing status of the country. As in other Latin American countries, Brazil's limited resources were initially channeled to serve wealthier segments of the population who could afford the service; they were not distributed to the majority of the population, which consisted mostly of low-income residents[57]. These resource-limited conditions resulted in 28% of Brazil's urban population and 87% of the country's rural population still not having access to sewer systems or septic tanks in 2000, with most of the lower income segments of the population remaining unserved[58]. But even with adequate resources, projects could fail as a result of institutional forces. As one group of researcher argues:

> In the absence of a clear government mandate to support [grassroots water and sanitation] efforts, programs can also be subverted in any number of ways by the normal bureaucracy, as well as partisan politics. Government officials may. . . feel apprehensive about the spin-off empowerment effects, particularly if there is any danger that the community-managed project may be co-opted by political or other groups. (McCommon, et al., 1990: 35)

As a result of grassroots struggles for enfranchisement and the democratic transition in Brazil, officials and institutions supportive of serving the poor emerged and investment in basic urban services for the poor became more likely.

The World Bank has concluded that implementing urban services for the poor requires a different institutional approach than implementing services in higher-income communities[59]. Case studies on water and sanitation projects illustrate a growing consensus that approaches involving participation increase the opportunity for service provision to the poor[60]. Korten and others contend that low-income areas benefit more from participation approaches that are characterized by low-technology infrastructure conceived from the perspective of the community itself[61].

The literature suggests that lower costs, relaxed technical standards, participation, and a localized institutional approach are four fundamental aspects of implementing successful projects in low-income areas[62]. Participation approaches generally involve some combination of simple, low-cost equipment and local materials; lower design and construction standards; labor-intensive rather than equipment-intensive installation and maintenance techniques; a localized or decentralized agency approach; affordable user fees; and participation in identifying local needs, formulating solutions, and implementing projects (see appendix D for more discussion of participation). Condominial sewers exemplify this approach.

Consideration of the inherent characteristics of poor areas helps explain why it is difficult to simply blanket poor areas with services. Poor areas are characterized by high levels of risk and ambiguity, which contribute to a complex environment for implementing projects. Because of the multiple obstacles that exist in poor areas, it is difficult to attract investment in infrastructure projects. The combination of low levels of investment and low returns on investment creates a resource-constrained environment. Under these conditions, a singular success in one poor area cannot readily be replicated in other poor areas. Other obstacles to the replication of development projects for the poor are summarized by Binswanger and Aiyar as follows[63]:

1. High costs
2. Hostile institutional setting
3. Lack of coordination among stakeholders
4. Lack of adaptation to the local context
5. Lack of scale-up logistics

Successful replication of projects in poor areas is more likely when projects are fine-tuned to each local situation; when fees are considered reasonable by users; and when projects are simple. These criteria for replication are embodied in the condominial sewer participation approach. Participation provides a mechanism for agencies to acquire local knowledge from residents, knowledge that is needed to fine-tune projects to their local situations. Participation also allows residents to express their needs and receive information about the sewer service. The use of simplified sewer technology with relaxed engineering standards provides a mechanism for reducing technical complexity. And the low-cost and reduced fees of condominial sewer technology provide mechanisms for reducing investment risk and for increasing affordability.

In addition to the physical and economic characteristics of poor areas that impede service provision, there are other impediments. These include a lack of demand for sewer service. Demand for sanitary sewers is affected by at least five factors: 1) population density, 2) availability of lower-cost options, 3) competing demands, 4) water supply, and 5) income level[64]. Demand for sanitary sewers tends to increase as urban population density grows. In dense urban areas with constraints on the availability of land and water, using the available land and water for onsite waste disposal in leachpits, cesspools, and septic tanks has high opportunity costs. By contrast, rural areas are less densely populated and have more available land and water per capita that can be used to dispose of waste at relatively lower opportunity costs. There are benefits in moving from on-site waste disposal to sewer collection and treatment systems, namely a lessening of the costs of inferior public health, economic inefficiency, and individual inconvenience. As residents become aware of these increasing urban costs and of the availability of sanitary sewer technology that can reduce these costs, their demand for sanitary sewerage naturally tends to increase.

Demand for sanitary sewers also tends to increase as higher-priority demands are met. Poor residents often do not express demand for sanitary sewerage until their demands for other services (such as land tenure, electricity, and water) have been satisfied. It is difficult for government authorities to justify large-scale investments in sanitary sewerage when the public has other more immediate demands. In Brazil's urban development history, most investment dollars first went towards water supply infrastructure rather than sewer infrastructure, because water supply is a primary need that rightly comes before sewerage[65].

Demand for sanitary sewers tends to increase with water availability because increased water use creates more wastewater, which increases the costs of disposal to non-sewer alternatives (e.g., leachpits, cesspools, septic tanks, storm drains, and local surface waters). As income increases residents are able to expend some of their resources protecting themselves from the threats posed by sewage, sewer expenditures become a smaller percentage of income, and sanitation becomes less directly threatening. At levels of affluence the sanitation problem, having been solved, ceases to be a high priority and larger environmental concerns beyond the household move into focus[66].

The persistence of traditional Brazilian patterns of clientelism and patronage is an additional obstacle to successful service provision in poor areas. Clientelistic and patronage-based systems continue to exist throughout Brazil despite the end of the authoritarian regime. The result is that most issues, even basic human needs, become politicized, and the behavior of government agencies is significantly dependent on which regime is in power. Understanding the urban political context is therefore crucial to understanding the process of implementing urban services in poor areas. Although the people of Brazil displayed a desire and a capacity to form more progressive, pluralistic organizations prior to the democratic transition, the government did not change its style significantly. In the words of one researcher writing in 1984:

> As the curtain of "abertura" was being drawn, the scenario it revealed was one of a society which had mobilized and organized itself, but in which the possibility of substituting pluralistic practices for authoritarian, clientelistic arrangements was actually low. (Boschi, 1984:134)

The political commitment to serve the poor was certainly lacking in Brazil's past, when traditional styles of development, governance, and decision-making actually exacerbated the problem of poverty. The democratic transition brought noticeable but not permanent improvements in service provision, as exemplified by increases in urban services in some cities. Such changes were not possible under the previous authoritarian regime. Effectively addressing or even only representing the needs of people living in favelas has yet to occur on a grand scale in Brazil, but increasingly democratic political arrangements may offer promise in this direction.

4.3.1 Favela Urbanization

During and following the democratic transition, some Brazilian officials started addressing the needs the poor by implementing favela urbanization programs. In Pernambuco state, several favela urbanization projects were implemented by the State Housing Agency (*Companhia de Habitacao do Pernambuco, or COHAB*). In December 1994, I spoke with a former COHAB staff member, Maria (a pseudonym), who had been involved with implementing an urbanization project in Recife. The project is called Grand Favela for the purposes of this discussion. Pictures of the neighborhood are presented in Photos 4-1 and 4-2.

The Grand Favela urbanization project illustrates some of the complexities involved in implementing condominial sewer projects for the poor. One source of complexity is the changing pattern of political alignments that result in unpredictable variability in support

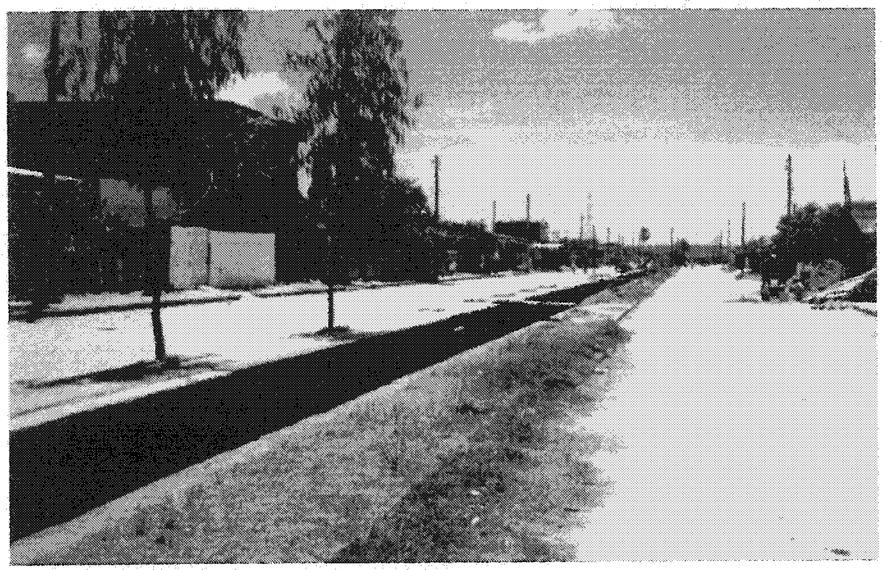


Photo 4-1. Street scene of the "Grand Favela" neighborhood in Recife, 1994. A key feature of the neighborhood is the large drainage canal down the center of the main street. Also visible in this photograph are electric utility poles, paved streets, and homes of solid (brick) construction in a regular block layout.

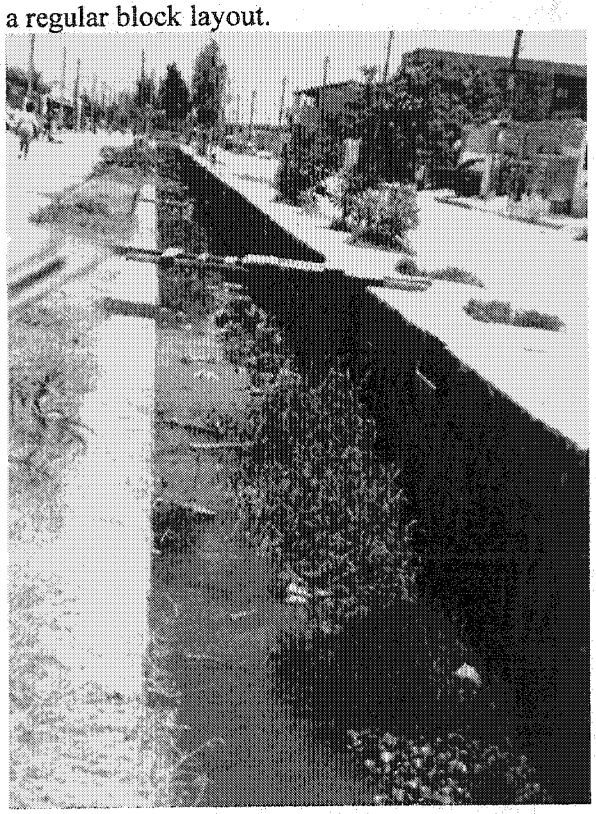


Photo 4-2. Close-up view of the main drainage canal in the "Grand Favela" neighborhood in Recife, 1994. Because of poor sewer system performance and cross-connections to the sewer system, some raw sewage is discharged to the drainage canal, causing malodorous conditions and excess plant growth.

for individual projects. Another is the opportunity for involvement of project beneficiaries in a variety of project implementation activities and in the political process, and the different levels of influence held by different communities. Finally, the ambiguity of project outcome itself is another source of complexity in the condominial sewer implementation process. The lack of a consistent, generally agreed upon standard of performance makes it difficult for project practitioners to learn from project experience.

The Grand Favela project and several other projects were implemented under the Urbanization Program (*Projeto de Urbanizacao*) championed by Governor Miguel Arraes' administration of 1987 to 1990. Arraes was elected in 1987 as a populist politician. He was strongly supported at the grassroots level by poor and middle-income residents, who were then able to participate as citizens in Brazil's new democratic electoral process and political party system. The objective of Arraes' program was to integrate favelas into cities by providing legal land tenure, by regularizing the layout of homes and streets, and by providing urban services (including condominial sewers). The urbanization projects were targeted to the very poor and were subsidized by the implementing agency (COHAB). Residents purchased their own building materials and either performed their own labor or hired contractors with their own funds.

Maria explained that COHAB's implementing approach was to enter an unplanned settlement and create organized lots, water supply, sewerage, drainage, electricity, lights, and pavement. Prior to the project, the Grand Favela neighborhood was a randomly organized group of dwellings (*i.e.*, a favela) built on a swamp. The whole area was flooded. COHAB's implementation of the project consisted of conducting a survey of the area; relocating all of the residents to another nearby location; importing soil to increase the elevation of the land and eliminate the swamp; constructing approximately 3100 urbanized lots with complete urban services (water supply, sewerage, drainage, electricity, lights, and pavement); and returning the people to the area so they could construct their own homes with their own materials.

In addition to the urban infrastructure services, COHAB also provided public facilities such as a nursery, a school, and a police station. Two lots were given to each of the four existing community-based organizations so they could construct their own buildings. COHAB social workers helped conduct surveys and helped beneficiaries procure the materials they would need to build their homes after COHAB urbanized the area. COHAB staff also inquired about which social services residents wanted and helped them find temporary places to live.

4.3.2 The Grand Favela Condominial Sewer

The Grand Favela project included a condominial sewer system. All the condominial sewers were installed in the rear of the lots, resulting in a backyard layout. The residents received their lot with the backyard condominial sewer (but not the house connections) already constructed. I asked if the residents participated in the sewer system, and Maria told me, "the residents had no say in the sewer system because they were worried about their housing situation first." The original huts built by residents did not even have bathrooms. She argued that because the residents did not even provide themselves with a bathroom when they built their shacks, they likely knew very little about sewer systems or condominial sewers. To facilitate the construction of bathrooms inside the homes built by residents, bathroom kits were made available for those residents who wanted them. However, the residents considered the kits too expensive. Maria said that about 60% of the residents in Grand Favela wanted bathroom kits. They were given 25 years to pay them off, but Maria reported that by 1994 (after five years or so) "everybody had stopped paying."

The existing favela residents received lots first, and then other people were allowed to move in from other areas to fill in the remaining lots. There were three or four block meetings to explain to residents how the condominial sewer worked. At first, the COHAB social workers planned to do this in a series of small meetings with two or three blocks of residents. But, ultimately, private contractors were hired to construct the project and to explain the condominial sewer system. Maria explained that after the first few blocks were constructed, the private contractor held two block meetings with the residents of each block to explain the system to them (the meetings were held on the corners of the first few blocks). As work progressed, the pace of construction increased to the point that many blocks were being completed every day. It became impossible for the contractor to keep up with the block meetings. After the first two block meetings, there were only a couple of general meetings for the entire project area. Given the large number people living in the neighborhood, it was not possible to teach everybody about the condominial sewer system in the context of a couple of huge gatherings. Consequently, the residents were not well-informed about their condominial sewer, and many of the original residents did not understand the system.

Within the first year of the project, about 30 percent of the original residents sold their lots to middle-class residents who were more familiar with sewers and who already understood how to use the system. Residents had not participated in some key project decisions, such as the selection of the sewer service level (which defined the tariff level). Many people sold their lots and moved to other favelas because they were not accustomed to paying for all of the utilities associated with the newly urbanized community.

Just over 3100 condominial sewer connections were constructed in Grand Favela. But after construction, the Grand Favela sewer system was not "accepted" by the State Water and Sanitation Agency (*Companhia do Pernambuco de Saneamento e Agua, or COMPESA*) for maintenance. This meant that COMPESA did not regularly maintain the system. COHAB built a community septic tank and the public sewer system in addition to the condominial sewers, but COMPESA did not maintain these facilities in a consistent manner.

Maria was proud of the project and was obviously fond of her work in Grand Favela. I asked her if COHAB considered this project a success and she said, "Basically, yes." Maria remembered what the neighborhood was like before the project, and said that the neighborhood was now completely transformed and much cleaner. She said the area was no longer a favela and that the project was successful even though the sewer system did not work. The urbanization of this favela meant that the standards of cleanliness and order were significantly improved even without a well performing sewer system.

She led me to one family whose house was still under construction. It appeared as if they were adding a second story while living on the ground floor. The front yard was filled with "tijolo" bricks and other construction materials. The condominial sewer connection inside the resident's home was not working. The father of the household explained that when the sewage pumps broke down, workers had to re-route the sewage directly to the canal so they could work on the pumps, requiring them to break and re-route some of the sewer pipes. Evidently, his pipes had been re-routed, but they also had become blocked and unusable in the process. It was so bad that one of his neighbors had poured concrete into his sewer connection box to keep the sewage out of the neighbor's lot.

The resident also had a septic tank on his lot. Prior to the condominial sewer, he had discharged sewage to his individual septic tank and it was still there on his lot. But now the wastewater from his home went directly to the canal because of the broken sewage pumps. The wastewater from households on the part of the system with the broken sewage pumps either discharged directly to the canal or into the street gutters. The resident I interviewed did not seem perturbed by this situation. Neither did Maria. I sensed a low level of concern about the sewer system and more interest in the other aspects of the project, especially the individual lots and public facilities (i.e., a nursery, a school, a police station, and a future health clinic). All the other practitioners I spoke to were united in their judgment that the sewer project performed relatively poorly.

At the end of our tour, I asked Maria if she would ever go back to work at COHAB and she said she was going back to work for Governor Arraes at the beginning of the year. In the state elections of 1994, Miguel Arraes had won another term as governor after four years out of office. Maria explained that Governor Arraes had invited all of "his employees" back to their old jobs through an advertisement in the previous month's Urban Life section of the Pernambuco Daily newspaper (*Diario do Pernambuco*)[67]. She said there were probably 100 or so employees who had lost their jobs at COHAB when Governor Arraes left office in 1991. After Governor Miguel Arraes' term expired in 1991, Governor Joaquim Francisco took office and executed the normal practice of elected officials throughout Brazil at that time. Francisco "wiped out" Arraes' favela urbanization program (the Urbanization Program) and the housing program (the Habitation Program) that Arraes had supported, and fired all of the staff associated with these programs. The staff went to the local governments of a number of different municipalities, including the City agency where she now worked. Maria referred to herself as an "original" COHAB employee who had been displaced because of the change in political regime.

COHAB had built the Grand Favela sewer collection system, community septic tank, and sewage pump station under Governor Arraes, but when Governor Francisco was elected the alignment of interests changed significantly. By the time the project was to be handed over to the State Water and Sanitation Agency (*Companhia do Pernambuco de Saneamento e Agua, or COMPESA*) for maintenance, COMPESA's interests had changed (via staff appointments by the new governor). Consequently, COMPESA did not accept COHAB's project and did not provide regular maintenance of Grand Favela's sewer facilities. This had a direct impact on project performance.

4.3.3 The Implementation Context

The recent democratization of Brazil was not only a transition of political power from the military to the public, but also a transition in the policy framework within which urban services were provided. The transition was accompanied by local efforts to improve living conditions for the poor, increased interest in decentralizing the provision of services, simplification of sewer technology to serve more people, and participation by residents, beneficiaries, and communities. Implementation of the Grand Favela project reflects these changes.

Community Influence and Participation. The mobilization of votes is often the only source of influence available to poor communities such as Grand Favela. Grand Favela residents mobilized political support for Governor Arraes and received an urbanization project for their community. In addition to their participation in the political process, Grand Favela residents participated in a variety of project-related activities. Residents procured materials and they constructed portions of the project. Residents also performed some project maintenance. However, Grand Favela residents had few opportunities to participate in project decisions or to receive education about the sewer system because of the limited number of participation meetings provided by COHAB's contractor. The term "participation" is used very broadly in the literature on public involvement in infrastructure planning. Presumably, participation includes all project implementation activities, including activities actually undertaken by beneficiaries *and* activities that were not available to residents or activities that were not fully realized in the project. The catch-all nature of the participation variable is problematic. In order to determine which Grand Favela participation activities mattered with respect to project outcome, a more finely drawn conception of participation – one that distinguishes among the various types of participation activities (e.g., mobilizing project demand, planning and decision-making, and constructing and maintaining projects) is needed.

Project Outcome. The Grand Favela project illustrates the ambiguous nature of project outcome. The project staff and beneficiaries interviewed considered this project "successful" even though the infrastructure itself functioned at a low level. Beneficiaries in the Grand Favela project did not mobilize to demand better maintenance or to complain about what was widely recognized as the poor performance of their condominial sewer. On the contrary, they took pride in what had been accomplished. Their perception of project outcome was not based solely on performance or even on the consistency of service by the agency. Beneficiaries and practitioners were pleased with the very significant improvements in the overall quality of life created by the project, of which sanitation was only one aspect. Many residents were simply satisfied with the elements of the project that worked well. Likewise, COHAB staff thought of the Grand

Favela project as a success while, at the same time, they agreed that sewer performance was poor.

Shifting Alignments. The Grand Favela urbanization project illustrates how projects and people can be impacted by political and social factors. In the 1980s, grassroots popular movements and popular elections emerged in Brazil, resulting in the election of populist politicians, such as Governor Miguel Arraes, who were willing to target the poor with urban infrastructure services implemented through state agencies like COHAB. Governor Arraes and COHAB were both supportive of the Grand Favela project during the project implementation period. However, when a new governor was subsequently elected, the alignment of interests changed significantly. By the time the project was to be handed over to COMPESA for maintenance, COMPESA's interests had changed (via staff appointments by the new governor), and so the agency did not accept the project. This had a direct impact on the project when inadequate maintenance was done on the sewage pumps.

Summary. The Grand Favela project brings together much of the background material that was presented in this chapter. The following four ideas are salient:

1. Shifting alignments of political interests and implementing agency alliances affected the implementation and outcome of the Grand Favela condominial sewer project;

2. The influence of Grand Favela residents on politicians and implementing agencies affected the implementation and outcome of the condominial sewer project;
3. Among the variety of potential activities for resident involvement in the project, some activities may have had more impact on project outcome than others; and.
4. Expectations for the performance of the Grand Favela condominial sewer project were relatively low.

These four ideas will be brought into even sharper focus in the next two chapters. Starting in Recife and then moving to Natal, I will revisit these ideas as I describe, in detail, the implementation of condominial sewer projects in each city.

---

[1]Gerschman, 1993; Watson, 1992; Boschi, 1984.
[2]Watson, 1992.
[3]Gay, 1990: 116.
[4]Mainwaring, 1999:177.
[5]Leeds, 1981; and Perlman, 1981.
[6]Perlman, 1981.
[7]UFRJ-NCE Noticias, 1993.
[8]Della Cava, 1968.
[9]Hahner, 1986.
[10]Perlman, 1981: 168.
[11]Perlman, 1976: 240.
[12]Hoffman, 1989.
[13]UFRJ-NCE Noticias, 1993.
[14]World Bank, 1994.
[15]Hoffman, 1989: 199.
[16]Hoffman, 1989.
[17]Hoffman, 1989: 211.
[18]IBGE, 2001.
[19]Power and Roberts, 2000: 248.
[20]Hoffman, 1989.
[21]Katzman, 1989.
[22]Montanari, et. al., 1987.
[23]Sinnatamby, 1983.
[24]UFRJ-NCE Noticias, 1993.
[25]WHO, 2000 and PAHO, 1998.

[26]Menendez, 1991.
[27]Samuels, 2000:92.
[28]Samuels, 2000: 86.
[29]Mainwaring, 1999: 323.
[30]Samuels, 2000:84.
[31]Mainwaring, 1999.
[32]Gerschman, 1993.
[33]Mainwaring, 1989:199; and Mainwaring, 1986.
[34]Boschi, 1984.
[35]Boschi, 1984.
[36]Watson, 1992.
[37]Watson, 1992.
[38]Watson, 1992.
[39]Watson, 1992.
[40]Gay, 1990.
[41]Gay, 1990.
[42]Mainwaring, 1999.
[43]Gay, 1990.
[44]Mainwaring, 1989:195; and Mainwaring, 1986: 27.
[45]Boschi, 1984.
[46]Gay, 1990.
[47]Parlatore, undated, pg. 4.
[48]Silva, et. al., 1996:26.
[49]Samuels, 2000: 82-83, 93.
[50]Other Brazilian cities, such as the city of Sao Paulo, had far greater resources and made far greater increases in water and sanitation services, as detailed by Watson, 1992.
[51]The Recife and Natal time periods are slightly different because connection data for Natal were not available prior to 1990.
[52]Possible explanations for this are that Natal could have exhibited higher rates of water system expansion in previous years, or that Recife could have counted more of its unconnected households (i.e., poor households) than Natal. On the second possible explanation, it is instructive to know that Recife had more favelas within its boundaries than Natal, and that Recife had granted land title to many of its favelas, while Natal had not. Consequently, the "unofficial" favelas in Natal may not have been counted as unconnected households. It is also instructive to know that Natal's population growth during that time (14 percent) exceeded Recife's population growth (9 percent).
[53]Golladay, 1983.
[54]Menendez, 1991; Dillinger, 1994; Cernea, 1992.
[55]Schiller and Droste, 1982.
[56]Bryant and White, 1982.
[57]World Bank. 1989.
[58]IBGE, 2000.
[59]World Bank, 1994; Wright, 1997.
[60]Narayan, 1994; Gerson, 1993; Wright, 1997:9.
[61]Korten, 1980.
[62]Korten, 1980.
[63]Binswanger and Aiyar, 2003.
[64]Briscoe and Garn, 1995.
[65]Briscoe and Garn, 1995.
[66]McGranahan, Songsore, and Kjellen, 1996:107.
[67]Diario de Pernambuco, November 1994.

Chapter 5

Condominial Sewer Implementation in Recife

The particular experiences of condominial sewer implementation in Recife reveal a complex implementation context. This chapter disaggregates Recife's context and points out characteristics that were most salient to condominial sewer implementation from 1980 to 1995. In this chapter, I introduce the urban setting and water environment of Recife (Section 5.1); describe the organizations involved in implementing condominial sewer projects in Recife (Section 5.2); discuss the sanitation needs and circumstances of Recife's residents (Section 5.3); review the condominial sewer projects and programs that were implemented in Recife from 1980 to 1995 (Section 5.4); summarize three case study condominial sewer projects and some noteworthy failed projects (Section 5.5); and characterize the overall record of condominial sewer performance in Recife (Section 5.6).

Information about condominial sewer implementation in Recife was obtained from interviews with engineers, participation staff, maintenance staff, managers, agency officials, elected officials, and engineering consultants. Key informants included Informants 1, 3, 4, 7, 9, 12, 16, 29, 30, 31, 59, 100, 101, 102, 103, 105, and 106; however many others also contributed. Other sources of information were also used, including project reports, maps, engineering drawings, memoranda, census records, newspaper clippings, interviews with residents, and other sources.

During the period examined, Recife's approach to condominial sewer implementation can be characterized as lacking in overall coherence; however, by the end of the period (in 1995), some actions to increase coherence were beginning to be taken. During the 1980-1995 period, condominial sewers were implemented by four different implementing agencies, each with its own approach. Some agencies embraced participation and some did not. Some agencies believed in condominial sewer technology and some did not. There were episodes where the city and state levels of government did not cooperate, and periods where city agencies with overlapping roles in condominial sewer implementation did not cooperate. One positive consequence of having multiple implementing agencies was that condominial sewers were implemented continually from 1985 to 1995, since at least one of the several agencies involved had access to funding during this time.

The main feature of urban politics in Recife was discontinuity from one political administration to the next. As a result, support waxed and waned for condominial sewer technology, for participation programs, and for individual projects. Community organizing was quite active in Recife neighborhoods, and neighborhood associations were often focused on obtaining urban services, such as condominial sewers. Some agencies attempted to implement condominial sewers in favelas and other poor areas of Recife, with varying degrees of success. In Recife's highly political decision-making environment, participation had an instrumental role in condominial sewer project implementation. The substantive factors affecting condominial sewer implementation were the changing political alignments of elected officials and agencies, and the disproportionate ability of different neighborhoods to influence elected officials and agencies.

5.1 The Setting

Recife, with its 66 canals, has a drainage problem of notable proportions. When the Dutch ruled the city in the 1600s, they installed a system of canals to drain the city of excess water. This system has been updated and expanded over the years to form the 92-kilometer-long canal network of today. The drainage problem in Recife has profound implications for sanitation. A relatively high water table, a generally flat topography, and poorly drained soils increase the difficulty of collecting, transporting, and discharging wastewater. Recife has a relatively high average population density (of approximately 6,536 people/square kilometer[1]) and has one of Brazil's highest favela populations per capita. Recife has an international port and a well-developed industrial sector. Table 5-1 presents some basic demographic data for Recife, including population, water connections, and sewer connections. In the late 1990s, the percentage of people with access to piped water and sewer systems in Recife was very close to Brazil's national average (see Table 5-1).

Recife is located in the Northeast state of Pernambuco. Like other states in Brazil, Pernambuco state is divided into counties (*municipios*), cities, political-administrative regions (*regioes politico-administrativos*, or RPAs), and neighborhoods (*localidades* or *bairros*). The map in Figure 5-1 shows the city subdivided into political-administrative

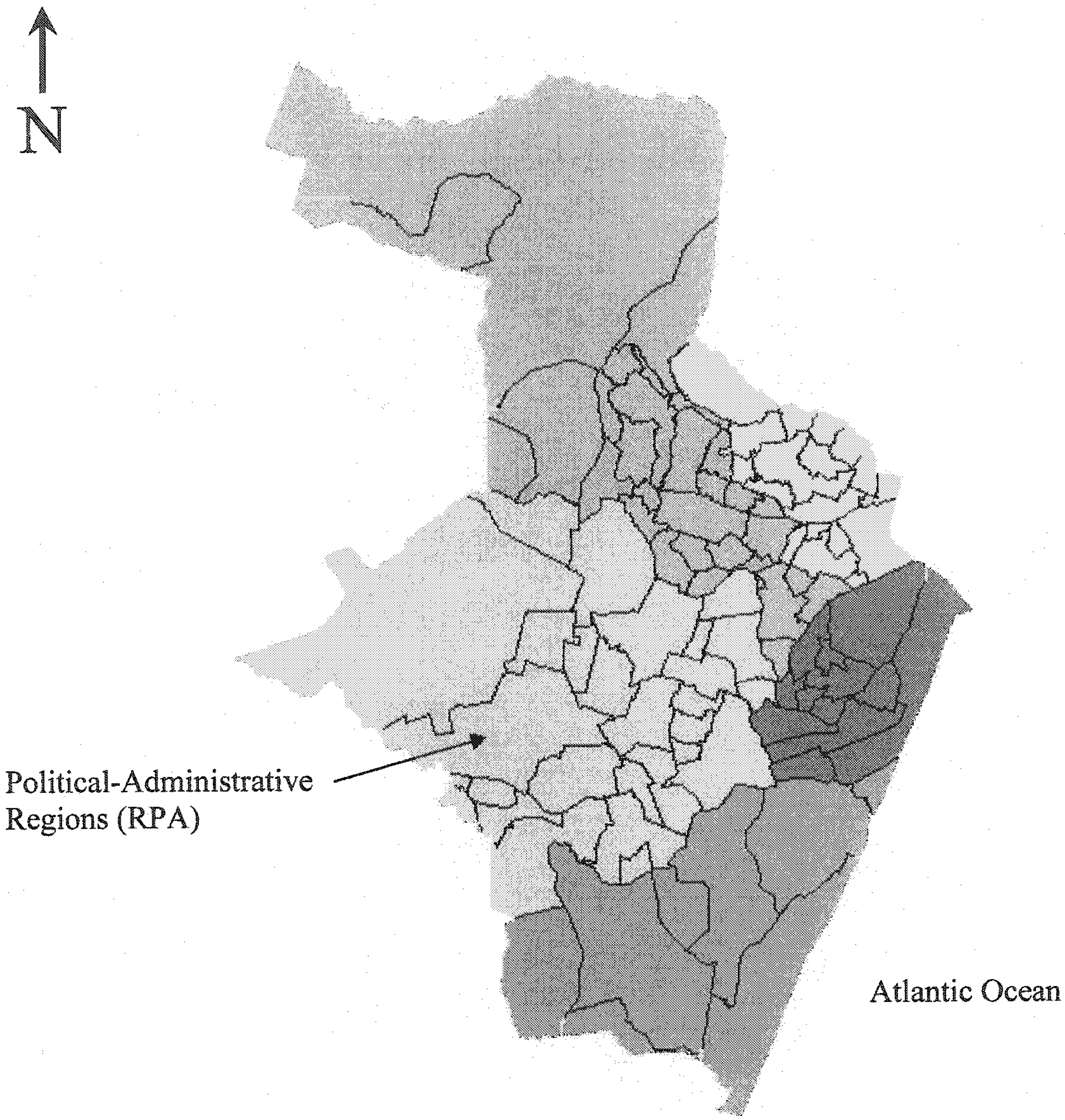


Figure 5-1. City of Recife with RPA boundaries and geographic regions (in color) as of 2003.
Source: Prefeitura da Cidade do Recife, www.recife.pe.gov.br.

regions. The State Water and Sanitation Agency of Pernambuco (*Companhia Pernambucana de Saneamento*, or COMPESA) has further divided the state into water supply districts (*escritorios locais*, or *elos*), which are typically larger than a

Table 5-1. Population, water access, and sewer access in Recife, in the Recife metropolitan region (RMR), in poor areas of the region, and in Brazil.

Year	Recife Population	Population with Access to Piped Water	Population with Access to Sewers(a)
1991	151,152,000 (Brazil)	86% (Brazil)	49% (Brazil)
1994	1,327,000 (Recife)	-	24% (Recife)
1995	161,374,000 (Brazil)	91% (Brazil)	18% (RMR) 66% (Brazil)
1999	167,967,000 (Brazil)	84% (Brazil)[b]	41% (Brazil)[b]
2000	1,422,905 (Recife)	88% (Recife)[b] 89% (RMR) 76% (poor RMR)	43% (Recife)[b] 36% (RMR) 7% (poor RMR)

Sources: World Factbook, www.odci.gov/cia/publications/factbook/geos/br.html; IBGE, www.ibge.gov.br, 2001; IBGE PNAD, 1999; IBGE *Anuario Estatistico do Brasil*, 1992; IBGE *Censo Demografico 2000 – Malha Municipal Digital do Brasil*, 1997; www.ibge.gov.br/cidadesat; Populstat, www.library.uu.nl/wesp/populstat/Americas/brazilc.htm, 2003; World Bank, 1994; World Bank, 2003; and Parlatore, undated.

a. Access to sewers does not include access to septic tanks.

b. My calculations with IBGE data.

neighborhood, except in cases where a very large neighborhood makes up an entire "elo." Elos are purely administrative and they do not necessarily correspond to watersheds or drainage basin boundaries.

Recife has seven water districts (*elos*), three regional sewer divisions, and 98 sewer basins, the boundaries of which correspond neither to each other nor to the county, city, RPA or neighborhood boundaries. In addition to these boundaries, poor areas may be classified as special economic zones (*zeis*). The map in Figure 5-2 shows the boundaries of Recife's water districts (*elos*) as of 1995.

Figure 5-2. Water districts in Recife as of 1995.
Source: COMPESA, Planta Geral do Elos, 1993.

In 1995, the Recife metropolitan area, which includes Recife and several neighboring cities, had approximately 950 km of sewer pipe and three regional wastewater treatment plants (each serving a sewer division). The Cabanga and Peixinhos plants are located in the city of Recife, and the Janga plant is located in the nearby city of Olinda. There are 83 pump stations and 28 small local treatment plants in the Recife Metropolitan Region (RMR), which has a population of 3.3 million (in 2002).

Most of Recife's public sewer system is interconnected with the storm drain and canal systems, and cross-contamination is ubiquitous. Conventional sewers in Recife are required to have overflow (*extravassor*) pipes to route sewer overflows into storm drain canals, storm drain pipes, or rivers. These overflow pipes are used in the frequent case of the loss of a pump station due to a power outage or a need for maintenance. Multiple overflow pipes are often installed at various heights, so large volumes of sewage typically end up in the storm drain system and in local surface waters.

As of December 1994, an estimated 24% of the Recife population (and 18% of the regional RMR population) was connected to the public sewer system, and the remaining 76% of the population discharged sewage by using onsite systems (to leachpits, cesspools, or septic tanks), storm drain connections, street gutters, or open ditches. Regardless of which sewage collection method was used, most collected sewage was ultimately discharged untreated to rivers and canals that flowed to the ocean. Recife's three rivers are the Capibaribe, the Tejipio, and the Beberibe (*Rio Capibaribe, Rio Tejipio,* and *Rio Beberibe*). In the mid 1990s, the Recife City government (*Prefeitura da*

Cidade do Recife, or PCR) adopted a Sanitation Master Plan for Recife (*Plano Estruturador de Esgotamento Sanitario do Recife*), which mandated the use of condominial sewers in all future planned increases in sewer coverage.

5.2 Recife's Implementing Agencies

Numerous local and state institutions were involved in condominial sewer implementation in Recife during the 1980 to 1995 period. COMPESA and the State Housing Agency (*Companhia de Habitacao*, or COHAB) each had roles in the implementation of condominial sewer systems, as well as the implementation of conventional sewer systems, water supply systems, and housing. At the municipal level, the Urban Planning Agency (*Empresa de Planejamento Urbano do Recife*, or URB) and the Public Works Agency (*Empresa de Obras Publicas,* or OBRAS[2]; later renamed the Urban Cleanup Agency, *Empresa Municipal de Limpeza Urbana*, or EMLURB) were responsible for the planning, design, construction, and maintenance of condominial sewers in Recife, as well as pavement, drainage, trash collection, street cleaning, and tree control services (but not conventional sewers). Recife's local agencies (URB and OBRAS) began to implement condominial sewers in the mid-1980s under the leadership of a pro-condominial mayor and in response to a lack of progress by COMPESA in expanding the City's sewer system.

COMPESA was responsible for the planning, design, construction, maintenance, and billing of water and sanitation infrastructure for the State of Pernambuco. The

COMPESA organization consisted of a president, five directorates, and various departments, such as the Metropolitan Sewer Department (*Gerencia Metropolitana de Esgotos*, or GME), which maintained the regional sewer system, pump stations, and treatment plants of Recife. There are three sewer divisions in Recife - Peixinhos, Sul, and Cabanga - each with its own chief. On a day-to-day basis, the Division Chief decides which projects and which neighborhoods receive maintenance service. COMPESA's maintenance budget was typically very limited. During March of 1995, COMPESA had three sewer maintenance trucks and an operations and maintenance budget of only R$9000 per month (equivalent to about US$9000) for the entire Peixinhos sewer division[3]. According to COMPESA staff, maintaining the trucks was the biggest expense. Several informants from COMPESA said that water supply was, "without a doubt," the top priority for both COMPESA and the public, because there were still cities in Pernambuco without an adequate supply of water[4]. From 1980 to 1995, sewerage was the second priority for the agency. By 1995, COMPESA had not constructed any major sewer works for 15 years; the agency had only installed a small project here and there.

5.2.1 Sewer Fees and Connections

In Recife, condominial sewer fees are charged as a percentage of the water bill (see Chapter 2 for a description of condominial sewers and the different layouts). Residential water bills are determined either by the volume of water consumed (for metered households) or by a flat rate (for unmetered households)[5]. COMPESA charges 40 percent of the water bill for households with backyard or front yard condominial sewers;

80 percent of the water bill for households with sidewalk condominial sewers or for households with backyard or front yard condominial sewers installed by COHAB; 100 percent of the water bill for households with conventional sewers; and 50 percent of the water bill for households with a "dreno" system installed by COMPESA[6]. "Dreno" systems connect homes to an existing storm drain system, which may ultimately lead to a low level treatment system (such as a stabilization pond), or which may discharge sewage (or, in some cases, solids-free wastewater) to a local water body. Fees for sewer service in Recife are summarized in Table 5-2. In January 1995, the minimum water tariff (the rate charged to unmetered households) was R$2.60 per month (equivalent to US$2.60 per month at that time) and the associated backyard condominial sewer charge was R$1.04 per month (equivalent to US$1.04 per month)[7].

Table 5-2. Fees charged by COMPESA for sewer service in Recife as a percentage of the water bill, as of 1995.

Level of Sewer Service	Fee (% of water bill)
Condominial	
Backyard Layout	40%
Front Yard Layout	40%
Sidewalk Layout	80%
COHAB Condominial[a]	
Backyard Layout	80%
Front Yard Layout	80%
Sidewalk Layout	80%
Dreno	50%
Conventional	100%

Source: COMPESA billing records, 1995.
a. Higher fees were charged for condominial sewer systems installed by COHAB.

It is difficult to state with accuracy the number of conventional and condominial sewer connections in Recife. Total sewer connections can be roughly estimated by the number of dwelling units billed (known as *economias* in COMPESA's R12 computerized billing records). In 1994, COMPESA billing records showed 40,427 conventional sewer units billed and 10,272 condominial sewer units billed. However, the actual number of connections is larger than the number of dwelling units billed, so an accurate estimate of the total number of household sewer connections is difficult to obtain. For example, single-family households with condominial sewers were typically billed as individual dwelling units even when the homes shared a collective block sewer. Apartment complex owners were typically billed for one dwelling unit and an entire building was counted as one sewer connection, even though multiple dwelling units (or households) were served. A high level COMPESA official estimated that, in 1995, there were on the order of 20,000 condominial connections in Recife[8]. It is possible to obtain a more accurate estimate of the total number of water connections for residential, commercial, industrial, and public customers (as listed in COMPESA's R11 computerized billing records), because all dwelling units are billed individually for water service. In 1994, the number of water units billed in Recife was 227,370.

5.2.2 Conflicts Within and Between Agencies

During the 1980 to 1995 period, the four implementing agencies (COMPESA and COHAB at the state level, and URB and OBRAS at the city level) did not always cooperate, and they did not follow a cohesive urban development plan with regard to sanitation. Comments from practitioners within these agencies reveal that they recognized the negative impact this disorganized institutional environment had on project performance.

Several practitioners noted the multiple rifts that existed within and among the local implementing agencies[9]. Within COMPESA in the mid-1980s, some staff were supportive of condominial sewer technology and some were completely against it. The maintenance staff was strongly opposed to condominial sewers, perhaps even more so than the engineering staff, because condominial sewers usually had more maintenance problems than conventional sewers. Centralized treatment plant maintenance was easier and less costly than the maintenance requirements of numerous community septic tanks scattered throughout the city, each associated with a condominial sewer. There was a perception among maintenance staff that residents would not take responsibility for the maintenance of their condominial sewer systems, and that the maintenance duties would ultimately fall to a maintenance department that was already under-funded, under-equipped, and under-staffed.

Conflict also existed between COMPESA and the City of Recife (City) implementing agencies during the 1980 to 1995 period. COMPESA resisted the City's efforts to install neighborhood condominial sewer systems in Recife in the mid-1980s, and it was not always willing to accept maintenance responsibility for these systems. One reason for COMPESA's resistance was that most condominial sewer systems being implemented did not have an adequate destination for the collected sewage. Another reason was that condominial sewers did not meet the industry standards COMPESA was trying to uphold. Many of the condominial sewer systems installed by the City used the storm drain and canal systems as interim destinations for the collected sewage. This happened for two reasons. First, the City was responsible for maintaining the drainage system of canals and storm drains, and thus it did not have to coordinate these discharges with another agency. Second, COMPESA had not been able to extend the public trunk sewer system to provide viable discharge points for collected sewage in neighborhoods, so the city frequently had no other option but to use the drainage system. COMPESA staff felt that discharging sewage to the drainage system undermined their official mission to collect, treat, and properly discharge the City's wastewater[10]. City staff felt that since COMPESA had been unable to provide public trunk sewers to the majority of the city at any cost, the City had an obligation to do whatever was feasible to remove sewage from the immediate home environment.

For a time, there was discord within the City itself, especially between URB and OBRAS, the City's two sewer implementing agencies. OBRAS staff tended to embrace condominial sewer technology and participation by project beneficiaries in mobilizing, decision-making, construction, and maintenance. URB staff tended to be skeptical or critical about condominial sewer technology and generally opposed to participation. Each agency was supposed to act independently, focusing on different areas of the city and using separate sources of funding. URB was responsible for condominial sewer implementation in favelas using funding from the World Bank and other sources that was channeled directly to cities starting in the late 1980s. OBRAS was responsible for condominial sewer implementation in the rest of the city using a combination of city funds, state funds (from *Superintendencias do Desenvolvimento do Nordeste*, or SUDENE), and federal funds (from the Federal Bank of Brazil, *Caixa Economica Federal,* or CEF) channeled through COMPESA. Several staff from the agencies noted that the lack of cooperation between URB and OBRAS had a negative impact on overall effectiveness, and that sometimes the agencies competed for projects in the same neighborhood.

The institutional environment created by the rifts between agencies contributed to an overall sense of disorganization and ineffectiveness among the agencies responsible for implementing sewers in Recife. The World Bank has characterized Recife's institutional environment as follows:

> The shelter situation of the poor and the virtual breakdown of urban systems provision in the RMR [Recife Metropolitan Region] reflects more than the scarcity of resources for investment, or of income to pay for services but also largely reflects the poor management of public resources and the failure of government to plan, regulate, enforce property rights, invest appropriately, and define transparent and fair subsidies for the urban poor. The government strategy has been to address these multi-sector issues in an ad hoc and mostly uncoordinated manner. (World Bank, 2003:9.)

5.3 Recife's Condominial Sewer Beneficiaries

By interviewing dozens of condominial sewer practitioners in Recife (in 1994 and 1995), I gained a wealth of information about the beneficiaries they serve. Moreover, from my interviews with hundreds of households in Recife during the same period, I obtained first hand accounts of a range of beneficiary viewpoints. This section provides an introduction to the sanitation problems faced by residents in Recife.

Because of the generally low rate of service provision in Recife during the early 1980s, it was customary for residents to manage their sewage by using individual solutions. The most common individual solutions were onsite leachpits, onsite cesspools, onsite septic tanks, vacant areas, clandestine connections to storm drains; the dreno system, and open ditches that transported sewage to street gutters, storm drains, rivers, or canals. When an onsite system stopped working, sewage either backed up onto the property and into the house of the resident, or it overflowed onto neighboring properties whose systems may have been working normally. In some cases, sewage even backed up into the house of neighbors interconnected to the common collection pipe. Community septic tanks tended to function better than onsite septic tanks because of better siting decisions and better maintenance. Onsite septic tanks were usually installed in any convenient location, while the location of community septic tanks was determined by engineers. The "dreno" systems typically functioned well at first; however, if residents forgot to maintain their septic tank, then solids ended up passing into the dreno pipes when the septic tank filled up. Some residents only cleaned out their septic tank when the sewage overflowed into the yard or into the house.

Residents who are satisfied with their individual sewage solutions usually do not feel the need to connect to and pay for a separate sewer system, and consequently do not typically express a desire to further resolve sewage problems at the regional or citywide level. Once the sewage problem moves beyond most residents' individual lot or block, there is typically little willingness to participate or mobilize around sanitation issues[11]. On the other hand, Recife residents in the following circumstances typically expressed higher levels of demand for sewer infrastructure and tended to be more willing to mobilize around and participate in sewer solutions[12]:

- Residents whose only option was to discharge to open ditches (*valas negras*);
- Residents whose onsite septic tanks, leachpits, or cesspools did not function well (because of poor drainage, high water table, shoddy construction, or lack of funds to pay for pumping); and
- Residents who did not have other infrastructure services or topographic conditions that effectively reduced the local build-up of sewage (e.g., piped water, good drainage, good topography, and pavement).

At the time of my fieldwork in 1994-1995, the typical cost to a resident for cleaning out an onsite septic tank was R$200 per truckload (roughly US$200 at that time)[13]. This was extremely expensive even for a middle-income individual, who typically earned about R$300 per month (roughly US$300 at that time), the equivalent of about 4 minimum salaries[14].

Most residents in Recife had a basic understanding of how individual wastewater solutions worked because they were familiar with them. But during the 1980s, many residents were not familiar with condominial sewers. The technology was new and condominial sewer systems were installed for very few homes. This was confirmed in my interviews with both residents and practitioners. The following statements typify viewpoints expressed by practitioners about the public's level of familiarity with sewers at that time:

> "Residents don't know the difference between a storm drain and a condominial sewer, and when a storm drain exists they use it as a sewer." (Informant 16, president of a Recife sewer agency, interview by author, 16 March 1995, Recife, transcript.)

> "Sewers are a question of culture, and a sewer culture does not exist. People have televisions, stereos, and refrigerators, but not toilets." (Informant 7, URB department chief, interview by author, 8 March 1995, Recife, transcript.)

The lack of public knowledge in Brazil about sanitary sewers is reflected in the lack of a specific word for sewer in the native language used by lay Brazilians. The Portuguese word *rede de esgoto* means sewerage system[15]. However, everyday people do not necessarily use or understand this meaning of the word. To everyday people, *rede de esgoto* can also mean any manner of transporting wastewater (*esgoto*) through a network (*rede*), including either a sewer system or a network of street gutters, ditches, or storm drains[16]. The word *saneamento*, meaning sanitation[17], also may be used to refer to water supply and sanitation collectively, as in *Companhia Pernambucana de Saneamento*, or the Water and Sanitation Company of Pernambuco (COMPESA).

During the 1980's in Recife, there were approximately one million unpaved streets in the city[18]. Consequently, most residents expressed a primary demand for pavement[19]. It was commonly believed that pavement would simultaneously solve both the drainage problem and the sewage problem, because paved streets would improve the control of runoff and street gutters would collect and transport sewage away from homes.

5.3.1 Maintenance by Beneficiaries

At the time of my fieldwork in 1994-1995, several agency staff reported that few residents were actually performing maintenance on their condominial sewers. Even residents who had signed contracts with the sewer implementing agency agreeing to perform maintenance typically did not perform or take responsibility for maintenance in the manner intended by the agreement. Instead, residents with condominial sewers often called city and/or state agencies for maintenance service. A sample of statements by residents about why they did not perform maintenance is presented in Table 5-3. Speculations from practitioners about user resistance to maintenance are summarized below in Table 5-4.

Table 5-3. Statements from beneficiaries in Recife about who does maintenance on their condominial sewers and house connections.

Beneficiaries' Statements About Maintenance
"A government agency already exists to provide this service."
"The government has better tools and equipment to do the job."
"I pay the sewer fee each month, which includes maintenance service."
"I tried to do it myself and gave up."
"Most of the problems are in the public part of the sewer."

Sources: Condominial sewer beneficiaries, interviews by author, 1995, Recife, transcripts.

Table 5-4. Explanations given by practitioners in Recife for why some beneficiaries do not perform maintenance on their condominial sewers.

Practitioners' Reasons for Lack of Maintenance by Beneficiaries
"Lack of knowledge of how to do maintenance."
"Lack of adequate tools."
"Unwillingness and laziness."
"Because of the objectionable nature of the task."
"Confusion about ownership of the system."
"Renters don't feel responsible for resolving the problem."
"Lack of awareness about the existence of the maintenance agreement."

Sources: Informants 1, 3, 16, and others, condominial sewer practitioners, interviews by author, 1994-1995, Recife, transcripts.

Residents who were unsatisfied with their condominial sewers displayed a variety of responses and tactics. Usually, their first step was to try to fix the problem themselves, either individually or as a group. Next, they typically complained to a city or state agency - usually, but not always, this was the implementing agency associated with their condominial sewer system. The next response was to complain to a political official, complain to the media, or mobilize the residents and demonstrate around the issue.

Some residents also resorted to damaging the condominial sewer system by breaking their cleanout box or by filling it with concrete, dirt, rocks, or other debris. Because there was no requirement to connect to a sewer, there were typically no consequences for residents who damaged their system. Some residents ultimately abandoned their system entirely by doing one of the following:

1. Constructing an onsite septic tank right next to, or on top of, the condominial sewer system;
2. Making an individual connection to a nearby storm drain; or
3. Discharging their wastewater to *valas negras* or to street gutters.

Although the boundary between the public and private parts of condominial sewer systems may have been clear to engineers and maintenance workers, it was not at all clear to many residential users. When asked in semi-structured interviews where this boundary was located, residents from Recife gave the following range of responses[20]:

- Components of the system that lie within the property line are private; everything else is public.
- Components constructed by the resident are private; components constructed by the sewer agency are public.
- The entire system is public because the project was implemented by, funded by, and therefore belongs to the sewer agency.
- The household cleanout box (typically located in the backyard or front yard of homes) is the dividing point for the public and private parts of the system.
- The collective cleanout box for the block is the dividing point for the public and private parts of the system.

5.4 Recife's Condominial Sewer Programs, 1980-1995

I divide Recife's experience in the 1980s and 1990s into a pre-implementation phase followed by three phases of condominial sewer implementation. In the following sections, I describe the significant events and relevant details of these three phases of implementation and provide a brief introduction of the period leading up to implementation. A timeline that summarizes this entire section is presented in Table 5-5.

This section provides empirical evidence to support my assertion that shifting alignments in the interests of elected officials and implementing agencies had a significant impact on condominial sewer project outcome in Recife during the 1980s and early 1990s.

One indication of these shifting alignments was the discontinuity in political support for condominial sewer projects from one political administration to the next. Who was governor and who was mayor, and whether they supported specific condominial sewer projects and programs, had an impact on condominial sewer project implementation and outcome, because mayors and governors set the development priorities and filled the implementing agencies with their staffs.

Another indication of shifting alignments was the lack of a coherent approach to implementing condominial sewers. There were four implementing agencies in Recife, each using its own approach that depended on a) the degree to which its engineering staff accepted condominial sewer technology, and b) who had been elected to office.

Table 5-5. Timeline of events related to the implementation of condominial sewers in Recife from 1980 to 1995.

Year	Events
	Pre-Implementation
1980	COMPESA produces the Recife Metropolitan Sewer Plan covering 3 cities, 4 wastewater treatment plants, all conventional sewers.
1981	URB revises the Recife portion of the Recife Metropolitan Sewer Plan, replacing conventional sewers with condominial sewers.
	Phase 1
1985	City agencies begin to install some of the first condominial sewers in Recife under the Condominial Program, the Condominial SOS Program, and the Recife Program.
1987	COHAB implements the Urbanization Program and the Habitation Program.
1988	Several completed condominial sewer systems are transferred from City agencies to COMPESA for ongoing maintenance.
	Phase 2
1989	The Condominial Program is stopped by the newly-elected mayor. COMPESA constructs 5 condominial sewer projects during this phase, but does not perform regular maintenance on the City's condominial sewer projects.
1991	The Urbanization Program and the Habitation Program are stopped by the newly-elected governor. Recife makes condominial sewers mandatory by adding them to municipal law under Lei No. 15.547/91.

Continued…

Table 5-5. Continued.

Year	Events
	Phase 2
1992	URB constructs 4 condominial projects in this period. COMPESA stops performing maintenance on some condominial sewer systems, but continues to collect the monthly fees.
	Phase 3
1993	The newly-elected mayor begins negotiations with COMPESA about their acceptance and maintenance of projects constructed by the City and issues the Director's Development Plan for the City of Recife, which establishes condominial sewers as the City's technical norm. City agencies are consolidated into a single condominial sewer implementing agency. URB implements three condominial sewer projects in this period.
1994	A new sewer plan (*Plano Estruturador de Esgotamento Sanitario do Recife*) calls for all planned increases in sewer coverage to use condominial technology. The Mayor proposes a new law (*Leis Complementares*) to resolve the political discontinuity problem in project implementation and to establish the roles and responsibilities of each implementing agency.

Sources: COMPESA, COHAB, EMLURB, and URB staff, interviews by author; 1994-1995, Recife, transcripts; http://www.recife.pe.gov.br/pr/galeria/index.php4; http://www.fundaj.gov.br/docs/pe/pe0036.html; and http://www.pernambuco.gov.br/governo_galeriadosgoves.htm.

5.4.1 Pre-Implementation (1980-1984)

The early 1980s marked a turning point in Recife's water and sanitation sector. The inability of COMPESA to implement its sewer plans or to expand sewer services was broadly realized. In 1980, COMPESA issued the Recife Metropolitan Sewer Plan, which called for the expansion of conventional sewers in the three cities making up the Recife

Metropolitan Region (RMR). COMPESA also proposed to use the *elo* as the standard service area for both water supply and sewage collection. According to COMPESA staff, the 1980 plan was never enacted because of the lack of staff, money, and equipment to maintain the public sewer, and because of internal resistance to the plan by senior staff. The very next year, URB revised the Recife portion of the Recife Metropolitan Sewer Plan, replacing conventional sewers with condominial sewers. The City had little confidence in COMPESA's ability to carry out its plans. The city also considered conventional sewers to be infeasible, and was interested in developing its own sanitation capability.

The turning point was also marked by experimentation at many levels. While Recife was still in the planning stages, condominial sewer research programs and pilot studies were already being conducted in Natal in the early 1980s. Full-scale condominial sewer projects were being implemented in other Northeast cities, including Petrolina, Pernambuco. Brazil's professional engineering societies were disseminating information about condominial sewer technology. After this early period of research, pilot projects, planning, and successful implementation of condominial sewers, Recife embarked on its own period of vigorous implementation of condominial sewers from 1985 to 1995.

5.4.2 Phase 1 – Initiating a Participation Approach (1985-1988)

In 1985, Jarbas Vasconcelos of the centrist Party of the Brazilian Democratic Movement (PMDB) was elected Mayor of Recife. Jose Carlos Melo was appointed Vice Mayor.

This marked the beginning of a surge of condominial sewer implementation in Recife. Prior to Mayor Jarbas (popular Brazilian politicians are commonly referred to by their first names), most of the condominial sewers in Pernambuco State were located outside of the capital city. These projects were located primarily in the medium-sized interior town of Petrolina and also as part of new housing construction in small towns. In 1986, the City began to construct some of the first condominial sewers in Recife (in small-scale projects measured in the 100's of connections per project) under the Condominial Program (*Projeto Condominio*). From 1986 to 1989, the City Public Works Agency (OBRAS), located in the Secretary for Transportation and Public Works, served as the main implementing agency for condominial sewer projects supported by Mayor Jarbas and Vice Mayor Melo.

Vice Mayor Melo, also president of the AcquaPlan Engineering Company, was perhaps the most influential promoter of condominial sewer technology in Brazil. He brought to his hometown of Recife a wealth of condominial sewer experience, including experience installing condominial sewers in Natal with their State Water and Sanitation Agency (Companhia de Aguas e Esgotos do Rio Grande do Norte, or CAERN), experience executing condominial sewers for state housing projects with COHAB, and experience implanting condominial sewers throughout the Northeast region with the San Francisco River Hydroelectric Development Agency (Companhia Hidro Electrica do Sao Francisco, or CHESF). Melo's extensive experience included implementation with and without participation. In addition to introducing Recife officials to the benefits of condominial sewers, Melo and his colleagues from CAERN taught many of Recife's city, state, and private engineers how to implement the technology. He brought Edrise Aires, a former COMPESA employee and a defender of Melo's ideas, into the City administration as President of OBRAS. President Edrise (also known by his first name) brought with him his loyal COMPESA staff.

Melo envisioned condominial sewers as an affordable alternative to conventional sewers[21]. He wanted to take advantage of the reduced overall costs associated with constructing sewers before installing pavement. He also wanted to eliminate the *dreno* system (described earlier in Section 5.2.1) and the general use of storm drains for sewage collection because of the resulting pollution problems and high volume of wastewater produced. Previously, conventional sewers had been sited based on the availability of an existing trunk sewer as a discharge point. Since very few households were adjacent to an existing trunk sewer, and since COMPESA did not have the resources to extend the trunk sewer and treatment plant network, the conventional sewer philosophy severely restricted any progress in sanitation.

The lack of sanitary sewerage was compounded by serious drainage problems in many areas of Recife. Ideally, drainage should be in place prior to the installation of sewers; otherwise residents would use their sewers for drainage, which could exceed the capacity of the system and lead to performance problems[22]. On the other hand, installation of a drainage system prior to the sewer could potentially reduce demand for the sewer because residents would use the drainage system as a sewer[23].

At that time in Recife, middle income residents with well-functioning septic tanks were most interested in resolving pavement and drainage problems, not in resolving the sanitation problem[24]. Because of a general lack of demand for sewers among middle-income residents, Melo decided to attach condominial sewers to an existing City pavement program already being implemented by OBRAS. This existing pavement program from the previous mayoral administration was known by several names, including the Pavement Program (*Projeto para Pavimento*), the Program for Everyone (*Projeto para Todos*), and the One for All Program (*Projeto Um por Todos*)[25]. In this pavement program, the City paved residential streets in partnership with residents. Neighborhoods had to show interest in the program by filling out a formal application. The City selected the most organized and most interested neighborhoods for pavement. Cobblestone pavement was and still is the norm for most residential streets in Recife. Melo decided to focus on these interested neighborhoods because their streets were still unpaved (which facilitated sewer construction), and because they had already organized themselves to apply for a project (which Melo considered advantageous). Under this new program, known as the Condominial Program, Melo proposed adding sewers as a condition of receiving pavement.

The Condominial Program included pavement and sewer services partly financed by the City and partly financed by residents. House connections and condominial sewers were installed under the Condominial Program; no public trunk sewers were installed because that was COMPESA's role. Only those residents who agreed to pay for their house connection received a project. This led to some areas ending up with only a single street receiving sewer service. To be eligible to receive a project, residents had to mobilize, elect a representative, and express interest by completing a formal application for a project. They were added to the City' list of interested communities, and selected neighborhoods were offered a proposal for a sewer and pavement project. Unpaved streets that were already sewered by COMPESA were automatically included in the City's list because it was simple to install a condominial sewer and connect its discharge to COMPESA's public sewer[26]. Residents paid for the labor and the City provided the construction materials. The criteria for deciding which middle-income areas would receive a project were as follows[27]:

- Areas with the most critical need for a sewer system;
- Areas with high interest and demand from residents; and
- Residents willing to pay for the collective condominial sewer and individual house connections.

Under the Condominial Program, OBRAS installed about 16 condominial sewer projects in middle-income neighborhoods. OBRAS' implementation approach included participation, education, consideration of need, and consideration of resident demand for a project. Working in collaboration with OBRAS, the City's Secretary for Social Action (*Secretaria Acao Social de Prefeitura*, or SAS) carried out the participation and mobilization activities for OBRAS, so that OBRAS could focus on the planning, design, construction, and maintenance activities. Backyard and front yard layouts were used in the majority of projects - use of the sidewalk layout was rare.

OBRAS administered a second condominial sewer program at the same time it was administering the Condominial Program. In its Condominio SOS Program (*SOS Condominio*), OBRAS implemented urbanization projects for the poor using participation[28]. Condominial sewer systems were included in the urbanization projects. Condominio SOS was a City program funded by the Federal Secretary for Community Action (*Secretaria Especial de Acoes Communitarias*) and implemented by OBRAS. The program was created to provide total urbanization of favelas using participation during the implementation of projects. In 1986, the City requested program funds from the Federal Bank of Brazil (CEF), and in 1988 the money arrived. OBRAS' criteria for deciding which poor areas would receive an urbanization project were as follows:

- Areas with the most critical need for a sewer system;
- Areas in which more people could be served with the same amount of money;
- Areas without major technical problems (bad topography, no final destination, etc.);
- Areas where the residents were most interested in sewers.

Condominio SOS staff visited the neighborhoods that requested sewers, observed local conditions and the level of need for sewerage, and held meetings with residents to determine what their priorities were in terms of infrastructure. There was a general lack of demand for sewers at that time – most residents wanted drainage and felt that drainage would also resolve their sewage problem[29]. Condominio SOS provided poor residents with an alternative to the traditional process of acquiring public assistance. The traditional process involved patron/client transactions in which politicians sought votes from poor residents in exchange for benefits that ranged from soccer team uniforms to a small urban project. One Condominio SOS program official remarked that, "all the poor areas with projects used this process, and poor areas without a link to politicians had no chance of getting a project"[30].

Because consecutive terms were not allowed, the Jarbas administration would end in 1989. And because the CEF funds arrived in 1988, Condominio SOS had less than one year to plan and implement its projects. As a result, many of its projects were not completed. Only three neighborhoods were served with condominial sewers under Condominio SOS.

Another City agency, URB, was simultaneously involved in implementing condominial sewers under a program called the Recife Program (*Projeto Recife*). The Recife Program was an infrastructure program financed by the National Housing Bank (*Banco Nacional de Habitacao*, or BNH) with funds from the World Bank. The URB agency was parallel to OBRAS, but was located in a different secretariat, the Secretary of Planning (*Secretaria da Planejamento*). URB was created to design, construct, and maintain infrastructure projects in poor areas known as special economic zones (*zeis*), whereas OBRAS at that time designed, constructed, and maintained infrastructure projects for the rest of the city.

During the 1985-1988 period, Jaime Guzman was president of URB and Teogenes Leitao served as URB's director of public works. President Guzman and many of the managers and engineers within URB did not completely agree with Melo's approach to condominial sewers. They tended to implement condominial sewer projects without user participation. During this time, URB often competed for the same projects areas as OBRAS using different sources of funding. The period is marked by significant interagency struggle and role confusion between URB and OBRAS.

In 1987, Miguel Arraes was elected governor of the state of Pernambuco. Sharing the same centrist Party of the Brazilian Democratic Movement (PMDB) as Jarbas, and running on a populist platform, Arraes' election initiated a peak period of political support for condominial sewer technology. Governor Arraes started both the Habitation Program (*Projeto de Habitacao),* a housing program implemented primarily outside of Recife, and the Urbanization Program (*Projeto de Urbanizacao*), a favela urbanization program (which included condominial sewers) that was implemented throughout the state and in Recife.

Under these two state programs, large-scale projects (measured in 1000's of connections per project) were implemented. Both of the Governor's programs were financed principally by CEF and were implemented through COHAB. Favela urbanization projects were targeted to the very poor and included lots, water, sewer, drainage, electricity, street lights, regrading, and pavement as necessary. The entire set of services was provided free to poor residents – only the monthly utility fees were charged.

COHAB's implementation approach did not generally involve participation, although beneficiaries were usually expected to build their own homes after the urbanized lots were completed. COHAB also installed condominial sewers in the interior of the state – also without participation – through its "conjunto" housing programs. Many poor residents who moved into COHAB homes typically were not familiar with sewers or how to use them[31].

To summarize the events of Phase 1, condominial sewer technology was introduced into the city of Recife through four major programs: the Condominial Program (implemented by OBRAS with assistance from Secretaria Acao Social), the Recife Program (implemented by URB), the Condominio SOS Program (implemented by OBRAS), and the Urbanization Program (implemented by COHAB). Large-scale and small-scale condominial sewer projects were provided to poor, low-income, middle-income, and to a few high-income residents. The City agencies (OBRAS and URB) tended to concentrate on installing systems that either discharged to a public sewer, or (more often) to the nearest available location, including the storm drain system. It is ironic that some condominial sewers ended up discharging to the storm drain system even though Melo's initial motivation for condominial sewers was to end reliance on the storm drain system for sewage collection. OBRAS embraced condominial sewer technology and usually implemented participation programs in their projects. URB was more critical of condominial sewer technology and generally did not embrace participation.

The main role of the State agencies (COMPESA and COHAB) was to install public trunk sewers, so that there would be something for the condominial sewers to connect to. In addition, COMPESA was responsible (theoretically) for maintaining all sewer systems and for administering water and sewer utility billing. Neither COMPESA nor COHAB embraced participation for the majority of their projects, and COMPESA was generally critical of condominial sewer design standards and construction quality. One practitioner estimated that up to 80 percent of the engineers in COMPESA were opposed to condominial sewer technology during Phase 1[32]. EMLURB staff estimated that COMPESA accepted maintenance responsibility for approximately 60 percent of the City's condominial sewer connections (not including projects that were not completed); the remaining 40 percent of the connections were left without a formal maintenance agency[33].

5.4.3 Phase 2 - Revisiting a Conventional Approach (1989-1992)

Joaquim Francisco of the rightist Party of the Liberal Front (PFL) took office as Mayor of Recife in 1989. He appointed Jose de Anchieta dos Santos to replace Edrise Aires as the president of OBRAS. Edrise Aires moved to COMPESA with his entire OBRAS staff, including the coordinator of the Condominial Program. The coordinator of Condominio SOS also left OBRAS after disagreeing with the Francisco administration's non-participation approach to her program. Jose Carlos Melo left his position as Vice Mayor of Recife to become the State Secretary of Sanitation for the Governor Arraes administration. In his new position, Melo was able to direct condominial sewer funding to the interior city of Petrolina under Brazil's Medium-Size Cities Program (*Cidades de Porte Medio*).

No unfinished condominial sewer projects from the previous administration were concluded by Mayor Francisco. The Condominial Program was paralyzed by the new mayor, who was not interested in promoting the programs of the previous administration. Such discontinuity and political individualism were common practice throughout Brazil (as discussed in Chapter 4). I consider this practice a manifestation of Brazil's history of political patronage and clientelism. Because projects and programs were often designed to serve a particular clientele (e.g., a particular neighborhood), newly-elected officials had no sense of obligation to maintain the previous official's projects and programs. On the contrary, the newly-elected official had his or her own clientele to consider. The very logic of patronage and clientelism precludes continuity from one regime to the next.

Francisco continued to spend the leftover funds to build projects, but he eliminated participation and focused only on the public parts of the system (not condominial sewers or house connections). In the case of one condominial sewer project, Francisco completed the public trunk sewer but did not complete the condominial sewer or house connections. The result was a functioning public trunk sewer system with few or no homes connected to it.

By 1989, OBRAS had completed several condominial sewer projects and passed the maintenance responsibility over to COMPESA. However, COMPESA did not perform regular maintenance duties on all of these projects even though users continued to pay sewer fees to COMPESA. Ostensibly, COMPESA used a 2-step process for deciding whether or not to accept responsibility for maintenance on condominial sewers implemented by the City agencies. Prior to construction, COMPESA would form a 3-member committee – made up of one representative each from COMPESA's Engineering, Construction, and Maintenance Departments – to review the implementing agency's design and write a report that included design recommendations. After the implementing agency constructed the project, COMPESA would form another committee to review the as-built drawings and to determine whether or not COMPESA should accept maintenance responsibility for the project.

Reasons for not accepting maintenance responsibility included a lack of as-built drawings, lack of an appropriate sewage destination, or a design that did not meet COMPESA guidelines. Some projects were initially accepted and then subsequently abandoned by COMPESA. Reasons given by COMPESA staff for abandonment included poor project performance, excessive maintenance costs, or substandard design. Although the results of these design and acceptance reviews were documented in agency memoranda and letters, there were no formal written rules, criteria, or norms for acceptance[34]. In deciding whether to accept maintenance responsibilities on a project, COMPESA staff used so-called "practical" rules. For example, condominial sewer projects would not be accepted by COMPESA unless the following technical criteria were satisfied:

- Mandatory use of iron-trimmed manhole covers;
- Maximum distances between manholes ≤ 80 meters;
- Standard dimensions for manholes;
- Minimum diameters for pump suction piping; and
- Minimum distances between pumps and overhead structures.

Over and above these so-called practical rules, COMPESA staff acknowledged that the decision to accept maintenance responsibility for a project was also a political decision, because the neighborhoods that received projects had already been chosen on political grounds by higher officials[35]. It was, therefore, probably no coincidence that COMPESA, under Governor Arraes, did not agree to maintain Mayor Francisco's condominial sewer projects. During this time, the mayor and the governor were politically opposed, so their implementing agencies had little incentive to cooperate.

Sewer projects continued to be implemented with state money and with funds from the World Bank via the Grand Recife Program (*Projeto Grande Recife*), which was a follow-on to the previous Recife Program. These funds were channeled from the World Bank to CEF, through the Municipal Development Foundation (*Fundacao de Desenvolvimento Municipal*, or FIDEM), and down to the Pernambuco state government. The earlier Recife Program, which had a stronger focus on condominial sewers, was also funded by the World Bank during the 1980's, but its funds had been channeled directly to the City government in an attempt to reduce the impact of corruption[36].

Governor Arraes' Urbanization and Habitation Programs continued to be implemented by COHAB until 1991, when Joaquim Francisco left his position as Mayor of Recife to take office as Governor of the state. As expected, Francisco eliminated the Urbanization and Habitation Programs and fired about 100 COHAB employees that were associated with these programs and who were aligned with Arraes. The fired staff went back to work for their "home" government agencies in Recife (including URB), and in other counties and cities. Francisco's Vice Mayor, Gilberto Marques Paulo (also of the rightist PFL party), took over as Mayor of Recife from 1990 to 1992. He appointed Roberto Andrade as president of OBRAS in 1990. After 1990, with Francisco as Governor and his ally as Mayor of Recife, COMPESA showed little interest in Recife's condominial sewers. COMPESA did not even allow condominial sewer-related documents into its archives, and much of COMPESA's pre-1991 condominial sewer data were destroyed[37].

5.4.4 Phase 3 - Consolidating a Participation Approach (1993-1995)

In 1993, Jarbas was re-elected to his second Mayoral term, this time without a party affiliation but continuing with his populist platform. The Pernambuco Daily Newspaper announced that, for the second time, Jarbas had been voted best mayor in all of Brazil in a public survey[38]. His approval rating was over 70 percent, the highest in the country at that time.

Jarbas continued working on the unfinished condominial sewer projects that had been started during his first term. City condominial sewer staff continued to complain that

COMPESA did not perform maintenance on many condominial sewer systems, but continued to collect tariffs on the systems. Jarbas initiated the Plan of Order (*Plano de Ordenamento de 1994*) to formalize his negotiations with COMPESA about their acceptance and maintenance of projects constructed by the City. Jarbas wanted to transform informal maintenance agreements into a law, so that COMPESA could be relied upon to maintain City projects. In the case of failed negotiation with COMPESA, Jarbas planned to develop a permanent maintenance group within the City that would last beyond his political tenure. This option would be less desirable, however, because the City would have to acquire the resources, equipment, or staff to perform adequate maintenance.

Jarbas also reinforced his decentralized, micro-regional approach to sewer collection and treatment by issuing the Director's Plan for the Development of Recife (*Plano Diretor de Desenvolvimento da Cidade do Recife*) and including the text of a little known condominial sewer law (Lei 15.547/91) into Article 77 of the Plan. This Plan challenged COMPESA's regional sewage collection and centralized treatment approach because it attempted to institutionalize condominial sewer technology by a) mandating condominial sewers (not conventional sewers) as the technical norm for the City, and b) stating that residents were responsible for maintaining their sewer connection. Jarbas' persistence in pushing for an innovative approach to sewerage in Recife contributed to a sense of hope and possibility among many sewer practitioners. In his first term, Jarbas had proved he could expand sewer service using condominial sewer technology implemented by municipal agencies. At the same time, COMPESA had been unable to expand conventional sewer service in Recife for the previous 15 years. The following statement by a condominial sewer practitioner exemplifies the promise attributed to Jarbas' condominial approach:

> "The sewer law (Lei 15.547/91) and the *Ordenamento* mean that everyone in Recife will eventually be served by condominial sewers." (Informant 1, engineering consultant, interview by author, 2 March 1995, Recife, transcript.)

Mayor Jarbas made some key organizational improvements in his second term. He moved URB from the Secretary of Planning into the Secretary of Infrastructure (previously called the Secretary of Transportation and Public Works) with OBRAS. He also changed the name and responsibilities of OBRAS. OBRAS's name was changed to the Urban Cleanup Agency (*Empresa Municipal de Limpeza Urbana*, or EMLURB), and its previous responsibilities for planning, design, and construction were moved to URB. The new EMLURB agency was temporarily tasked with administering maintenance for condominial sewer projects of all sizes (through contracts with private firms), performing small sewer system rehabilitation and reconstruction (less than 300 connections), evaluating condominial sewer projects, and surveying and mapping existing condominial sewer projects so that reliable as-built information could be made available (which would improve the chances of COMPESA accepting City projects). EMLURB was also the agency that, if necessary, would become the City's official sewer maintenance agency if negotiations with COMPESA were not successful.

EMLURB no longer had responsibility for the design and construction of condominial sewer projects (or any projects) as it had when it was called OBRAS. URB now served as the main implementing agency for new condominial project construction under Mayor Jarbas Vasconcelos, and was the main agency involved in discussions with COMPESA about establishing clear maintenance roles and responsibilities. Under the new organization scheme for City agencies, only the URB agency performed new project design, construction, and participation. URB was also responsible for large system rehabilitation and reconstruction (projects with more than 300 connections).

URB's implementation approach for condominial sewers changed dramatically in Phase 3, because the agency took into account the lessons learned from the previous Jarbas term in Phase 1. One practitioner remarked that, "Engineers now believe that the education, orientation, and mobilization of residents is needed and important. This is the biggest change"[39]. Under its new approach, URB implemented condominial sewers in the following four general approaches, depending on the income of neighborhood served:

1. For middle-income and high-income neighborhoods, the residents who wanted a sewer connection decided on which layout they preferred (backyard, sidewalk, or front yard), they paid 100% of the capital costs (materials and labor), and they either contracted out the construction of their house connections or did it themselves. The City constructed the condominial sewer. For backyard and front yard systems, residents were responsible for maintaining private house connections and collective

condominial sewers. For sidewalk systems, COMPESA or the City was responsible for maintaining the sidewalk sewer.

2. For low-income neighborhoods, the residents who wanted a sewer connection decided on which of the three layouts they preferred, and they paid for the capital cost of materials for their house connections. The City constructed the condominial sewer and house connections. For backyard and front yard systems, residents were responsible for maintaining private house connections and collective condominial sewers. For sidewalk systems, COMPESA or the City was responsible for maintaining the sidewalk sewer.

3. For poor and very poor neighborhoods, the residents who wanted a sewer connection received only backyard condominial systems (no layout choice was offered), and they paid 50% of the capital cost of materials for their house connections and bathroom. The City constructed the condominial sewer and house connections. Residents were responsible for maintaining private house connections and collective condominial sewers.

4. In favelas, the residents who wanted a sewer connection received only backyard condominial systems (no layout choice was offered), and they constructed their own bathrooms using materials provided by the City. The City constructed the condominial sewer and house connections, and provided bathroom materials.

Residents were responsible for maintaining private house connections and collective condominial sewers.

By 1995, the City of Recife was planning larger scale condominial sewer projects, such as one proposal to serve 500,000 residents in the flat center of the city, which was only 10% sewered. In cases where COMPESA did not accept maintenance responsibility for a project, the City was now tentatively accepting maintenance responsibility through its EMLURB agency.

Changes were also taking place at the state level. In November 1994, after winning the gubernatorial election under the leftist Brazilian Socialist Party (PSB), Arraes invited all of "his employees" back to their old jobs at COHAB through an ad in the Vida Urbana section of the Pernambuco Daily (*Diaro de Pernambuco*) newspaper. Since his 1987-1990 term as governor, Arraes had fallen out with Jarbas Vasconcelos, left his old party (the centrist PMDB), and gained the support of the leftist PSB political party. Arraes began his 1995-1998 term as governor at the first of the year in 1995.

During the 1980s, COMPESA had not been very interested or involved in the implementation of condominial sewers in the city of Recife. The agency was, by and large, resistant to using participation in the planning, design, and construction of condominial sewers, and had been generally opposed to accepting the maintenance responsibility for condominial sewers implanted by City agencies. COMPESA had been more involved with implementing condominial sewers outside of Recife, such as in the interior city of Petrolina. But by 1995, COMPESA's attitude towards condominial sewers in Recife had changed dramatically, as expressed in the following statement by a COMPESA engineer:

> The attitude of COMPESA towards condominial sewers has improved greatly, with more knowledge, more acceptance of systems, and agreement now with the technology. If COMPESA had the money, we would probably prefer conventional sewers, but the reality is we do not have money and have therefore grown to accept condominial sewers. (Informant 12, COMPESA engineer, interview by author, 10 March 1995, Recife, transcript.)

I believe COMPESA's limited access to direct funding, combined with the Plano Diretor, which institutionalized condominial sewer technology as the norm in the city of Recife, had a lot to do with COMPESA's evolution. COMPESA staff noted two problems with the *Plano Diretor*. First, the Plan only applied to the city of Recife, but the City's sewer system extended beyond the city limits to surrounding cities that were also served by COMPESA. Second, compliance with the Plan was difficult when one neighbor cut off, cemented in, or otherwise sabotaged the collective system[40]. Nevertheless, the Plan was put in effect despite its imperfections. In 1995, COMPESA's Alternative Technology Program staff were beginning to implement condominial sewers under the PROSANEAR Program (funded by the World Bank)[41]. COMPESA had also initiated a participation and education component that was implemented statewide through a permanent staff of social workers[42].

5.4.5 Section Summary

In Section 5.4, I presented the details of condominial sewer implementation in the City of Recife from 1980 to 1995. The main themes of this section are:

1. There was discontinuity in support for condominial sewer projects by elected officials and implementing agencies from one administration to the next.
2. There was an overall lack of coherence in the implementation of condominial sewers, with several different approaches being applied simultaneously by different agencies (i.e., an "ad hoc" approach).

5.5 Case Study Projects in Recife

I selected three of Recife's condominial sewer projects as case studies and I examined them in detail. Table 5-6 summarizes the number of households, the income levels, and the sanitary infrastructure conditions of each case study project area at the time of my fieldwork (1995). Table 5-6 reveals that only one of the case study projects (Case R3) achieved full sanitary sewer coverage. Some households in the Case R1 and Case R2 project areas still disposed of sewage to onsite systems after the condominial sewer project had been completed. However, it must be noted that squatters had invaded the outlying parts of the Case R3 project area, and these squatters were not connected to the sewer system[43]. Consequently, even though the Case R3 project area was completely sewered, the area was still impacted by the sewage disposal practices of neighboring squatters. There were no squatters in the Case R1 and Case R2 project areas.

A brief synopsis of each case study is presented in the following sub-sections[44]. Based on these case studies, I argue that each community wielded a different level of influence, and this influence affected the implementation and outcome of each condominial sewer project. Following the brief case study descriptions, I tell the stories of two additional condominial sewer projects in Recife that failed. These two failed projects further illustrate how communities with low levels of influence on politicians and implementing agencies lacked the ability to facilitate project success in the context of Recife.

In Recife, the "neighborhood" was the basic unit of condominial sewer implementation, largely because of the long tradition of using urban service projects as elements of political patronage. Because of the neighborhood focus, differences between neighborhoods were important. Neighborhoods that could support the election of a political official were favored over neighborhoods that could not, for example. Wealthier and better organized neighborhoods were also favored and, consequently, had more influence and better condominial sewer project outcomes.

Table 5-6. Income levels and sanitary infrastructure conditions in the three Recife case study project areas.

			Percentage of Households Served[a]				
Case Study	**Total Households[b]**	**Estimated Income Level[c]**	**Condo. Sewer System**	**Conven. Sewer System**	**Onsite Septic Tank[d]**	**Dreno System[e]**	**Sewer Coveragef**
R1	293	middle income	79%	3%	12%	6%	82%
R2	158	low income	48%	0%	35%	2%	48%
R3	1349	poor	100%	0%	0%	0%	100%

Source: Project area residents, interviews by author, 1995, Recife, transcripts.

a. I estimated the percentage of households served based on my interviews with a representative number of households (at the 90% confidence level) in each project area. I interviewed 33 households for Case R1, 41 households for Case R2, and 59 households for Case R3.
b. To determine the total number of households in each project area, I conducted a neighborhood census in which I counted every household.
c. Based on the definitions presented in Chapter 3 (Table 3-12), middle income is >5 and ≤10 minimum salaries per household, low income is >3 and ≤5 minimum salaries, and poor is >1 and ≤3 minimum salaries per household.
d. Includes cesspools, leachpits, and septic tanks.
e. Recife's dreno system, installed by COMPESA, routes household sewage directly into the storm drain system.
f. Overall sewer coverage includes both condominial and conventional sewer connections.

5.5.1 Case R1

This project was implemented in a middle income neighborhood between 1986 and 1988 as part of the City's *Projeto Condominio* program. Case R1 is located in COMPESA's Sul Sewage Treatment Division. Included in the project were backyard and sidewalk condominial sewers, drainage, pavement, and final discharge of the collected sewage (untreated) to a nearby concrete-lined, uncovered, storm canal. The project was planned and funded through OBRAS, designed and constructed by an OBRAS contractor, and accepted and maintained (as of 1995) by COMPESA. Case R1 was completed in one implementation period. Project performance was good. Photo 5-1 shows the Case R1 neighborhood in 1995.

Photo 5-1 – Case R1 neighborhood in 1995.

Some residents in the Case R1 neighborhood were connected to Joaquim Francisco, an elected official. In 1985-1986, the residents spontaneously mobilized to apply for a pavement project from the City and the neighborhood was placed on the City's list of eligible neighborhoods under the Condominial Program. The City approached the residents with a proposal: the City would pave the neighborhood streets if the residents agreed to accept and pay for a condominial sewer system that would be installed before the pavement was constructed. Two community leaders mobilized residents to help the City convince enough residents to accept a condominial sewer and make the project viable.

After construction, COMPESA accepted the project and performed regular maintenance of the public sewer, maintenance of the condominial sewer, maintenance of individual house connections and, in some cases, maintenance inside homes. The residents demobilized with respect to the sewer system after the project was installed. Some residents performed maintenance, while others became accustomed to calling COMPESA for maintenance. Overall, COMPESA provided a high level of maintenance service on the Case R1 condominial sewer.

5.5.2 Case R2

This project was implemented between 1987 and 1992 in a low income neighborhood as part of the City's *Projeto Grande Recife* program. Case R2 is located in the COMPESA's Cabanga Sewage Treatment Division. Included in the project were condominial sewers (installed in backyards, front yards, sidewalks, pathways, and open areas), treatment of the collected sewage in a community septic tank, and final discharge by pumping to a nearby underground storm drain. The project was planned and funded by URB in 1987, then designed in 1988 and re-designed in 1991 by a local engineering consultant hired by URB. Case R2 was subsequently modified again by COMPESA through the same local engineering consultant, constructed by an URB contractor in 1992, and accepted and maintained by COMPESA in 1992 but subsequently abandoned. Project performance was poor. Photo 5-2 shows the Case R2 neighborhood in 1995.

Photo 5-2 – Case R2 neighborhood in 1995.

Residents in the Case R2 project area had no informal ties or patron-client relations with officials, but the residents' relationship with COMPESA and City agencies could be described as paternalistic. Residents of the adjacent neighborhood were organized into a neighborhood association (*Conselho dos Moradores or Associacao dos Moradores*) that was led by a formally elected president. The Case R2 neighborhood was part of this adjacent neighborhood association, and their president represented the residents of the Case R2 project area. There were also two community leaders and a community organization (i.e., the Council of Mothers, or *Conselho de Maes*) within the Case R2 project area. Residents had not mobilized autonomously prior to the project, and they did not seek active involvement in the project during implementation. Statements by residents revealed that many of them had become apathetic because of the failure of previous projects in their neighborhood.

5.5.3 Case R3

Condominial sewer case study R3 was installed in a favela between 1987 and 1990 as part of the State's *Projeto Urbanizacao* program. Case R3 is located in COMPESA's Peixinhos Sewage Treatment Division. The project included complete urbanization of the favela, which consisted of planned and regraded lots, pavement, drainage, water supply, electricity, trunk sewers, condominial sewers, community septic tanks, sewage pump stations, final discharge to a nearby river (Rio Morno), and new homes constructed by the residents. In January 1995, the area received 6 hours of water service every other day. Residents subsequently turned some of the lots into stores and schools, which were not included in the project design. Case R3 was planned and funded through COHAB, designed and constructed by a large engineering and construction company contracted by COHAB, and accepted and maintained (as of 1995) by COMPESA. Approximately 95% of the project was completed in one implementation period. Project performance was good. Photo 5-3 shows the Case R3 neighborhood in 1995.

Photo 5-3 – Case R3 neighborhood in 1995.

When Miguel Arraes took office as governor of Pernambuco in 1987, poor residents started occupying (i.e., invading) the Case R3 area for the purpose of establishing a community with official urban services. Residents created an organization called the Occupation Commission (*Comissao de Ocupacao*) to represent their interests, and hoped that Governor Arraes would provide them with urban services as he had done previously in other areas. In the 1960s, during Arraes' first gubernatorial term, there was a large invasion of poor citizens into the Green Garden neighborhood (a pseudonym). Arraes legalized the land and provided infrastructure for the inhabitants. So when Arraes took office again in 1987, the people who had invaded the Case R3 area were betting on him giving them a project. Community leaders mobilized the inhabitants to "fight" – actually to negotiate – for complete urbanization of the invaded area.

Their mobilization tactics included assembling the votes of the community and negotiating with authorities for the project. The Occupation Commission was disbanded after the project but, as of 1995, the leader of the community continued to meet with COMPESA directors every month to complain and call attention to the community's water and sewer maintenance needs. As the community evolved, several other organizations were created as of January 1995, including the Union of Residents of Case R3 (*Uniao dos Moradores do Caso R3*), the Association of Mothers (*Associacao das Mulheres*), the Nen Nursery School (*Creche Nana Nen*), the Machado de Assis Group of Mothers (*Grupo de Maes Machado de Assis*), and the Residents Association of Upper Case R3 (*Associacao dos Moradores do Caso R3*).

COMPESA accepted and, as of 1995, continued to provide regular maintenance of the public street sewer, while residents were expected to perform maintenance within their lots. As new residents moved into the area, they requested connection to the sewer system from COMPESA.

Case R3 residents expressed great interest in this project by organizing and mobilizing autonomously prior to the project. As they did prior to the project, community leaders took the initiative to make demands on authorities with regards to ongoing maintenance. Consequently, when the sewer system became plugged or needed maintenance, COMPESA usually resolved the problem and the system continued to function at a relatively high level (as of 1995).

The main point to take away from the three case studies is that condominial sewer implementation was a function of each neighborhood's ability to affect the course of events in its neighborhood. The communities of Cases R1 and R3 were able to express demand and exercise some influence, whether directly or indirectly, in ways that contributed to a successful condominial sewer project. In contrast, the residents of Case R2 did not have the ability to effectively communicate their interests nor the influence to persuade politicians or implementing agencies to take their interests into account, and their condominial sewer project was unsuccessful.

5.5.4 Failed Projects in Recife

Some failed condominial sewer projects in Recife are noteworthy because they reveal the impact of failure on beneficiaries, and because they provide further information about the impact of participation on project outcome. The Casa Jeri project (a pseudonym) in Recife had high demand and interest from residents, but the project was never concluded. The residents of Casa Jeri mobilized around the idea of receiving a condominial sewer project during the pro-condominial Mayor Jarbas administration of 1985-1988. The City worked with residents to design the condominial sewer system, but the project could not be constructed before the next mayoral election cycle. After Mayor Jarbas' term expired in 1988, Mayor Joaquim Francisco took office and cancelled the Casa Jeri project. Although the middle-income residents of Casa Jeri supported the project and were well-mobilized, after the election there was no longer any political or institutional support for continuing the project. Support from the City's implementing agency disappeared because Mayor Jarbas' staff had been supplanted by Mayor Francisco's staff.

Casa Jeri residents were very disappointed after this experience. At the time of my fieldwork in 1994-1995, several Casa Jeri residents remarked that the entire neighborhood was no longer interested in community meetings or collective action, and that they were "tired of empty promises"[45]. Even though the Casa Jeri residents had mobilized well, this did not overcome the negative affects of discontinuity between political regimes. This experience reveals the strong impact of changing political alignments, especially the lack of political continuity, on service provision and on the beneficiaries themselves. This project also shows the conditions in which participation in project mobilizing can be insufficient for producing a successful project outcome.

In the Jose Pico project (a pseudonym) in Recife, the socio-economic instability of the residents made it impossible to establish even minimum levels of service. During the pro-condominial Mayor Jarbas administration, the City of Recife's Public Works Agency (*Empresa de Obras Publicas*, or OBRAS) obtained funding to urbanize favelas. For the Jose Pico project, OBRAS built houses, condominial sewers, and a community septic tank in a vacant area. The project was implemented without any participation whatsoever[46]. After construction was complete, the City moved people who had invaded the bank of a nearby canal into the houses.

Although the targeted beneficiaries lived near each other on the canal bank, they had not mobilized or organized themselves with respect to this project. The people immediately sold their new homes, took the profit, and moved to the bank of another canal. Individuals also removed sewer pipes from the ground for their resale value. The newly developed Jose Pico area was also subject to further invasions by other poor people, and the area quickly deteriorated into a favela. The Jose Pico sewer system fell into disrepair and disuse, and residents reverted to the use of open ditches to carry raw sewage from homes to a nearby storm canal[47]. This case reveals the significant impact of socio-economic conditions on service provision. The desperate circumstances of Jose Pico residents made it difficult for them to accept the project as it was supplied. This case also reveals the fundamental error of not including a participation program in the process of implementing urban services for poor residents. In this case, simply supplying a project did not ensure success.

5.6 Recife's Overall Record of Project Performance

As of 1995, Recife had a sketchy overall record of project performance. Fully half of the 43 condominial sewer projects implemented in Recife from 1980 to 1995 had less than 50 connections each. Many condominial sewer projects were never concluded, a large percentage of projects barely functioned, and most projects were not designed with a suitable destination for the collected sewage[48]. There were some successful projects; however, agency staff I interviewed unanimously characterized Recife's overall performance as "fair" when choosing among the categories "bad", "fair", "good", "very good", and "excellent"[49]. The following quotes provide additional characterizations of condominial sewer performance in Recife:

> The number of functioning projects is very small. (Informant 16, president of a Recife sewer agency, interview by author, 16 March 1995, Recife, transcript.)

> Some [projects] are very bad, some are good. (Informant 59, COMPESA division chief, interview by author, 20 March 1995, Recife, transcript.)

> Sanitation is bad here in Recife. (Informant 100, president of an engineering company, interview by author, 19 March 1995, Recife, transcript.)

In my view, Recife had a poor overall record of condominial sewer performance. My characterization is supported by the findings of a survey of condominial sewer experience commissioned by the World Bank in 1993[50]. The study investigated and compared the condominial sewer experiences of seven Brazilian cities: Brasília, Recife, Natal, Cuiabá, Joinville, Petrolina, and Itapissuma. The sample of cities chosen for the investigation consisted of two-thirds of all known condominial sewer connections at that time: 52,550 out of 75,000 total connections. In the study, the overall record of condominial sewer performance in Recife was characterized as "bad," based on a 3-category scale of excellent/good/bad[51]. The study found that some projects were operating well even in the badly performing cities of Recife and Cuiabá, and that all cities had some problems[52].

A couple of practitioners I interviewed in 1995 took a revisionist view of Recife's condominial sewer experience. They referred to the 1980-1995 experience as a series of demonstration projects undertaken by the City to disseminate condominial sewer technology and to show COMPESA how to resolve the sanitation problem[53]. Although the condominial sewer programs implemented at that time may have had these effects, they were implemented at full-scale, and were not designed solely as demonstration projects (although some of the full-scale projects did have pilot-scale projects within them).

If the scope of Recife's programs and projects was limited, it was because of limitations in funding and political support, not because the programs and projects themselves were set-up for demonstration purposes. Furthermore, if Recife's condominial sewer programs and projects represented a wide range of approaches, this did not result from a planned demonstration of these approaches. Rather, the wide range of approaches was symptomatic of several dysfunctions:

1. An incoherent approach to sanitation development;
2. Conflicts among multiple implementing agencies;
3. A focus on implementing projects in neighborhoods that had disproportionate levels of influence; and
4. The unpredictable political alignments of elected officials and implementing agencies.

A key point expressed by many of Recife's condominial sewer practitioners was that participation in all aspects of project implementation matters[54]. However, after considering the empirical evidence on condominial sewer implementation in Recife from 1980 to 1995, I have settled on the notion that context also matters, and that it may be much more significant than a participation program, per se. From my perspective as a cross-cultural evaluator, unpredictable changes in the alignments of politicians and agencies appeared to have an overwhelming impact on condominial sewer project implementation and outcome. In addition, the fact that neighborhoods received service according to their level of influence was a second overwhelming factor in project implementation and outcome. In the following chapter, I examine a different context – the City of Natal – to discover what was important about condominial sewer implementation in that city.

[1]My calculations using data from the 2000 Brazilian Census (IBGE).
[2]OBRAS is my abbreviation for *Empresa de Obras Publicas*.
[3]Informant 59, COMPESA division chief, interview by author, 20 March 1995, Recife, transcript.
[4]Informant 12, COMPESA engineer, interview by author, 10 March 1995, Recife, transcript.
[5]COMPESA, 1995.
[6]COMPESA, 1995.
[7]COMPESA, 1995.
[8]Informant 37, COMPESA technical director, interview by author, 23 November 1994, Recife, transcript.
[9]Informant 1, engineering consultant and former official, interview by author, 2 and 13 March 1995, Recife, transcript; Informant 31, engineer for an engineering company and former director of a state agency, interview by author, 3 March 1995, Recife, transcript; and Informant 16, president of a Recife sewer agency, interview by author, 16 March 1995, Recife, transcript.
[10]COMPESA had installed "dreno" systems in some neighborhoods, which discharged household wastewater directly to the drainage system. The agency abandoned this practice, however.
[11]Informant 1, engineering consultant and former official, interview by author, 2 and 13 March 1995, Recife, transcript.
[12]Informant 1, engineering consultant and former official, interview by author, 2 and 13 March 1995, Recife, transcript.
[13]Informant 59, a division chief for COMPESA, interview by author, March 20, 1995, Recife, transcript.
[14]See Chapter 3, Section 3.2.3 for a discussion of minimum salaries.
[15]Langenscheidt's Pocket Portuguese Dictionary, 1989:532.
[16]Discussions with a professional Brazilian translator, 1994, Recife; and interviews with residents, 1995, Recife.
[17]Langenscheidt's Pocket Portuguese Dictionary, 1989:731.
[18]Informant 16, president of a Recife sewer agency, interview by author, March 16, 1995, Recife, transcript.
[19] See Chapter 4, Section 4.3 for a discussion of demand for pavement.
[20]Responses of residents to open-ended interview questions, Recife, 1995.
[21]Jose Carlos Melo, personal communication with author, March 1995, Recife.
[22]Jose Carlos Melo, personal communication with author, March 1995, Recife.
[23]Jose Carlos Melo, personal communication with author, March 1995, Recife.
[24]Informant 1, engineering consultant and former official, interview by author, 2 March 1995, Recife, transcript.
[25]Informant 3, EMLURB official, interview by author, March 13, 1995, Recife, transcript; and Informant 16, president of a Recife sewer agency, interview by author, March 16, 1995, Recife, transcript.
[26]Informant 16, president of a Recife sewer agency, interview by author, March 16, 1995, Recife, transcript.
[27]Informant 4, URB social scientist and former project director in the Secretary for Social Action, interview by author, March 14, 1995, Recife, transcript.
[28]See Chapter 4, Section 4.3.1 the discussion of favela urbanization.
[29]Informant 3, EMLURB official, interview by author, March 13, 1995, Recife, transcript.
[30]Informant 3, EMLURB official, interview by author, March 13, 1995, Recife, transcript.
[31]Informant 16, president of a Recife sewer agency, interview by author, March 16, 1995, Recife, transcript.
[32]Informant 31, consulting engineer and former director of a state agency, interview by author, 3 March 1995, Recife, transcript.
[33]Informant 9, EMLURB engineer, interview by author, March 8, 1995, Recife, transcript.
[34]Informant 12, COMPESA engineer, interview by author, March 10, 1995, Recife, transcript.
[35]Informant 29, COMPESA technical manager, interview by author, March 16, 1995, Recife, transcript.
[36]Corruption had (and still has) a tremendous impact on Brazil's ability to make effective use of public monies, and it was widely perceived to exist on every level of the Brazilian government. The World Bank attempted to reduce the impact of corruption by reducing the number of institutions through which Recife Program money had to flow. In this case, funds went as directly as possible to municipal governments.
[37]Informant 3, EMLURB official, interview by author, March 13, 1995, Recife, transcript.

[38] *Diario de Pernambuco*, January 8, 1995.
[39] Informant 9, EMLURB engineer, interview by author, March 8, 1995, Recife, transcript.
[40] Informant 12, COMPESA engineer, interview by author, March 10, 1995, Recife, transcript.
[41] Informant 12, COMPESA engineer, interview by author, March 10, 1995, Recife, transcript; and direct knowledge of the PROSANEAR program obtained while working as a summer intern at the World Bank Water and Sanitation Division, Washington, D.C., 1993 and 1994.
[42] Informant 12, COMPESA engineer, interview by author, March 10, 1995, Recife, transcript.
[43] Squatter homes were not included in the resident interviews for Case R3. Because the Case R3 project area was too large to conduct a household census, and because good project maps were available for this case, I used the maps to conduct the household census. Since squatter homes did not appear on the project area maps, they were not included in resident interviews.
[44] See Appendix E for comprehensive case study descriptions.
[45] Direct observation and discussions with residents, January 24, 1995, Recife.
[46] Informant 9, EMLURB engineer, interview by author, 18 May 1994, Recife, transcript.
[47] Informant 9, EMLURB engineer, interview by author, 18 May 1994, Recife, transcript; and direct observations and discussions with residents, May 18, 1994, Recife.
[48] Informant 16, president of a Recife sewer agency, interview by author, March 16, 1995, Recife, transcript.
[49] This result is based on the average response of eight agency staff to the question, "How would you evaluate the overall performance of condominial sewers in Recife?" Possible answers were based on the following 5-point scale: 1-Poor, 2-Fair, 3-Good, 4-Very Good, 5-Excellent. The interviews were conducted in Recife in the month of March, 1995.
[50] Watson, 1993.
[51] The seven cities represented 60 neighborhoods; however, cities were the unit of analysis, so there was no evaluation of individual projects. Also, there was no description of how the excellent/good/bad performance measures were derived.
[52] Watson, 1993:21.
[53] Informant 3, EMLURB official, interview by author, March 13, 1995, Recife, transcript; and Informant 7, URB department chief, interview by author, March 8, 1995, Recife, transcript.
[54] See Chapter 2, Table 2-3 for a list of quotes from 12 practitioners.

Chapter 6

Condominial Sewer Implementation in Natal

When viewed in comparison to Recife's experience (see Chapter 5), the condominial sewer implementation experience in Natal (from 1980-1995) offers a contrasting example of how the context of implementation matters. Unlike Recife, Natal enjoyed a 10-year period of relatively stable political alignments between elected officials and implementing agency officials, in which support for condominial sewer projects was relatively strong. These stable alignments played a major role in allowing Natal to develop a series of condominial sewer projects that are widely viewed as successful. In this chapter, I introduce the urban setting and water environment in Natal (Section 6.1); describe the organizations involved in implementing condominial sewer projects in Natal (Section 6.2); discuss the sanitation needs and circumstances of residents (Section 6.3); review the condominial sewer projects and programs that were implemented in Natal from 1980 to 1995 (Section 6.4); summarize three case study condominial sewer projects and some noteworthy failed projects (Section 6.5); and characterize the overall record of condominial sewer performance in Natal (Section 6.6).

Information about condominial sewer implementation in Natal was obtained from interviews with engineers, participation staff, maintenance staff, managers, agency officials, elected officials, and engineering consultants. Key informants included Informants 75, 76, 77, 78, 83, 84, 87, 88, 89, 96, 98, 99, 120, 121, and 122, however many others also contributed. Other sources of information were also used, including project reports, maps, engineering drawings, memoranda, census records, newspaper clippings, interviews with residents, and other sources.

I characterize Natal's approach to condominial sewer implementation in this period as relatively coherent in the first decade, but this coherence began to deteriorate in the 1990s. In Natal, a single, state-level implementing agency was responsible for condominial sewers. Moreover, this agency embraced condominial sewer technology and participation, so there was no lack of agency support as there had been in Recife. Also, only one agency was involved, issues of inter-agency or inter-governmental conflict did not exist in Natal.

6.1 The Setting

Natal is a coastal city built in the floodplain of the Potengi River (*Rio Potengi*) in the state of Rio Grande do Norte. Natal's conventional sewer infrastructure was built by the US military during World War II. Brazil, an ally of the US, allowed the US military to be stationed in Natal because it was the shortest distance from the Americas to Africa. One of the benefits to Brazil was the US military's construction of conventional sewers throughout the city. The conventional sewer system built in the 1940s was well-made using conservative sewer system design criteria that called for large, deep vitrified ceramic and concrete pipes (up to 9 meters deep in some places) and full-size concrete manholes layed in the middle of paved streets. The conventional sewer system begins in the City's Ribeira district and flows through the city. In 1967, Natal expanded its conventional sewer system, but by 1995, Natal still had only one operating stabilization pond to treat the collected sewage. Additional treatment capacity was still in the planning stages.

The map in Figure 6-1 shows the city, its neighborhoods (*bairros*), and its four administrative regions (*regioes administrativas*): Norte, Leste, Oeste, and Sul. Table 6-1 presents some basic demographic data for Natal, including estimated population, water connections. As shown in Table 6-1, access to piped water in Natal exceeded Brazil's national average in the late 1990s, but access to sewers was only a little over half of Brazil's national average. In 2000, Natal had an average population density of 4,219-people/square kilometer, indicating Natal was about two-thirds as dense as Recife[1].

Natal's sewer implementing agency, the North Rio Grand State Water and Sanitation Agency (*Companhia de Agua e Esgoto do Rio Grande do Norte*, or CAERN) divided Natal into water sectors and sewer basins. Sewer basins are bigger than water sectors and usually contain several water sectors. Sewer basins are hydrologically based, while water sectors are commercial divisions for billing, administration, and other uses. During the implementation of a condominial sewer, CAERN participation staff (i.e., the engineers, social workers, and technicians who implemented CAERN's participation program) worked with the residents one water sector at a time or one block at a time, rather than one neighborhood at a time.

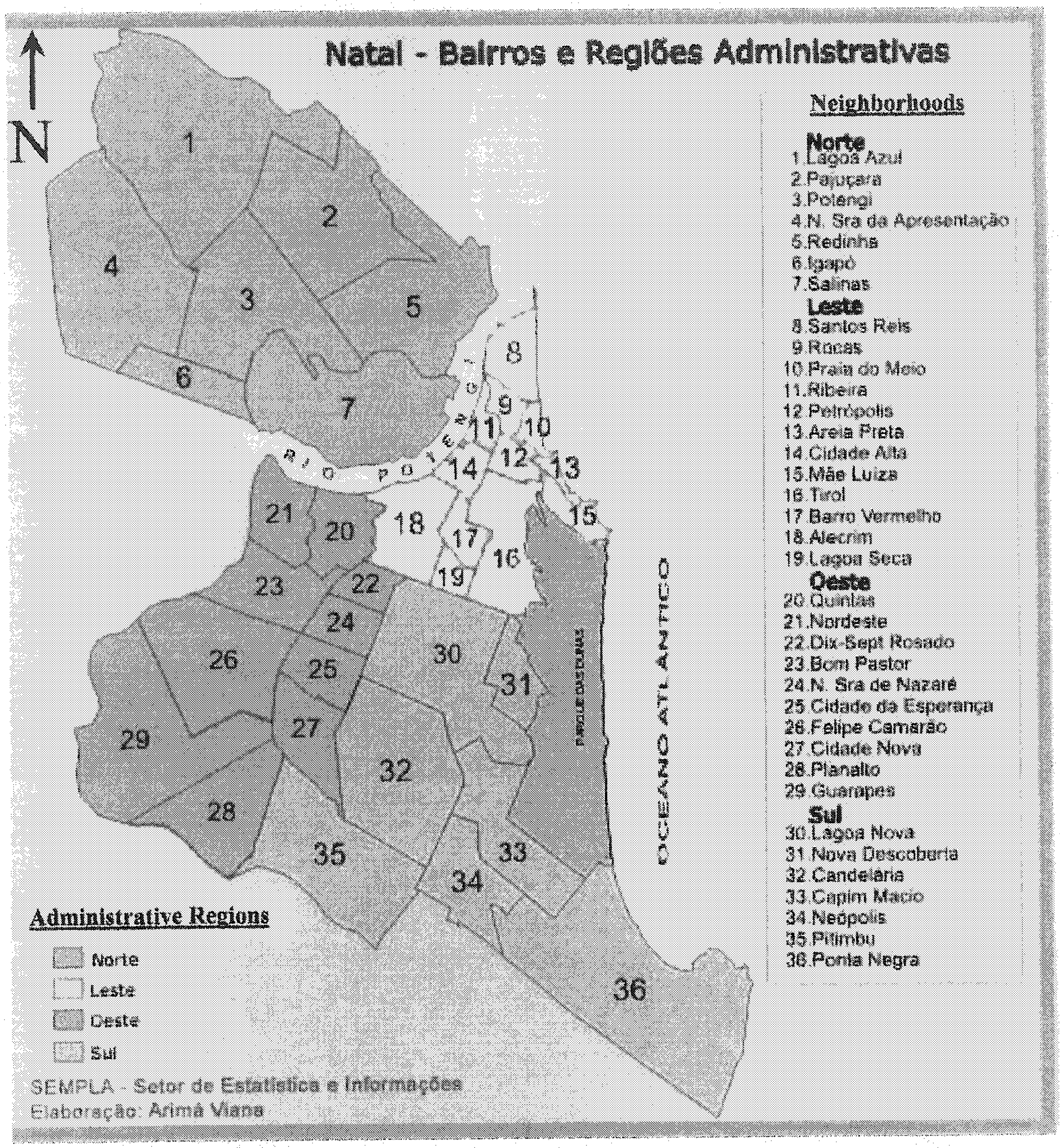


Figure 6-1. City of Natal with neighborhood boundaries and administrative regions (in color) as of 2003.
Source: Prefeitura do Natal, www.natal.rn.gov.br.

Table 6-1. Population, water access, and sewer access in the city of Natal and in Brazil.

Year	Natal Population	Population with Access to Piped Water	Population with Access to Sewers[a]
1991	151,152,000 (Brazil)	86% (Brazil)	49% (Brazil)
1995	695,374 (Natal) 161,374,000 (Brazil)	95% (Natal) 91% (Brazil)	19% (Natal) 66% (Brazil)
1999	167,967,000 (Brazil)	84% (Brazil)[b]	41% (Brazil)[b]
2000	712,317 (Natal)	97% (Natal)	26% (Natal)

Sources: World Factbook, www.odci.gov/cia/publications/factbook/geos/br.html; IBGE, www.IBGE.gov.br, 2001; IBGE PNAD, 1999; IBGE *Anuario Estatistico do Brasil*, 1992; IBGE *Censo Demografico 2000 – Malha Municipal Digital do Brasil*, 1997; www.ibge.gov.br/cidadesat; Populstat, www.library.uu.nl/wesp/populstat/Americas/brazilc.htm, 2003; World Bank, 1994; Parlatore, undated; and Informant 79, CAERN planning division chief, interview by author, 24 April 1995, Natal, transcript.

a. Access to sewers does not include access to septic tanks.

b. My calculations with IBGE data.

Figure 6-2 shows the 15 sewer basins of Natal, which are labeled with letters of the alphabet from A through K. CAERN organizes sewer funding, planning, engineering, and construction based on sewer basins (theoretically), so projects are known by their sewer basin (e.g., Basin A, Basin B, Basin C, etc.), in addition to the neighborhoods served. A single sewer project may include more than one neighborhood or may serve only a fraction of a single neighborhood. CAERN's complaint and repair records are categorized by neighborhood, not by basin. Because CAERN often distributed scarce maintenance resources to satisfy the political objectives of the state governor, knowing which neighborhood was being served was important to the decision makers[2].

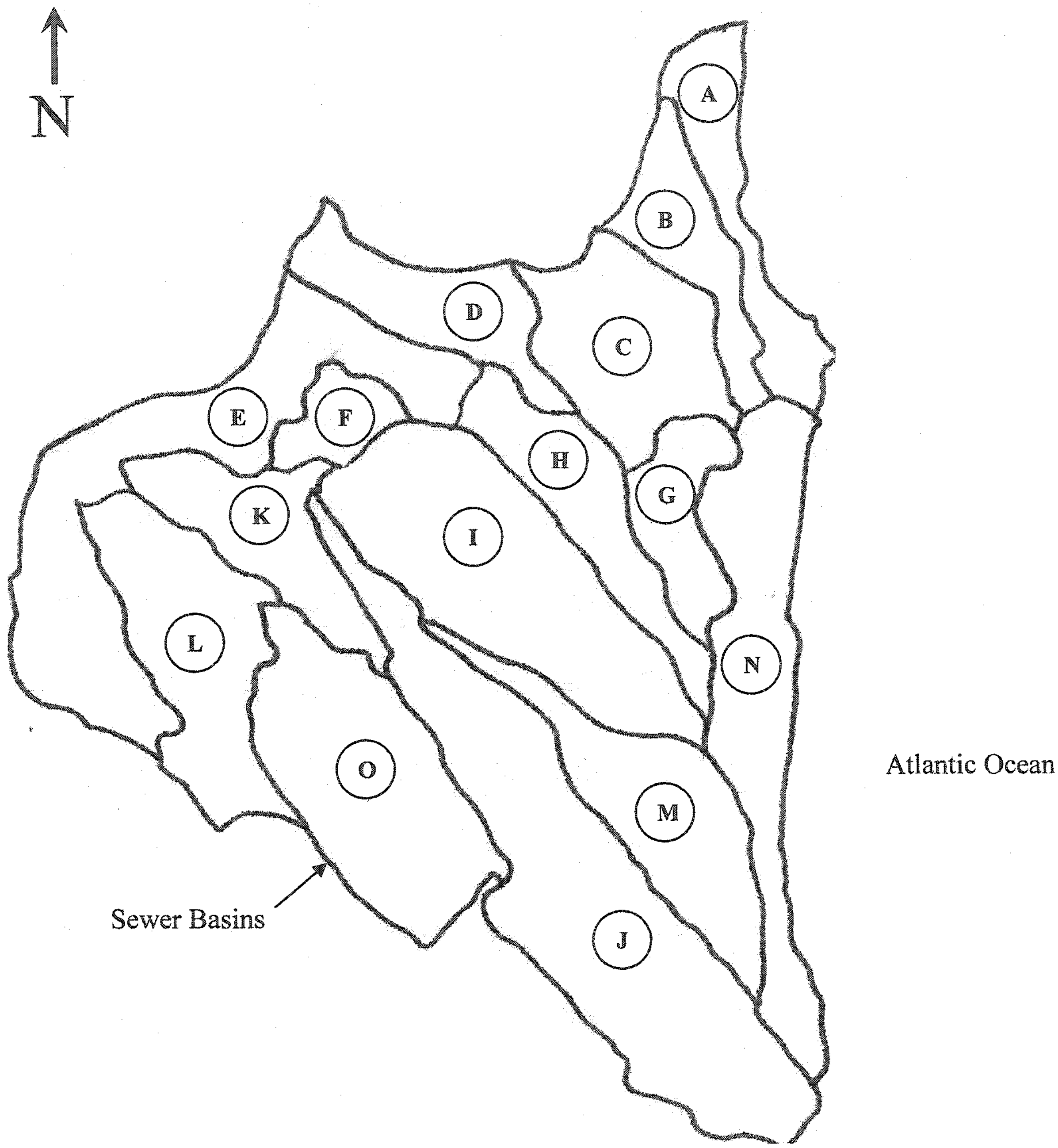


Figure 6-2. Sewer basins in Natal as of 1995. (Sewer basins located in the northern part of the city are not shown because that area was primarily unsewered at the time of my fieldwork in 1994-1995).
Source: CAERN, Planto Diretor de Esgoto Sanitarios, 1994.

The true number of sewer connections is difficult to obtain for two reasons. First, the planned number of connections is different than the number of connections actually built, so project planning documents, engineering reports, and blueprints may overstate the actual number of connections. Second, all households in Natal's sewered areas are charged a monthly sewer fee whether they are connected or not. CAERN's reason for doing this is that sewers are a public good, thus everyone in the project area receives the benefits of the sewer and should contribute to its cost. Because of this billing approach, billing records may also overstate the number of connections. Nevertheless, billing records are still one of the best sources of information for tracking growth in the total number of connections because the records are continually updated.

The first condominial sewers in Natal were completed in 1982. Sewer tariffs were not charged until 1986-87 around the same time that CAERN computerized its records. Consequently, CAERN's billing records and sewer connection information prior to 1986 do not include any information about condominial sewers, since these early connections were not yet being charged. Condominial sewer project funding was stopped for periods of time, but CAERN still considered a project to be a single project - not two separate projects - even when funding stopped for 5 years and started again later[3].

In 1995, CAERN staff estimated that approximately 20-25% of Natal's population was sewered (with conventional and condominial sewers), and the about 90% of the condominial sewer connections were for low-income and poor residents. Middle-income and high-income beneficiaries made up the remaining 10% of condominial sewer beneficiaries.

6.2 Natal's Implementing Agency

When the Brazilian National Housing Bank (*Banco Habitacao Nacional*, or BNH) created CAERN in the 1970s, Brazil was being governed by an authoritarian military regime, and a top-down, centrally planned approach to water and sanitation development made political sense. A total of 157 cities in the state of Rio Grande do Norte, including Natal, hired CAERN under 20-year concession contracts. Natal's contract with CAERN started on October 27, 1972. Only six cities in the state remained autonomous in terms of water and sanitation development; these six cities chose not to hire CAERN. While the amount of responsibility given to CAERN varied for each city, Natal transferred to CAERN most (if not all) responsibility for water and sanitation investment, planning, engineering, construction, maintenance, billing, and administration. During its 20-year contract period with Natal, CAERN was the one and only organization responsible for the implementation of condominial sewer systems in Natal.

The CAERN organization was led by a Directorate that consisted of a president, an engineer, and an administrator, each appointed by the governor. During the 1980s and 1990s, the CAERN Directorate sought and obtained project funding on its own and acted quasi-independently from the governor of Rio Grande do Norte. CAERN was divided into three Divisions: Projects (*Setor de Projetos*), Construction (*Setor de Obras*), and

Operation (*Setor de Operacao*). In May of 1994, staff of the Construction Division consisted of three engineers, one social scientist, three engineering technicians, one administrative technician, and 16-student interns form the local sanitation vocational school[4]. The Projects Division was staffed with one engineer, four engineering technicians, and eight student interns[5]. In January 1995, CAERN took steps to decentralize by extending its maintenance offices into the four administrative regions of the city to better serve its customers.

CAERN's Directorate focused most of the agency's sewer maintenance resources (for Natal) on the sewage collection system, which included sewage pump stations, conventional sewers, and condominial sewers[6]. Few resources were channeled toward maintaining Natal's sewage treatment system, a central stabilization pond, which provided the only form of treatment for sewage collected from the city. CAERN had almost abandoned the treatment system, and thus it did not function well. Even though beneficiaries were responsible for maintenance on condominial sewer systems, CAERN used some of its resources to perform maintenance on condominial sewer systems. Rather than reducing CAERN's maintenance effort, the condominial sewer system actually required more maintenance attention from CAERN.

CAERN charged a 40 percent tariff for condominial sewers (as a percentage of the water bill) compared to an 80 percent tariff for conventional sewers[7]. Fees for sewer service in Natal are summarized in Table 6-2. At the time of my fieldwork (1994-1995), CAERN's water fee was R\$1.39 per 10 cubic meters (equivalent to US\$1.39 per 10 m^3)[8]. In June

1995 the minimum water tariff (the rate charged to unmetered households) was R$3.81 per month (roughly equivalent to US$3.81 per month) and the associated backyard condominial sewer charge was R$1.52 per month (roughly equivalent to US$1.52 per month). During interviews, CAERN management staff remarked that water fees were kept low for historical reasons, and that neither the water nor the sewer fees covered CAERN's true maintenance costs. Approximately 60 percent of CAERN's funds came from user fees paid by its customers in Natal – the remainder came from customers outside the capital city or from other sources[9].

Table 6-2. Fees charged by CAERN for sewer service in Natal as a percentage of the water bill, as of 1995.

Level of Sewer Service	Fee (% of water bill)
Condominial	
Backyard Layout	40%
Front Yard Layout	40%
Sidewalk Layout	80%
Conventional	100%

Source: CAERN sewer billing records, 1995.

In 1995, CAERN billing records showed 17,282 conventional sewer units billed, 12,752 condominial sewer units billed, and 148,519 water units billed.

The performance of CAERN's condominial sewer projects in Natal varied. More complaints were received and more maintenance was performed on condominial sewers than on conventional sewers, even though the conventional sewer system had more overall pipe length and served more customers than the condominial sewer system. Also, middle-income and high-income beneficiaries experienced significantly fewer problems with the performance and use of their condominial sewers, compared to low-income beneficiaries[10].

CAERN's maintenance records include information about the type of problem, the neighborhood, the date of the service, and the time period of the initial complaint(s). Maintenance records from January 1993 to July 1994 showed an average of over 350 sewer system service calls per month for the whole city, which had approximately 27,055 sewer connections at that time[11].

The backyard location of some condominial sewers was one factor that impacted sewer performance[12]. It was customary for residents in Natal (and throughout Brazil) to build structures in their backyards, although construction often took many years. Typically, a son builds a house in his father's backyard if the family cannot afford to buy additional land. Some residents eventually construct houses and other structures over the condominial sewer pipes and cleanout boxes, making sewer access difficult. Without access to cleanout boxes, it is very difficult to unplug sewers. Construction materials often end up entering the sewer system and causing obstructions, and sometimes the shallow-laid sewer pipe is broken during the construction process.

Several CAERN staff reported that the Projects Division and the Construction Division cooperated well, but there was an historic lack of information flow between these two divisions and the Operations Division[13]. CAERN maintenance staff complained that information commonly known to them was not being used by the engineers for incorporation into new project designs. For example, the maintenance staff had learned early that the diameter of the most downstream condominial sewer pipe - the pipe that served all the homes on a block (i.e., the block collector pipe, or *saida da quadra*) - needed to be 150 mm rather than the standard 100 mm. They had also learned from maintenance experience that fewer homes should be connected to each condominial sewer that pipe angles smaller than 90 degrees did not work and should never be used, and that undersized cleanout boxes were difficult to maintain. Because of the lack of communication between the Projects Division and the Construction Division, it took over 10 years for this performance information to travel from the Operations staff to the Projects and Construction staffs.

Cooperation between divisions improved greatly in 1994 after the Projects, Construction, and Operations Divisions held an internal congress to review their experience with condominial and conventional sewers, water supply systems, pump stations, and treatment plants. CAERN summarized the findings and recommendations in a report[14]. The main finding of the 1994 congress regarding condomininal sewer implementation was that poor design by the Projects Division, compounded by inadequate field corrections by the Construction Division, led to defective projects being handed over to the Operations Division. Based on the report, the Construction Division replaced numerous 100 mm block collector pipes with 150 mm sections, resulting in significantly improved performance. Rather than experiencing weekly blockages as the area had before, the rehabilitated locations experienced only one blockage every 2 to 5 months after replacements were made[15].

Despite the important role of condominial sewer technology in CAERN's history and reputation, a senior CAERN official reported that among CAERN staff there were supporters of the technology, opponents of the technology, and staff who were indifferent about the technology. Among those opposed to the technology were high-level officials and managers of the agency. All CAERN staff was not convinced about the advantages of condominial sewer technology.

6.3 Natal's Condominial Sewer Beneficiaries

6.3.1 Types of Beneficiaries

Beneficiaries of condominial sewers in Natal can be placed into four categories based on their sewage situations prior to receiving a condominial sewer. Category 1 concerns affluent households with land. These beneficiaries typically have a well-functioning septic tank (*fossa septica*) plus a leachpit (*sumidouro*). Feces stay in the septic tank and solids-free wastewater flows to the leachpit, where it seeps into the ground. Septic tank functioning is enhanced because of the leachpit. Functioning is also enhanced for residents affluent enough to have their septic tank cleaned regularly. In most affluent households, fixtures are already piped to the septic tank and leachpit, so when a condominial sewer is eventually installed it is relatively easy to connect the sewer to the existing pipe. Affluent residents can afford high quality construction of their house connections, and they tend to have adequate drainage infrastructure, which reduces the incentive to connect rainwater to the sewer system.

Category 2 includes less affluent residents who typically have a septic tank, but no associated leachpit. The septic tank receives both feces and wastewater, thus it fills up sooner than it would if a leachpit were used. Additionally, residents in category 2 cannot always afford to have their septic tank cleaned out regularly. On my first day in Natal I spotted a septic tank pump truck owned by a private company, and I asked how much it would cost to clean out a septic tank. The price was less than one minimum salary, about R$55 to R$60 per month (roughly equivalent to US$55 to US$60 per month in March 1995)[16]. The pump truck company had their own stabilization pond where they discharged the sewage. This price was inexpensive compared to Recife, where it cost on the order of R$200 (2 minimum salaries), and where some companies discharged illegally to canals, storm drains, or vacant sites, because they did not have adequate discharge locations.

Category 3 includes low-income and poor residents who use a simple septic tank with an overflow pipe that carries wastewater to a storm drain or canal. Feces stay in the septic tank (this is comparable to the "dreno" system of Recife, as described in Chapter 5).

Residents in Category 4 are low-income and poor, and they employ simple septic tanks that connect only to their toilets. Sewage flows to the septic tank; and all other domestic wastewaters (i.e., gray water) are collected in buckets and then thrown into the street.

This allows the septic tank to function longer between cleanings, which is important because these residents typically cannot afford regular septic tank cleaning. Category 4 is the worst of the four in terms of public health. Because only the toilet is connected to the septic tank, it is a relatively difficult and expensive task to connect the remaining household fixtures to the cleanout box when a condominial sewer is eventually installed. These residents also cannot typically afford high quality construction. Instead of buying regular pipes, they might buy half-pipes (open on top) to connect solids-free wastewaters to the condominial sewer. This solution reduces system capacity because rainwater can enter the sewer. When residents do install house connections to the cleanout box, pieces of brick or concrete may enter the system and increase the possibility of future blockages. Low-income and poor residents typically can only afford to connect each household fixture to their condominial sewer one by one, and the process of connecting all fixtures can take months[17].

Residents living in favelas and very poor areas typically do not fall into any of the four categories above, and CAERN did not focus on expanding condominial sewers to these areas during the period studied. As of 1995, CAERN had not implemented condominial sewers in any of Natal's favelas. However, the agency had implemented thousands of condominial connections in low-income and poor (non-favela) areas of Natal. CAERN's priority was to provide condominial sewers to Category 4 residents, because of the health problems associated with discharging gray water into the street. CAERN staff reported that residents who were accustomed to throwing their gray water into the street often did not change this practice after they received a condominial sewer. Some residents used their sewers to dispose of solid waste (i.e., they removed the cover from the cleanout box on their property and put trash inside), which caused more frequent blockages. Some residents ended up connecting rainwater to their condominial sewer, which overloaded the system. When sewage backed up onto lots or into homes – indeed a serious situation – residents often called CAERN to fix the problem. However this maintenance arrangement was expensive for the agency.

CAERN used several criteria for selecting which areas of Natal would receive a condominial sewer[18]. Some of CAERN's funds were restricted in how they could be used. This meant that some funds were directed to specific service areas or to low-income residents. Apart from these special circunstances, two factors influenced project development decisions:

1. Technical considerations related to topography, treatment availability, and the location of the final destination of the wastewater; and
2. The level of mobilization and interest expressed by the area's residents.

6.3.2 CAERN's Participation Program

CAERN's participation program included the following:

- Mobilizing residents to encourage widespread support for the project;
- Mobilizing residents to educate them about the benefits of sanitary sewers;

- Involving residents in project decisions;
- Obtaining contributions from residents in project construction; and
- Obtaining commitments from residents to contribute to project maintenance.

CAERN staff cited the lack of user education as a primary reason for misuse of the condominial sewer systems[19]. Several CAERN staff were unsatisfied with the way CAERN's participation program was used to educate beneficiaries about sewer system maintenance[20]. They felt that one block meeting or house visit was not enough to be effective in fully educating beneficiaries about their condominial sewer; and that ongoing education about how to perform maintenance was more likely to promote proper use and maintenance of the system[21].

Emphasis of individual elements of CAERN's participation program in Natal varied slightly from project to project. But few, if any, condominial sewer projects were implemented without the participation program[22]. Resident involvement (i.e., the percentage of residents who participated) in CAERN's participation program varied by block for every project. CAERN's level of investment in its participation program also varied from project to project[23]. According to practitioners in Natal, the levels of resident involvement actually experienced in condominial sewer projects were typically 30% of the neighborhood population (with typical highs of 40-50 percent); however levels as high as 100 percent involvement, although very rare, were also reported[24]. Attendance rates above 50 percent were considered good[25]. CAERN participation staff did a number of things to facilitate resident involvement and the development of user groups (called *condominios or pactos condominios*), which CAERN considered important for project success. CAERN staff contacted residents directly, administered questionnaires, distributed meeting invitations, posted fliers, held meetings, and had informal conversations with residents.

Given the low levels of education and literacy of residents in most low-income and poor neighborhoods, written invitations to project meetings were not always effective. CAERN used speaker cars (*carros de som*) to invite residents to project meetings and found this to be very effective. A person sitting inside the speaker car made announcements into a microphone that transmitted their voice through giant speakers mounted on the roof of the car. The car was driven through the neighborhood so that as many residents as possible would hear the announcement.

Typically 30 percent of residents on a given block attended participation meetings held by CAERN prior to the construction of a condominial sewer project. The objectives of these meetings were to educate residents about sanitation, inform them about the condominial sewer system, distribute educational pamphlets, motivate the formation of a user group, and convince as many residents as possible to accept a sewer connection, authorize construction, and agree to perform maintenance. CAERN's participation program meetings included the experimental use of theater groups (*teatros*). At first, the theater groups were included in block-by-block project meetings. Amateur actors performed skits to educate residents on the benefits and operation of the condominial sewer system. But since only 15-20 residents were typically present for each block meeting, it was decided that this was not a big enough audience to justify the time and energy involved in preparing and performing the skits multiple times. The theater groups were then moved to local schools to educate students about sewers and sanitation.

For the 70 percent of residents that did not attend a typical project meeting, CAERN's student interns and vocational school graduates went house-to-house to explain the project and to obtain the signatures of residents who were interested in hooking up. Typically, the end of CAERN participation program coincided with the end of project construction. As a result, only the implementation staff (not the operations and maintenance staff) was involved in the participation program. Despite the fact that the participation program included education about how to perform maintenance, and that user maintenance was a goal of the participation program, maintenance staff was not involved in the participation program.

6.3.3 Maintenance by Beneficiaries

Most condominial sewer beneficiaries signed contracts with CAERN stipulating that they would contribute to maintenance and that, in return, they would receive a reduced monthly sewer fee. Theoretically, each household was expected to perform maintenance on their individual house connection, and the residents also were expected to form block-by-block user groups and maintain the condominial sewer collectively. In practice this rarely occurred. A sample of statements by Natal residents about why they did not perform maintenance is presented in Table 6-3. Speculations from practitioners about why beneficiaries resisted maintenance are summarized below in Table 6-4.

When maintenance service was needed, beneficiaries either tried to fix the problem themselves or called CAERN for maintenance service. Research conducted by CAERN maintenance staff revealed that approximately 50 percent of condominial sewer maintenance was performed by CAERN and 50 percent was performed by residents[26]. CAERN was politically obligated to respond to service calls, even though the agency only had two maintenance trucks to serve the entire city in 1995[27]. If CAERN did not respond, some residents would call journalists and television reporters to expose their problem to the media. The upper management of CAERN could not accept the bad publicity and would require the maintenance division to solve the problem. Or, more uncommonly, political opponents of an incumbent governor would use complaints about CAERN against the governor. CAERN maintenance staff could refuse to respond, but they always ran the risk of bad publicity. So even though the residents signed agreements accepting responsibility for maintenance on the condominial sewers within their blocks, and even though many residents did make initial attempts to fix their sewers, CAERN still ended up performing about half of the maintenance.

Notwithstanding the maintenance contracts signed by beneficiaries, some CAERN staff thought that residents were only responsible for maintaining their house connections (from the house to the first cleanout box on the property), and that CAERN was responsible for maintaining the condominial sewer and cleanout boxes that served the

Table 6-3. Statements from beneficiaries in Natal about who does maintenance on their condominial sewers and house connections.

Beneficiaries' Statements About Maintenance
"I call the responsible agency, which is SUMOV[a]."
"I think I would solicit some responsible agency, but at the moment I don't know which one that would be."
"I would request a government organization to verify the problem and resolve the question of who is going to fix it."
"I fix it myself."
"The only problem I have had was resolved by CAERN, and I didn't pay anything."
"CAERN does the maintenance."
"If a problem were to occur, I would pay someone to resolve it."
"If it's a simple problem I try to resolve it, otherwise I call someone from CAERN."

Sources: Condominial sewer beneficiaries, interviews by author, 1995, Natal, transcripts.
a. SUMOV is the City of Natal's Public Works and Transit Agency.

Table 6-4. Explanations given by practitioners in Natal for why some beneficiaries do not perform maintenance on their condominial sewers.

Practitioners' Reasons for Lack of Maintenance by Beneficiaries
"Some residents are too old to do it."
"Some residents are too poor to afford the tools."
"Tools available to residents break or don't work."
"Residents do not have access to pump trucks and other specialized sewer equipment."
"Neighbors don't respond when they are called for help."
"Residents know that CAERN will usually respond."
"The users group only functions well during construction, not during maintenance."
"The majority of people who call CAERN are new residents…When people move, this is a problem."

Sources: Informants 75, 88, 83, and others, condominial sewer practitioners, interviews by author 1995, Natal, transcripts.

block[28]. Residents and CAERN staff had become accustomed to this arrangement in spite of the contracts. For sidewalk condominial systems, however, CAERN was officially responsible for the parts of the system within public rights-of-way (i.e., sidewalks) and residents were responsible for the parts of the system on private lots.

6.4 Natal's Condominial Sewer Programs, 1980-1995

I divide Natal's experience in the 1980s and 1990s into three phases of condominial sewer implementation. In the following sections, I describe the significant events and relevant details of these three phases of implementation. A timeline that summarizes this entire section is presented in Table 6-5. This section adds to the empirical evidence supporting my contention that the alignment of interests between elected officials and implementing agencies had a significant impact on condominial sewer project outcome in Natal during the 1980s and early 1990s.

As in Recife, political administrations (i.e., regimes) changed at every election in Natal; but for most of the 1980s, each administration gave CAERN a degree of autonomy in implementing condominial sewers. During the 1980s, regime change in Natal did not have the substantial impact on condominial sewer implementation that it had in Recife, because there were not major shifts in support condominial sewers by elected officials and by CAERN. I argue that this stability was the foundation of Natal's implementation success in the 1980s. In the 1990's, however, there were shifiting alignments of interests between elected officials and CAERN officials, and these shifting alignments began to affect condominial sewer implementation. One indication of shifting alignments was the lack of enthusiastic support for condominial sewers from a newly elected governor in 1991 and his appointed director of CAERN. Precipitating this shift in support was the expiration of CAERN's contract in 1992, and decentralization of funding from state governments to municipal governments in the early 1990s. The overall result was a four-year period (1991-1994) in which no condominial sewers were implemented in Natal.

A second indication that shifting alignments affected condominial sewer implementation in Natal was the election of a new mayor of Natal in 1994 who strongly promoted municipal control and quasi-privatization of Natal's sewer system. At this point, the City Urbanization Agency (*Empresa da Urbanizacao do Natal*, or URBANA) was competing with CAERN for project funds and for authority over sewer development in Natal.

6.4.1 Pre-Implementation (pre-1980)

In 1978, CAERN had planned to construct a pump station and conventional sewer system in the neighborhoods of Rocas and Santos Reis, Natal. But the residents were poor and did not have the resources to connect to the proposed system. Moreover, only 600 of the homes could be served if the funding had been used for conventional sewers. To resolve this problem, Jose Carlos Melo, an engineer from Recife, was called to Natal as a consultant. He proposed a condominial sewer system that would serve all 3000 homes with the same funds[29]. At that time, simplified backyard and sidewalk sewers and dreno-type sewer systems were only known to exist outside of Brazil[30].

Table 6-5. Timeline of events related to the implementation of condominial sewers in Natal from 1980 to 1995.

Year	Events
	Phase 1
1980	CAERN received funds for the implementation of the first condominial sewer system in Natal, Rio Grande do Norte.
1982	CAERN President Josemar Azevedo provided enthusiastic and consistent support of condominial sewer technology. The first condominial sewers in Natal were completed in the neighborhoods of Rocas and Santos Reis. CAERN received additional funds for more condominial sewers throughout the state.
1983	CAERN presented its condominial sewer experience in an engineering conference in Santa Catarina, Brazil. A wave of interest in condominial sewer technology spread through Brazil's water and sanitation industry.
1987	Support for condominial sewer projects continued, but access to new project funding started to shrink following 1986 changes in federal finance rules. CAERN began charging sewer tariffs to condominial sewer beneficiaries, computerized its records, and focused on maintaining existing projects instead of implementing new projects.
1988	Brazil's first Constitution was ratified, empowering cities to receive direct financing for water and sewer infrastructure. Implementation of this change did not occur in Natal until the early 1990s.
	Phase 2
1991	CAERN President Walter Gomez implemented condominial sewers in Basin I using funds leftover from the previous administration. The lack of enthusiastic support and the lack of new funding led to the paralysis of condominial sewer implementation.
1992	CAERN's 20-year water and sanitation service contract with the City of Natal expired.
1994	Conflict began between CAERN and the City of Natal. Mayor Aldo Tinoco Filho promoted the quasi-privatization of a new treatment plant and sewer system in Natal and the development of a water and sanitation division within City government. CAERN and the City of Natal each received new project funds and began implementing condominial sewer projects simultaneously.

Continued...

Table 6-5. Continued.

Year	Events
	Phase 3
1995	CAERN President Luiz Jorge Coelho Leal used the funding received at the end of the previous administration to implement the Basin I project. CAERN also received funding to complete the Basin D project. CAERN underwent a major re-organization in which the agency was decentralized.

Sources: CAERN staff, interviews by author, 1995, Natal, transcripts; and http://www.natal.br.gov.

6.4.2 Phase 1 - The Golden Age (1980-1990)

I call Natal's initial phase of condominial sewers the "golden age" because it was, by all accounts, the most successful period of implementation the City had experienced (as of 1995). During the first seven years of Phase 1 (1980-1986), Josemar Azevedo served as President of the CAERN Directorate. President Josemar (known by his first name) was supported by Lucio Flavio as Directorate Engineer and Valmir Rocha as Directorate Administrator.

In 1980, CAERN applied for and received World Bank funds from BNH/PLANASA to implement Natal's first condominial sewer pilot project in the neighborhoods of Rocas and Santos Reis. President Josemar assembled a handful of interested civil and environmental engineers and formed a specialized condominial sewer group to lead the implementation effort. CAERN took on more responsibility in executing its first project; and less was expected of the residents. CAERN implemented a participation program to mobilize, educate, and orient beneficiaries to the new sewer system. CAERN built the condominial sewer and the house connections.

CAERN engineering staff reported that the Rocas and Santos Reis systems were initially "well-designed" and that the engineers were "very detailed and careful." They used a survey instrument to confirm the field elevations and to design the location of the condominial sewers and cleanout boxes[31]. But during construction, the layout of the sewer had to be completely changed. The careful work engineers had done during design was futile for those parts of the condominial sewer that were located on private property, because these sections on the system had to be re-designed. From this experience, CAERN learned that the final layout of the condominial sewer and the final location of the cleanout boxes on private property had to be made in the field, with the consultation of residents. Design and construction activities could not be separated into two distinct phases; rather, they had to be combined[32]. The traditional concept of the project cycle, in which design was distinct from construction, did not work well in the context of condominial sewers because of their location on private property.

In 1982, CAERN applied for and received federal funding (from the World Bank through PLANASA/BNH) for three condominial sewer projects in the interior of the state of Rio Grande do Norte. These additional projects provided an opportunity for CAERN to gain further experience in implementing condominial sewers. At a 1983 engineering convention in Santa Catarina, Brazil, CAERN staff presented their condominial sewer experience and created a sense of excitement in the sanitary engineering community, because their results were so promising. Following the success of its condominial sewer pilot projects in Rocas and Santos Reis, Natal, and the success of its other projects in the interior, CAERN went on to install thousands more condominial sewer connections in Natal over the next 10 years. These connections were located in Sewer Basins A, C, D, E, and K (see Figure 6-2). Much of the financing for these projects came from the World Bank's Medium-Size Cities Program and the 1984-1988 State Program (*Programa do Estado*)[33].

Josemar Azevedo served an unprecedented two consecutive terms as President of the CAERN Directorate – unprecedented because his terms overlapped with three different governors who represented different political parties[34]. Josemar's two terms covered 8 of the 11 years that comprised Phase 1 (1980-1987). For the first two years of Josemar's term (1980-1981), the governor had been appointed by the military regime. For the next four years of Josemar's presidency (1982-1985), Jose Agripino Maia of the rightist Party of the Liberal Front (PFL) (who was now elected) served as governor from 1982-1985. For the final two years of Josemar's presidency (1986-1987), Geraldo Jose da Camara Ferreira de Melo of the centrist Party of the Brazilian Democratic Movement (PMDB) served as governor.

During Phase 1, governors played a lesser role in condominial sewer implementation compared to CAERN's Directorate, which played a direct role. CAERN staff explained that none of the governors during the 1980-1990 period expressed interest in condominial sewers, per se. Consequently, the CAERN Directorate, which was appointed by the governor, was able to act quasi-autonomously with regard to condominial sewers. CAERN's relative autonomy was enhanced by its direct access to federal funds during the first seven years of Phase 1 (1980-1986). The Directorate used its access to the governor as necessary to facilitate their search for condominial sewer project funds. The City government had little or no influence on CAERN with regard to condominial sewers in Phase 1.

In 1987, Luiz Roberto was appointed President of the CAERN Directorate by Governor Geraldo Melo. Joao Felipe Medeiros was appointed Directorate Engineer, and Roger Mariz was appointed Directorate Administrator. This Directorate served until 1990, the end of Phase 1. The timing of President Roberto's administration coincided with a change in federal funding arrangements and an increased difficulty in acquiring funding. In 1986, the BNH had been disbanded and replaced by *Caixa Economica Federal* (CEF); and funding from PLANASA ended in 1987. In 1988, Brazil's new Constitution was ratified, which decentralized federal financing of the sanitation sector and transferred some responsibilities to municipalities[35]. President Roberto was only able to continue implementing condominial sewers using resources from the previous Josemar administration. Since new project funding was now much more difficult to obtain, Roberto increased the agency's focus on maintenance activities and integrated the group of specialized condominial sewer engineers into the regular staff of CAERN. The condominial sewer specialists were integrated into all three Divisions of the agency (i.e., the Projects, Construction, and Operations Divisions).

During Phase 1, the following condominial sewers were installed in Natal: Basin A (large pilot project in Rocas and Santos Reis neighborhoods), Basin C (small projects in

Tirol and Lagoa Seca neighborhoods), Basin K (small project in Felipe Camarao neighborhood), and Basins D and E (grand projects Quintas, Nordeste, Alecrim, Bom Pastor, and Dix-Sept Rosado neighborhoods). Most of the condominial sewer funding received by CAERN in Phase 1 came with the condition that it be applied only in low-income or poor areas. With a few exceptions, all of the neighborhoods listed above were low-income or poor; none were favelas.

6.4.3 Phase 2 – The Intermission (1991-1994)

This phase represents a complete interruption in the implementation of condominial sewers in Natal, resulting from CAERN's inability to obtain funds for new projects. Walter Gomez was appointed President of the CAERN Directorate by Governor Jose Agripino Maia, who had just been elected to his second (non-consecutive) term under the rightist PFL party. (Recall that Agripino had been governor during the first half of Phase 1). Francisco Pancracio Madruga was appointed Directorate Engineer, and Rui Barbosa was appointed Directorate Administrator.

President Gomez substituted key condominial sewer staff within CAERN with new employees who did not understand or support the original condominial sewer approach. Gomez did not initially seek new condominial sewer project funding; rather he used funds that were leftover from the previous administration. Some staff believed that this Directorate was not as supportive of condominial sewer technology as the previous

Directorates. Other staff reported that the Directorate wanted to seek new funds, but was limited by the changed finance rules.

Funding for projects undergoing implementation was abruptly halted. One project was paralyzed after only 77% of the condominial sewer (54 of 70 blocks) and 16% of the house connections (900 of 5500 connections) had been completed. Beneficiaries who lived on the completed blocks took the initiative to finish constructing their house connections during the project down time. One advantage of the project stoppage was that it allowed time for house connection construction to catch up to the level of construction progress already achieved in the rest of project[36].

The original specialized condominial sewer staff stayed in CAERN through the various phases of support and non-support during the 1980s and 1990s. Individuals took assignments in different departments of CAERN, but the individuals could be reconvened as a group whenever implementation of condominial sewer projects started up again. CAERN staff who had been part of the original specialized group that implemented condominial sewers during the golden age was particularly frustrated with this phase[37]. During periods of funding paralysis, the specialized condominial professionals within CAERN prepared and submitted project proposals and put together engineering plans for the extension of condominial sewers into new basins. Knowing that eventually the project-funding environment would become favorable again, they wanted to be ready to implement as many connections as possible during the next period of support.

It did take CAERN some time to identify and apply for other sources of funding in the new environment. Towards the end of his term (in 1994), Gomez finally received condominial sewer funding from the German Development Bank for Basin I. There would be little time for his administration to implement the projects, however.

6.4.4 Phase 3 – Support and Destabilization (1995-on)

In 1995, Luiz Jorge Coelho Leal was appointed President of the CAERN Directorate by the newly elected Governor Garibaldi Alves Filho of the centrist PMDB party. Celso Veiga was appointed Directorate Engineer and Ismael Wanderly was appointed Directorate Administrator. Some CAERN condominial sewer staff expected a continuation of project paralysis during the President Jorge administration. Unexpectedly, President Jorge did not redirect the project funding for Basin I that had been received at the end of the previous administration, thereby providing indirect support for continued expansion of condominial sewers in Natal. At the beginning of President Jorge's term, CAERN received additional funds from the Inter-American Development Bank (IDB) in 1994 (US$9 million from the PROSEGE Program), and was able to restart implementation of the condominial sewer projects that had been abruptly stopped. Despite this, some CAERN staff still characterized this phase as "a continuation of the indifference towards condominial sewer technology that had begun in the 1990-1994 period, because of the lack of commitment to seek new funds"[38]. In the words of one CAERN staff:

> In the old days [of the 1970s and 1980s], the CAERN Directorate would go to Brasilia [the federal capital] in search of project money, until about four years ago [in 1990] when it changed. Now the mayors, deputies, and senators go to Brasilia in search of money and they hire CAERN to do the project and the maintenance. It was better when CAERN sought funds. Today CAERN's continuing expenses are a problem, since it only gets funds on a project basis. CAERN gets less money with the new decentralized system. (Informant 122, CAERN construction division chief, interview by author, June 7 1995, Natal, transcript.)

Another complaint of some CAERN staff was that as the number of condominial sewer connections in Natal grew, there was no additional funding to augment the operations and maintenance department. They made this complaint because most international lenders and funding sources only provide new project money, not money to maintain existing projects. Maintenance funds are supposed to be provided by the home country government and from user fees. The combination of CAERN's dwindling access to federal funding and its financially unsustainable sewer fee structure are the reasons behind the staff's complaint.

CAERN revised its participation approach again for the condominial sewer projects in Phase 3. In the original approach applied in the early part of Phase 1, CAERN had provided the materials and constructed the house connections for residents. In its revised approach of the later part of Phase 1, CAERN provided the house connection materials and residents constructed or contracted the construction of their house connections. Thousands of connections had been installed in this manner, with plumbing contractors being paid directly by the residents. The consequence of this change was that newly constructed projects could no longer be immediately transferred to CAERN's maintenance division because of the need to wait for the majority of residents to construct their house connections[39]. In Phase 3, CAERN decided to stop providing materials. Residents were now expected to install their own condominial sewer connections without any financial assistance from CAERN. The residents had to buy their own materials and install the connections themselves or hire a contractor. CAERN reasoned that residents would do this if they were genuinely interested in having a sewer.

These changes in CAERN's program indicate that residents were expected to contribute more than they had in the previous phases. Interestingly, one staff characterized the changes in CAERN's expectations of what beneficiaries should do as a reduction in participation rather than an increase[40]. The staff member said that participation in the 1980-1990 period – such as in the Rocas and Santos Reis projects – was "better" than in 1995 because CAERN made more of an investment in its participation program, and because residents were more interested in the condominial sewer systems. The staff member argued that as projects got bigger over the years, the pace of construction increased and it was no longer possible to perform all of CAERN's participation program activities that had previously been performed with the same number of staff. For the previously cited staff statement, "participation" apparently meant CAERN's participation program, and not spontaneous involvement by residents in a project (with or without a participation program).

CAERN's implementation of condominial sewers in Phase 3 had evolved in other ways as well. Design was simplified by the use of standard sizes and off-the-shelf parts, instead of custom-sized systems that required detailed calculations and non-standard parts. Financial technicians were now included in participation meetings to answer questions and to assist residents with house connection finance issues. CAERN also started documenting its participation process in written reports for the first time, beginning with the new projects in Basins I and D[41].

Reflecting on the overall problems they faced, CAERN staff noted that the two areas most needing improvement were poor condominial sewer performance and the routine lack of maintenance by beneficiaries. Less frequently mentioned was the problem of maintaining the *condominios*, or resident user groups. One senior CAERN staff reported that "only functioning [of condominial sewers] had not improved" and "there is a contract between CAERN and residents for the residents to do their own operation and maintenance, but CAERN ends up doing it"[42]. Other staff made similar statements.

CAERN maintenance staff had a different perception than CAERN engineering staff about the source of the problems with one specific condominial sewer system (i.e., the system in Rocas)[43]. They reported that the Rocas condominial sewer system suffered from inadequate pipe slopes, elevations, and angles that were designed by engineers and installed by construction crews. These problems were particularly bad for homes that had been built below the elevation of the street. These design and construction problems were exacerbated by the high water table and flat topography of the area, and by system misuse by the beneficiaries (e.g., building backyard structures that damage the sewer, and diverting storm water runoff that overloads the sewer). According to one staff, similar problems existed in two other sewer basins.

In October 1992, CAERN's 20-year contract with Natal expired. The City had not developed the know-how, the staff, or the equipment to manage its water and sanitation infrastructure alone. Despite this, the City did not immediately renew their contract with CAERN as most interior cities had done. During this "no contract" period, CAERN continued to provide water and sanitation services on an interim basis while City officials decided what to do about the contract. Notwithstanding CAERN's past efforts and modest progress in developing water and sanitation services in Natal, the agency's entire role in Natal was now being questioned due to higher expectations for progress and system expansion.

By 1995, only about 20 percent of Natal's residents had access to sewer systems (see Table 6-1). This striking statistic overshadowed CAERN's years of commitment to developing and disseminating condominial sewer technology, implementing condominial sewer projects, and perfecting its participation program. Despite its success in using participation to implement projects in low-, middle-, and high-income areas, CAERN had not been able to sustain success over time because of changes in federal rules and increasing expectations. A high-level City official stated that the achievement of only 20 percent sewer coverage over 20 years was a sign of CAERN's ineffectiveness[44].

Aldo Tinoco Filho, a former CAERN civil engineer, was elected Mayor of Natal in 1994 under the center left Party of Brazilian Social Democracy (PSDB). In 1995, Mayor Tinoco and the President of Natal's Urbanization Agency (*Empresa de Urbanização do Natal*, or URBANA) began negotiating with a private firm. The negotiations centered around a potential 30-year contract for the design, construction, operation, and maintenance of a new sewage treatment plant and sewer system extension. CAERN's proposed role would be to administer the billing of new customers. This represented a very significant reduction in responsibility compared to what CAERN had done in the past.

Historically, the City of Natal had not been directly involved in water and sanitation functions, and had only expressed a passive interest in the subject[45]. The City and CAERN had not worked closely together in the past, because the City had relied entirely on CAERN to provide water and sanitation services.

With the election of an engineer-mayor who had experience implementing condominial sewers, Natal's City government became more interested in developing the capacity to independently manage its water and sanitation sector. Collectively, the City's new found interest in taking more responsibility for local water and sanitation, the federal government's empowerment of cities through the decentralization of project funding arrangements, and the growing dissatisfaction with CAERN's lack of progress combined to create an atmosphere of conflict between the City and CAERN in Phase 3. Both CAERN and URBANA could now compete independently for funds from the federal government (e.g., from the *Banco Nacional Desenvolvimento Social*, or National Bank of Social Development) or from international lending agencies (e.g., the World Bank).

Criticisms by City staff and CAERN officials were that the agency was a "paternalistic bureaucracy". To quote one official, "CAERN is the mother and the father and wants to do everything for the people". CAERN's practice of performing maintenance on condominial sewers was noted as evidence of its paternalistic culture. Opponents viewed CAERN's maintenance decisions as a major error in policy implementation, since condominial sewer beneficiaries had signed contracts (called *Adhesao de Servico* or *Cartas de Adhesao*) obligating them to do their own maintenance, although these contracts were not legally binding. In 1995, a senior CAERN official reported that "relations between CAERN and the City are the worse they've ever been now that Aldo is Mayor"[46].

During Phase 3, URBANA applied for and received US$3 million from the IDB's PROSEGE Program to implement its first condominial sewer project. Two units within the City government were assigned to the project: URBANA and the Municipal Public Works Division (*Superintendencia Municipal de Obras e Viacao*, or SUMOV). The City government also decentralized itself and installed offices in the four administrative regions of the city to increase its local community presence. URBANA implemented the City's first condominial sewer project at the same time CAERN was using its own PROSEGE funds to complete the unfinished condominial sewers from Phase 1. URBANA was able to construct its entire project (3000 connections for 15,000 residents) for only US$840,000, which was less than one-third of the estimated cost[47]. URBANA's cost per sewer connection (or "unit" cost) was much lower than CAERN's unit cost, and the City used this fact as evidence that it could utilize sanitation funds more efficiently than CAERN.

The mayor of Natal, the governor of the State of Rio Grande do Norte, and the president of URBANA all supported the idea of creating a municipal water and sewer agency (*Companhia Municipal de Saneamento*) to implement water, sewer, solid waste, and drainage infrastructure services in Natal. CAERN supported the proposal even though the agency did not agree with Natal's desire to privatize some components of the sanitation infrastructure.

In Phase 3, CAERN implemented a new condominial project in Basin I and continued its implementation of an existing condominial sewer project in Basin D. During this Phase, other international lending organizations (beyond the World Bank) became involved in condominial sewer project financing, including the Bank of Germany and the Inter-American Development Bank.

6.4.5 Section Summary

In Section 6.4, I presented the details of condominial sewer implementation in the City of Natal from 1980 to 1995. The main themes of this section are:

1. There was relative stability in support for condominial sewers by elected officials and CAERN officials from 1980 to 1990.
2. There was overall coherence in the implementation of condominial sewers, with a single approach being perfected and revised over time by a single agency (i.e., a "centralized" approach).

6.5 Case Study Projects in Natal

I selected three of Natal's condominial sewer projects as case studies and I examined them in detail. Table 6-6 summarizes the number of households, the income levels, and the sanitary infrastructure conditions of each case study project area at the time of my fieldwork (1995). Table 6-6 reveals that all of the case study projects achieved very high levels of sanitary sewer coverage. Nevertheless, a few households in each project area still disposed of sewage to onsite septic tanks after the condominial sewer project had been completed.

A brief synopsis of each case study is presented in the following sub-sections[48]. Based on these case studies, I argue that all three communities wielded relatively low levels of influence on politicians and CAERN officials, and that, in Natal's context, community influence generally was not an important factor with respect to the implementation and outcome of these three projects. After the brief case study descriptions, I present two additional condominial sewer projects in Natal that failed. One of these failed projects illustrates a situation in which community influence was an important factor affecting the

Table 6-6. Income levels and sanitary infrastructure conditions in the three Natal case studies project areas.

Case Study	Total Households[b]	Estimated Income Level[c]	Percentage of Households Served[a] Condo. Sewer System	Conven. Sewer System	Onsite Septic Tank[d]	Dreno System[e]	Sewer Coverage[f]
N1	384	high income	36%	56%	8%	0%	92%
N2	757	low income	76%	20%	4%	0%	96%
N3	964	lower middle income	76%	17%	7%	0%	93%

Source: Project area residents, interviews by author, 1995, Natal, transcripts.

a. I estimated the percentage of households served based on my interviews with a representative number of households (at the 90% confidence level) in each project area. I interviewed 39 households for Case N1, 46 households for Case N2, and 46 households for Case N3.

b. To determine the total number of households in each project area, I conducted a neighborhood census in which I counted every household.

c. Based on the definitions presented in Chapter 3 (Table 3-12), high income is >10 minimum salaries, low income is >3 and ≤5 minimum salaries, and lower middle income is >5 and ≤6 minimum salaries.

d. Includes cesspools, leachpits, and septic tanks.

e. The dreno system did not exist in Natal at the time of this fieldwork

f. Overall sewer coverage includes both condominial and conventional sewer connections.

condominial sewer project. The other failed project shows how both low community influence and a lack of participation in project mobilizing left the community with little control or say in what services they received.

Community organizing for condominial sewers was less active in Natal, because, unlike Recife, projects in Natal were not organized around neighborhoods. In Natal, projects were primarily organized around sewer basins. In contrast to Recife, Natal did not implement condominial sewers in favelas or in very poor areas. As such, the range of conditions faced by Natal's implementing agency was smaller than the range of conditions faced by implementing agencies in Recife. Overall, community influence in Natal was less critical (compared to Recife) because of CAERN's focus on sewer basins instead of on neighborhoods, and because of the smaller differences between the communities receiving condominial sewer projects.

6.5.1 Case N1

Case N1 was implemented in 1987 in a high income area. This relatively small project included a mix of sidewalk condominial sewers, backyard condominial sewers, and conventional sewers. Final discharge of the collected sewage (untreated) went to the Potengi River. The project was planned and funded through CAERN, designed and constructed by a CAERN contractor, and accepted and maintained (as of 1995) by CAERN. Case N1 was completed within one governor's administration. The sewer connection rate was high and project performance was good. Photo 6-1 shows the Case N1 neighborhood in 1995.

Photo 6.1 – Case N1 neighborhood in 1995.

The Case N1 neighborhood did not have a community leader or a neighborhood association at the time of my fieldwork in 1995. However, one resident did report that the residents had mobilized once to bring speed bumps to the neighborhood. Case N1 was a relatively small project in a high income neighborhood. A neighboring high income community had gone to CAERN to request a sewer system for households not already served by existing conventional sewer. CAERN responded with a condominial sewer project, and decided to include the Case N1 area in the project because it was located only a few blocks away.

6.5.2 Case N2

Case N2 was implemented between 1986 and 1989 in a low income area. This relatively large project included all backyard condominial sewers and final discharge of the collected sewage (untreated) to the Potengi River. The project was planned and funded through CAERN, designed and constructed by a CAERN contractor, and accepted and maintained (as of 1995) by CAERN. Case N2 was completed in two stages (i.e., over two governors' administrations) because project funds were redirected in 1989; implementation of the second stage started in 1994. The sewer connection rate as high and project performance was good. Photo 6-2 shows the Case N2 neighborhood in 1995.

Photo 6.2 – Case N2 neighborhood in 1995.

The Case N2 neighborhood did not receive water every day, and this was a point of great dissatisfaction among residents. Residents reported that their water supply, street lights, and pavement infrastructure had been installed as piecemeal projects, each associated with a different mayor. In some cases, great political conflict would result in the paving of an individual block or street, leaving the unserved residents to wait for the next mayoral election to fight again for their piece of infrastructure.

This neighborhood historically had a community president, sometimes two, although there was not always a functioning community association. At the time of my fieldwork in 1995, there were two community presidents and no community association. One community president reported that the community had grown apathetic about organizing and mobilizing. He said residents had lost trust in the authorities (CAERN and the City), and that politicians only provided projects during election time based on their own interests, not those of the people.

6.5.3 Case N3

Case N3 was implemented between 1986 and 1989 in a lower middle income area. This relatively large project included backyard condominial sewers and final discharge of the collected sewage (untreated) into Natal's uncovered stabilization pond treatment plant. The project was planned and funded through CAERN, designed and constructed by a CAERN contractor, and accepted and maintained (as of 1995) by CAERN. The project was completed in two stages (i.e., over two governors' administrations) because project funds were redirected in 1989; implementation of the second stage started in 1994. The sewer connection rate was high and project performance was good. Photo 6-3 shows the Case N3 neighborhood in 1995.

Photo 6.3 – Case N3 neighborhood in 1995.

The Case N3 neighborhood historically had a neighborhood association, but at the time of my fieldwork in 1995, the residents I interviewed could not identify a community president. As for most of the condominial sewer projects in Natal, CAERN had planned and proposed the project to residents, and there was no prior organizing by residents for a sewer project.

In each of the three case studies in Natal (i.e., Cases N1, N2, and N3), CAERN was able to successfully mobilize residents and stimulate demand, even though the residents had not organized themselves around sanitation issues prior to the project. In Natal, this approach generally resulted in high connection rates and good performance in both low-income and middle-income areas, and for big and small projects. The effectiveness of CAERN's approach is evident in the fact that in Cases N2 and N3, residents continued to construct their part of the project on their own after project funding was stopped.

6.5.4 Failed Projects in Natal

Natal experienced some absolute project failures that are worth noting because they reveal the impacts of a lack of participation and a lack of community influence on project outcome. One project in a low-income/poor area, Rosa Flora (a pseudonym), could not be finished despite a high level of interest and demand for the project from residents. The residents of Rosa Flora wanted a condominal sewer very much. CAERN built the public trunk sewer and community septic tank first. The final destination for the collected sewage was a drainage lake that was maintained by the City of Natal. The City supported CAERN's project and had agreed to allow CAERN to discharge treated sewage from the community septic tank to the City-owned drainage lake.

The problem with the Rosa Flora project was that middle income residents who lived near the septic tank, but who would not be served by the project, mobilized against the project. The opposing residents did not want a treatment plant located in their area that would be handling sewage from the poor part of the neighborhood. The treatment plant was not accepted by the people in the middle-income area, and thus there was no viable final destination for the sewage that was to be collected from Rosa Flora. While trying to resolve this situation, CAERN ran out of money for installing house connections in Rosa Flora and for installing another project in an adjacent neighborhood that would have also discharged to the lake. Consequently, the houses in Rosa Flora were never officially connected to the public sewer, and CAERN ultimately closed off the inlet pipe to the septic tank to prevent clandestine use of the system[49]. This project shows the conditions in which participation in mobilizing can be insufficient for producing a successful project; and the importance of community influence on project outcome.

In another notable failure, residents in the Playa Sul (a pseudonym) project area were strongly opposed to a condominial sewer project. There were many unpaved streets in Playa Sul, and the residents expressed a preference for getting the streets paved instead of installing sewers. Residents were not very interested in CAERN's proposed condominial sewer project. There was also relatively "little investment" by CAERN in the participation program component of this project. As a result, resident involvement in the sewer project was extremely low. There were few project meetings because it was a small project with few blocks. CAERN implemented the condominial sewer project anyway, but very few residents connected to the condominial sewer[50]. This project experience reveals how a lack of participation in mobilizing can contribute to project failure.

6.6 *Natal's Overall Record of Project Performance*

As of 1995, Natal had a good overall record of project performance, despite a low sewer access rate across the city. The majority of condominial sewer projects that were initiated in the 1980-1990 period were either completed or in the process of being completed. Most of these projects functioned adequately (as of 1995), and most projects had a suitable destination for the collected sewage[51] (although the sewage treatment plant was barely maintained). Agency staff I interviewed characterized Natal's overall performance as "good" when choosing among the categories "bad", "fair", "good", "very good", and "excellent"[52]. In my view, Natal had a good overall record of condominial sewer performance. This characterization is supported by a World Bank-commissioned condominial sewer survey[53], in which Natal's overall project performance is characterized as "good" on an excellent/good/bad scale compared to six other Brazilian cities[54].

Just like Recife's condominial sewer practitioners, Natal's practitioners stressed that participation matters[55]. Despite this, CAERN consistently practiced a participation program, where beneficiaries were involved in all aspects of project implementation, including mobilizing residents, project decision-making, project construction, and project maintenance. This program evolved over time, but CAERN's commitment to having a participation program was unwavering.

I believe that the empirical evidence on condominial sewer implementation in Natal from 1980 to 1995 provides further support for my view, which is that the political/institutional context was the substantive factor in condominial sewer implementation, and that participation had a secondary, albeit still important, role. I argue that the impact of participation was primarily instrumental, and that Natal's decade-long period of stable alignments in support of condominial sewers had a more substantive impact on project implementation and project outcome. In the following two chapters, I provide results and analyses that support this view, including an analysis of the implementation experiences that were described in this and the previous chapter, and an in-depth analysis of participation and performance for the case study projects.

[1]My calculations using data from the 2000 Brazilian Census (IBGE).
[2]Informant 83, CAERN, engineering director, interview with author, 4 July 1995, Natal, transcript.
[3]Informant 78, CAERN sewer design division chief, interviews with author, 18 April 1995 and 2 May 1995, Natal, transcripts; and Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 17 April 1995, Natal, transcript;
[4]Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 24 May 1994, Natal, transcript.
[5]Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 24 May 1994, Natal, transcript.
[6]Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 25 May 1995, Natal, transcript.
[7]See Chapter 2, Section 2.1 for a discussion of condominial sewers layouts.
[8]Informant 98, CAERN director president of a Natal sewer agency, interview with author, 6 June 1995, Natal, transcript.
[9]Informant 76, CAERN social worker, interview with author, 11 April 1995, Natal, transcript; and Informant 88, CAERN condominial sewer technician, interview with author, 11 May 1995, Natal, transcript.
[10]Informant 76, CAERN social worker, interview with author, 30 May 1995, Natal, transcript. Also see Chapter 4, Section 4.3 for an explanation of why urban services in poor areas are generally more challenging.
[11]CAERN *Relatorio de Desempenho Comercial*, November 13, 1993.
[12]Informant 88, CAERN condominial sewer technician, interview with author, 11 May 1995, Natal, transcript.
[13]Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 17 April 1995, Natal, transcript; Informant 84, CAERN maintenance division chief and engineer, interview with author, 1 June 1995, Natal, transcript; and Informant 122, CAERN staff member, interview with author, 7 June 1995, Natal, transcript.
[14]CAERN *Cartilha o Projeto de Recomendacoes Tecnico*, 1993; and Informant 89, CAERN senior maintenance technician, interview with author, 23 May 1995, Natal, transcript.
[15]Informant 89, CAERN senior maintenance technician, interview with author, 19 May 1995, Natal, transcript.
[16] See Chapter 3, Section 3.2.3, for a discussion of Brazil's minimum salary.
[17]Informant 76, CAERN social worker, interview with author, 30 May 1995, Natal, transcript.
[18]Informant 121, CAERN sewer construction division manager and former CAERN directorate member, interview with author, 1 June 1995, Natal, transcript.
[19]Informant 76, CAERN social worker, interview with author, 11 April 1995, Natal, transcript.
[20]Informant 76, CAERN social worker, interviews with author, 11 April 1995 and 30 May 1995, Natal, transcripts; Informant 120, URBANA civil engineer, interview with author, 31 May 1995, Natal, transcript; and Informant 78, CAERN sewer design division chief, interview with author, 24 May 1995, Natal, transcript.
[21]Informant 76, CAERN social worker, interview with author, 11 April 1995, Natal, transcript; and Informant 120, URBANA civil engineer, interview with author, 31 May 1995, Natal, transcript.
[22]Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 17 April 1995, Natal, transcript.

[23]Informant 85, CAERN participation staff, interview with author, 11 May 1995, Natal, transcript.
[24]Informant 75, CAERN senior civil engineer and sewer construction coordinator, interviews with author, 23 May 1995 and 24 May 1995, Natal, transcript; Informant 120, URBANA civil engineer, interview with author, 31 May 1995, Natal, transcript; interview with Informant 75, CAERN senior civil engineer and sewer construction coordinator, (May 24, 1994), Natal.
[25]Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 23 May 1995, Natal, transcript.
[26]Informant 76, CAERN social worker, interview with author, 30 May 1995, Natal, transcript.
[27]Informant 89, CAERN senior maintenance technician, interview with author, 23 May 1995, Natal, transcript.
[28]Informant 84, CAERN maintenance division chief and engineer, interview with author, 1 June 1995, Natal, transcript; and Informant 122, CAERN staff member, interview with author, 7 June 1995, Natal, transcript.
[29] See Chapter 5, Section 5.4 for more information about Jose Carlos Melo
[30]Informant 89, CAERN senior maintenance technician, interview with author, 19 May 1995, Natal, transcript; and Informant 94, CAERN maintenance technician, interview with author, 19 May 1995, Natal, transcript.
[31]Although the use of survey instruments is common engineering practice in the United States, they are not used consistently in Brazil.
[32]Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 23 May 1995, Natal, transcript.
[33]Informant 1, engineering consultant, former municipal official, former state official, interview with author, March 1995, Recife, transcript; and Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 24 May 1995, Natal, transcript.
[34]My only explanation for why Azevedo was retained for so long is that CAERN's success in implementing condominial sewers – and the good reputation and prestige this success brought to CAERN and to the state governor – were attributed to Azevedo's leadership.
[35]See Chapter 4, Section 4.2.3 for a description of the change in finance rules.
[36]Informant 120, URBANA civil engineer, interview with author, 31 May 1995, Natal, transcript.
[37]Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 25 May 1995, Natal, transcript.
[38]Informant 121, CAERN sewer construction division manager and former CAERN directorate member, interview with author, 1 June 1995, Natal, transcript; and Informant 122, CAERN staff member, interview with author, 7 June 1995, Natal, transcript.
[39]Informant 88, CAERN condominial sewer technician, interview with author, 11 May 1995, Natal, transcript.
[40]Informant 78, CAERN sewer design division chief, interview with author, 24 May 1995, Natal, transcript.
[41]Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 24 May 1995, Natal, transcript.
[42]Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 25 May 1995, Natal, transcript.
[43]Informant 84, CAERN maintenance division chief and engineer, interview with author, 1 June 1995, Natal, transcript.
[44]Informant 99, Natal elected official, interview with author, 27 June 1995, Natal, transcript.
[45]Informant 121, CAERN sewer construction division manager and former CAERN directorate member, interview with author, 1 June 1995, Natal, transcript.
[46]Informant 121, CAERN sewer construction division manager and former CAERN directorate member, interview with author, 1 June 1995, Natal, transcript.
[47]URBANA had to return the funds it did not use on the project.
[48]See Appendix F for comprehensive case study descriptions.
[49]Informant 85, CAERN participation staff, interview with author, 11 May 1995, Natal, transcript; and Informant 75, CAERN senior civil engineer and sewer construction coordinator, interview with author, 23 May 1995, Natal, transcript.

[50]Informant 85, CAERN participation staff, interview with author, 11 May 1995, Natal, transcript.
[51]Informant 16, agency president, interview with author, 16 March 1995, Recife, transcript.
[52]This result is based on the average response of five agency staff to the question, "How would you evaluate the overall performance of condominial sewers in Natal?" Possible answers were based on the following 5-point scale: 1-Poor, 2-Fair, 3-Good, 4-Very Good, 5-Excellent. The interviews were conducted in Natal in 1995.
[53]Watson, 1993.
[54]See Chapter 5, Section 5.6, for a discussion of this report.
[55]See Chapter 2, Table 2-4 for a list of quotes from 10 practitioners.

Chapter 7

Project-Level Performance and Correlations with Participation

In this chapter, I present the case study performance results (Section 7.1); the case study participation results (Sections 7.2); and I analyze the association between participation and performance for the six case study projects (Section 7.3). The results suggest that participation in mobilizing and decisions is associated with project performance.

7.1 Case Study Performance Results

Project performance is defined in this dissertation as *the degree to which a project operates effectively and produces beneficial impacts*. The shorthand term "operability" is used to describe whether the physical works function effectively, and the term "impacts" is used to describe whether the outcome of the project is beneficial. The conceptual framework for this definition of performance is described in Appendix C.

7.1.1 Measuring Project Performance

A method for measuring project performance was developed and applied to characterize the performance outcome of each case study project[1]. Performance was conceived as the level of achievement of two objectives (operability and impacts). The measure for operability included the reported frequency of sewer system blockages and operability ratings by agency staff. Impacts were measured in terms of customer satisfaction and whether sewage was still present above ground in the neighborhood. The overall level of performance was expressed as a sewer performance index (SPI) on a scale from 0 to 100. An SPI of 0 indicates that a project had the lowest possible response from interview questions and the worst possible result from direct observation data for every component of the index. An SPI of 100 indicates that a project received the highest possible score in every component of the index and therefore fully achieved the two performance objectives. Performance data came from the following four sources:

1. Residents - the median response to questions asked in semi-structured interviews with residents from randomly selected households;
2. Engineering staff - the median response to questions asked in semi-structured interviews with engineering staff of the agency responsible for designing and building the project;
3. Maintenance staff - the median response to questions asked in semi-structured interviews with maintenance staff of the agency responsible for maintaining the project; and
4. Direct observations – a score based on my own field work, which included systematic inspections of the observable condition of the sewer system in streets, yards, and homes.

A list of the questions asked in each of the aforementioned semi-structured interviews is given in Appendix B.

For each case study, scores for 27 performance measures were used to determine the degree of achievement of the two performance objectives. These measures are summarized in Table 7-1. The raw data (i.e., responses to interview questions and results of direct observations) are presented in Appendix B.

An algorithm was developed to convert the raw data into scores that correspond to each performance objective. The sewer performance index (SPI) was measured as the sum of the median scores (equally weighted) of each performance measure. Refer to Appendix C for a comprehensive description of this methodology.

7.1.2 Results of Performance

For the purpose of making an initial interpretation of the scores on the 27 performance measures, the performance scale (0-100) is divided into thirds, corresponding to low (0-33), medium (34-67), and high (68-100). The distribution of the 27 performance measures for the six case studies is presented in Table 7-2. As indicated in Table 7-2, more than half of the 27 performance measures had scores in the middle third and top third ranges of the scale for Cases R1, R3, N1, N2, and N3. For Case R2 however, more than half of the 27 scores were in the bottom third of the scale.

Table 7-1. Selected questions sorted into groups that correspond to the two performance indicators[a].

Sources of Data	Operability (20 questions)	Impacts (7 questions)
Resident Interviews	1. Ratings of House Connection Operability (Q1-2) 2. Ratings of Street Sewer Operability (Q1-3) 3. Reported Problems with Condominial Sewer and House Connection (Q1-4)	1. Ratings of Satisfaction with Condo. Sewer at Time 1 (Q1-6)[b] 2. Ratings of Satisfaction with Condo. Sewer at Time 2 (Q1-7)[c] 3. Reported Disadvantages of the Condominial Sewer (Q1-8) 4. Reported Improvements to Local Health and Environment(Q1-9)
Maintenance Staff Interviews	4. Reported Blockages in the Street Sewer (Q7) 5. Reported Blockages in the Condominial Sewer (Q8) 6. Reported Blockages in the House Connections (Q9) 7. Reported Blockages Caused by Soil (Q10) 8. Reported Blockages Caused by Trash (Q11) 9. Reported Blockages Caused by Damaged Pipes or Manholes (Q12) 10. Reported Blockages Caused by Sewage (Q13) 11. Reported Blockages Caused by Storm Water (Q14) 12. Reported Malfunctioning of the Sewage Pump Station (Q18) 13. Reported Malfunctioning of the Sewage Treatment Plant (Q19) 14. Reported Lost or Damaged Manhole Covers (Q20)	Not Used

Continued...

Table 7-1. Continued.

Sources of Data	Operability (20 questions)	Impacts (7 questions)
Engineering Staff Interviews	15. Ratings of Condominial Sewer Operability at Time 1 (Q32)[b] 16. Ratings of Condominial Sewer Operability at Time 2 (Q33)[c]	Not Used
Direct Observations	17. Observed Number of Sealed Street Manhole Covers 18. Observed Number of Intact Household Manhole Covers (Q5-6h) 19. Observed Number of Intact Household Sewer Pipes (Q5-6e) 20. Observed Number of Buried Household Sewer Pipes (Q5-6d)	5. Observed Number of Households with Sewers (Q1-1) 6. Observed Frequency of Public Graywater 7. Observed Frequency of Public Sewage

a. The selected questions passed two screening criteria: a) content matching for all questions, and b) expected response ≥ 3 for resident questions. Other questions that did not satisfy these criteria were not used. See Appendix B for the results for each question. See Appendix C for a detailed description of the scoring methodology.

b. Time 1 refers to the time period just after project completion (1988-1991 time frame).

c. Time 2 refers to the time of the interview (1994-1995 time frame).

Table 7-2. Distribution of scores for the 27 performance measures that make up the sewer performance index for the six case study projects.

Case	Number of Performance Measures that Scored in Each Range			Median of all 27 Scores[a]
	Bottom Third	Middle Third	Top Third	
R1	4	10	13	66
R2	18	5	4	12
R3	7	6	14	67
N1	8	4	15	69
N2	9	5	13	58
N3	11	5	11	53

a. The median of all 27 performance measure scores is not the same as the sewer performance index (SPI). The overall median does not account for there being more measures of the operability objective (20) than of the impacts objective (7). The SPI does account for this difference because equal weights are assigned to the two objectives.

Performance in Recife. Most of Case R2's sewer system was non-operational. The operational parts of the system had frequent blockages, and the pump station and treatment plant had been abandoned. Cases R1 and R3 both achieved reasonable levels of operability and beneficial impacts. The Case R3 area had been a *favela,* so the improvements brought about by the project were significant. These results are indicated by the scores in Table 7-3.

A sewer performance index (SPI) for each case was calculated. The SPI represents overall performance, and it is the equally weighted sum of operability and impacts. Overall performance of the Recife case studies is indicated by the scores in Table 7-3.

Table 7-3. Scores for performance in the three case study projects in Recife (100 = maximum performance).

Performance Objective	Performance Scores		
	Case R1	**Case R2**	**Case R3**
Operability	58	7	55
Impacts	77	17	87
Sewer Performance Index	67	12	71

Source: My calculations use primary data from interviews with random samples of residents, interviews with engineering and maintenance staff, and my direct observations. Calculations follow the method presented in Appendix C. Raw data and descriptive statistics are presented in Appendix B.

Performance in Natal. All three Natal case studies achieved reasonable levels of operability and beneficial impacts. In Case N3, however, a small portion of the project area achieved far lower levels of operability and beneficial impacts than the majority of the project area. For this reason, agency staff considered Case N3 to be one of the worst performing projects in Natal. However, when performance was measured for the Case N3 project area as a whole, the resulting scores were only slightly depressed compared to the other cases. These results are indicated by the scores in Table 7-4.

Table 7-4. Scores for performance in the three case study projects in Natal (100 = maximum performance).

Performance Objective	Performance Scores		
	Case N1	**Case N2**	**Case N3**
Operability	56	48	47
Impacts	80	84	63
Sewer Performance Index	68	66	55

Source: My calculations use primary data from interviews with random samples of residents, interviews with engineering and maintenance staff, and my direct observations. Calculations follow the method presented in Appendix C. Raw data and descriptive statistics are presented in Appendix B.

To arrrive at a basis for grouping the six cases, a simple statistical test (called the Median Chi-squared test of significance) was performed using the 27 scores that make up the SPI for each case. I proceeded by conducting a series of Median Chi-squared tests of the differences in performance scores among the six cases. The Median Chi-squared test (also called the Median test) is a non-parametric equivalent of the standard t-test. The Median test was selected because unlike other non-parametric tests (e.g., the Mann-Whitney t-test, the Kruskal-Wallis H-test, or the Wilcoxon Rank Sum test), the Median test is appropriate when a non-parametric set of data contains more than a few ties, as was the case here.

Using the method described by Huck (2000:656), Median tests were carried out to test the null hypothesis that median scores of the population (of performance measures) represented by the sample (of 27 performance measures) were equal for any two case study projects (or grouping of case study projects). Rejection of the null hypothesis would indicate a statistically significant difference between the cases. In this dissertation, the term "significant" corresponds to a statistical value called *rho,* (ρ), at or below the 10 percent level (i.e., $\rho \leq 0.10$). Terms used in this dissertation that correspond to other values of *rho* are listed in Table 7-5.

Table 7-6 shows the results of applying the Median Chi-Squared test several times. In the first instance, which is the "main test" in Table 7-6, the null hypothesis was that the median scores of the populations (from which samples were taken) for the six cases were

Table 7-5. Terms used in this dissertation that correspond to different levels of statistical significance, ρ.

Rho (ρ)	Corresponding Term
$\rho \leq 0.01$	Extremely Significant
$\rho \leq 0.05$	Very Significant
$\rho \leq 0.10$	Significant
$\rho \leq 0.15$	Somewhat Significant

Table 7-6. Results of a series of Median tests of significance on 27 unweighted performance scores.

Main Test	Median Chi-Squared Test[a]			
	df[b]	X^2	$X^2_{critical}$	**Reject H_0?**[c]
Case R1 Case R2 Case R3 Case N1 Case N2 Case N3	5	16.2793	9.2363 ($\rho \leq 0.10$)[d]	Yes
Post Hoc Tests[d]	**df**	X^2	$X^2_{critical}$	**Reject H_0?**
Case R1 Case R3 Case N1 Case N2 Case N3	4	1.9294	10.4637 ($\rho \leq 0.0333$)	No
Case N1 Case N3	1	1.5104	4.5303 ($\rho \leq 0.0333$)	No
Case R2 Case N3	1	5.7778	4.5303 ($\rho \leq 0.0333$)	Yes

a. Median test methodology is described by Huck, 2000:656.
b. df = degrees of freedom.
c. The null hypothesis, H_0, used for this test is: *The sample population medians are equal.*
d. To maintain an overall level of significance of $\rho \leq 0.10$, the Bonferroni Adjustment was applied to the three post hoc tests, resulting in a level of significance of $\rho \leq 0.0333$ per test (Huck, 2000).

equal. This hypothesis was rejected at the $\rho \leq 0.10$ level. This result indicated a "significant" difference (in a statistical sense) between at least two of the six cases. To determine which of the six cases were statistically different, three additional Median tests (called "post hoc tests") were performed.

To maintain an overall level of significance of $\rho \leq 0.10$ for the main test, a Bonferroni adjustment was applied to each of the three post hoc tests using the method described by Huck (2000). Using the Bonferroni adjustment in this instance amounted to simply dividing the overall level of significance of the main test by three, because I performed three post hoc tests. Application of this adjustment resulted in a minimum level of significance of $\rho \leq 0.0333$ for each post hoc test. To utilize the additional information provided by the three post hoc tests in support of an overall level of significance at the $\rho \leq 0.10$ level, each post hoc test must show a statistical difference at the $\rho \leq 0.0333$ level. As more post hoc tests are performed, increasingly higher standards of significance must be applied to maintain the overall level of significance of the main test. The Bonferroni adjustment is an extremely conservative test[2].

The second rejection of the null hypothesis occurred for the post hoc test between Case R2 (the unqualified worst performer) and Case N3 (the lowest performer of the other 5 cases). The results of this series of Median tests suggest (at the $\rho \leq 0.10$ level of significance) that these six cases, when compared against each other, should be placed into two performance groups. Cases R1, R3, N1, N2, and N3 make up the group with higher performance, and Case R2 makes up the group with lower performance[3]. There is no statistically significant difference between the median scores for Cases R1, R3, N1, N2, and N3. In addition, because the median scores for Case R2 and N3 are statistically different, and because Case N3 scored the lowest among the top five cases, it follows that the median score for Case R2 also has a statistically significant difference from the median score for each of the other top five cases (Cases R1, R3, N1, N2, and N3).

Using Median tests to categorize the six cases based on statistical differences among the 27 performance scores is not the only way to interpret the case study results. Table 7-7 presents another way to categorize the performance of the six cases: by rank order of the SPI. The method for determining rank order is explained by Huck (2000) and Hinton (2001). Because there are no ties in the SPI, the rank order follows the numerical order of the SPI. Since the SPI is an ordinal value, the distances between the ranks are not necessarily uniform. The rank order implies that there is a difference between the first-ranked case and the fifth-ranked cases, when, in fact, the results of the Median test showed no statistical difference between these cases. Simply considering the cases by rank order is a less compelling approach than the Median test.

A third way to categorize the six cases is to divide the range of the SPI index into thirds, and to simply group the cases according to which third corresponds to the SPI (top third, middle third, or bottom third) . Under this approach, Cases R3 and N1 are in the top third group, Cases R1, N2, and N3 are in the middle third group, and Case R2 is in the bottom third group, as shown in Table 7-8.

Table 7-7. Rank ordering the six cases based on the sewer performance index (SPI).

Rank Order	Project Performance
1st	Case R3 (SPI = 71)
2nd	Case N1 (SPI = 68)
3rd	Case R1 (SPI = 67)
4th	Case N2 (SPI = 66)
5th	Case N3 (SPI = 55)
6th	Case R2 (SPI = 12)

Although this approach may be more compelling than rank order alone, the main disadvantage is the arbitrariness of using thirds (as opposed to fourths, fifths, etc.) as the criteria for grouping cases. This is most apparent when considering Cases N1 and R1, which are in two different groups even though their SPIs are quite close (67 versus 68). However, an advantage of this approach is that the groupings do not change as more cases are added.

Table 7-8. Grouping the six cases into thirds based on the sewer performance index (SPI).

Groupings	Project Performance
Top Third	Case R3 (SPI=71) Case N1 (SPI=68)
Middle Third	Case R1 (SPI=67) Case N2 (SPI=66) Case N3 (SPI=55)
Bottom Third	Case R2 (SPI=12)

I considered the Median approach the most powerful of the three approaches, and the least arbitrary. For the remainder of this dissertation, the cases will be grouped according to the results of the Median test. Cases R1, R3, N1, N2, and N3 are in the "good" performance group, and Case R2 is in the "poor" performance group[4].

The resulting grouping of the six cases is not what I anticipated in my original research desing. I selected cases based on what agency staff considered "good" and "bad" cases in the two cities (refer to Table 3-9 in Chapter 3). The unexpected grouping results because the performance of the "bad" case in Natal (Case N3) is similar to the good cases in Recife (Cases R1 and R3).

7.2 Case Study Participation Results

Participation is defined in this dissertation as *the contributions and involvement of residents, households, and the community in a project.* Contributions can include the use of residents' time, money, and labor for project construction and maintenance. Involvement can include residents gathering together to learn about and drum up support for the project (i.e., mobilizing), and residents taking part in project decisions. The conceptual framework for this definition of participation is described in Appendix D.

7.2.1 Measuring Participation

A method for measuring participation in condominial sewer projects was developed and applied, and it is detailed in Appendix D. Four categories of participation were measured: participation in project mobilizing, participation in project decisions, participation in project construction, and participation in project maintenance. Project mobilizing included attendance at project meetings and the formation of user groups.

Project decisions included selecting the service level and selecting the piping layout. Project construction included building house connections and purchasing materials. Project maintenance included accepting responsibility for maintaining and fixing the system.

The degree of participation realized was expressed on an ordinal scale from 0 (indicating a low degree of participation) to 100 (indicating a high degree of participation) for each category of participation. Results from interviews and direct observations, and information from the case study descriptions comprised the data for measuring the degree of participation in each case study project. Participation data came from the following three sources:

1. Residents – the median response to questions asked in semi-structured interviews with residents from randomly selected households;
2. Participation staff – the median response to questions asked in semi-structured interviews with participation staff of the agency responsible for implementing project participation; and
3. Fieldwork – my direct observations of participation in maintenance, formal and informal interviews, and reviews of project documents and participation materials. These observations were made during 5 months of fieldwork in each city.

For each case study, scores for 31 participation measures were used to determine the four categories of participation. These measures are summarized in Table 7-9. The raw data (i.e., responses to interview questions, results of direct observations, and case study descriptions) are presented in Appendices B, E, and F.

An algorithm was developed to convert the data on each of the 31 measures into scores corresponding to each category of participation: mobilizing, decision making, construction, and maintenance. Each category of participation was represented as the median of the scores (equally weighted) of the participation measures making up the category; that is, a separate index was created for each category. For example, the index for participation in project decisions (the item called "Project Decisions" in Table 7-9) consisted of scores for responses to four measures: 1) residents' perceptions of their role in selecting piping layouts, 2) staff perceptions of the residents' role in selecting piping layouts, 3) staff perceptions of the resident's role in determining the service level, and 4) my perception of the level of resident input to service level.

To control for cases in which many of the original residents moved away (i.e., high resident turnover), scores for participation in mobilizing, decisions, and construction were normalized so that only those residents who lived in the project area during the corresponding phases of the project cycle were included. For example, if I interviewed 10 randomly-selected residents about their degree of participation in project construction, and if only 5 of the residents had lived in the area during the time of project construction,

Table 7-9. Selected questions sorted into groups that correspond to the four categories of participation[a].

Sources of Data	Project Mobilizing (15 questions)	Project Decisions (4 questions)	Project Construction (8 questions)	Project Maintenance (4 questions)
Interviews with Residents	1. Mobilization of Residents (Q3-2i) 2. Meetings among Residents (Q3-2a) 3. Meetings with Agency Staff (Q3-2b) 4. Discussions with Agency Staff (Q3-2c) 5. Sanitation Education Program for Residents (Q3-2d) 6. Health Program for Residents (Q3-2e) 7. Resident Questionnaires (Q3-2g)	1. Residents Selected Piping Layout (Q3-2h)	1. Residents Authorized Construction (Q3-2j) 2. Residents Constructed System (Q3-2f) 3. Residents Contributed Materials, etc. (Q3-4)	1. Residents Performed Maintenance (Q2-4)

Continued…

Table 7-9. Continued.

Sources of Data	Project Mobilizing (15 questions)	Project Decisions (4 questions)	Project Construction (8 questions)	Project Maintenance (4 questions)
Interviews with Participation Staff	8. Residents Were Mobilized (Q2a) 9. Residents Received Orientation (Q2b) 10. Residents Received Education Program (Q2c) 11. User Groups were Formed (Q2d) 12. Residents Attended Meetings (Q2e) 13. Residents Were Visited in Their Home (Q2f) 14. Residents Received Project Literature (Q2g)	2. Residents Decided the Layout of the System (Q2h) 3. Residents Decided to Accept the Service Level (Q2i)	4. Residents Constructed Condominial Sewers (Q2k) 5. Residents Purchased Materials (Q2l) 6. Houses were Connected to the Condominial Sewer (Q3g) 7. Residents were Responsible for Constructing House Connections (Q4c)	2. Residents Accepted Responsibility for Maintenance (Q2j) 3. Residents Performed Maintenance (Q3c)
Assigned by the Author	15. Level of User Authority in Project Mobilizing	4. Level of User Authority in Service Level Selection	8. Level of User Authority in House Connection Construction	4. Level of User Authority in Condominial Sewer Maintenance

a. The selected questions passed two screening criteria: a) content matching for all questions, and b) expected response ≥3 for resident questions. Other interview questions that did not pass these criteria were not used. See Appendix B for the results for each question. See Appendix D for a detailed description of the scoring methodology.

then I used 5 in that score's denominator rather than 10, since only 5 of the 10 residents were eligible to participate in project construction.

In one case study, Case R2, I had to face the problem of missing data. The participation staff I interviewed did not provide answers to the questions. Agency staff was sensitive about Case R2 because it was a failed project. For this reason, they did not respond to some questions related specifically to Case R2 during the formal semi-structured interviews. However, during informal interviews I was able to obtain information about Case R2 from agency staff and other practitioners who were involved in the project. This is the information that I used to write the detailed case study description for Case R2 (see Appendix E).

I considered several possible ways of dealing with the missing data, and they are summarized in Table 7-10. Because I had acquired detailed qualitative information, I decided the best way of dealing with the missing data was to answer the interview questions myself (option 9 in Table 7-10). This approach is recommended by Babbie (1992:177) in cases where other sources of information are available. I had three sources of participation data (as described above), so the missing questions that I answered represented one-third of each total participation score, thus limiting the potential impact of any error introduced by my answers to the interview questions. Also, the missing data were all comprised of nominal questions, so it was a rather simple task to assign a "yes" or "no" answer using other information to support the assigned score.

Table 7-10. Approaches for handling missing data.

Approaches	Disadvantages	Advantages
1. Exclude the missing data categories from the index for all cases.	This approach only works if the remaining data categories are still sufficient and if exclusion of missing data do not result in a biased sample.	
2. Exclude the missing data categories from the index only for the case(s) with missing data.	Not a practical approach in this case because doing this would introduce error.	
3. Treat the missing data as a "no" or "I don't know" response, and assign scores to the missing responses accordingly.	This approach only works if it is readily apparent what the missing answer would have been, based on the question format.	
4. Interpret the missing data for patterns of meaning, if possible, and assign scores to the missing responses accordingly.	This approach only works if there is a sound basis for the interpretation, otherwise new error is introduced.	
5. Assign the middle value of the range of possible scores (for ordinal, nominal, or category data).		A conservative approach that (theoretically) does not affect the relationship between variables.
6. Assign the mean value of the range of possible scores (for interval, ratio, or continuous data).	Not a practical approach because the missing data are nominal.	
7. Assign values at random.	Not a defendable approach in this case.	
8. Assign scores based on the proportion of the total score actually achieved from the available data.	Not a practical approach in this case, because the other available data are from residents (not participation staff), and unanimity of response is not expected.	
9. Construct the index from data gathered with other methods.		A better, more defendable approach in this case, because qualitative data is available and the questions are easy to answer. Babbie (1992) recommends this as the safest, most conservative, and likely the best approach.

Source: Adapted from Babbie (1992:177).

7.2.2 Results of Participation

The distribution of the 31 participation measures for the six case studies is presented in Table 7-11. As indicated in Table 7-11, more than half of the 31 participation measures had scores in the middle third and top third ranges of the scale for Cases R1, R3, N1, N2, and N3. For Case R2, however, more than half of the 31 scores were in the bottom third of the scale.

Table 7-11. Distribution of scores for 31 participation measures for the six case study projects.

Case	Number of Participation Measures that Scored in Each Range			Median of all 31 Scores
	Bottom Third	Middle Third	Top Third	
R1	11	5	15	50
R2	22	0	9	3.4
R3	15	4	12	50
N1	13	3	15	50
N2	13	3	15	50
N3	13	3	15	50

In Tables 7-12 and 7-13, the scores for participation in mobilizing, decisions, construction, and maintenance are presented for Recife and Natal, respectively. Natal used a relatively consistent participation program for its projects, while Recife did not. Consequently, there is more variation for participation in Recife than in Natal, as indicated by the scores in Tables 7-12 and 7-13.

Table 7-12. Scores for participation in the three case study projects in Recife. (100 = maximum participation).

Category of Participation	Participation Scores		
	Case R1	Case R2	Case R3
Mobilizing	60	2	71
Decisions	47	6	36
Construction	30	72	49
Maintenance	62	100	76

Source: My calculations use primary data from interviews with random samples of residents, interviews with agency staff, and project knowledge acquired by the author. Calculations follow the method presented in Appendix D. Raw data and descriptive statistics are presented in Appendix B.

Table 7-13. Scores for participation in the three case study projects in Natal. (100 = maximum participation).

Category of Participation	Participation Scores		
	Case N1	Case N2	Case N3
Mobilizing	42	44	43
Decisions	33	38	25
Construction	64	72	71
Maintenance	56	45	49

Source: My calculations use primary data from interviews with random samples of residents, interviews with agency staff, and project knowledge acquired by the author. Calculations follow the method presented in Appendix D. Raw data and descriptive statistics are presented in Appendix B.

To determine whether there was any significant difference between the scores for each category of participation, Median Chi-squared tests were performed. Tables 7-14 and 7-15 show the results of these Median tests, as well as the results of post hoc Median tests for the Recife cases. The results in Table 7-14 reveal that differences in the scores for participation in mobilizing in Recife were "extremely significant" (at the $\rho \leq 0.01$ level of significance). Differences in the scores for participation in decisions in Recife were "very significant" (at the $\rho \leq 0.05$ level of significance). These results indicate that Case R2 exhibited much lower levels of participation in mobilizing and decisions than the other two Recife cases (Cases R1 and R3). The scores for participation in construction and maintenance in Recife were basically constant across all three cases; that is, differences between the scores were too small to be statistically significant (at the $\rho=0.15$ level of significance). All three cases exhibited equivalent levels of participation in construction and maintenance.

Table 7-14. Results of Median tests of significance on the four categories of participation for the three case studies in Recife.

Main Test	Median Chi-Squared Tests for Recife[a]			
	df[b]	X^2	$X^2_{critical}$	Reject H_0?[c]
Mobilizing Case R1 Case R2 Case R3	2	15.0000	9.2104 ($\rho\leq0.01$)	Yes
Decisions Case R1 Case R2 Case R3	2	6.0000	5.9915 ($\rho\leq0.05$)	Yes
Construction Case R1 Case R2 Case R3	2	1.5000	3.7942 ($\rho=0.15$)	No
Maintenance Case R1 Case R2 Case R3	2	3.0000	3.7942 ($\rho=0.15$)	No
Post Hoc Test[d]	**df**	X^2	$X^2_{critical}$	**Reject H_0?**
Mobilizing Case R2 Case R3	1	9.6000	6.6349 ($\rho\leq0.01$)	Yes
Decisions Case R2 Case R3	1	4.8000	3.8415 ($\rho\leq0.05$)	Yes

a. Median test methodology is described by Huck, 2000:656.
b. df = degrees of freedom.
c. The null hypothesis, H_0, used for this test is: *The sample population medians are equal.*
d. To maintain overall levels of significance of $\rho\leq0.01$ and $\rho\leq0.05$, Bonferroni Adjustments at the $\rho\leq0.01$ and $\rho\leq0.05$ levels of significance were applied to the post hoc tests for mobilizing and decisions, respectively.

For all four categories of participation in Natal, the results in Table 7-15 show that differences between the scores were too small to be statistically significant (at the ρ=0.15 level of significance). All three cases exhibited equivalent levels of participation in mobilizing, decisions, construction, and maintenance. This is consistent with the fact that Natal implemented a relatively consistent participation program.

Table 7-15. Results of Median tests of significance on the four categories of participation for the three case studies in Natal.

Main Test	Median Chi-Squared Test for Natal[a]			
	df[b]	X^2	$X^2_{critical}$	Reject H_0?[c]
Mobilizing Case N1 Case N2 Case N3	2	0.0000	3.7942 (ρ=0.15)	No
Decisions Case N1 Case N2 Case N3	2	0.0000	3.7942 (ρ=0.15)	No
Construction Case N1 Case N2 Case N3	2	0.3750	3.7942 (ρ=0.15)	No
Maintenance Case N1 Case N2 Case N3	2	0.7500	3.7942 (ρ=0.15)	No

a. Median test methodology is described by Huck, 2000:656.
b. df = degrees of freedom.
c. The null hypothesis, H_0, used for this test is: *The sample population medians are equal.*

7.3 Analysis of Participation and Performance

In the following sections, I analyze the possible association of participation with the performance results represented by the sewer performance index.

7.3.1 Participation in Mobilizing and Performance

Figure 7-1 presents a scatter plot of participation in mobilizing and the sewer performance index for the three case studies in Natal. As revealed by previous statistical tests (see Table 7-6), there is no statistically significant difference in the SPIs for the projects in Natal: all three of these cases represent good performance. Despite my attempt to identify case study projects that represented the best and worst in terms of performance (and participation) in each city, the project performance scores for the three case studies in Natal are nearly constant and probably should be considered to be a single point. Likewise, previous statistical tests showed no significant variation in participation in mobilizing (see table 7-15), and since performance is also constant, there is not enough variation in the Natal cases to discern any potential association between participation and performance. Because the same reasoning about the constancy of performance and participation scores for the Natal cases will apply to other aspects of participation (i.e., decisions, construction, and maintenance), scatter plots for the Natal cases would provide no information about probable correlations, and they are not presented in the following sections.

Real variation in participation and performance is apparent in the Recife case studies, which do represent Recife's best and worst projects in terms of participation and performance. The scatter plot for Recife in Figure 7-2 suggests a positive association between participation in mobilizing and performance.

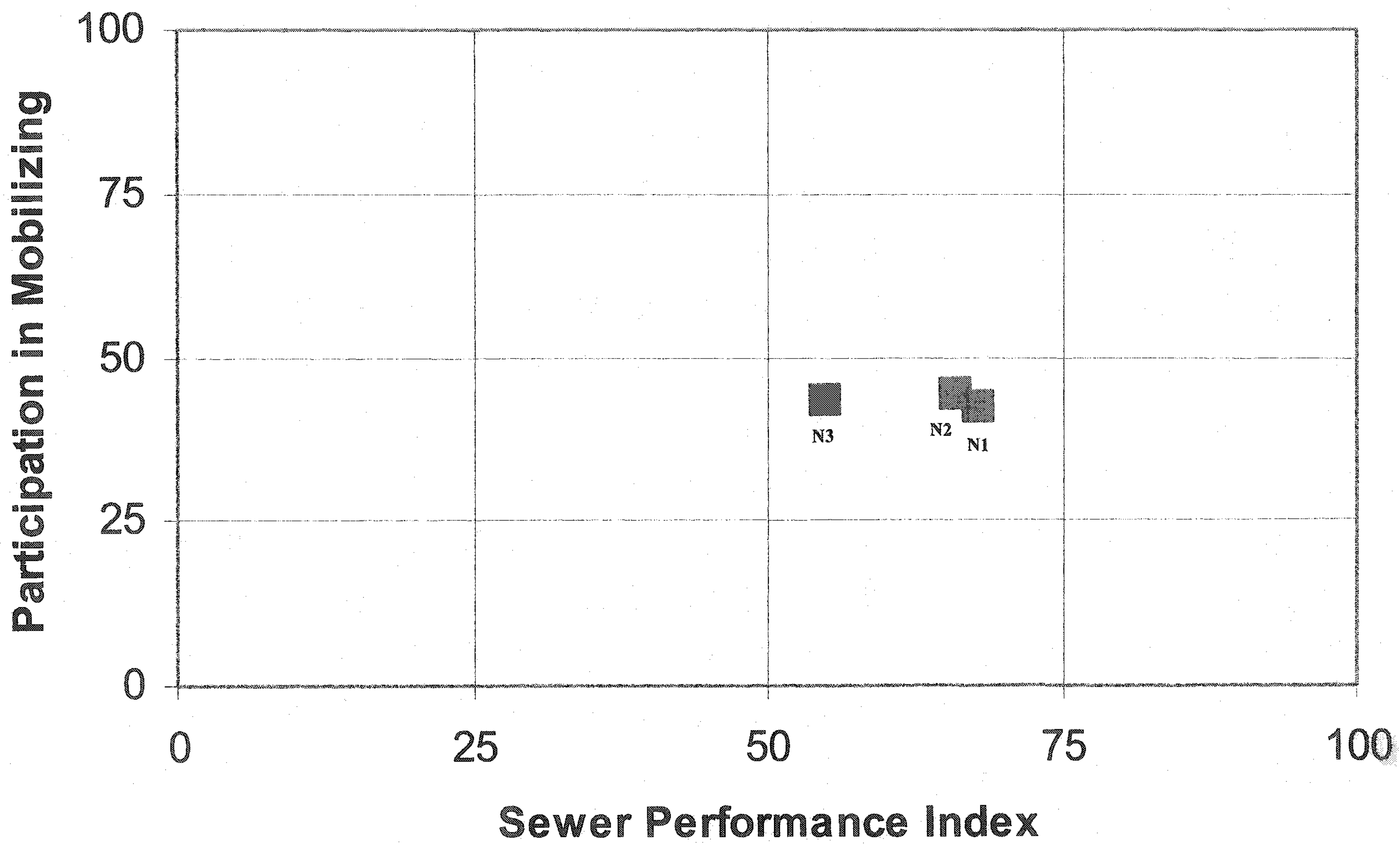


Figure 7-1. Scatter plot of participation in mobilizing and the sewer performance index for the three case studies in Natal.

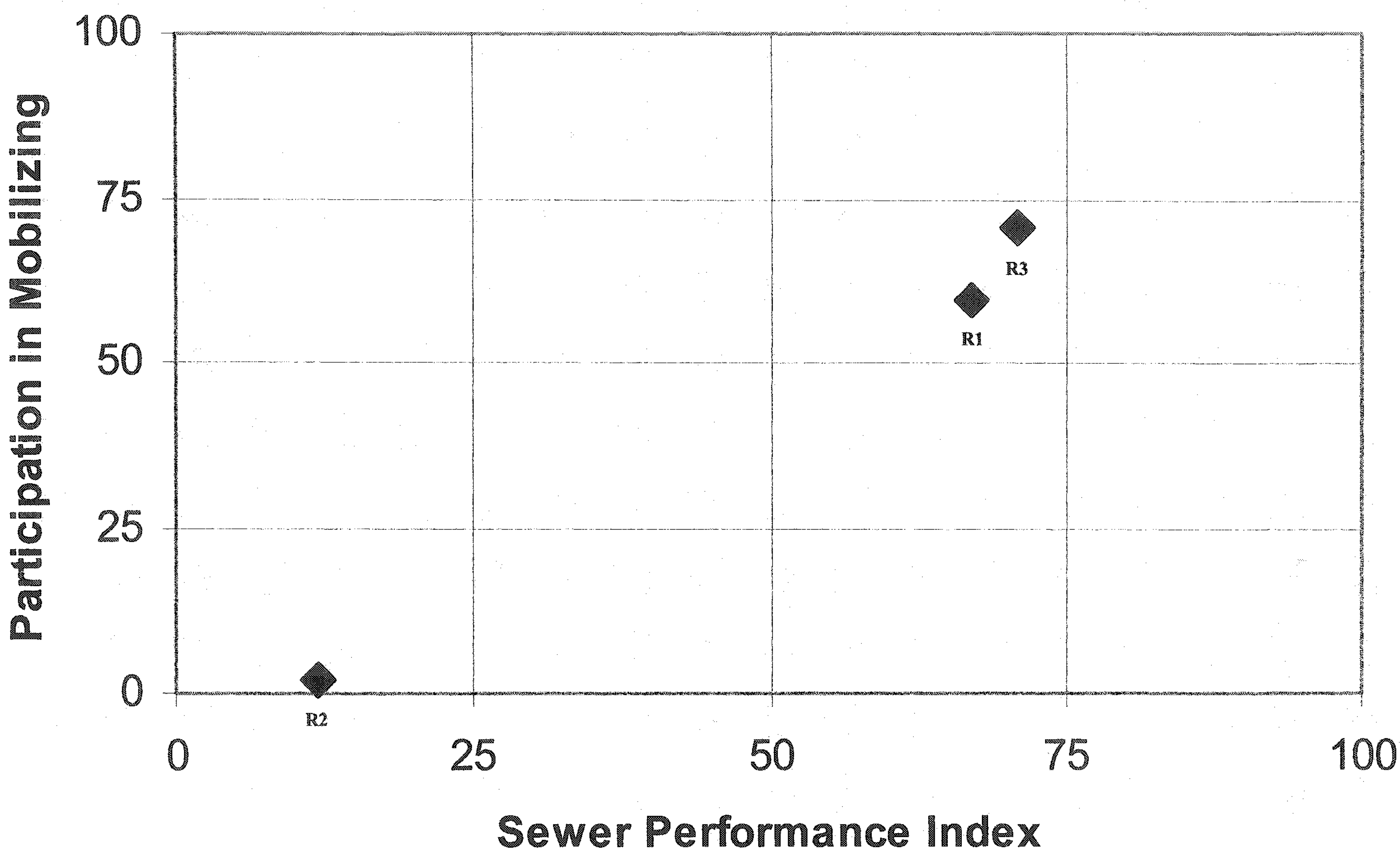


Figure 7-2. Scatter plot of participation in mobilizing and the sewer performance index for the three case studies in Recife.

7.3.2 Participation in Decisions and Performance

Figure 7-3 presents a scatter plot of participation in decisions and the sewer performance index for the three case studies in Recife. The scatter plot for the case study projects in Recife suggests a positive association between participation in decisions and performance.

7.3.3 Participation in Construction and Performance

Figure 7-4 presents a scatter plot of participation in construction and the sewer performance index for the three case studies in Recife. The scatter plot for the case study projects in Recife suggests there is *not* a positive association between participation in construction and performance.

7.3.4 Participation in Maintenance and Performance

Figure 7-5 presents a scatter plot of participation in maintenance and the sewer performance index for the three case studies in Recife. The scatter plot for the case study projects in Recife suggest there is *not* a positive association between participation in construction and performance.

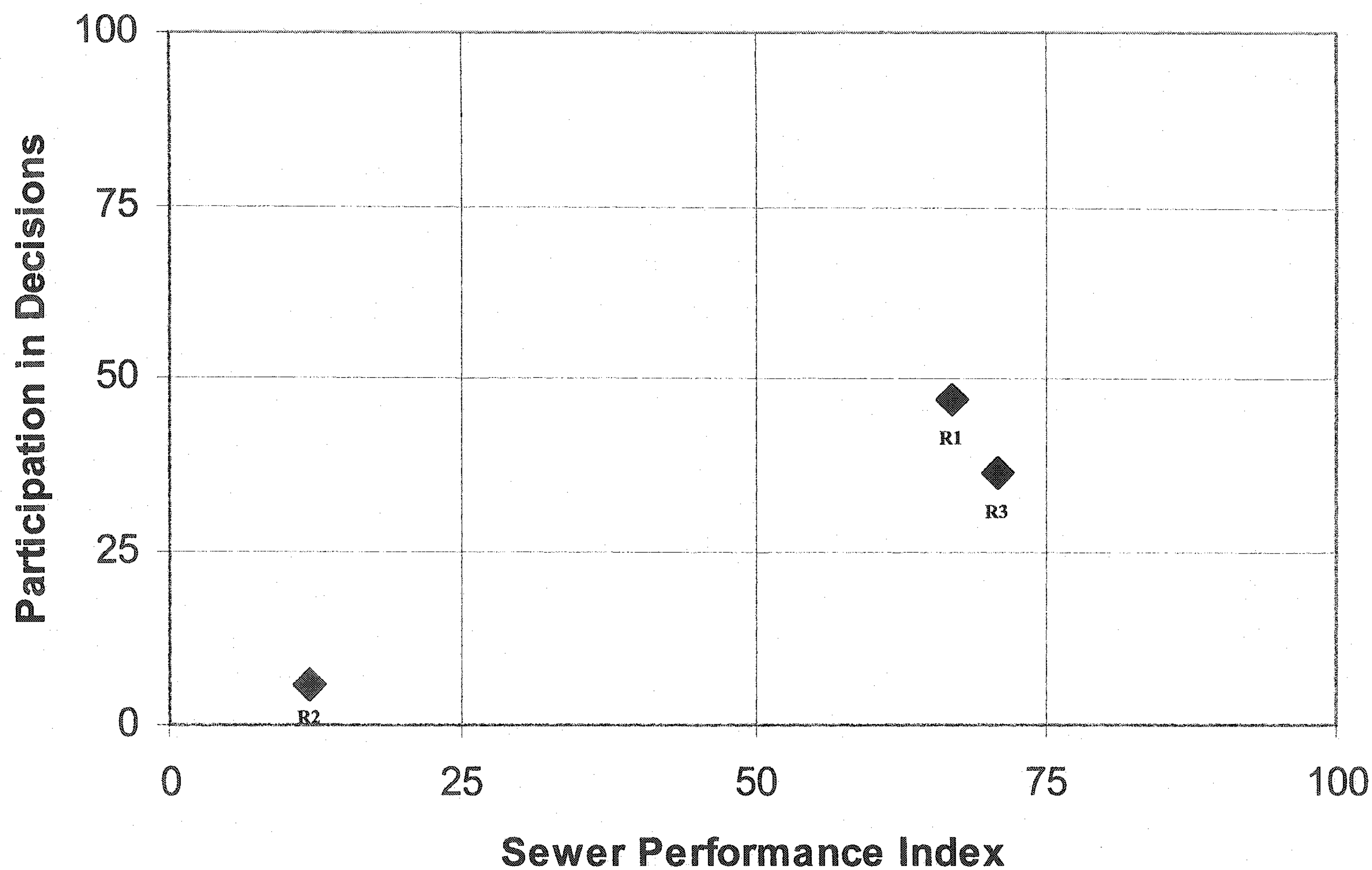


Figure 7-3. Scatter plot of participation in decisions and the sewer performance index for the three case studies in Recife.

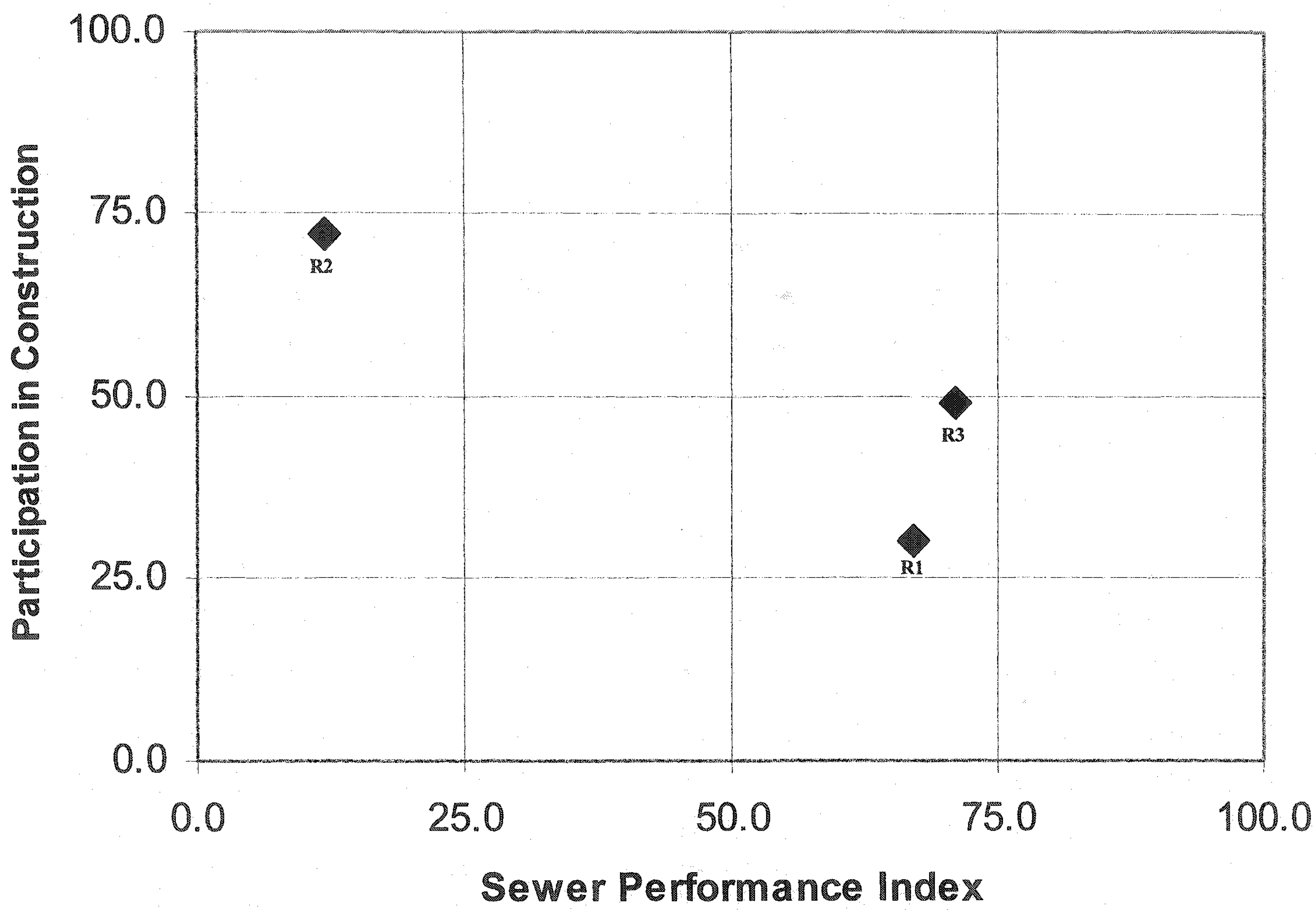


Figure 7-4. Scatter plot of participation in construction and the sewer performance index for the three case studies in Recife.

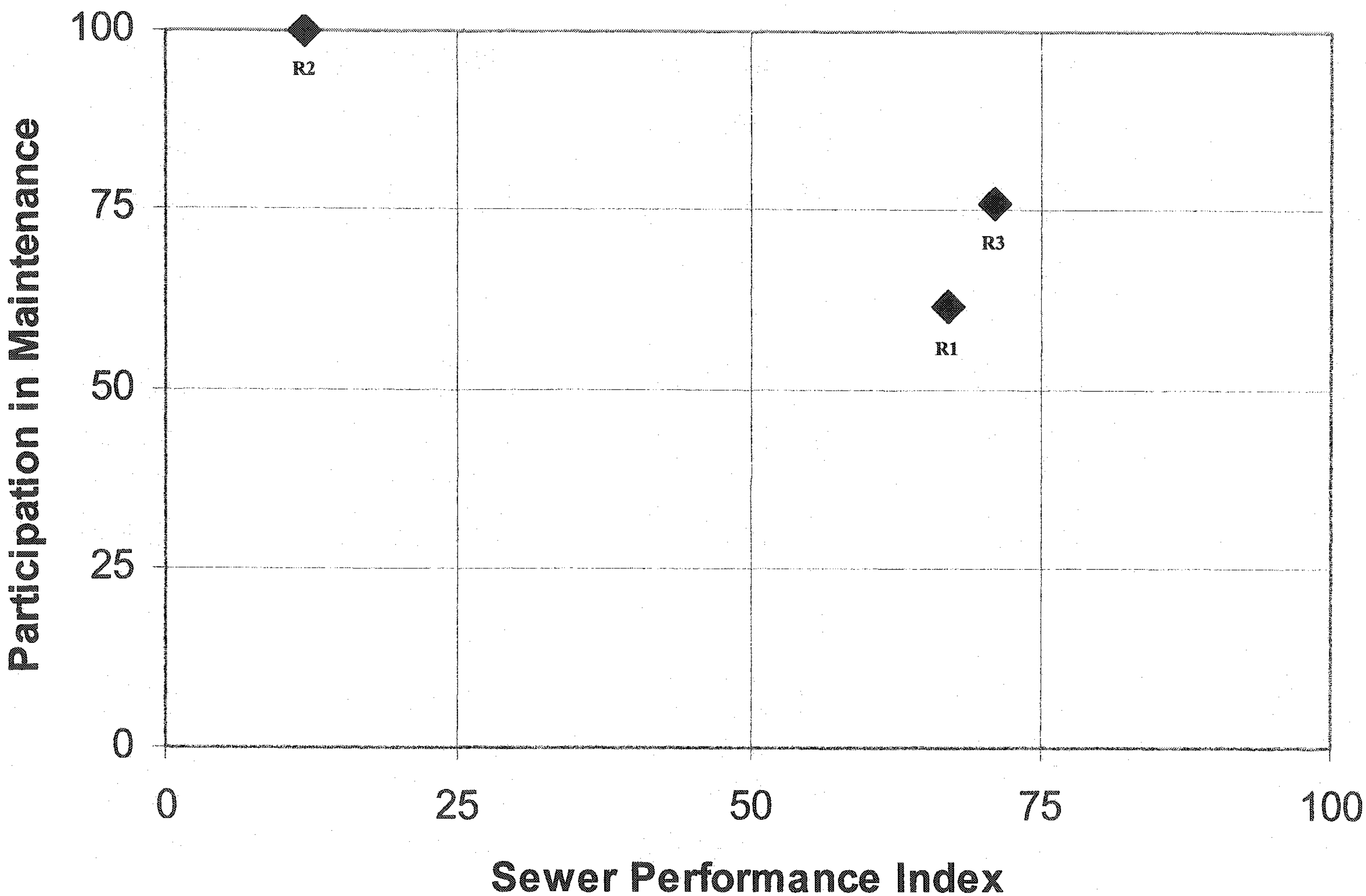


Figure 7-5. Scatter plot of participation in maintenance and the sewer performance index for the three case studies in Recife.

7.3.5 Discussion

Participation in mobilizing and in decisions were shown to be positively associated with performance for the three Recife case studies. This positive association is in agreement with most of the case study evidence on participation in rural water supply and other infrastructure projects[5], and is in agreement with anecdotal statements made by condominial sewer practitioners in Recife and Natal[6]. Although condominial sewer practitioners in Natal made similar anecdotal statements, the case study results for Natal do not vary enough to support or reject the possibility of an association between participation and performance. The Recife case study results support the hypothesis that participation is positively correlated with project performance only if participation is conceived as participation in *mobilizing and decisions*, and not participation in *construction and maintenance*.

Based on the participation literature[7], I expected to find a correlation between all categories of participation and project performance. What I found was an association between performance and participation in mobilizing and decisions, but no association between performance and participation in construction and maintenance. These findings add a new dimension to the participation hypothesis. The discussion below suggests why the associations that I found may exist for urban condominial sewer projects in Brazil.

Why Participation in Mobilizing Mattered. The mobilization of residents provides two benefits that could improve project performance. The first benefit of mobilization is the increased potential for *consolidating demand.* Whether residents mobilize themselves or are mobilized by an outside actor, the unification of interest around a project is beneficial for project outcome. The mobilization of demand can result in a higher number of sewer connections, which contributes to better performance as measured by the sewer performance index.

The second benefit of mobilization is the increased potential for *transferring knowledge*. When a majority of residents express interest in a project, the implementing agency can educate more residents about the health impacts of uncollected sewage, on the proper use of the sewer system, and on suitable techniques for maintaining their sewer system. Moreover, when a critical mass of residents has adequate knowledge about the health impacts of sewage and the proper use of the sewer system, a "sewer culture" can begin to develop, in which most residents expect higher levels health, hygiene, and sewer system performance in their neighborhood. The spread of sanitation-related knowledge throughout a community can lead to better care and use of the sewer by users, less system damage caused by users, and a better sewer condition, all of which contribute to better performance as measured by the sewer performance index.

Evidence supporting this explanation is provided by the data in Figures 7-6 and 7-7. In these Figures, I have disaggregated the performance data to illuminate the nature of the proposed association between participation in mobilizing and performance. Figure 7-6 shows the scores for one of the 27 performance measures that make up the sewer performance index: sewer connections. High scores for this measure indicate many connections, and low scores indicate few connections. Figure 7-6 shows that the Cases with good performance (i.e., Cases R1 and R3) scored higher on connections *and* higher on participation in mobilizing. The Case with bad performance (i.e., Case R2) scored lower on connections *and* lower on participation in mobilizing.

Figure 7-7 shows the median scores for four of the 27 performance measures related to the sewer condition: 1) sealed street manholes, 2) intact household cleanout box covers, 3) intact household sewer pipes, and 4) buried household sewer pipes. High scores for these measures indicate good sewer condition, and low scores indicate poor sewer condition. Figure 7-7 shows that the Cases with good performance (i.e., Cases R1 and R3) scored higher on the sewer condition measure *and* higher on participation in mobilizing. The Case with bad performance (i.e., Case R2) scored lower on sewer condition *and* lower on participation in mobilizing.

The relationships shown in Figures 7-6 and 7-7 support my proposed explanation for why participation in mobilizing is associated with performance, but descriptive information from the case study experiences is needed to fully illustrate the proposed relationship. In the two successful Recife cases (Cases R1 and R3), neighborhood leaders organized the residents prior to the existence of a project. Case R1 residents had a strong demand for paved streets, and they organized around the idea of getting a pavement project from the

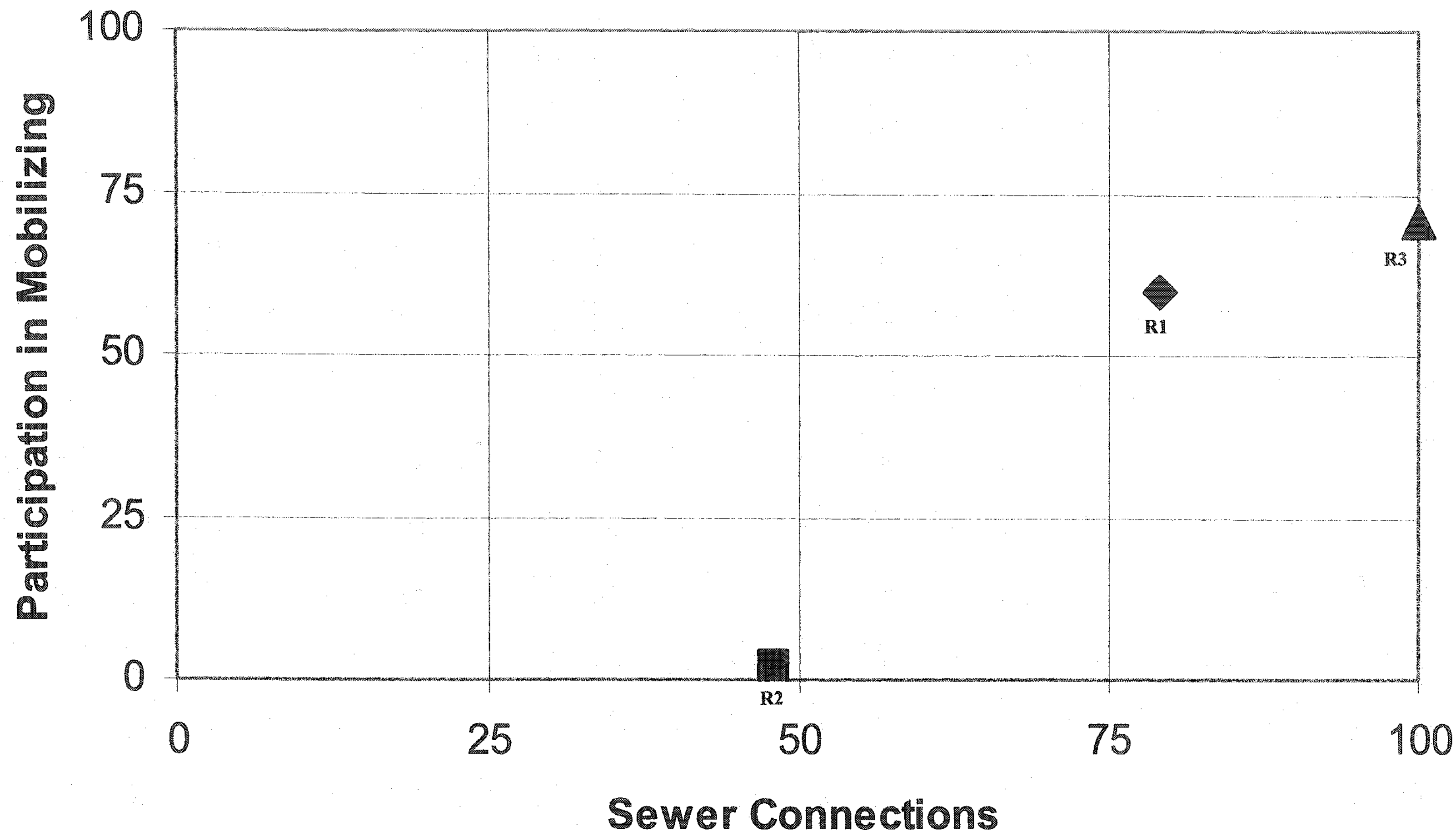


Figure 7-6. Scatter plot of participation in mobilizing and the number of sewer connections for the three case studies in Recife.

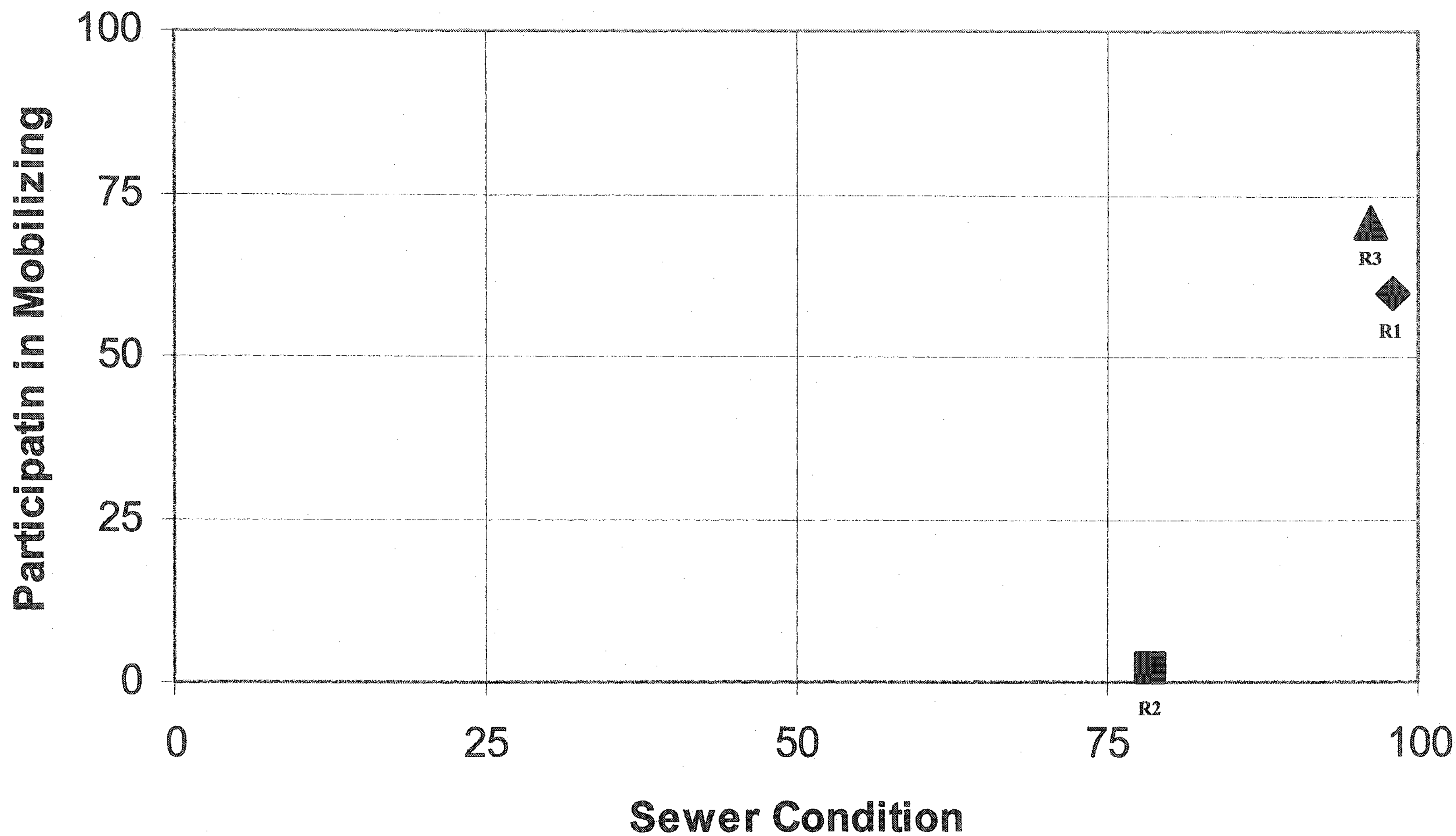


Figure 7-7. Scatter plot of participation in mobilizing and sewer condition for the three case studies in Recife.

City. The City, which at that time was promoting condominial sewers under the leadership of its pro-condominial mayor (Mayor Jarbas Vasconcelos), responded with a project that combined pavement with a condominial sewer. By combining the two, the condominial sewer project was linked to the residents' well-mobilized demand for pavement. This high demand resulted in a high level of attendance at project meetings, high levels of involvement in the sanitation education program, and notable interest in discussing the project with agency staff, which resulted in a high overall score for participation in mobilizing (60 out of 100). In this case, residents took action to mobilize their inherent demand by forming a community-based organization for the project, and a majority of residents connected to the Case R1 condominial sewer (79 out of 100).

In Case R3, residents had a strong demand for housing and urban services. Prior to the existence of a project, these residents organized themselves around the idea of getting land tenure and housing from the State. A state agency (i.e., COHAB), under the leadership of a populist and pro-condominial governor (i.e., Miguel Arraes), responded with a favela urbanization project, which included residential lots, housing materials, and a full complement of urban services (including condominial sewers). This multi-objective project met the demands of the residents quite well.

The neighborhood formed a leadership committee to represent the residents' collective demands during project implementation. As the project was implemented, the neighborhood experienced high rates of turnover, in which original residents sold their lots to newcomers. This turnover weeded out individual residents with lower demand for the project and, through self-selection, brought in new residents who had a higher demand for the project. Interest in the project among residents continued to increase, as indicated by a high level of attendance at project meetings, notable involvement in the sanitation education program, and a relatively high overall score for participation in mobilizing (71 out of 100). The ultimate rate of connection to the condominial sewer in Case R3 was also relatively high (100 out of 100).

During project implementation, COHAB held project meetings and showed educational videos to residents. But as the project was finished in one area after another, the sewer system experienced numerous blockages. COHAB personnel believed some residents did not know how to use the system, so the agency enhanced the educational component of its participation program. Social workers from COHAB were brought in to educate the residents on the use of the sewer system. This education was done through house-to-house visits and distribution of pamphlets.

To summarize Case R3, residents took action to mobilize their demand for housing and urban services by forming a community-based organization for the project. Demand was further enhanced in this case by the unexpected high rate of resident turnover and the resulting influx of residents interested in the project. Sewer system knowledge was also enhanced throughout the Case R3 neighborhood as a result of agency actions to educate the residents as part of the participation program.

In the three Natal cases (Cases N1, N2, and N3), the implementing agency organized residents as part of a participation program that was implemented prior to and during the installation of each project. In all three cases, residents had not organized spontaneously around the idea of a condominial sewer project. Rather, the implementing agency (i.e., CAERN) approached the residents and proposed the project. CAERN took action to stimulate demand in each case study area by holding general project meetings, holding block-by-block project meetings, visiting residents house-by-house, and distributing project literature. Their objective was to mobilize residents around the project so that the highest possible connection rate would be achieved. In these cases, the implementing agency recognized the importance of the mobilization of demand, even when demand for sewers did not naturally emerge from the residents. As expected, the three Natal cases all had very similar scores for participation in mobilizing and sewer connections, as shown in Figure 7-8. These cases reflect the results of CAERN's standard implementation approach repeated in three different communities; thus, there is no significant variation in the scores. Because of this lack of variation, further graphs of the Natal cases will not be presented.

The impacts of a complete lack of mobilizing, which was the case for Case R2, will be discussed in a later section of this chapter.

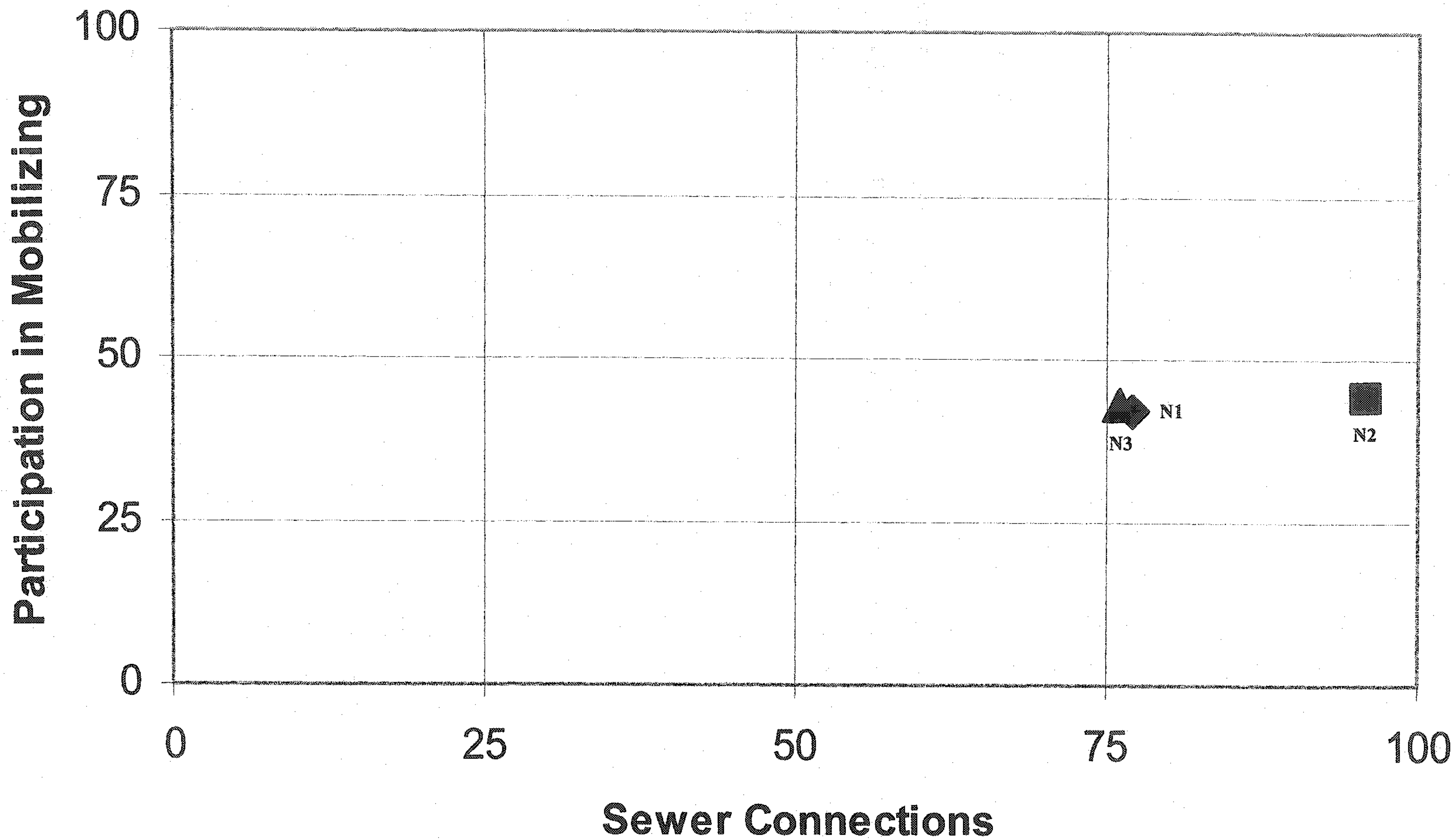


Figure 7-8. Scatter plot of participation in mobilizing and the number of sewer connections for the three case studies in Natal.

Why Participation in Decisions Mattered. The participation of residents in project decisions provides two benefits that could improve project performance. The first benefit of participation in decisions is the increased potential for *producing satisfied beneficiaries*. Allowing residents to "buy into" the decision about what level of service they receive enhances acceptance and a sense of ownership of the project by residents. Participation in project decisions can result in a higher degree of satisfaction among residents, which contributes to better performance as measured by the sewer performance index.

The second benefit of participation in decisions is the increased potential for *selecting appropriate layouts*. Allowing residents a say in how the piping is laid out on their property increases the likelihood that suitable and convenient locations will be chosen for the sewer pipes and cleanout boxes on private property. When a majority of residents are aware of the layout of underground piping on their property, and when they helped determine where the piping and cleanout boxes were to be located, then more residents can avoid damaging their house connections and onsite condominial sewer connections (e.g., by not building structures over the top of the sewer system when they expand their home). The widespread selection of suitable and convenient locations for piping and cleanout boxes on private property can lead to better care and use of house connections and condominial sewer connections by users, less system damage caused by users, and better house connection operability, all of which contribute to better performance as measured by the sewer performance index.

Evidence supporting this explanation is provided by the data in Figures 7-9 and 7-10. In these Figures, I have disaggregated the performance data to illuminate the nature of the proposed association between participation in decisions and performance. Figure 7-9 shows the median scores for two of the 27 performance measures that make up the sewer performance index: 1) satisfaction with the project just after construction, and 2) satisfaction with the project after several years of operation (i.e., in 1995) . High scores for this measure indicate high levels of satisfaction among residents, and low scores indicate low levels of satisfaction.

Figure 7-9 shows that the Cases with good performance (i.e., Cases R1 and R3) scored higher on satisfaction *and* higher on participation in decisions. The Case with bad performance (i.e., Case R2) scored lower on satisfaction *and* lower in participation in decisions.

Figure 7-10 shows the score for another one of the 27 performance measures that make up the sewer performance index: house connection operability. High scores for this measure indicate good operability and low scores indicate poor operability. Figure 7-10 shows that the two Cases with good performance (i.e., Cases R1 and R3) scored higher on operability *and* higher on participation in decisions. The Case with bad performance (i.e., Case R2) scored lower on operability *and* lower on participation in decisions.

Case R3 illustrates how participation in even just a few key decisions can lead to better performance. Although Case R3 residents did not choose the service level, residents still

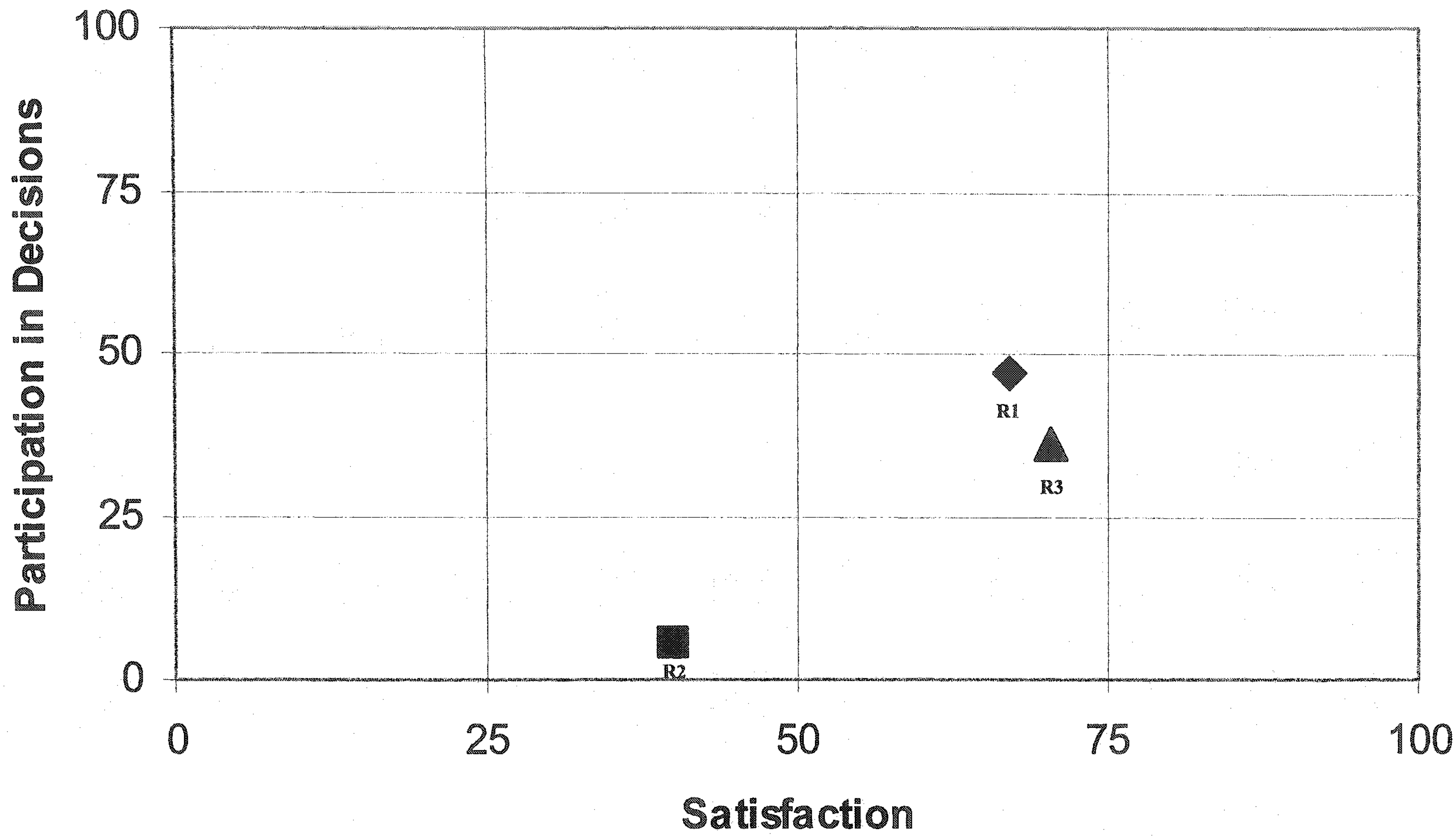


Figure 7-9. Scatter plot of participation in decisions and beneficiary satisfaction for the three case studies in Recife.

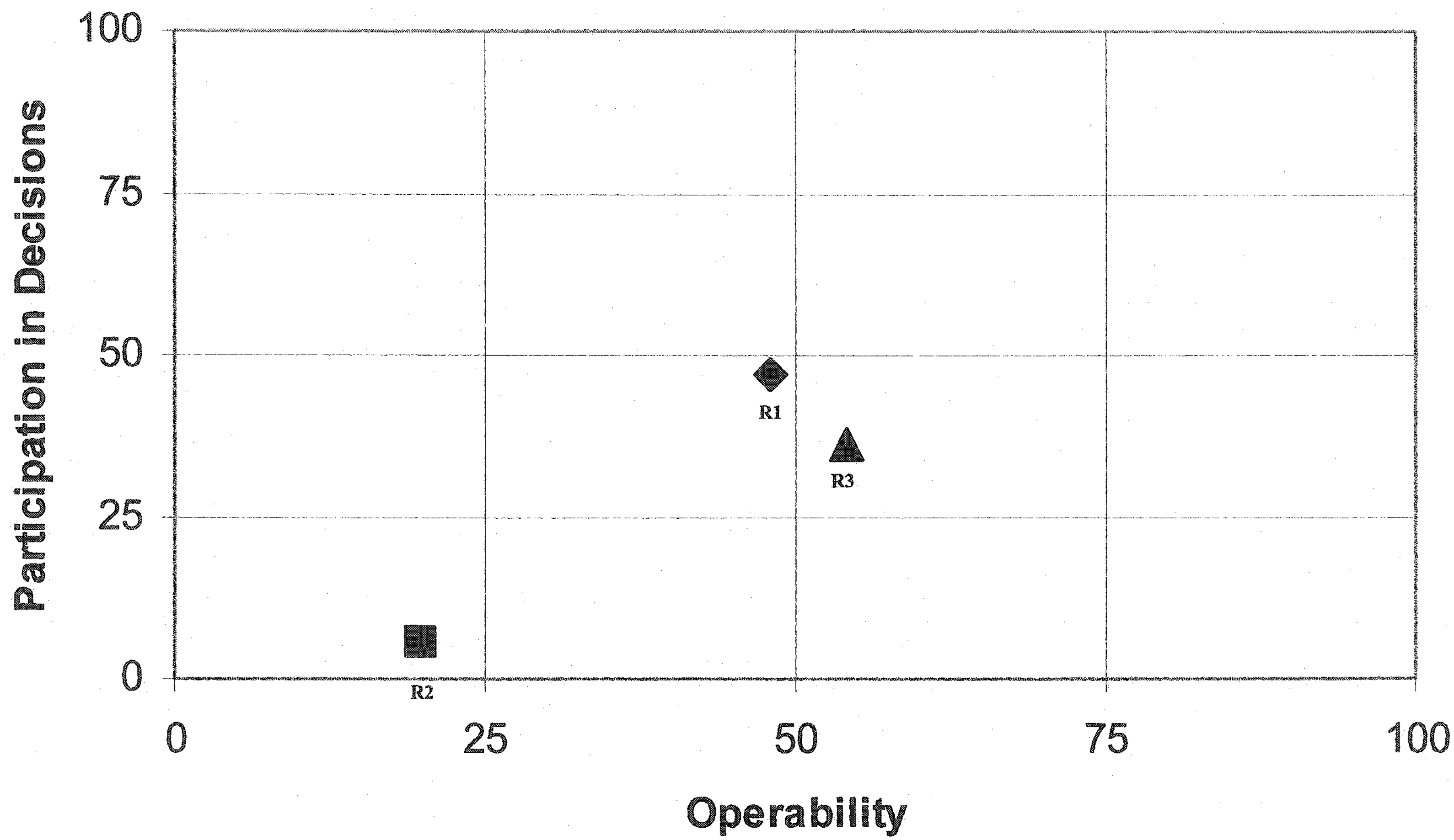


Figure 7-10. Scatter plot of participation in decisions and house connection operability for the three case studies in Recife.

had complete decision authority over their lot. All residents had to design and build their houses. They also decided whether they wanted an indoor bathroom, and which fixtures would be connected to the sewer system. The implementing agency supported residents by providing construction materials, loans, and technical support for residents to construct their homes, bathrooms, and house connections. Because of variations in topography, some lots were interconnected with backyard condominial sewers and some had sidewalk condominial or individual connections to the street sewer. COHAB selected the layout of the public sewers and, in some cases, the location of the cleanout boxes on individual lots.

In cases where the cleanout boxes were not already located and built by COHAB, residents and COHAB field crews worked together to lay out and construct the onsite portion of the sewer system, depending on the interest and skill level of the resident. Consequently, some Case R3 residents were involved in onsite decisions about the piping layout and the location of their cleanout boxes. In addition, all Case R3 residents were involved in decisions about their home, bathroom, and house connections. The overall score for participation in decisions was moderate (36 out of 100), however Case R3 residents had a relatively high level of satisfaction with their condominial sewer (71 out of 100), and they reported moderate levels of house connection operability (54 out of 100).

As in Case R3, Case R1 residents did not choose the service level, per se, but they did make decisions regarding the location of cleanout boxes and house connection piping on their lots. They participated in only a few key decisions, as reflected in a moderate score for participation in decisions (47 out of 100), however, like Case R3, they reported a reasonable level of satisfaction (67 out of 100) and a moderate level of house connection operability (48 out of 100).

It is important to point out that the socio-economic levels of Case R1 and Case R3 households differed significantly. On average, Case R1 households had high incomes (i.e., over 10 minimum salaries per month), and Case R3 households had low incomes (i.e., 2-5 minimum salaries per month). This difference in income confounds the relationship between participation in decisions and residents' satisfaction with the project, as measured by the median score of two other aspects of the sewer performance index: 1) that residents perceived of improvements to local health and environment because of the condominial sewer, and 2) that residents found few disadvantages with their condominial sewer. Even though Figures 7-9 and 7-10 showed similar relationships between participation in decisions and *overall* satisfaction for Cases R1 and R3, Figure 7-11 illustrates that Case R1 residents were relatively less satisfied with the degree of neighborhood improvement offered by their project, compared to Case R3 residents. Case R1 residents reported few advantages and little neighborhood improvement resulting from their condominial sewer (32 out of 100), while Case R3 residents reported few disadvantages and significant improvements from their condominial sewer (84 out of 100). These relationships are even better illustrated by details from the case study experiences.

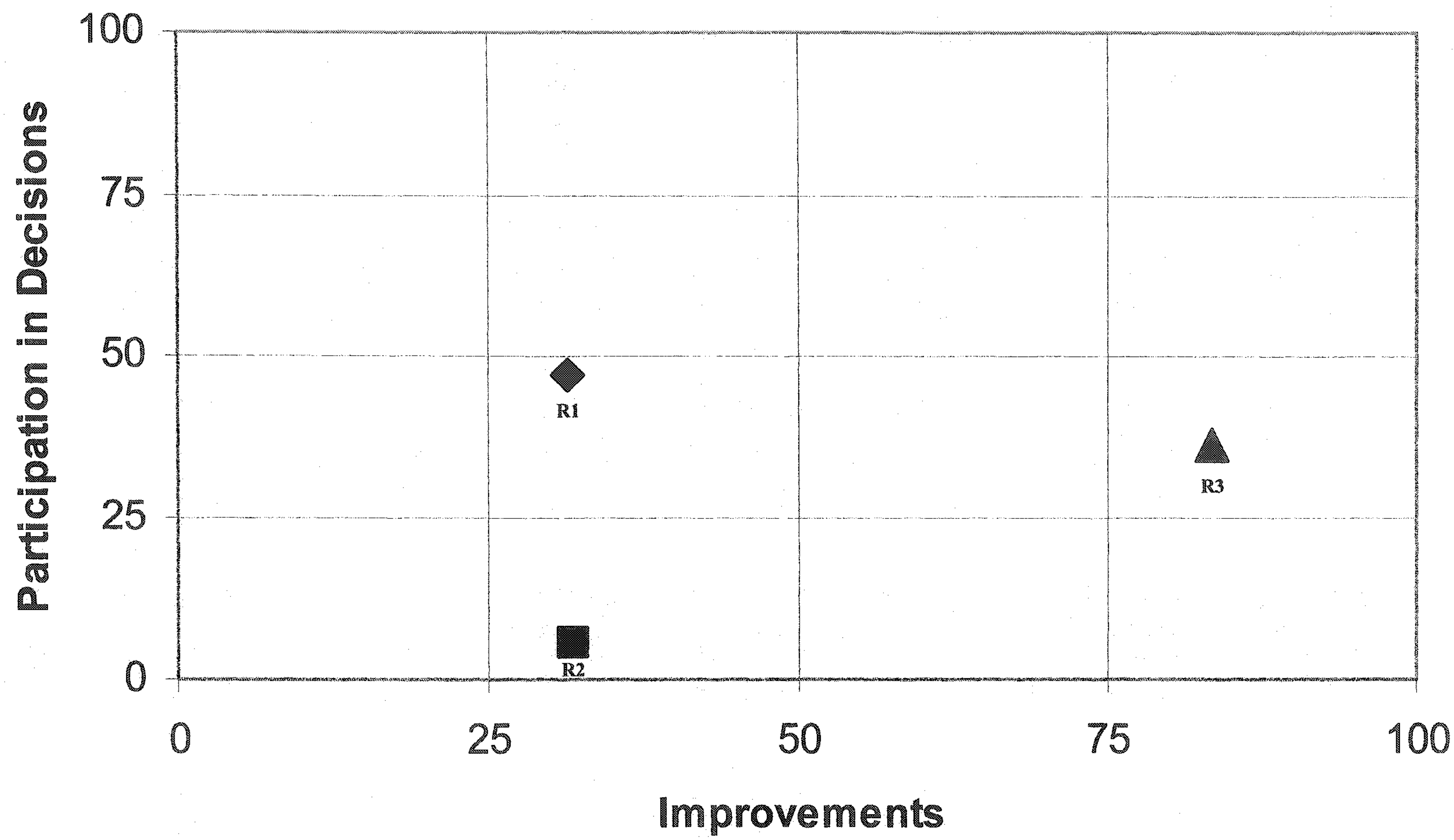


Figure 7-11. Scatter plot of participation in decisions and perceived improvements for the three case studies in Recife.

Residents of Case R3 had aspired to receive land tenure, homes, and official urban services, and the completion of the Case R3 condominial sewer significantly transformed their neighborhood. Conversely, Case R1 residents had aspired to receive pavement and sewerage improvements to their already urbanized neighborhood. While the Case R1 condominial sewer was an improvement over the onsite septic tanks that residents had previously relied, Case R1 residents were not as pleased as Case R3 residents with the overall level of neighborhood improvement provided by the condominial sewer. Neither the Case R1 residents nor the Case R3 residents were offered a choice of service level by their respective implementing agencies; residents were simply informed about the level of service that had been selected by the implementing agency.

For Case R3 residents, the level of service chosen by their implementing agency (i.e., COHAB) had generally matched residents' aspirations. In Case R1, however, residents had aspired to a higher level of service than that offered by their implementing agency (i.e., OBRAS). OBRAS proposed a backyard condominial sewer layout, but many Case R1 residents expressed a preference for either a sidewalk condominial layout or conventional sewer connections. Nevertheless, OBRAS did not offer residents a choice in the level of service, and the degree of resident participation in project decisions was limited. Notwithstanding that both Case R1 and Case R3 were among the best performing condominial sewer projects in Recife, the consequences of limited participation in decisions had a down side in Case R1 but not in Case R3, as indicated by Case R1's significantly lower scores for perceived improvements and advantages.

The consequences of a complete lack of participation in decisions, which was the situation in Case R2, will be discussed in a later section of this chapter.

Participation in Maintenance. Although participation in maintenance was not associated with performance for any of the case studies presented in this dissertation, the findings on participation in maintenance require further interpretation. Results for participation in project maintenance reveal that beneficiaries were doing more maintenance work than they were given credit for by agency staff. The levels of participation in maintenance ranged from moderate to very high (with scores ranging from 45 to 100) for the six case study projects. But, according to the agency staff I interviewed, none of the six cases achieved the stated objective for user maintenance, which was that most maintenance on the condominial part of the sewer system would be performed by users. Agency staff clearly had much higher expectations for how much maintenance should be performed by users. The levels of participation in maintenance achieved in these six case study projects did not meet the expectations of most agency staff I interviewed.

Maintenance by beneficiaries is a defining characteristic of the concept of condominial sewer technology. Participation in maintenance is intended to reduce system maintenance costs and allow implementing agencies to conserve their limited funds so that sewer service can be extended to more people. In practice, however, most beneficiaries seemed to prefer and expect maintenance service from the sewer authority, even if they signed an agreement and accepted responsibility for maintenance. In the worst functioning project (Case R2), beneficiaries had to do their own maintenance because either their complaints were neglected or they did not receive consistent service from the sewer agency. Their maintenance efforts were, however, ineffective. Case R2 achieved a score of 100 in this category of participation, but high levels of participation in maintenance did not improve system performance.

Based on my household interviews in Recife and Natal (1995), users' statements about why they did not perform more maintenance can be divided into four categories:

1. Users said that the sewer agency was responsible for maintenance because it was better equipped and more knowledgeable.
2. Users who paid a monthly fee for sewer service thought the fee should cover maintenance service by the agency that received the fee.
3. Users experienced difficulty in maintaining sewers and viewed it as an unpleasant task.
4. Users said the sewer agency was responsible for maintenance because the project was proposed, planned, and installed by the sewer agency as part of the citywide sewer system.

Many residents reported that the agency was solely responsible for the condominial sewer even after residents signed contracts stating otherwise. As of 1995 in Recife and Natal, residents were not organizing into block-by-block user groups (*condominios*) to maintain their collective sewer. They more commonly performed maintenance on an individual basis, and often ended up calling the sewer agency for maintenance assistance, even after attempting their own maintenance. The fact that residents signed a contract indicating that they would perform maintenance seemed to have no bearing on the behavior of some residents. One informant even concluded that "user maintenance is infeasible in an urban setting"[8].

Why Case R2 Failed. Case R2's condominial sewer performed miserably because much of the system was poorly designed and poorly installed by the implementing agency. After the problem areas were discovered, nothing was done to correct them; rather, the project was abandoned by the maintenance agency (although residents in Case R2 continued receiving bills for sewer service). No participation program was implemented by the implementing agencies, and the residents did not spontaneously mobilize demand for sewer service. The implementing agencies did not endeavor to involve residents in project decisions, and the residents did not express an interest in getting involved in project decisions. The implementing agencies did not support the residents in constructing their house connections. Most residents built house connections six months or more after the system was installed. The implementing agency abandoned and stopped maintaining the public parts of the sewer system (i.e., the pump station and neighborhood treatment plant); however, residents did continue to try to maintain the collective parts of the sewer system. In fact, Case R2 exhibited the highest levels of participation in construction and maintenance of any of the six case studies. Obviously, high levels of participation in construction and maintenance were not related to performance. The question that remains is, "Did Case R2 fail primarily because of a lack of participation in mobilizing and decisions?"

Certainly, the lack of participation in project mobilizing (2 out of 100) and project decisions (6 out of 100) is reflected in low scores for some components of the sewer performance index for the Case R2, especially for connections (48 out of 100), satisfaction (26 out of 100), and perceived improvements (32 out of 100). Actions and decisions taken by the implementing agencies – specifically project funding levels, major design changes, and field changes[9] – significantly affected the performance of Case R2, as indicated by low scores for other aspects of the sewer performance index, such as blockages (0 out of 100). Consequently, the poor performance of this case cannot be explained based solely by the lack of participation in mobilizing and decisions. The lack of participation in mobilizing and decisions Case R2 may have contributed to poor performance, but these were not the only important factors. Other important factors from the larger political-institutional context – factors that affected the actions and decisions of implementing agencies – will be considered in the next chapter.

Why Participation Does Not Explain Everything. The average levels of participation in mobilizing (average=44) and decisions (average=31) were somewhat lower than the average levels of participation in construction (average=60) and maintenance (average=64) for the six case study projects. Residents participated in construction and maintenance at relatively high levels, but these categories of participation were not associated with the degree of project performance achieved. In fact, the highest levels of participation in construction and maintenance were associated with the worst performing project (Case R2). Lower levels of participation in mobilizing and decisions, however, were unmistakably correlated with performance in Recife. My interpretation of these results is that higher levels of participation, broadly defined, may not be associated with better performance; rather, the type of participation may be more important than the level of participation. For my cases, moderate levels of participation in mobilizing and decisions were more closely associated with the degree of performance achieved than high levels of participation in construction and maintenance.

Even so, participation by residents in project mobilizing and in project decisions were not the only factors that affected condominial sewer performance. Residents also participated in the political process by exerting influence on elected officials and implementing agencies, because residents recognized that elected officials and implementing agencies could affect the success or failure of individual projects. In the next chapter, I explain how these other factors affected the performance of my six case study projects.

---

[1]See Appendix C for a description of the method for measuring project performance.
[2]Huck, 2000; and Babbie, 1992.
[3]Because the Bonferroni adjustment is so conservative, the results did not differentiate among Cases R1, R3, N1, N2, and N3, even though Case N3 had a higher proportion of lower scores. If the Bonferroni adjustment had not been applied, then the same series of Median tests would have shown a marginally significant difference (at the $\rho \leq 0.22$ level of significance) between Case N3 and the other four cases.
[4]Recall from Chapter 3 that polar cases were initially identified based on the judgments of agency staff in each city. Agency staff in Natal judged Case N3 to be among the worst performers in that city; however, its overall performance score was not statistically different (at the $\rho \leq 0.10$ level of significance) from performance scores for other cases that were judged among the best. To understand this, one needs to know that a small part of the Case N3 project area performed much worse than the majority of the project area. My resident data and direct observation data were from the entire project area, not only from the bad performing part. It is possible that agency staff who initially judged Case N3 to be among the worst

performing projects were only focusing on the poor performing part of the Case N3 project area. Evidence for this comes from the project plan for the Case N3 condominial sewer (CAERN, 1988). This plan focused heavily on the poorest area of the neighborhood, even though the project service area extended far beyond the poorest area. The poorest area is the same area that exhibited the worst performance.
[5]For example, see Finsterbusch, 1989; Narayan, 1994; Gelting, 1995; and Prokopy, 2003.
[6]See Chapter 1, Table 1-2 for a list of quotes.
[7]For example, see Schubeler, 1993; Gerson, 1993; Paul, 1987; Finsterbusch, 1987; Narayan, 1994; Korten, 1980; Korten and Alphonso, 1985; Bryant and White, 1982; and others.
[8]Informant 89, CAERN operations technician, interview by author, 23 May 1995, Natal, transcript.
[9]See Appendix E.

Chapter 8

Community Influence and Alignment of Interests as Factors Affecting Performance

In addition to participation, other important factors were associated with condominial sewer performance in Recife and Natal. In this chapter, I state why other explanatory factors are needed (Section 8.1); introduce "community influence" on elected officials and implementing agencies as an important factor (Section 8.2); introduce the "alignment of interests" among elected officials and implementing agencies as another important factor (Section 8.3); perform a qualitative analysis of the significance of these other factors on project performance (Section 8.4); and summarize the results of the chapter (Section 8.5). The results suggest that alignment of interests and community influence are correlated with the performance of condominial sewer projects in Natal and Recife.

8.1 Why Factors Unrelated to Participation are Relevant

Irrespective of the pattern of association between participation (in mobilizing and decisions) and performance suggested by the case studies in Recife, other factors also play a significant role in explaining variability in project performance. Indeed, based on the six case study experiences, the overall significance of participation to project performance seemed to pale in comparison to the significance of two other factors: the alignment of interests among politicians and implementing agencies, and the political influence of local residents.

The limitations of participation (in mobilizing and decisions) as an explanatory variable become apparent when project performance outcomes are viewed in a broader context. The measurement of performance by individual projects (presented in Appendix C) is one way of characterizing the variation in project outcomes. Another way to view this variation is by looking at citywide condominial sewer project experiences, both in terms of the temporal variation in the number of connections per capita and in terms of the overall range of performance. Looking at citywide performance also provides an opportunity to compare projects across the two cities.

Condominial sewer projects in Natal generally performed better than projects in Recife for the time period studied (i.e., 1980-1995). As of 1995, Recife had a problematic overall record of project performance. Fully half of the 43 condominial sewer projects implemented in Recife from 1980 to 1995 had less than 50 connections each. Many of Recife's condominial sewer projects were never concluded, a large percentage of projects barely functioned, and most projects were not designed with a suitable destination for the collected sewage[1]. There were some successful projects in Recife; however, agency staff I interviewed unanimously characterized Recife's overall performance as "fair" when choosing among the categories "bad", "fair", "good", "very good", and "excellent"[2].

In a 1993 World Bank-commissioned survey of condominial sewer experience, the overall record of condominial sewer performance in Recife was characterized as "bad," based on a 3-category scale of excellent/good/bad[3]. The World Bank study investigated and compared the condominial sewer experiences of seven Brazilian cities: Brasília, Recife, Natal, Cuiabá, Joinville, Petrolina, and Itapissuma. The sample of cities chosen for their investigation consisted of two-thirds of all known condominial sewer connections at that time – 52,550 out of 75,000 total connections. The seven cities included sample projects in 60 neighborhoods. However, the report used cities as the unit of analysis, so there was no evaluation of individual projects and the report provided no description of how its excellent/good/bad performance measures were derived. The report stated that some projects were operating well even in the badly performing cities of Recife and Cuiabá, and that all cities had some problems[4].

As of 1995, Natal had a good overall record of condominial sewer project performance, despite having a somewhat lower overall sewer access rate than Recife (19% in Natal compared to 24% in Recife)[5]. The majority of Natal's condominial sewer projects were either completed or in the process of being completed. Most projects functioned adequately, and most projects had a suitable destination for the collected sewage[6]. Agency staff I interviewed characterized Natal's overall performance as "good" when choosing among the categories "bad", "fair", "good", "very good", and "excellent"[7]. This characterization is supported by the World Bank's 1993 condominial sewer survey, in which Natal's overall project performance is characterized as "good"[8]. The six cases offer some evidence that supports this characterization.

Cases N1 and N2 were judged by CAERN staff to be among the best performing projects in Natal, and Case N3 was judged to be among the worst (see Chapter 3 for more details). But as measured by the sewer performance index (SPI), I found no statistically significant difference between these three projects. The range in SPI results between the perceived best and worst projects was only 13 points. Conversely for Recife, I did find a statistically "significant" difference (at the $\rho \leq 0.10$ level) between the best and worst projects in the City. The difference in SPI results between the projects judged best by City and COMPESA staff (Cases R3 and R1) and the project judged worst (Case R2) was 59 and 55 points, respectively.

My results suggest, in general, that Natal's condominial sewer systems performed better than those in Recife, because projects perceived to be the worst in Natal received scores similar to the best projects in Recife. And my general results are consistent with general observations by agency staff and the 1993 World Bank study. However, Natal's participation scores (average=38) were often lower than Recife's participation scores (average=54). It is therefore not convincing to argue that participation was the reason Natal's projects performed better overall than Recife's projects. Furthermore, the lack of participation is not the only reason some of Recife's projects failed, despite the notable correlation between participation in mobilizing and decisions and performance that was found for Recife's best and worst case study projects (see Chapter 7).

The Brazilian context (described in Chapter 4), the implementing experiences in Recife and Natal (described in Chapters 5 and 6), and the case study descriptions (summarized in Chapters 5 and 6 and elaborated in Appendices E and F) suggest other factors that may provide a richer explanation of the variation in performance outcome at both the individual project level and the overall city level. The influence of residents in the communities being served by projects and the alignment of the interests of politicians and implementing agencies are two factors that seemed to be more important than participation alone in explaining the case study performance outcomes.

8.2 Community Influence

Based on my case study and city descriptions, the influence that communities in Recife and Natal had on project implementation can be characterized using four parameters:

1) Socio-economic status;

2) Population size;

3) Relationships; and

4) Degree of organization.

8.2.1 Socio-economic Status

Socio-economic Status. Agency staff in Recife and Natal each stated that the socio-economic level of the project area seemed to be associated with performance of condominial sewer systems[9]. Their perceptions match the tendency described in the international development literature: sanitation project success is harder to achieve in poorer areas (see Chapter 4)[10].

One specific reason that condominial sewer performance was expected to be worse in poor areas was that, compared to middle income and high income areas, poor areas typically had more houses per block and more people per house (i.e., higher density)[11]. And since typical condominial sewer designs called for a standard size pipe on every block, the sewer pipes on those blocks with higher housing and population densities had to accommodate a greater flow of wastewater. Agency staff reported a higher incidence of performance problems with these sewer pipes because the pipes typically lacked the capacity to handle the greater flows[12].

Table 8-1 presents average monthly household income (based on random household interviews) and my estimates of income levels for the six case study projects. Based on these data, my six cases represent five socio-economic categories: poor, low income, lower middle income, middle income, and high income. As discussed below, the expected relationship between socio-economic status and project performance is only partially supported by my six cases.

The communities served by Cases R1 and N1 are classified as middle income and high income, respectively. Both of these case study projects are good performers based

Table 8-1. Average monthly household income and estimated income levels for the six cases.

Case	**Average Monthly Household Income** $R (1995)	Minimum Salaries	Estimated Household Income Level[a]
Case R1	$778.00	7.78	middle income
Case R2	$333.80	3.34	low income
Case R3	$246.24	2.46	poor
Case N1	$1,007.92	10.08	high income
Case N2	$306.79	3.07	low income
Case N3	$516.71	5.17	lower middle income

Source: Project area residents, interviews by author, 1995, Recife and Natal, transcripts.

a. Definitions of income levels were provided in Section 3.2.3 of Chapter 3. "High" income represents more than 10 minimum salaries; "middle" income represents more than 5 and up to 10 minimum salaries; "lower middle" income represents more than 5 and up to 6 minimum salaries, "low" income represents more than 3 and up to 5 minimum salaries, and "poor" represents more than 1 and up to 3 minimum salaries per month per household.

on the sewer performance index. Case N3, another relatively good performer based on its sewer performance index, is classified as lower middle income. These results are what I would expect; that is, that projects with good performance are in middle income and high income communities. Case R2 is classified as low income and is a bad performer, which I would also expect. The results for Cases R1, N1, N3, and R2 all support the view that socio-economic status is positively associated with project performance.

Cases R3 and N2 are classified as poor and low income, respectively, based on their estimated average monthly household incomes. Yet, these two case study projects are good performers based on their sewer performance index. Cases R3 and N2 are examples of successful implementation in spite of the poor and low income status of the residents. Therefore, poor or low income status, by itself, does not always imply that performance will be bad in each and every project, even though the overall tendency (i.e., poor performance in poor and low income areas) still exists. Exceptions to the rule, such as Cases R3 and N2, hold the most promise for learning about what works in low income areas.

Two cases stand out in the discussion of the affect of income variation: Case R2 and Case R3, the worst and best performance outcomes, respectively, with low income and poor status. Contrary to what I would expect, Case R3's poor status did not preclude good project performance. The cases in Natal provide further support for the finding that socio-economic status and project performance do not always exhibit a positive association. The difference in performance between Case N1 (high income) and Case N2 (low income) was not statistically significant, yet these two communities had a significant difference in their respective income levels. Consequently, income alone (a proxy for socio-economic status), while important, does not appear to explain the performance outcomes of these two cases either.

8.2.2 Population Size

Highly-populated communities tend to have more leverage than small communities because a larger population size represents more votes, a larger potential threat of mobilizing to make demands or to expose problems, and a relatively larger project impact (as described in Chapter 4). Collectively, these factors give larger communities more potential influence on implementing agencies and politicians. Project area populations for the six case studies (as of 1995) are summarized in Table 8-2. As this table shows, Case R2, the worst performing project, has the smallest population of the six cases. This is consistent with the view that the ability to deliver large numbers of votes and otherwise exert pressure is linked to condominial sewer performance.

Table 8-2. Estimated project area populations for the six cases.

Case Study	No. of Households	No. of People per Household	Estimated Project Area Population[a]
Case R1	293	4.5313	1328
Case R2	158	4.4634	705
Case R3	1349	4.6957	6335
Case N1	384	4.6579	1789
Case N2	757	4.6667	3533
Case N3	964	3.8043	3667

a. My calculations from primary data I gathered in each case study area in 1995 (through household interviews and project area censuses).

8.2.3 Relationships

Individuals with personal, business, political, or familial relationships with public officials, agency staff, or politicians often have greater access to power holders and decision-makers and thus more potential influence (as described in Chapter 4). As explained by Mainwaring (1999), in Brazil "getting a job as a janitor in a public building, as a garbage collector, a teacher . . . frequently depends on political contacts."[13] The benefits of influence created by relationships and social ties can spread to the whole community when the ties are used in association with a neighborhood project. Relationships held by the six case studies (as of 1995) are summarized in Table 8-3. As this table shows, evidence of specific relationships was found for Cases R1 and R3, and there was no evidence of relationships for the Natal cases.

For Case R1, some informants reported in interviews that residents had political ties to Joaquim Francisco and his political party (the rightist Party of the Liberal Front, or PFL). Some residents reported they had ties to COMPESA staff. Some COMPESA staff also lived in the Case R1 project area. During my fieldwork in the Case R1 neighborhood, I observed that this condominial sewer project received consistent maintenance attention from COMPESA. On several instances, I observed COMPESA staff fixing problems inside the home, which was unusual because residents were responsible for their in-home plumbing, fixtures, and house connections.

In Case R3, community leaders developed patronage ties to Miguel Arraes and relationships with COMPESA staff. When Governor Arraes was elected, he included the Case R3 area in his favela urbanization program. Residents I interviewed reported that politicians always visited the Case R3 area just before election time. In my interview with the president of the Case R3 community association he reported that he made monthly visits to COMPESA, in person, to voice complaints on behalf of the neighborhood and to reinforce the need for continued maintenance.

Table 8-3. Existence of relationships to public officials and agency staff held by the six case study communities.

Case Study	Indications of Relationships[a]
Case R1	Yes
Case R2	No
Case R3	Yes
Case N1	No
Case N2	No
Case N3	No

a. These indications of the presence or lack of specific relationships are based on information provided by case study residents and community leaders who were interviewed in 1995.

I observed COMPESA staff fixing sewer problems in the Case R3 area on several occasions during my fieldwork.

8.2.4 Degree of Organization

Communities that are effectively mobilized and organized also have more potential influence (as described in Chapter 4). Effective neighborhood organizations and grassroots popular movements became important during and following the democratic transition in Brazil, where neighborhoods first mobilized against the authoritarian military regime and then mobilized for "citizenship," which included the right to receive basic urban services[14]. Communities can use the influence created by organizing and mobilizing to bring urban services (e.g., sewers) into their neighborhood, or to improve the quality of service provided by public agencies. The degree of organization of the six case studies (as of 1995) is summarized in Table 8-4.

As this table shows, Cases R1 and R3 were the better organized communities among the six cases, and the Natal cases consistently were not well-organized. In Case R1, residents spontaneously organized around the idea of bringing pavement to the neighborhood through an existing City program. When the City responded with a condominial sewer and pavement project, Case R1 community leaders helped the City mobilize interest in the sewer project among the residents.

In Case R3, residents formed an organization called the Occupation Commission to bring an urbanization project to the neighborhood. Their mobilization tactics included assembling the votes of the community and negotiating with Arraes for the project. After the project was concluded, the community remained well-organized with a strong and active community president. Several other community-based organizations were formed as the Case R3 community evolved, including (as of January 1995) the Union of Residents of Case R3 (*Uniao de Moradores da Caso R3*), the Association of Mothers

Table 8-4. Relative degree of organization of the six case study communities.

Case Study	Degree of Organization[a]
Case R1	High
Case R2	Low
Case R3	High
Case N1	Low
Case N2	Low
Case N3	Low

a. My estimates of the degree of community organization are based on information provided by case study residents and community leaders who were interviewed. The presence of a neighborhood association, a community president, user groups, or an organization formed specifically around the condominial sewer project were indications of a well-organized community.

(*Associacao das Mulheres*), the Nenê Nursery School (*Creche Nana Nenê*), the Machado de Assis Group of Mothers (*Grupo de Maes Machado de Assis*), and the Residents Association of Upper Case R3 (*Associacao dos Moradores de Alto Caso R3*).

The main point of Section 8.2 has been to define the dimensions of community influence, and to identify patterns in the incidence of community influence and project performance. Table 8-5 combines the elements of community influence that were previously presented in Tables 8-1 through 8-4.

Table 8-5. Levels of community influence for the six cases.[a]

Case	Community Influence				
	Socio-Economic Status of the Project Area	Population Size of the Project Area	Degree of Organization of the Project Area	Relationships Held by Individuals in the Project Area	Overall Characterization b
R1 (SPI=67)	✓		✓	✓	High
R2 (SPI=12)					Low
R3 (SPI=71)		✓	✓	✓	High
N1 (SPI=68)	✓				Low
N2 (SPI=66)		✓			Low
N3 (SPI=55)		✓			Low

a. A check mark indicates the presence of an indicator.
b. An overall characterization of "low" corresponds to zero, one, or two check marks. "High" corresponds to three or four check marks.

The pattern that emerges from Table 8-5 is that, for Recife, community influence was high in Recife's two best performing condominial sewer projects. This is significant because Recife is not known for having lots of good condominial sewer projects. These two rare instances of success are exceptions to Recife's overall record of poor performance and, as such, offer a possible explanation of how success was achieved in the context of Recife. Cases R1 and R3 both exhibited organized communities and personal relationships with officials. These data suggest the possibility that these two aspects of community influence facilitated successful project performance in Recife's context.

The pattern for Natal that emerges from Table 8-5 is that community influence was not a notable factor in the three case studies. Furthermore, none of the three cases in Natal had organized communities or personal relationships. These data support the assertion that these two aspects of community influence – organized communities and personal relationships – were not necessary to achieve relatively successful project performance in Natal's context.

One possible explanation for the low levels of community influence in Natal is the centralized approach to condominial sewer development adopted by CAERN, illustrated by its use of sewer basins as the basic project unit. The agency implemented an overall plan that included a participation program in which agency staff mobilized the residents around the condominial sewer project. In general, residents did not have to exert influence to receive a project or to receive service in Natal. Conversely, Recife had an ad hoc approach to condominial sewer development, with multiple agencies each trying its own approach and with elected officials and agency officials each expressing different levels of commitment for condominal sewer technology and participation by beneficiaries. Most importantly, neighborhoods were the basic project unit in Recife. To a far greater extent than in Natal, residents in Recife had to exert influence to receive a condominial sewer project or to receive service.

8.3 Alignment of Interests

A second factor that emerges from the case study and city descriptions in previous chapters is the role of "alignment of interests" in project implementation. I use the term "alignment of interests" to refer to four types of alignment:

1) Elected officials and implementing agencies are aligned in their interest in being responsive to popular needs;
2) Elected officials and implementing agencies are aligned in their support of condominial sewer technology as a viable alternative to conventional sewers;
3) Among elected officials, there is continuity of interest in sanitation development from one political regime to the next; and
4) Among implementing agencies (city-to-city and city-to-state), there is a shared or mutual interest in coordinating their efforts to solve sanitation problems.

8.3.1 Responsiveness to Popular Needs

I hypothesize that the chances for a successful project outcome are higher when the elected officials and implementing agencies are responsive to the needs of the poor and middle class. Historical trends described in Chapters 4, 5, and 6 are consistent with this hypothesis. Before democratization began in Brazil, local level units of state organs that implemented sewer projects were supportive of elites and were either neglectful or repressive towards the needs of the poor and the middle class[15]. This changed somewhat with the introduction of democratization in Brazil in the early 1980s. Democratization was accompanied by a wave of political interest in meeting the needs of the masses, especially with regard to urban services. Through fiscal decentralization, municipalities were granted direct access to infrastructure funds and, as a result, they acquired more autonomy. Samuels (2000) argues that municipal, state, and even federal politicians became particularly interested in serving urban areas as a result of the fiscal decentralization policies of the 1988 Brazilian Constitution[16]. The status and prestige of the position of mayor increased significantly. This is evidenced by the increasing number of state and federal level politicians who sought the position of mayor after the late 1980s and through the 1990s.

Newly-elected mayors and governors who were responsive to popular needs often appointed like-minded individuals to run the condominial sewer implementing agencies and to develop projects that would meet popular needs. Policy innovations, such as condominial sewers and the approach of involving beneficiaries in project implementation activities, flourished in the new political environment created by fiscal decentralization. Recife's and Natal's innovation with condominial sewers and participation during the 1980s and 1990s is a prime example. My subjective estimates of agency responsiveness to popular needs for the six case studies is summarized in Table 8-6. As this table shows, agencies were responsive to popular needs in all cases except Case R2. The Case R2 project was implemented "on the cheap" in a disjointed fashion, at the expense of responding to people's needs. The Case R2 project was planned and funded through a City agency (URB) in 1987, designed in 1988, and re-designed in 1991 by a local engineering consultant hired by URB. The project was subsequently modified again by COMPESA through the same local engineering consultant, constructed by an URB contractor in 1992, and accepted and maintained by COMPESA in 1992, but subsequently abandoned.

Table 8-6. Impact of agency responsiveness to popular needs on the six cases.

Case Study	Agency Responsiveness?[a]
Case R1	Yes
Case R2	No
Case R3	Yes
Case N1	Yes
Case N2	Yes
Case N3	Yes

a. My estimates of agency responsiveness are based on information I gathered in 1994-1995 for the detailed case study descriptions in Appendices E and F.

Multiple difficulties were experienced during the convoluted implementation of the Case R2 project. For example, COMPESA mandated modifications to the original design, which included putting both the pump station and the treatment plant underground, and eliminating the screens and grit chamber because they were considered high maintenance, high cost items. Also, topographic information for the area was not properly developed. URB did not perform any field surveys to verify the elevations of the planned route of the pipes. Instead, URB provided the engineering consultant with an old topographic map, which had been drawn at an impractical 1:2000 scale and which had many houses missing[17]. These difficulties demonstrate a lack of will by elected officials and implementing agencies to invest adequate resources in this project.

8.3.2 Support for the Technology

Based on my observations, I believe the chances for a successful project outcome are higher when the implementing agency embraces condominial sewer technology and encourages participation in mobilizing and decision-making. During the period of study, condominial sewers were an emerging technology in Brazil, and this new technology was not equally supported by all agencies; indeed, some agency staff and elected officials actively opposed condominial sewers. Condominial sewer projects implemented by agencies that accepted and embraced the concept of condominial sewers had better chances of success. These agencies hired social science staff to implement the participation aspects of project implementation, and developed cadres of condominial sewer specialists within their organizations.

My subjective estimates of agency support for condominial sewers among the six case studies is summarized in Table 8-7. As this table shows, agencies were supportive in all cases except Case R2. At the time Case R2 was implemented, URB and COMPESA (the two implementing agencies for Case R2) did not embrace condominial sewers or participation in general. Within COMPESA in the 1980s, some staff were supportive of condominial sewer technology and some were completely against it[18]. The maintenance staff was strongly opposed to condominial sewers, perhaps even more so than the engineering staff, because condominial sewers usually had more maintenance problems than conventional sewers. COMPESA resisted the City's efforts to install neighborhood condominial sewer systems in Recife in the 1980s, and COMPESA was not always willing to accept maintenance responsibility for these systems[19].

Table 8-7. Impact of agency support on the six cases.

Case Study	Agency Support?[a]
Case R1	Yes
Case R2	No
Case R3	Yes
Case N1	Yes
Case N2	Yes
Case N3	Yes

a. My estimates of agency support for condominial sewer technology are based on information I gathered in 1994-1995 for the detailed case study descriptions in Appendices E and F.

One reason for COMPESA's resistance was because most of the condominial sewer systems being implemented did not have an adequate destination for the collected sewage. Another reason was that condominial sewers did not meet the sewer industry standards COMPESA was trying to uphold. There was also discord within the City itself, especially between URB and OBRAS, the City's two sewer implementing agencies[20]. Based on the evidence presented in Section 5.2.2 of Chapter 5, OBRAS staff tended to embrace condominial sewer technology and beneficiary participation, and URB staff tended to be skeptical or critical about condominial sewer technology and generally opposed to beneficiary participation.

The implementing agencies for Cases R1 (OBRAS) and R3 (COHAB) were relatively more supportive than URB and COMPESA at the time these projects were implemented[21]. As discussed in Sections 5.2.2 and 5.4.2 of Chapter 5, OBRAS fully embraced and promoted condominial sewer technology and a participation approach in all of its projects, while COHAB installed thousands of condominial sewer connections but was inconsistent in its application of a participation program. As discussed in Sections 6.3.2 and 6.4.2 of Chapter 6, Natal's implementing agency (i.e., CAERN) was an enthusiastic promoter and developer of condominial sewers and participation programs for all of its projects, including Cases N1, N2, and N3, as summarized in Table 8-7.

8.3.3 Regime Continuity

My results suggest that the chances for a successful project outcome are higher when project implementation begins and ends within a single political regime. Scholars have noted the chaotic nature of Brazilian politics and the persistence, even after the democratic opening in the 1980s, of an individualist political culture in which elected officials serve their own interests[22]. Within this individualistic political culture, as new leaders are elected and regimes are installed, little or no value is given to providing a sense of continuity for the policies, projects, or staff of the previous regime[23]. Based on the evidence presented in Section 5.4 of Chapter 5 for Recife, even "basic needs" projects (e.g., sanitation projects) were politicized to a high degree, because projects were tightly linked to the elected official in charge of implementation. When a new official was elected, he or she frequently abandoned the neighborhood projects initiated by the previous official, because those projects represented the patronage of that official[24]. This practice was not exclusive to one political party; leftist, centrist, and rightist politicians all carried out the custom.

Projects that lose political support (and the funding that goes with it) because of a change in regime obviously have a lower probability of success. This is particularly true for sewer projects because their performance depends on ongoing maintenance and rehabilitation. Several examples of the impact of regime discontinuity on condominial sewer projects were provided by the case studies in Recife and Natal[25]. Case R2 is perhaps the most poignant because of the disastrous outcome.

Case R2 was planned in 1987 by URB at a time when the mayor of Recife and the governor of Pernambuco were in the same political party and were both supportive of condominial sewers. URB hired a private, local, engineering consultant in 1988 to design a condominial sewer, pump station, and a community septic tank. The engineer completed the design and submitted it to URB, but the agency was not able to implement the project before the 1989 election of a new mayor who did not immediately continue the project. The change in regime and the lack of continuity of support for the technology resulted in a three year period (1989-1991) where no progress was made on the Case R2 project. It was not until the new mayor took office as governor of Pernambuco in 1991 and his vice mayor became mayor of Recife, that the Case R2 project would be continued[26].

My estimates of the impact of regime discontinuity on project implementation for the six case studies is summarized in Table 8-8. As this table shows, the implementation of Cases R2, N2, and N3 were negatively affected by a lack of regime continuity.

In Cases N2 and N3, following the election of a new governor in 1991, project funding stopped abruptly before these projects were completed. Approximately 74% of the sewer connections in Case N2, and 77% of the sewer connections in Case N3 were completed. At this point some residents asked CAERN for materials so they could continue constructing parts of the system and their house connections. CAERN provided these residents with technical support and the sewer designs to use as guides. This regime

Table 8-8. Impact of regime discontinuity on the six cases.

Case Study	Continuous Regime?[a]
Case R1	Yes
Case R2	No
Case R3	Yes
Case N1	Yes
Case N2	No
Case N3	No

a. My estimates of which projects were affected by regime discontinuity are based on information I gathered in 1994-1995 for the detailed case study descriptions in Appendices E and F.

change led to a reduction in the number of connections that were ultimately installed for these two projects, and completely stopped the implementation of additional condominial sewers in Natal for the duration of the political term[27].

8.3.4 Agency Coordination

Chances for a successful project outcome also appear to be higher when the implementing agencies involved interact with each other in a coordinated manner. Scholars have noted the lack of vertical (state-city) and horizontal (city-city or state-state) coordination between Brazil's government agencies since democratization and the concurrent wave of decentralization[28]. Since the 1980s, Brazilian agencies at the same level of government, and agencies at different levels of government, typically have had increased difficulty working together[29].

This pattern of difficulties with vertical and horizontal agency coordination existed in the context of condominial sewer projects as well. Many of the condominial sewer projects in Recife required more than one implementing agency, and oftentimes the agencies were at different levels of government (city and state). As shown in Section 5.2.2 of Chapter 5, during the 1980 to 1995 period, Recife's four implementing agencies (COMPESA and COHAB at the state level, and URB and OBRAS at the city level) did not always cooperate, and they did not follow a cohesive urban development plan with regard to sanitation. This lack of coordination and cooperation among agencies did not exist in Natal because only one agency (CAERN) implemented condominial sewers during the period studied. Condominial sewer projects that were implemented by more than one agency had reduced chances of success when the agencies did not coordinate their activities.

My subjective estimates of which cases experienced a lack of agency coordination during project implementation for the six case studies are summarized in Table 8-9. As this table shows, only Case R2 was negatively affected by a lack of agency coordination. When URB began to implement the Case R2 condominial sewer project in 1991 – after a three-year delay since the project had been designed – the agency had to work with COMPESA, the sewer maintenance agency. In order to gain COMPESA's acceptance of the project, URB submitted the original design to COMPESA for review. COMPESA mandated several significant design changes, including putting the pump station underground and eliminating the screens and grit chamber, which were considered high maintenance items. URB re-hired the original project engineering consultant to re-design

Table 8-9. Impact of agency coordination on the six cases.

Case Study	Agency Coordination?[a]
Case R1	Yes
Case R2	No
Case R3	Yes
Case N1	Yes
Case N2	Yes
Case N3	Yes

a. My estimates of which projects were affected by lack of agency coordination are based on information I gathered in 1994-1995 for the detailed case study descriptions in Appendices E and F.

the project based on COMPESA's requirements. During project construction, URB instituted a series of cost-saving measures, such as foregoing a topographic survey. Immediately after construction was complete, it became apparent that the sewer system performed poorly, and COMPESA abandoned the project. Rather than negotiating a reasonable set of design changes and coordinating their actions towards the mutual goal of successful project outcome, each agency focused on its own interests and objectives with little accountability for the result. Neither URB nor COMPESA attempted to rehabilitate the worst-functioning parts of the Case R2 sewer system, despite repeated complaints by residents.

Section 8.3 defines the dimensions of alignment of interests and identifies patterns in the alignment of interests was strong for the six condominial sewer projects in Recife and Natal. Table 8-10 combines the elements of alignment of interests that were previously presented in Tables 8-6 through 8-9.

Table 8-10. Degree of alignment of interests for the six cases[a].

Case	Alignment of Interests				
	Agency Support for the Condo. Approach	Agency Responsiveness to Popular Needs for Sanitation	Project Completion within a Continuous Regime	Coordination Between Different Implementing Agencies	Overall Characteriz-ation[b]
R1 (SPI=67)	✓	✓	✓	✓	Stable
R2 (SPI=12)					Unstable
R3 (SPI=71)	✓	✓	✓	✓	Stable
N1 (SPI=68)	✓	✓	✓	✓	Stable
N2 (SPI=66)	✓	✓		✓	Stable
N3 (SPI=55)	✓	✓		✓	Stable

a. A check mark indicates the presence of an indicator.
b. An overall characterization of "unstable" corresponds to zero, one, or two check marks. "Stable" corresponds to three or four check marks.

The pattern that emerges from Table 8-10, for both Natal and Recife, is that alignment of interests is stable for all five good performing projects. This is significant because I originally expected community participation to stand out as the common variable among the good performing projects. Instead, alignment of interests (and also community influence, as discussed earlier in Section 8.2) emerges as an important variable in both cities.

Recife's instances of good performance are rare, given its overall poor record of performance, and all four elements of alignment of interest were present in the successful cases. In Natal, where overall performance was good, two of the cases achieved good performance with only three of the four elements of alignment of interest. Cases N2 and

N3 were each only partially (about 75 percent) completed because funding was cut following the election of a new governor. This act did not doom the projects, however, because residents, having attended CAERN's participation program, organized themselves to complete their part of the project; and because CAERN provided some informal technical assistance to Case N2 and N3 residents as they constructed their house connections to the completed parts of the system.

In the following section, the concepts that were introduced and defined in this section – community influence and alignment of interests – will be discussed in much more detail, with a focus on the qualitative impact of these factors on project performance outcomes. Evidence from the case studies and city experiences in Recife and Natal will be presented to illustrate the suggested associations.

8.4 Qualitative Analysis of Community Influence, Alignment of Interests, and Performance

The results of the previous discussion (Sections 8.2 and 8.3) are summarized in Table 8-11. This table contains my overall characterizations of the alignment of interests (stable or unstable) and community influence (high or low) for the six case studies. In general, I characterized the alignment of interests as "stable" if more than half of its indicators were present. Likewise, I characterized community influence as "high" if more than half of its indicators were present. Next, I provide a qualitative analysis of how these two factors impacted condominial sewer project performance in the six case studies.

Table 8-11. Characterizations of the alignment of interests and community influence for the six cases[a].

Case	Alignment of Interests					Community Influence				
	Agency Support for the Condominial Approach	Agency Responsiveness to Popular Needs for Sanitation	Project Completion within a Continuous Regime	Cooperation Between Different Implementing Agencies	Overall Characterization (b)	Socio-Economic Status of the Project Area	Population Size of the Project Area	Degree of Organization of the Project Area	Relationships Held by Individuals in the Project Area	Overall Characterization (c)
R1	✓	✓	✓	✓	Stable	✓		✓	✓	High
R2					Unstable					Low
R3	✓	✓	✓	✓	Stable		✓	✓	✓	High
N1	✓	✓	✓	✓	Stable	✓				Low
N2	✓	✓		✓	Stable		✓			Low
N3	✓	✓		✓	Stable		✓			Low

a. A check mark indicates the presence of an indicator.
b. An overall characterization of "unstable" corresponds to zero, one, or two check marks. "Stable" corresponds to three or four check marks.
c. An overall characterization of "low" corresponds to zero, one, or two check marks. "High" corresponds to three or four check marks.

8.4.1 Impact of Community Influence on Project Performance

In the two successful cases in Recife (i.e., Cases R1 and R3), the project communities had relatively high levels of influence. The Case R3 residents were poor and lacked the influence associated with social ties and high income; but they were well-organized and effectively developed patronage ties to the governor, which provided them with an effective form of influence. Case R3 was initiated during a gubernatorial election in which residents had the opportunity to leverage their political influence (i.e., their votes) to receive the project. The political influence exerted by these residents may have been the only option available to them for acquiring a successful condominial sewer project. In Case R1, some of the residents had relationships with COMPESA staff and with politician Joaquim Francisco (who served as mayor of Recife and governor of Pernambuco). This neighborhood had a relatively small population, but it was middle-income and the residents organized themselves spontaneously for the condominial sewer project.

The community served by the worst performing project in Recife (Case R2) had little to no influence. Case R2 residents were not organized to exert political influence, and they did not benefit from the influence that is inherent in communities with high incomes, large populations, or relationships with officials.

Community influence was also low in all the Natal cases (i.e., Cases N1, N2, and N3). Although none of these neighborhoods was well-organized (their community associations and presidents were inactive at the time of my fieldwork), and none had any notable relationships with officials, residents in all three neighborhoods responded very well to the implementing agency's participation program. CAERN's centralized condominial sewer development approach and use of sewer basins as the basic project unit reduced the importance of community influence in Natal's context. Consequently, good performance was achieved in communities with low influence.

8.4.2 Impact of Alignment of Interests on Project Performance

In the early 1980s, the environment for implementing water and sanitation projects in Brazil became more decentralized. The authoritarian military government transitioned to democracy with mandatory voting and statewide elections. Finance was decentralized in the 1988 Brazilian Constitution by allowing municipal governments direct access to federal funds for infrastructure improvements. And both city and state run water and sanitation agencies adopted localized sewer technology (condominial sewers) and bottom-up approaches to citizen participation in projects.

This movement in the direction of decentralization further strengthened the local level patronage system that traditionally had been the foundation of Brazilian politics. Local level patronage was enhanced in the newly decentralized implementing environment because local officials had increased access to infrastructure funding and therefore had more patronage to give out. Municipalities also gained more autonomy and freedom to try new ways of delivering basic urban services.

Although decentralization occurred throughout the country, its impact was manifested differently in Recife and Natal during the 1980-1995 time period. In Recife, evidence of local level empowerment lies in the city government's efforts to develop its own sewer service capability. Natal, on the other hand, maintained a state agency-led implementation approach for most of the period of interest. It was not until 1995 that the Natal city government initiated its own efforts to run parts of the local sanitation infrastructure from within city agencies.

Brazil's democratic opening brought more choice and more voice for its citizens, but it also brought wider swings in local government regimes, especially in Recife. Local political coalitions in Recife were transitory, with regimes only able to stay in power for a few short years at a time. These local governments offered brief windows of opportunity for implementing projects. Left-leaning local governments, such as those of Mayor Jarbas Vasconcelos, tended to target the poor using basic infrastructure services as patronage that was usually tied to neighborhoods. These governments readily embraced citizen participation approaches because participation fit into their ideals. In contrast, right-leaning governments, such as those of Mayor Joaquim Francisco, did not accept participation so readily, nor did they typically target the poor directly. While the democratic political opening resulted in populist platforms targeting the long-ignored poor, wide swings in local governments resulted in unstable implementing environments.

Policies and projects did not have continuous political support across elections and regimes.

Added to this discontinuity in local governing coalitions were centralized institutional arrangements left over from the 1962-1982 authoritarian military regime that were not amenable to decentralized implementation approaches. Under the military, all of the water and sanitation expertise had been concentrated at the state level in state-owned water and sanitation companies. The City of Recife tried to develop capacity to implement condominial sewer systems, but, as a condition of funding, had to hand over their completed projects to the state water and sanitation company for ongoing maintenance. During the 1980-1995 period, the state water and sanitation companies were often under governors from a different political party than the party of the mayor of Recife, and this difference in political parties reduced the incentives for city and state agencies to cooperate.

City and state cooperation was also influenced by the balance of power between Recife and the State of Pernambuco. Larger wealthier cities like Recife acted more independently from the state than smaller less wealthy cities. Also, state officials were not as dependent on votes from individual neighborhoods as city officials were. When there were differences between the political parties of the State of Pernambuco and the City of Recife, there were reduced incentives for agencies to provide continuous local sanitation services. A prime example is the two-year period (1987-1988) in which the mayor of Recife and the governor of Pernambuco were in the same political party. This period represents a peak period of condominal sewer implementation in Recife by both city and state agencies. The years prior to (1985-1986) and following (1989-1994) this peak period were marked by conflict between city and state implementing agencies about the adoption of condominial sewers, and by several instances of city projects being abandoned or not accepted by the state for maintenance.

As shown in Table 8-11, alignment of interests was stable during the implementation of the five successful cases, and was not present for the worst performing case (Case R2). For example, the Case R3 condominial sewer project was initiated in the beginning of Governor Arraes' 1987 - 1990 administration. Arraes' favela urbanization policy, implemented by COHAB through the Urbanization Program, included the large Case R3 housing and urban service project. Fortunately for the residents in Case R3, COHAB initiated, implemented, and completed the condominial sewer sub-project during the regime's term, and the project received continuous support from COHAB, a state-run implementing agency.

Likewise, Case N1 was implemented during what might be called CAERN's "golden age" of condominial sewer implementation (1980 - 1990). During the implementation of Case N1 (1987), CAERN had a directorate that promoted the use of condominial sewers. Furthermore, the State of Rio Grande do Norte's governor (i.e. Geraldo Melo) allowed CAERN to act quasi-autonomously with respect to condominial sewers. The scope of the Case N1 project was small enough to be initiated, implemented, and completed during this period of alignment of interests between Governor Melo and CAERN.

Case R2, on the other hand, was implemented in a disjointed fashion by a city agency (i.e., URB) and a state agency (i.e., COMPESA). The project was planned and designed by URB during the first Jarbas Vasconcelos mayoral regime of 1985 – 1988, a regime that strongly supported condominial sewers. At that time, URB was responsive to the need for basic sewer services, but was not yet completely supportive of condominial technology or the participation approach. Despite its small scope, the project was not completed during the first Jarbas regime.

The next elected administration in Recife, headed by Mayor Jaoquim Francisco, "inherited" the unspent project moneys from the Jarbas regime but did not support the specific projects initiated by Jarbas. URB continued to implement the Case R2 project after Francisco left his position as mayor to become governor, and after his vice mayor Gilberto Marques Paulo assumed the mayoral position. But the project underwent a number of cost-cutting design changes driven by URB and by COMPESA – a state agency that was not supportive of condominial sewers at that time. These cost-cutting changes ultimately contributed to the Case R2 project's poor performance.

Case R1 was initiated, implemented, and completed during a period of alignment of interests between the mayor, the governor, the city agency, and the state agency. Case R1 was implemented by OBRAS under the first Mayor Jarbas regime. At that time, OBRAS was supportive of condominial sewer technology and responsive to popular needs. Under the first Arraes regime – which was also supportive of condominial sewer technology and responsive to popular needs - the project was handed over to COMPESA for maintenance.

Cases N2 and N3 were large projects implemented simultaneously by CAERN during its "golden age". At that time, CAERN was supportive of condominial sewer technology and responsive to popular needs. However, both projects could not be completed before the regime change that occurred with the election of a new governor in 1991, Governor Jose Agripino Maia. The new governor appointed a new directorate for CAERN, and funding for the Case N3 project stopped. After four years without any support, the Case N3 project started up again after the election of a new governor, Garibaldi Alves Filho, who favored condominial sewers and who appointed a supportive directorate for CAERN.

8.5 Summary

The argument I have made in this chapter can be summarized as follows:

1. In both Recife and Natal, the probability of good condominial sewer project performance increased when there was a stable alignment of interests, as indicated collectively by the following four features:
    - When the politicians and implementing agencies associated with the project were responsive to the needs of the poor and middle class.

- When the implementing agencies embraced condominial sewer technology and participation.
- When project implementation started and ended within a single political regime, or alternatively, when project implementation was not adversely affected by a change in political regime.
- When the implementing agencies coordinated their efforts, or alternatively, when there was only a single implementing agency.

2. In Recife, the probability of good condominial sewer project performance increased when community influence was high, as indicated collectively by the following four features:
    - When the project neighborhood had high socio-economic status.
    - When the project neighborhood had a large population.
    - When the project neighborhood had relationships with politicians, officials, or implementing agency staff.
    - When the project neighborhood was well organized for delivering votes.
3. The factors noted in item 2, which were important in Recife, did not play a significant role in the Natal case studies because the implementing agency employed a uniform, centralized approach to providing sanitation services and it employed sewer basins as the basic project unit. Consequently, variables related to a community's influence had relatively less affect (compared to Recife) on whether condominial sewer services were provided effectively.

[1]Informant 16, president of a Recife sewer agency, Interview by author, 16 March 1995, Recife, transcript.
[2]This result is based on the average response of eight agency staff to the question, "How would you evaluate the overall performance of condominial sewers in Recife?" Possible answers were based on the following 5-point scale: 1-Poor, 2-Fair, 3-Good, 4-Very Good, 5-Excellent. The interviews were conducted in Recife in the month of March, 1995.
[3]Watson, 1993.
[4]Watson, 1993:21.
[5]Refer to Table 5-1 (in Chapter 5) and Table 6-1 (in Chapter 6) for data on overall sewer access rates in Recife and Natal, respectively. One possible explanation for why Recife had a slightly higher sewer access rate than Natal is that multiple state *and* municipal agencies implemented condominial sewers in Recife throughout the 1985-1995 period, and only one state agency implemented condominial sewers in Natal during the same time period.
[6]Informant 16, president of a Recife sewer agency, Interview by author, 16 March 1995, Recife, transcript.
[7]This result is based on the average response of five agency staff to the question, "How would you evaluate the overall performance of condominial sewers in Natal?" Possible answers were based on the following 5-point scale: 1-Poor, 2-Fair, 3-Good, 4-Very Good, 5-Excellent. The interviews were conducted in Natal in 1995.
[8]Watson, 1993.
[9]For example, Informant 1, engineering consultant, former Recife official, and former state official. Interview by author, 1 December 1994, Recife, transcript; and Informant 76, CAERN social worker, Interview by author, 5 May 1995, Natal, transcript.
[10] Menendez, 1991.
[11]Informant 76, CAERN social worker, Interview by author, 30 May 1995, Natal, transcript.
[12]Informant 76, CAERN social worker, Interview by author, 30 May 1995, Natal, transcript.
[13]Mainwaring 1999:182.
[14]Hochstetler, 2000; and Mainwaring, 1989.
[15]Mainwaring, 1989:178.
[16]Samuels, 2000:92.
[17]See Appendix E for a full discussion of the implementation of the Case R2 project.
[18]Refer to Section 5.2.2 of Chapter 5 for supporting evidence.
[19]Refer to Section 5.2.2 of Chapter 5 for supporting evidence.
[20]Refer to Section 5.2.2 of Chapter 5 for supporting evidence.
[21]Refer to Sections 5.2.2 and 5.4.2 of Chapter 5 for supporting evidence.
[22]Skidmore, 1989; Mainwaring, 1989; Samuels, 2000:97; and Mainwaring, 1999.
[23]Refer to Sections 4.1 and 4.2 of Chapter 4, and Section 5.5.4 of Chapter 5 for supporting evidence.
[24]Refer to Sections 5.4 and 5.5.4 of Chapter 5 for supporting evidence.
[25]See Section 5.5 of Chapter 5 and Section 6.5 of Chapter 6 for brief synopses of the case studies. See Appendices E and F for full case study descriptions.
[26]See Appendix E for the complete case study description.
[27]Refer to Sections 6.4.2 and 6.4.3 of Chapter 6, and Appendix F for supporting evidence.
[28]Samuels, 2000:95.
[29]Samuels, 2000.

Chapter 9

Summary, Additional Analysis, and Theoretical Implications

In this chapter, I summarize the principal findings of the dissertation (Section 9.1), analyze one additional case study to test the findings (Section 9.2), and present my theoretical interpretation of these findings (Section 9.3).

9.1 Summary

The performance outcome of condominial sewers implemented in Brazil during the 1980s and early 1990s was mixed. As concluded in a World Bank-commissioned study that covered two-thirds of all condominial sewer connections in Brazil in 1993, some projects functioned well, a good number of projects functioned poorly, and some projects were eventually abandoned or were never completed[1]. The adverse public health and environmental conditions that result from a lack of sewer service are significant. Appropriate engineering solutions can potentially improve these conditions; however, the long-standing pattern of failed engineering solutions in general, and the mixed record of condominial sewer project performance in particular, suggest that engineering alone will not generate success[2]. Other factors must be put in place to enable engineering solutions to succeed.

The principal finding of this dissertation is that the factors that enabled performance success for condominial sewer projects depended on the local implementation context. In Recife's context, the following three factors enabled success:

- Stability in the alignment of interests of politicians and implementing agencies associated with a condominial sewer project, as indicated by responsiveness to popular needs for sanitation, agency support for condominial sewer technology and a participation approach, minimum discontinuity and disruption from one political regime to the next, and cooperation among implementing agencies.

- Influential communities, as reflected by a community's socio-economic status, population size, relationships with officials, and degree of organization.

- Participation, as indicated by the mobilization of residents in support of the project and the involvement of beneficiaries in project decisions.

In Natal's context, stability in the alignment of interests and participation in mobilizing and project decisions were the factors that enabled condominial sewer project success. Influential communities were not an important factor in Natal during the 1980 to 1995 time period.

The initial hypothesis for the research was based on the widespread agreement in the water supply and sanitation literature that participation in all aspects of project implementation is one of the keys to successful infrastructure projects in developing countries[3]. This apparent consensus was framed herein as a "participation hypothesis": participation contributes to more successful project outcomes. The reasoning behind this participation hypothesis is that participation in project implementation helps stimulate and mobilize people's demand for a project. In addition, it is hypothesized that participation provides implementing agencies with access to local knowledge about the community, and agencies can use their local knowledge to better shape projects to meet the needs and aspirations of the community. Moreover, when beneficiaries contribute labor, money, and materials to a project, these contributions increase the sense of ownership among beneficiaries, and their sense of ownership contributes to better care and use of the system by beneficiaries.

Applying this participation hypothesis to sanitary sewers, participation is hypothesized to be beneficial because it provides a process for educating beneficiaries on the links between sanitation and health, on the benefits of sewers over traditional onsite wastewater disposal solutions, on improved hygiene practices, and on the proper use of a sewer system. Participation also provides a way to stimulate interest in sanitation so that more people want to connect to the sewer system. Participation also provides an opportunity for residents to be involved in project decisions and for agencies to gain access to on-the-ground information that is needed to design projects that meet the needs of the community.

Evidence from both large-scale (big-N) and small-scale (small-N) studies of rural water projects in many developing countries has supported the hypothesis that participation is one of the most significant factors associated with project effectiveness. Most of the condominial sewer practitioners in Recife and Natal who were interviewed for this dissertation believed that projects implemented with participation performed better than projects implemented without participation.

This dissertation, an in-depth study of six condominial sewer projects in Natal and Recife, yielded data that are not completely consistent with the participation hypothesis in the context of urban condominial sewer projects. The results for Natal and Recife are consistent with the hypothesis that participation is positively associated with project effectiveness, but *only* if participation is limited to mean participation in project mobilizing and participation in project decisions. Contrary to expectations based on conventional wisdom, my study shows no association between participation in project construction or maintenance and condominial sewer project performance.

In this dissertation, I developed methods for gathering empirical data on participation and performance, and for deriving index scores to facilitate qualitative analysis of the relationship between participation and performance. Among my six cases, those with relatively high levels of participation in project mobilizing and project decisions had higher levels of project performance. Nevertheless, this association did not fully explain the range of project outcomes observed in Recife and Natal. Looking beyond the six case study projects, there were some projects that did not succeed even when participation in mobilizing and decision-making was high[4].

Looking at overall citywide experiences during the 1980-1995 period, Recife's condominial sewers performed poorly and condominial sewers in Natal performed relatively well. Recife's projects exhibited a wide range of performance; the range of performance of Natal's projects was narrower. While the benefits of participation in project mobilizing and decisions were particularly evident in Recife, participation alone did not explain all of the observed variation in project performance. The benefits of participation in mobilizing and decisions were not apparent in Natal because of the lack of significant variation among the selected cases.

Contrary to expectations based on conventional wisdom, participation (in mobilizing and decisions) does not stand out in my study as the most important factor associated with good project performance. Rather, it is one of several important factors. Two other variables help explain the observed variations in project performance: the alignment of interests of politicians and implementing agencies in support of a condominial sewer project, and the level of influence that could be exerted by project area residents. In addition to participation in mobilizing and decisions, stable alignments of interests played a key role in enabling successful projects in both Natal and Recife, and higher degrees of community influence played a key role in Recife (but not in Natal). These two variables – alignment of interests and levels of community influence – are important because condominial sewer projects can be adversely affected by Brazil's political and institutional traditions, such as discontinuity between political administrations, bias against the lower classes, and ambiguity in the assignment of agency responsibilities for water and sanitation. These adverse factors, which were exogenous to project implementation activities, had as much or more impact on case study project success as factors that were endogenous to project implementation (e.g., engineering, construction, maintenance, and participation activities).

Because my research focused on the project and neighborhood level, it was necessary to disaggregate the notion of the "Brazilian State" into the set of relevant actors and institutions that affected particular projects. For condominial sewer projects, these actors included local public works and urban planning agencies, city mayors, state-owned water and sanitation agencies, and state governors. The relevant actors, institutions, and community characteristics varied from project to project, and support for individual projects varied from one political regime to the next. The most important consideration at the project level was whether a political official and an implementing agency (or agencies) could form a stable alignment of interests around an individual project. And frequently, the degree of this support could be influenced by the community to be served by the project.

The relation between implementing agencies and political officials was particularly significant. Under Brazil's authoritarian regime, state-level agencies were empowered to carry out the centralized plans of the Brazilian State. Municipal level agencies were mere agents of political officials and rarely acted with autonomy. Little could be done by state or municipal level agencies without direct or indirect approval from high level officials in the authoritarian regime, and this was consistent with Brazil's long history of executive privilege and top-down decision-making. After democratization, elected officials became empowered to insert their agendas and individual goals into the activities of state and municipal agencies. Sweeping staff re-appointments and policy upheavals were typically made by newly elected officials, a continuance of the tradition of executive privilege and political individualism, but now without the central coordinating vision of the Brazilian State. Samuels (2000:97) articulates this tradition of individualism:

> Both within and across municipalities, executive dominance promotes individualistic political strategies on the part of local mayors. . . . Furthermore, executive dominance of municipal government perpetuates Brazil's traditionally individualistic and clientelistic style of politics. (Samuels, 2000:97)

From one elected administration to the next, great shifts in the goals, policies, resource allocations, project priorities, neighborhood priorities, and staff of implementing agencies were possible after democratization. For these reasons, it was not productive for me to conceptualize implementing agencies as actors without linking them to the elected officials that directly guided their actions. I found it more useful to examine the particular combination of political actors and implementing agencies that came together to implement each individual case study project.

Whether out of disinterest in specific projects or for other reasons, some elected officials allowed the implementing agency considerable autonomy in project decisions. Under these circumstances, the locus of decision-making authority shifted to the agency, and the interests of the agency became a key source of support for individual projects. This was the case for URB in Recife and CAERN in Natal. Both agencies had notable degrees of autonomy in condominial sewer implementation decisions. During the late 1980's, URB implemented condominial sewers without a strong participation approach, even though the elected official (Mayor Jarbas) was a powerful advocate for condominial sewers and participation. Likewise, during the 1980's CAERN obtained funding and implemented condominial sewers with little direct interest paid by the governors of the State of Rio Grande do Norte.

The idea of combinations of political actors and implementing organizations forming alignments around individual projects has been noted by scholars of urban politics in US cities. In their study of US mega-projects, Altshuler and Luberoff refered to "mega-project support coalitions" as mobilized constituencies, usually led by business interests, that were linked to elected state and local officials[5]. The authors' also cited several coalitions led by environmental interests. Based on Fainstein and Fainstein's book on the collaboration of local government and local business in urban development – known as regime theory[6] – Altshuler and Luberoff argued that project support coalitions "were indispensable to the success of mega-project proposals"[7]. The concept of a "project support coalition" effectively captures the idea that different projects can be supported by different sets of actors.

The project support coalitions that were relevant to condominial sewer projects in Recife and Natal consisted of elected officials and implementing agencies at the state and/or local level. While condominial sewer projects are by no means mega-projects, as an emerging technology, condominial sewer projects do share the following characteristics with mega-projects: a) they require the assembly of political support, public resources, and the resolution of conflict when the benefits of a project are targeted towards a specific population or geographic area; b) they can be controversial and non-routine, and c) they often require actions by multiple government agencies[8]. During the period studied, condominial sewers were an emerging technology with many, if not all, of these features. In particular, successful condominial sewer projects required political support and agency support across electoral cycles.

Under the conditions of Brazil's implementing environment, there is value in applying the concept of a "project support coalition" to condominial sewer implementation. The empirical evidence presented in this dissertation reveals that the alignment of interests between politicians and agencies had an impact on project performance for the six case study projects. When these alignments took on the characteristics of a project support coalition –i.e., when coalitions supported individual condominial sewer projects and were stable throughout the project implementing period – project performance was relatively good.

Implementing agencies in Recife and Natal generally experienced recurring funding problems and political disruption at each election cycle. The discontinuity in political support for projects could be considered a logical extension of Brazil's political traditions of clientelism, patronage, and individualism. Nevertheless, there were notable instances and brief periods where elected officials and implementing agencies were allies and, in effect, members of a project support coalition that supported a particular project, a particular technology or approach, or a particular neighborhood.

While I showed (in Chapter 7) that participation in mobilizing and participation in decisions were positively associated with project performance in Recife, the formation of stable alignments of politicians and agencies was even more critical than this participation to the performance outcome of projects. Unstable alignments (or a lack of alignment) resulted when elected officials and implementing agencies were not jointly responsive to popular needs for sewer infrastructure, were not jointly supportive of condominial sewer technology and participation, did not stay aligned long enough to complete the project implementation cycle, or did not have cooperation from other implementing agencies. Conversely, when stable alignments of agencies and officials existed, the agencies and officials acted like project support coalitions, and the existence of the coalitions increased the probability of project success.

In addition to stable alignments, the ability of project area residents to persuade elected officials and implementing agencies to take their interests into account was also important to the performance outcome of some projects (particularly in Recife). The influence of communities (as defined in Chapter 8) has relevance considering Brazil's grassroots and neighborhood social movements of the 1980s, especially those movements that mobilized around the perceived right to receive basic urban services, such as sanitation. With the transition to democracy, communities gained a new role as political actors who could exert some influence on politicians and implementing agencies. This influence was exerted through traditional channels of patronage; through connection to new, emerging political parties; or through protest, mass mobilizing, and other grassroots tactics.

I conceived of community influence as emerging from four sources: population size, socio-economic status, relationships with officials, and degree of organization. Highly-populated communities have more potential influence on elected officials and agencies, because they represent more votes and because the consequences of failure are greater. Higher income communities also have more potential influence because they have, historically, received more favorable treatment by the Brazilian State as a whole. There are also fewer challenges to implementing successful projects in communities with higher socio-economic status, making them more attractive to implementing agencies. When individuals in a community have access to officials - because of social, business, personal, or family ties – they are in a better position to exert influence on behalf of their community. And finally, effectively organized communities can yield influence because of their ability to assemble a geographic block of support to politicians (or, conversely, because of their ability to threaten politicians by mobilizing in opposition), and because implementing agencies often seek out well-organized communities in which to locate new projects.

By estimating the relative degree of community influence and the relative stability of the alignment between politicians and implementing agencies for each case study, I was able to explain the range of performance outcomes in condominial sewer projects in Recife and Natal. During the 1980-1995 period in Recife, alignments between politicians and implementing agencies were generally unstable at both the municipal and state levels. Characteristics of Recife's implementing environment at that time included regime discontinuity, lack of inter-agency cooperation, lack of consistent agency support for condominial sewer technology and participation, and an inconsistent agency response to popular needs for basic sanitation[9]. As a result, successful condominial sewer projects such as Cases R1 and R3 were uncommon in Recife.

Recife's municipal government was relatively powerful compared to its state government. The City of Recife's power and autonomy increased further after the federal government decentralized public finance arrangements[10]. With the election of Mayor Jarbas in 1985, Recife abandoned its complete reliance on the state water and sanitation agency (COMPESA) and began to develop its own capacity to provide local sanitation services. Because of Mayor Jarbas' leadership, municipal implementing agencies (OBRAS and EMLURB) were responsive to basic sanitation needs and were supportive of condominial technology and participation. Their approach to delivering sewer service was to focus on neighborhood-level projects[11]. Miguel Arraes, who at that time was a populist politician in the same political party as Mayor Jarbas, held the position of governor of the state during the last two years of the first Jarbas regime. During this brief period (from 1987 to 1988), the interests of the mayor and the governor with regard to sanitation development were in good alignment. Likewise, the interests of the state and municipal implementing agencies in Recife aligned briefly around condominial sewer projects that were implemented during this period (e.g., Case R1).

This two-year period of alignment between local and state politicians and agencies in Recife was uncharacteristic of the 1980-1995 period. Except for this two-year period of alignment, the mayor and the governor typically were in different, often oppositional, political parties. Moreover, the lack of alignment in interests made it difficult to consolidate condominial sewer technology as the technical norm in Recife. The EMLURB agency embraced condominial technology under Mayor Jarbas, but the COMPESA and URB agencies were not in agreement – some staff accepted condominial technology (and participation) and other staff wanted to maintain the high engineering standards of conventional sewers. Another source of conflict was that condominial sewer projects implemented by Recife's city agencies had to be reviewed by and handed over to a state agency (COMPESA) for maintenance. At that time, COMPESA was generally unresponsive to local needs in Recife and unsupportive of condominial technology and participation. As a result, COMPESA's support for the City's condominial sewer projects was inconsistent. The agency accepted some projects and abandoned others.

Unstable alignments in the interests of Recife's politicians and agencies led to poor project performance, especially in cases where the community had little influence and did not participate in project mobilizing and project decisions (e.g., Case R2). In cases where the alignments were stable, where the community had a higher degree of influence, and where beneficiaries participated in project mobilizing and decisions, project performance was good (e.g., Case R1 and R3).

During the same time period, the City of Natal experienced a long, relatively stable period of alignment, in which politicians and the implementing agency shared an interest in condominial sewer development. Compared to Recife, the City of Natal's government was less powerful relative to the state government, and Natal maintained its dependence on the state water and sanitation agency (CAERN) for a longer time than Recife. CAERN had developed a country-wide reputation for success in implementing condominial sewers, despite the relatively low percentage of the Natal population that was sewered. Compared to Recife, changes in municipal and state political regimes during the 1980s in Natal had less of an adverse impact on condominial sewer projects. Several state governors of different political parties allowed CAERN a degree of autonomy in implementing large condominial sewer projects in Natal.

Because condominial sewer projects in Natal were state-led rather than city-led, projects could be organized by sewer basin instead of by neighborhood. Unlike mayors, governors were not beholden to neighborhood-specific votes. Therefore, there was less political incentive for CAERN, a state agency, to organize projects by neighborhood. Since there was only one implementing agency in Natal, the lack of inter-agency cooperation was not an important factor as it was in Recife. Moreover, because of Natal's more stable political and institutional environment, condominial sewer technology and participation were accepted as the technical norm in Natal far earlier than they were in Recife. For all of these reasons, Natal enjoyed a stable alignment of interests between politicians and agencies in support of condominial sewers for an extended period of time (i.e., 1980-1990).

Projects that were implemented during Natal's 10-year period of stable alignments tended to perform relatively well, even in low income communities (e.g., Case N2). Evidence for good performance includes the narrow range between the perceived best and worst functioning projects in Natal, the relatively high sewer performance index (SPI) results for the worst project in Natal, comments from agency staff and condominial sewer practitioners in Natal and Recife, and my own direct observation of the conditions of many condominial sewer systems in both cities. A consistent program of participation also was routinely used by CAERN in most of Natal's condominial sewer projects. Evidence for consistency in participation is the similarity of scores for participation in mobilizing, decisions, construction, and maintenance across the three case study projects in Natal.

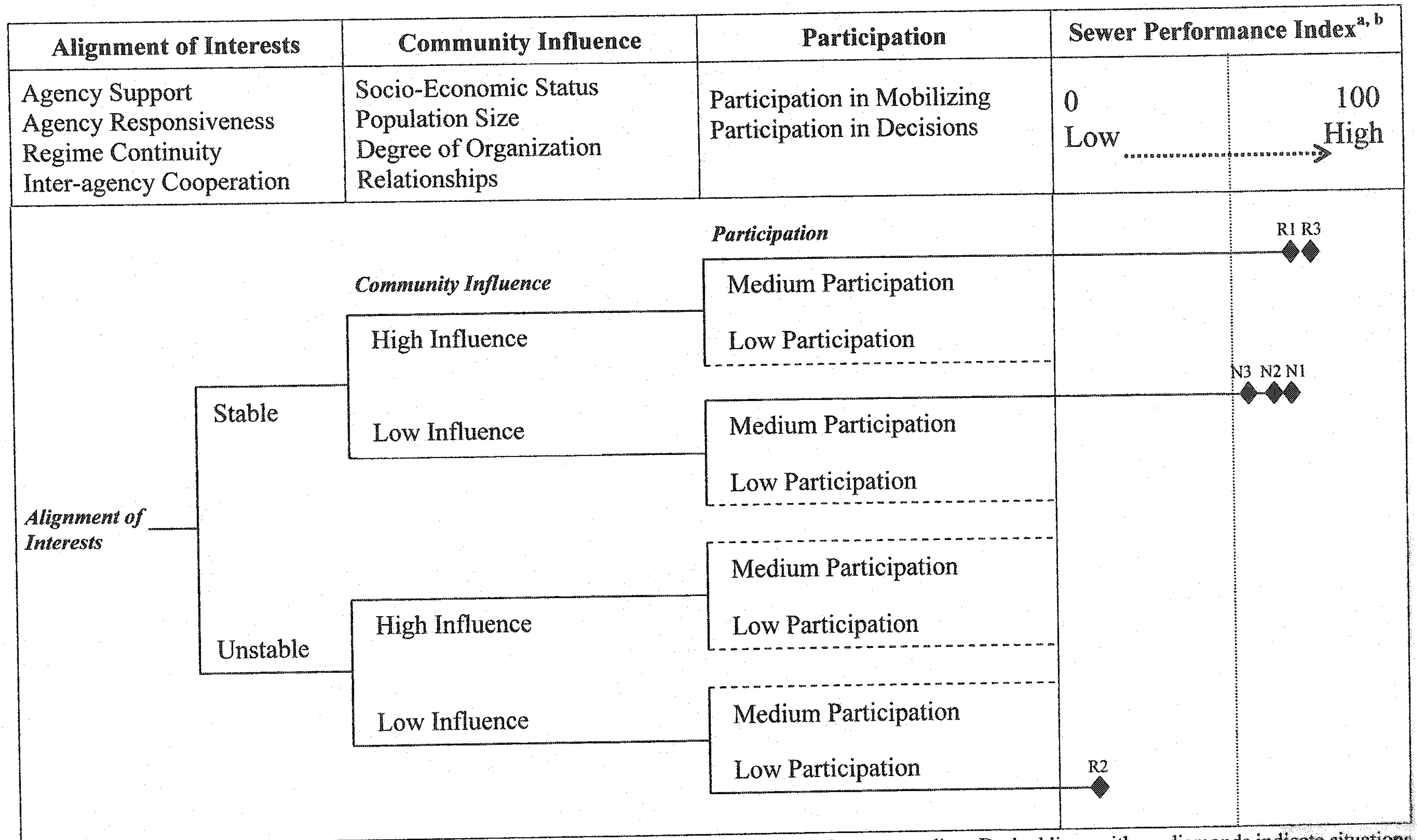
Just as a neighborhood focus was not important in Natal, community influence also was relatively less important, compared to Recife. Residents in Natal rarely mobilized to "fight" for sewer projects as they did in Recife during the period in question. Instead, CAERN routinely approached residents to offer them projects. CAERN had a basin focus, so project areas were generally large in Natal, and project area population size was often large, sometimes spanning several distinct neighborhoods. Nevertheless, these large project areas were not necessarily well-organized as a whole. Some of the neighborhoods making up project areas did not have a neighborhood president. Some had numerous community-based organizations (e.g., mother's clubs), but did not have an organization that represented the whole community. CAERN's approach did not rely on the mobilization and organization of the entire project area. CAERN's approach was to mobilize the residents of each block into sewer users groups and to implement its participation program block by block.

With regard to relationships, I did not identify any specific social, political, business, or family ties for the cases studied in Natal. Project areas in Natal varied mostly by socio-economic level. I estimate that none of the case study project communities in Natal had high overall levels of community influence, although project area populations were typically large and the neighborhoods making up the project areas did vary by socio-economic level. Despite the relatively low levels of community influence exhibited in Natal (compared to Recife), project performance outcomes were generally good. The explanation turns on the alignment of interests between the state governors and CAERN in the period in which the Natal cases were implemented.

The findings from Natal show that with stable alignments, good project performance could be obtained even in communities with relatively low influence. In contrast, the findings from Recife show that all three parameters (stable alignments, participation in project mobilizing and decisions, and high levels of community influence) were needed to produce good project performance.

Figure 9-1 presents a diagram that illustrates the three factors associated with performance. In Figure 9-1, one factor does not necessarily lead to the presence of another factor; rather, the presence of more factors at higher levels increases the overall probability of success. The relationships among these three factors will be considered in a later section of this chapter.

In Figure 9-1, the six case studies appear on the project performance scale based on the value of their respective sewer performance indices. The average SPI for Recife's best performing case study projects was 69, and the average SPI in Natal was 63. These rather ordinary values suggest that the best performing condominial sewer projects in Recife and Natal did not exhibit extraordinary levels of performance. The average score for participation in mobilizing and decisions among Recife's best performing case study projects was 54, and the comparable average score in Natal was 38. These medium level scores suggest that only medium levels of participation were achieved in Recife and Natal's best performing projects.



a. Filled diamonds and solid lines indicate a set of hypotheses supported by information from full case studies. Dashed lines with no diamonds indicate situations for which no case study evidence was evaluated in this dissertation.

b. R1 = Case R1; R2 = Case R2; R3 = Case R3; N1 = Case N1; N2 = Case N2; N3 = Case N3.

Figure 9-1. Diagram of the enabling factors that contribute to good condominial sewer project performance in Recife and Natal.

Based on the results in Recife, it appears that all three factors – alignment of interests, community influence, and participation in mobilizing and decisions – were needed to attain good performance in Recife. The project that had none of these three factors performed poorly (i.e., R2), and projects that performed well had all three factors present in a medium or high degree (i.e., R1 and R3). These results suggest that in Recife's context, all three factors were necessary for success.

Relatively good performance was attained for all of the case studies in Natal. These projects all had alignment of interests in a high degree and participation in mobilizing and decisions in a medium degree (i.e., N1, N2, and N3). The case studies in Natal all had low levels of community influence, which suggests that this was not an important factor in the context of Natal.

9.2 One Additional Case Study

An additional case study from Natal is introduced to test the integrity of the argument that was made based on the original six case studies.

Case Study N4. The Case N4 condominial sewer was installed in 1987 in a small high income area of Natal located across the street from CAERN's headquarters. Residents mobilized themselves around the idea of receiving a sewer project, and they requested a project from CAERN. The agency responded with a condominial sewer project and offered Case N4 residents a choice of condominial sewer layouts. Although the residents mobilized themselves for the project, their rates of involvement in CAERN's participation program were relatively low. Residents typically hired local contractors to construct their house connections and to maintain their sewers.

The resulting project consisted mostly of sidewalk condominial sewers discharging to existing conventional street sewers in the neighborhood. Final discharge of the collected sewage went untreated to the Potengi River. The project was planned and funded through CAERN, designed and constructed by a CAERN contractor, and accepted and maintained (as of 1995) by CAERN. The entire Case N4 project was completed during the "golden age" of condominial sewer implementation in Natal, during which political support for condominial sewers was continuous and CAERN, the sole implementing agency, was a driving force for condominial sewer development throughout the State of Rio Grande do Norte.

The Case N4 project had medium participation in mobilizing and decisions; and high participation in construction and maintenance. Medium operability and high impacts scores were achieved. These results are indicated by the scores in Table 9-1.

Table 9-1. Scores for participation and performance in Case N4. (100 = maximum participation and maximum performance).

Category of Participation	Scores
Mobilizing	60
Decisions	36
Construction	79
Maintenance	86
Performance Objective	**Scores**
Operability	58
Impacts	86
Sewer Performance Index	72

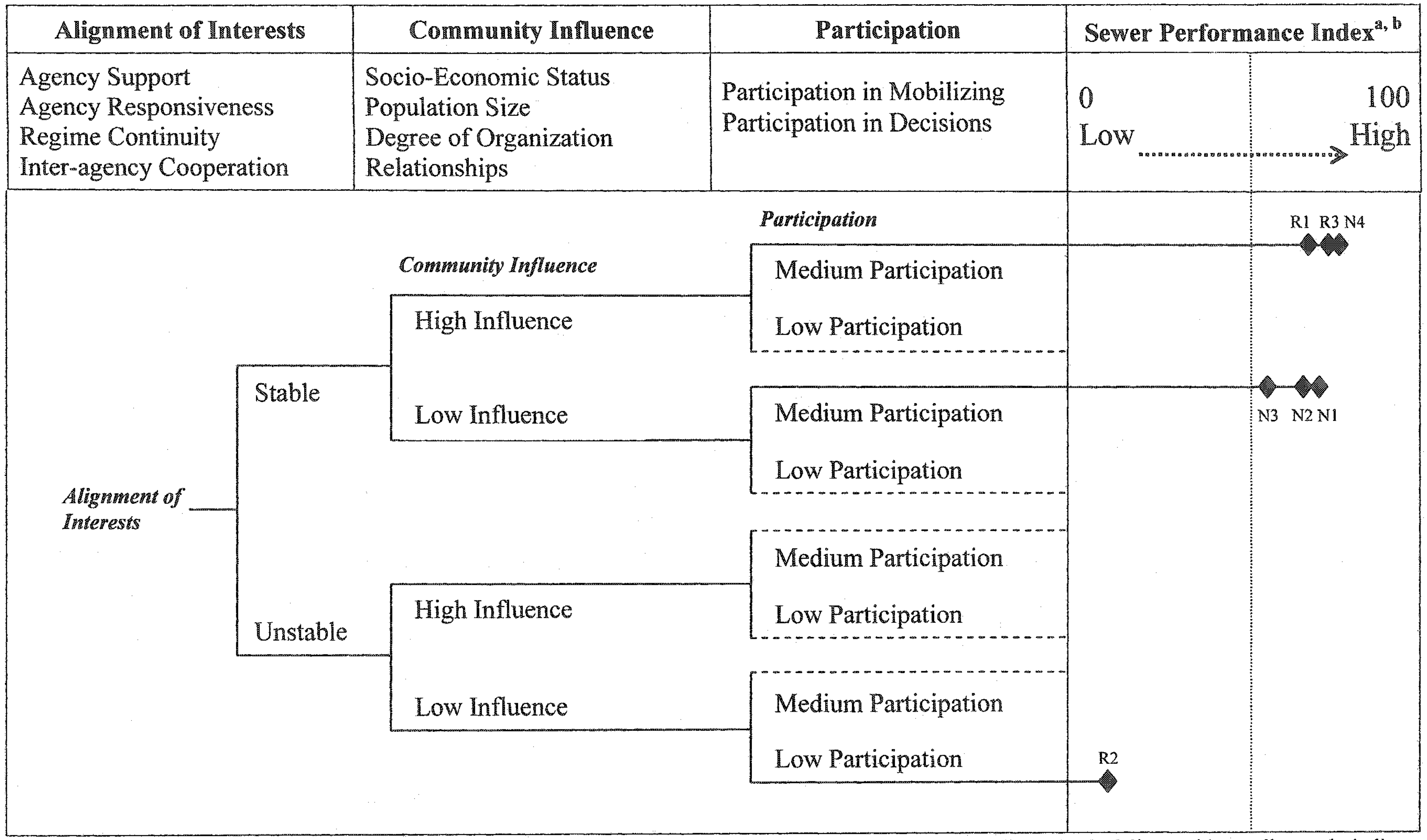
Source: My calculations use primary data from interviews with random samples of residents, interviews with engineering and maintenance staff, direct observations, and project knowledge acquired by the author. Participation calculations follow the method presented in Appendix D; performance calculations follow the method presented in Appendix C.

Information about the alignment of interests and the level of community influence for Case N4 is presented in Table 9-2, and Case N4 is added to the summary diagram in Figure 9-2. Case N4 had all three factors present and achieved good performance, which falls in line with the previous findings. The addition of Case N4 does not, however, provide an answer to why good performance was possible in Natal without community influence. In the next section, I present a theoretical interpretation of the findings that attempts to answer this question.

Table 9-2. Characterization of the alignment of interests and community influence for Case N4[a].

Case[b]	Alignment of Interests					Community Influence				
	Agency Support for the Condominial Approach	Agency Responsiveness to Popular Needs for Sanitation	Project Completion within a Continuous Regime	Cooperation Between Different Implementing Agencies	Overall Characterization[c]	Socio-Economic Status of the Project Area	Population Size of the Project Area	Degree of Organization of the Project Area	Relationships Held by Individuals in the Project Area	Overall Characterization[d]
N4	✓	✓	✓	✓	Stable	✓		✓	✓	High

a. A check mark indicates the presence of the factor.
b. N4 = Case N4.
c. An overall characterization of "unstable" corresponds to zero, one, or two check marks. "Stable" corresponds to three or four check marks.
d. An overall characterization of "low" corresponds to zero, one, or two check marks. "High" corresponds to three or four check marks.



a. Filled diamonds and solid lines indicate a set of hypotheses supported by information from full case studies. Dashed lines with no diamonds indicate situations for which no case study evidence was evaluated in this dissertation.

b. R1=Case R1; R2=Case R2; R3=Case R3; N1=Case N1; N2=Case N2; N3=Case N3; N4=Case N4.

Figure 9-2. Addition of Case N4 to the diagram of enabling factors.

9.3 Theoretical Implications: Project Coalitions

Why were all three factors needed to achieve good performance in Recife, and only two factors (i.e., alignment of interests and community influence) were needed to achieve good performance in Natal? To answer this question I introduce the concept of the project coalition, which consists of the main project stakeholders that support individual projects: elected officials, implementing agencies, and project communities. The linkages among these stakeholders are the alignment of interests between elected officials and agencies, community influence on elected officials and agencies, and participation in mobilizing and decisions. These concepts are illustrated visually in Figure 9-3. I argue that good project performance is primarily a function of the staying power of the project coalition, and that condominial sewer project coalitions formed more readily and lasted longer in Natal than in Recife during the period studied. Recife's ad hoc approach to sanitation development produced short-lived project coalitions[12]. This explains why there were fewer good performing projects in Recife overall, and why all three factors were needed to achieve the few instances of good performance that did emerge.

Natal had the benefit of a "golden age" of condominial sewer implementation, during which the interests of elected officials and the implementing agency (vis a vis condominial sewers) were in alignment for almost ten years. This, in addition to the professional commitment of CAERN staff to condominial sewer technology and a participation approach, resulted in a relatively coherent implementation approach as well as program improvements over time.

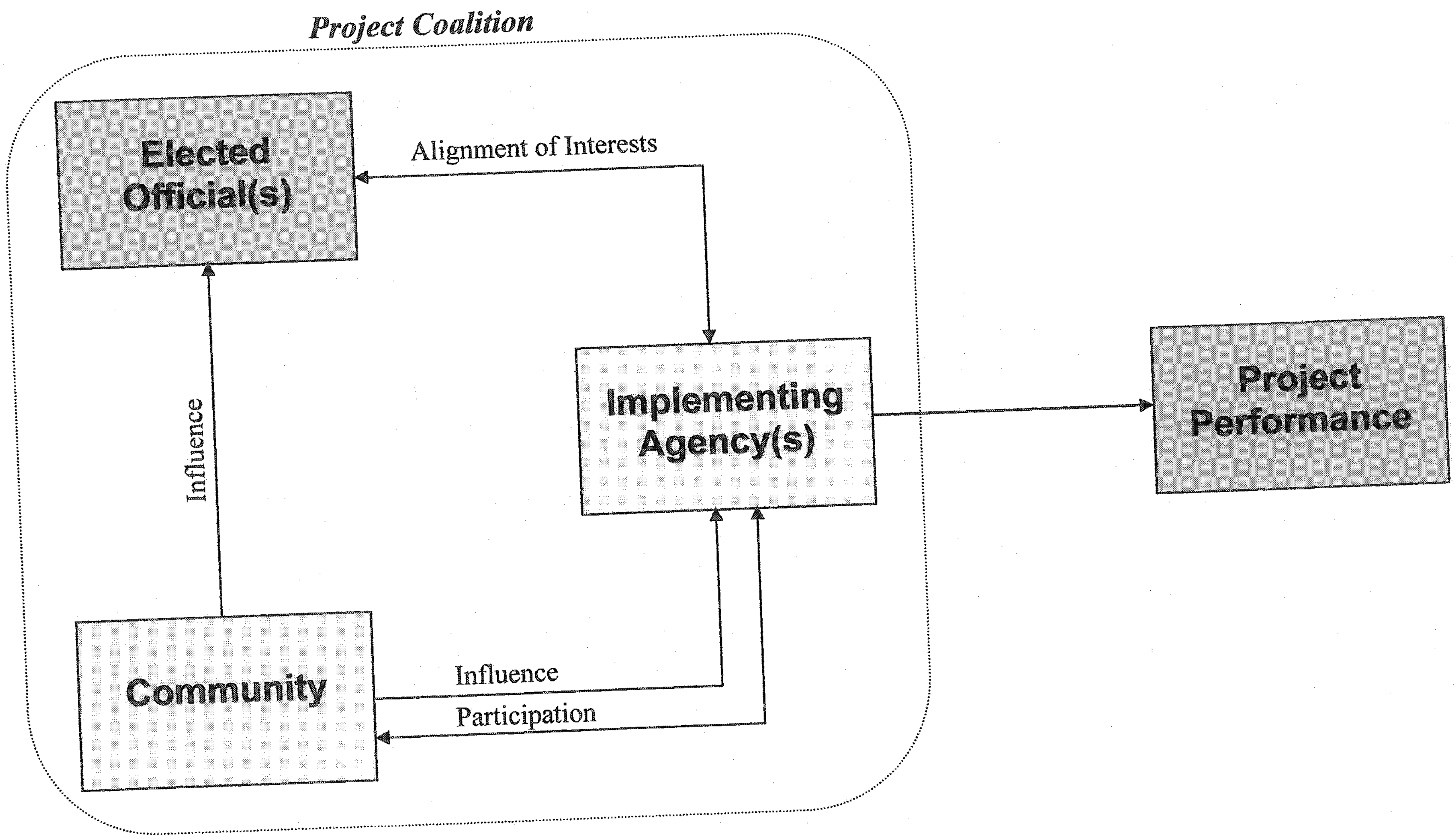


Figure 9-3. Illustration of the linkages among stakeholders that strengthened condominial sewer project coalitions and enabled good performance.

With few exceptions, most condominial sewer projects implemented during this period performed reasonably well in communities with relatively low influence (i.e., Cases N1, N2, and N3) as well as in communities with relatively high influence (e.g., Case N4).

The inclusion of beneficiaries in project mobilizing and project decisions strengthens the project coalition. However, condominial sewer performance in urban areas does not improve when residents contribute to project construction and maintenance. Rather, actions by the implementing agency directly lead to better project performance. In an urban setting with an established sewer authority, the actions of implementing agencies most directly affect project performance because agencies implement and maintain most of the sewer system. When the agency performs better, condominial sewer projects perform better.

The actions of politicians and beneficiaries can enable and support the actions of the implementing agency in achieving good performance. When politicians, implementing agencies, and beneficiares form a strong, cohesive project coalition with staying power, good project performance is more likely. Residents' participation in mobilizing and their involvement in project decisions provide local knowledge and a clear expression of local needs to the agency, thus enabling the agency to perform better during project implementation. However, while resident participation during the project implementation period may facilitate the installation of a project, it is not enough to sustain good long term performance. This is why the other factors are important.

Residents in Recife had to constantly exert influence or pressure on the implementing agency and on elected officials to maintain a coalition of support for the project and to ensure continued sewer service. To the extent that the interests of beneficiaries are taken into account, the project coalition is made stronger, more cohesive, and better targeted to succeed in meeting beneficiaries' needs. Cohesive, stable project coalitions – made up of agencies, politicians, and beneficiaries – have better chances of implementing projects *and* maintaining the investment than weak, short-lived coalitions.

The importance of a project coalition was derived inductively from the empirical data presented in this dissertation; however, the significance of project coalitions can be considered an extension of Korten's (1980) conception of "fit" for implementing successful development projects[13]. Korten proposed that the organization, the beneficiaries, and the project are tightly linked, and that a successful implementation occurs when all three parameters achieve a high degree of "fit." To achieve fit, the following must occur: a project must match the perceived needs of beneficiaries, beneficiaries must have effective ways of expressing their needs to the appropriate implementing organization, the organization must be responsive to these needs in its decision-making and, finally, the implementing organization must have the capacity to effectively carry out its work.

The idea of a project coalition extends Korten's conception by adding a political dimension. The trio of parameters making up Korten's conception are the organization, and beneficiares, and the project. The project coalition, however, is comprised of the implementing agency, the beneficiaries, and the *elected official*. Similar to the goal of achieving "fit," I argue for the importance of obtaining a cohesive, stable coalition. Cohesion and stability of project coalitions are achieved through participation of beneficiaries in project mobilizing and project decisions, through community influence on the agency and elected official, and through the influence of the elected official on the implementing agency.

The data from Recife and Natal suggest that when the interests of elected officials and implementing agencies are aligned in support of condominial sewer projects (or at least not in opposition), stronger project coalitions are able to form and project success is more likely. Project beneficiaries are an important member of project coalitions, and they can strengthen project coalitions by participating in project mobilizing and project decisions, and by exerting influence on officials and agencies. When alignments are stable over a long period, as they were in Natal, community influence is not particularly important. But when the stability of alignments is problematic, as it was in Recife, strong community influence was needed in order to keep project coalitions from falling apart.

Although more empirical evidence would be needed to further develop it, the project coalition concept in Figure 9-3 has three valuable characteristics. First, this concept is consistent with and extends existing theories of infrastructure service provision in developing countries (particularly the work of Korten (1980) and Narayan (1994)). Second, this project coalition argument provides a robust explanation for variations in the performance of condominial sewer projects in Natal and Recife during the 1980-1995 period. Third, Figure 9-3 represents a simplified explanatory model that has the potential to unify a set of complex phenomena, including the impact of participation and the impact of urban politics on project implementation.

---

[1]Watson, 1995.

[2]Korten, 1980; World Bank, 1994; and World Health Organization, 2003.

[3]For example, see Schubeler, 1993; Gerson, 1993; Paul, 1987; Finsterbusch, 1987; Narayan, 1994; Korten, 1980; Korten and Alphonso, 1985; Bryant and White, 1982; and others.

[4]Two examples are the Casa Jeri project in Recife (see Chapter 5, Section 5.3.2) and the Rosa Flora project in Natal (see Chapter 6, Section 6.3.3).

[5]Altshuler and Luberoff, 2003:222.

[6]Fainstein and Fainstein, 1983.

[7]Altshuler and Luberoff 2003:224.

[8]Altshuler and Luberoff, 2003:267.

[9]Refer to Sections 5.2 and 5.4 of Chapter 5 for evidence supporting this statement.

[10]Refer to Section 4.2.3 of Chapter 4 for a discussion of the decentralization of public finance.

[11]Refer to Sections 5.4.2 and 5.4.4 of Chapter 5 for evidence supporting this statement.

[12]Refer to Section 5.4.5 of Chapter 5 for a discussion of Recife's ad hoc approach. Also refer to Sections 5.4.2, 5.4.3, and 5.4.4 of Chapter 5 for supporting evidence.

[13]Korten, 1980:495-498.

Chapter 10

Conclusions

In this chapter, I summarize the conclusions of the dissertation (Section 10.1) and offer suggestions for follow-on research (Section 10.2).

10.1 Conclusions

The participation of beneficiaries in project mobilizing and project decisions was positively associated with project performance for the three condominial sewer case study projects in Recife. However, the participation of beneficiaries in project construction and project maintenance work was *not* positively associated with condominial sewer project performance in Recife. There was not enough variation among the three case study projects in Natal to discern an association between participation and performance.

Three key factors shaped project performance in Recife: the alignment of interests among elected officials and implementing agencies, the influence of communities on elected officials and implementing agencies, and the participation of communities in project mobilizing and project decisions. In Natal, the alignment of interests among elected officials and implementing agencies was so strong that community influence and participation seemed relatively less influential on project performance.

The case study results can be explained by the degree to which cohesive, stable project coalitions were formed, where project coalitions consisted of elected officials, implementing agencies, and project communities. Based on these conclusions, the following hypotheses are proposed:

1. Project performance is contingent on the cohesion and stability of project coalitions.
2. Project coalitions are strong and stable when the following conditions hold:
    a. Interests of elected officials and implementing agencies are aligned in support of a project;
    b. Project beneficiaries are able to influence elected officials and implementing agencies; and
    c. The project community participates in project mobilizing and project decision-making.
3. In some contexts, community influence, alignment of interests, and participation in mobilizing and decisions are necessary for good performance. In other contexts, good performance can be achieved with just alignment of interests and moderate levels of participation in mobilizing and decisions.

The analysis in this dissertation benefited from unpacking the concept of participation into four categories – mobilizing, decision-making, construction, and maintenance – and showing the relative importance of each category to condominial sewer project performance. Condominial sewer implementation is best understood in its broad political context, whereby communities can strengthen project coalitions through both their political participation and their project participation.

10.2 Suggestions for Further Research

If I were to conduct this research again, there are several ways I would improve the study, knowing what I know now. I would use a common scale for more of the interview questions to facilitate coding and analysis, and I would take more steps to improve the rate of response of residents to the semi-structured interview questions. I would conduct in-depth interviews with more city mayors and state governors, because they can directly impact projects throughout the project cycle (i.e., not just in the initial stages of a project). To address the lack of household-level public health data, I would conduct interviews with doctors from local health clinics for information regarding waterborne disease. Also, I would conduct more research in local libraries and government archives to establish the political platforms, parties, and timelines of city and state elections more precisely.

I would also pay more attention to the political administration that is in office during the fieldwork period, and the likely impact the administration might have on who could be interviewed and what information could be obtained. Most importantly, I would read more about the urban politics of each city in advance of the fieldwork. I learned that no matter how much knowledge I had about Brazil or about the region of interest (e.g., the history, the economy, the politics, the environment, the sociology, and the culture), I still needed a great deal of information about the local political forces within each case study city, and this level of information is difficult to obtain in the US.

I suggest the following subjects as potentially fruitful areas of future research on the performance of condominial sewers.

Follow-on Empirical Investigation of Condominial Sewer Implementation in Urban Areas. Conduct a study of the period immediately following the period studied in this dissertation. At the time I left the field in 1995, Natal's implementing environment seemed to be destabilizing as a result of the expiration of CAERN's contract and pressures on the City to privatize its sanitation services. Conversely, Recife's implementing environment seemed to be stabilizing as a result of the consolidating policies and regulations initiated during the second Jarbas regime. This consolidation was an effort to solve the earlier problems in which regime discontinuity and lack of agency cooperation stymied progress with condominial sewers.

Recent data from Brazil's Census Bureau show that Recife has made considerable progress in expanding sewer service since 1995[1]. By 2000, approximately 43 percent of the Recife population was sewered, while Natal had only increased its sewer coverage level to 26 percent of the population in the same year. It would be interesting to investigate how the alignment of interests, the degree of community influence, and the level of participation changed in Recife, and whether these changes were associated with improving or worsening project performance.

Development of a Sewer Performance Scale. In this dissertation, I took the initial steps of developing a sewer performance index for condominial sewer projects based on the concept of service performance developed by Abbott[2]. It would likely be advantageous to create a formalized scale (or index) for measuring sewer performance. In many developing country settings, firm technical evidence - in the form of as-built drawings, sewer videos, flow and depth measurements, infiltration/inflow studies, cost information, maintenance records, and household-level health and waterborne disease data - simply is not available. Although I sought this type of information, none of these data were available before, during, or after my fieldwork in a form that was disaggregated at the household or project level. The development of a performance scale based on the types of information that are available would be a useful analytical instrument for project evaluators in countries with similar constraints.

A sewer performance scale would clearly improve the ability to evaluate condominial sewer systems. A formal scale would also facilitate the comparison of project outcomes on a broader level, such as from one country to another. For example, having a formally developed and validated performance scale would facilitate the analysis and comparison of performance between condominial sewer projects in Bolivia and Brazil.

Empirical Investigation of Condominial Sewer Implementation in Rural Areas. Case studies in interior towns would allow for an investigation of the effectiveness of user groups (*condominios*) on project success. User groups did not fully form in the urban settings I studied in this dissertation. Several CAERN staff mentioned that condominial sewers in the small interior towns of Rio Grande do Norte (populations less than 20,000, typically) generally functioned better than projects in Natal[3].

CAERN staff suggested that the formation of user groups was a key to the improved performance in interior towns. People in the interior tended to own (not rent) their homes and to live in one home for a long time (often for their entire lifetime), so it was thought to be easier for interior residents to form cohesive user groups and to build a solid understanding of how to best use the sewer system. General knowledge about sewer systems is part of what is meant by a "sewer culture," whereby the general population understands the basic link between sanitation and health, and there is a widespread consensus about the fundamental need for sewer systems. In general, interior city residents formed user groups (*condominios*) and performed maintenance on their condominial sewers, only calling upon CAERN for help as a last resort. CAERN staff who had worked on sewer systems in towns in the interior said that residents there seemed to value their sewer system more than city residents, as evidenced by a higher level of overall cleanliness despite even worse poverty. They also reported that sewer systems in the interior experienced fewer blockages than the urban systems.

A second proposed reason why condominial sewer systems functioned better in the small rural towns of Rio Grande do Norte was the drier climate of the interior. Because the interior experienced less rainfall than the coastal city of Natal, there were fewer tendencies to connect storm water runoff to the condominial sewer system. Such connections decreased sewer performance because they contributed excess flow, soil, and debris to the sewer system.

Several staff also reported that city governments in the interior were more involved in condominial sewer implementation than Natal's municipal government[4]. In Natal, CAERN only worked with residents. In the interior cities, where the mayor was usually in the same political party as the governor, CAERN implemented condominial sewers in partnership with the city and with residents. Interior city governments constructed the condominial sewers and house connections, and CAERN constructed the street sewers and treatment facilities. Because of the interior city's involvement, the construction of house connections tended to be higher in quality and the systems tended to function better than systems in Natal where residents constructed their own house connections. This preliminary information about the implementation of condominial sewers in the interior of Natal suggests that the main factors associated with project success in a rural setting may be different than in the urban settings studied in this dissertation.

---

[1]IBGE, 2000.
[2]Abbott, 1996:167.
[3]Informant 121, CAERN sewer construction division manager and former CAERN directorate member, interview by author, 1 June 1995, Natal, transcript; Informant 96, CAERN civil engineer, interview by author, 25 May 1995, Natal, transcript; and Informant 76, CAERN social worker, interview by author, 30 May 1995, Natal, transcript.
[4]Informant 78, CAERN sewer design division chief, interview by author, 24 May 1995, Natal, transcript; Informant 122, CAERN sewer construction division chief, interview by author, 7 June 1995, Natal, transcript; Informant 121, CAERN sewer construction division manager and former CAERN directorate member, interview by author, 1 June 1995, Natal, transcript; and Informant 96, CAERN civil engineer, interview by author, 25 May 1995, Natal, transcript.

Appendix A

Guides for Semi-Structured Interviews

Implementação de Sistemas de Esgotos Condominiais no Brasil
Pesquisa pela E. Anaya Nance, Universidade de Stanford, EUA

Guia de Entrevista de Morador

Estudo de Caso:______ Bairro:_______________ ________ Domicilio:___________

Entrevistador:________________________ Local da Entrevista:__________________

Tempo:___________ Data:____________ Outro Data Combinada:______________

Moradores a Serem
Entrevistados: _________________________ Sexo ____ Consentimento Dado?____

_____________________________ Sexo ____ Consentimento Dado?____

* * *

1ª Parte - Resultado do Projeto

1-1. **A sua casa esta ligada ao sistema de esgoto condominial?**
Circula um.

Sim Nao

Em caso negativo, pergunte o seguinte:

Porque sua casa nao esta ligada?

1-2. **Qual a sua avaliacao sobre o funcionamento, hoje, do ramal do esgoto que interliga sua residencia ao esgoto condominial?**
Circula um.

Pessimo Regular Bom Muito Bom Otimo

1-3. **Como voce avaliaria o grau de eficiencia de funcionamento, do rede publica de esgoto condominial do seu bairro?**
Circula um.

Pessima Regular Boa Muito Boa Otima

1-4. **Descreva os problemas que voce tem tido com o ramal do esgoto condominial de sua residencia e com o sistema de esgoto condominial de sua rua.**

1-5. **Como funcionava o sistema de esgoto condominial logo apos a sua construcao?**

1-6. **Que avaliacao voce faria sobre o seu grau de satisfacao, para com o seu sistema de esgoto condominial em geral, quando o mesmo era novo?**
Circula um.

Nenhuma Baixo Medio Bom
Otimo

1-7. **Que avaliacao voce faria sobre o seu grau de satisfacao, para com o seu sistema de esgoto condominial em geral, hoje?**
Circula um.

Nenhuma Baixo Medio Bom
Otimo

1-8. **Quais sao as desvantagens do seu sistema de esgoto condominial?**

1-9. **Em sua opinao, de que forma ou em que grau mudou o meio-ambiente e a saude de sua comunidade, desde a implantacao do sistema de esgoto condominial?**

* * *

2ª Parte - Uso do Sistema e Servico

2-1. **Hoje, como voce faz para se livrar das aguas resultantes da limpeza domestica? E quanto aos fezes, onde eram lancadas?**

2-2. **Voce ja se queixou sobre o servico de esgoto ou situacao sanitaria? Em caso positivo, informe quantos vezes, a quem e como. E quanto tempo voce teve que demorar para atendimento, usualmente?**

Circula um.

Nunca ou | Ate 5 Vezes | Ate 10 Vezes | Mais de 10 Vezes | Uma Vez

Explique a quem e como.

Circula um.

Nunca Atentido	Atendido Esporadicamente	Dentro de Uma Semana	Dentro de Tres Dias

2-3. Quem mantem o sistema publico de esgoto e estacao de tratamento de esgoto, alem de dar-lhes manutencao, quando ocorre algum problema?

2-4. Quem conserta o sistema de esgoto de sua residencia, quando ha algum problema, e quem paga as despesas?

2-5. Voce ou alguem da sua residencia ja precisou remover ou quebrar a tampa da caixa de esgoto, dentro da sua propriedade, por algum motivo? Se sim, explique.

Circula um.

Sim Nao

Se sim, explique.

2-6. E quanto a tampa da caixa de esgoto da rua, ja precisou ser removido ou quebrado por voce ou alguem da sua residencia, por algum motivo? Se sim, explique.

Circula um.

Sim Nao

Se sim, explique.

2-7. De acordo com os itens abaixo, qual a situacao da tampa da caixa de esgoto, da sua propriedade?

Circula as respostas.

a. **A tampa esta danificada ou perdeu-se.** Sim Nao

b. **A tampa e mantida fora da caixa por nenhum motivo especial.**

Sim Nao

c. **Voces remover a tampa, para despejar esgoto domestico.**

Nunca ou Uma Vez | As Vezes | Frequentemente ou Todos os Dias

d. **Voces remover a tampa, para despejar lixo em geral.**

Nunca ou Uma Vez | As Vezes | Frequentemente ou Todos os Dias

e. **Voces remover a tampa, para despejar agua emposada da chuva.**

Nunca ou Uma Vez | As Vezes | Frequentemente ou Todos os Dias

f. **Voces remover a tampa, para desentupir o esgoto.**

Nunca ou Uma Vez | As Vezes | Frequentemente ou Todos os Dias

g. **Voces remover a tampa, para inspecionar o funcionamento da sistema.**

Nunca ou Uma Vez | As Vezes | Frequentemente ou Todos os Dias

2-8. **De quem voce acha que deveria ser a responsabilidade pelo funcionamento, do ramal de esgoto de sua residencia?**

2-9. **E quanto ao sistema publica na rua? De quem voce acha que deveria ser a responsabilidade pelo funcionamento dos mesmos?**

2-10. **Voce paga alguma taxa pelo seu esgoto condominial? Se sim, quanto?**

Circula um.

Sim Nao

Solicite a apresentacao de alguma conta de agua antigo ou recente, e registre os seguintes dados.

Agua Consumida: ________________________________ Data: ____________

Taxa de Consumo: ________________________________

Taxa de Esgoto: ________________________________

2-11. **Como voce avaliaria o preco da conta do seu servico de esgoto?**

Circula um.

Dificil para Pagar   Mais ou Menos   Facil para Pagar

2-12. **Voce ja viu ou ja tomou conhecimento de algum trabalho de manutencao, efetuado pela COMPESA, no sistema de esgoto condominial do seu bairro ou na estacao de tratamento de esgoto do mesmo?**

2-13. **E quanto a Prefeitura? Ja viu ou tomou conhecimento de algum trabalho de manutencao, realizado por ela, nos sistemas de esgoto e de tratamento de esgoto?**

2-14. **Voce ou alguem na sua casa sabe como consertar o sistema de esgoto condominial de sua residencia? Que ferramentas voce usa para conserta-lo? Quais os problemas mais comuns, que voce ja consertou?**

Circula um.

Sabe Como Consertar   Nao Sabe Como Consertar

Registra as ferramentas.

Registra os problemas.

*   *   *

3ª Parte - Envolvimento do Morador

3-1. **Estiveram alguns moradores envolvidos no planejamento, no desenho ou implantacao do sistema de esgoto condominial? Em que estiveram envolvidos?**

3-2. **Voce ou alguem de sua residencia esteve diretamente envolvido no planejamento, no desenho ou implantacao do sistema de esgoto condominial? Se sim, como?**

Marca tudo que aplica.

______ Reunioes dos moradores sobre o projeto.
______ Reunioes com tecnicos, funcionarios ou engenheiros sobre o projeto.
______ Debates com tecnicos, funcionarios ou engenheiros sobre o projeto.
______ Programas de educacao sanitaria.
______ Programas de saude.
______ Construcao do projeto.
______ Resposta aos questionnarios.
______ Decisoes sobre a localizacao da caixa, do cano, ou qualquer aspecto do projeto.
______ Mobilizacao dos moradores para trazer o projeto a seu bairro.
______ Autorizacao da construcao de seu ramal.
______ Outros.

Explique os que estiveram marcado acima.

3-3. **Porque voce decidiu tomar parte ou nao tomar parte da implantacao do sistema de esgoto condominial?**

3-4. **Voce ou sua residencia contribuiu com mao-de-obra, dinheiro, parte de sua propriedade, ferramentas, materiais ou alguma outra coisa para o projeto do esgoto condominial?**

3-5. **Quais os grupos comunitarios e associacoes de bairro que estiveram envolvidas no projeto de esgoto condominial? E de que modo?**

Registra os grupos.

Grupos e Associacoes	Modo de Envolvimento

1.

2.

3-6. Comparado a outras comunidades, voce acha que e relativamente facil mobilizar os moradores daqui?

Circula um.

Bastante Dificil Dificil Mais ou Menos Facil Muito Facil

3-7. Como voca avaliaria o grau de interesse dos moradores desta comunidade em saneamento e esgotos?

Circula um.

Nenhum Baixo Medio Acima da Media Alto

* * *

4ª Parte - Implantacao e Orgaos

4-1. Alguem ja perguntou a voce ou a alguem da sua residencia, se voces queriam um sistema de esgoto condominial? Voce ja teve que assinar algum tipo de contrato relacionado ao esgoto condominial? Se sim, o que foi acordado?

Circula as respostas.

Foi perguntada, sim. Nao foi perguntada. Nao sabe ou nao lembra.

Assinou, sim. Nao assinou. Nao sabe ou nao lembra.

Se assinou, explique o que foi acordado.

4-2. Voce conhece pelos nomes alguns funcionarios, engenheiros e tecnicos, que tenham estado envolvidos, de alguma forma, em algum trabalho realizado no sistema de esgoto condominial desta comunidade? Se sim, fale os nomes.

Circula um.

Sim Nao

Registra todos os nomes.

	Nome	Cargo (se conhecido)	Orgao/Companhia (se conhecidos)
1.			

2.

4-3. **O que voce lembra sobre o modo como foi implantado o sistema de esgoto condominial neste comunidade?**

4-4. **Seu ramal foi construido de que material? Ocorriam quaisquer modificacoes ao seu ramal desde que implantacao?**

Explique.

* * *

5ª Parte - Informacao Geral

5-1. **Quais sao as vantagens de se ter um sistema de esgoto condominial?**

5-2. **Alguma vez voce ja quis a implantacao de sistema de esgoto condominial ? Se sim, porque? Se nao, porque?**

Circula um.

Sim Nao

Explique.

5-3. **<u>Antes</u> do esgoto condominial, como voce fazia para se livrar das aguas resultantes da limpeza domestica e banho? E quanto aos fezes, onde eram lancadas?**

5-4. **Dentre os itens abaixo, quais os tres mais importantes na sua comunidade, hoje?**

Marca tres.

______ Calcamento	______ Policiamento
______ Agua Encanada	______ Iluminacao Publica
______ Servico de Transporte (Onibus)	______ Posto de Saude
______ Escola	______ Coleta de Lixo
______ Esgotos Residencial	______ Galeria ou Canal
______ Sistema Telefonico (Orelhoes)	______ Outros

5-5. *Se esta casa e ligado ao sistema de esgoto condominial, a pesquisadora desenhar abaixo essa ligacao. Inclua no desenho a seguinte:*

- *Planta da casa com seus limites*
- *Indicacao da frente da casa*
- *Banheiro(s)*
- *Caixas dentro da propriedade*
- *Caixas da rua ou travessa*
- *Canos de esgoto*

5-6. *A pesquisadora devera inspecionar o ramal(s) do esgoto condominial da casa e os acessorios ligados ao sistema sanitario. Verificar os seguintes itens e circular tudo que aplica:*

Caixa:	Entupida	Escoando Normalmente	Transbordando	Nao Tem
Area da Caixa:	Cimentada	Nao e Cimentada	Limpa	Lixo
Cano do Esgoto:	Exposto	Enterrado	Quebrado	
Agua da Chuva:	Sem Ligacao	Ligacao de Cano	Ligacao de Esgoto Aberto	
Tampa:	Perdida	Danificada	Intacta	No Lugar
Fossa:	Em Uso	Em Desuso	Nao Tem	

Outros Infra-Estruturas:

	Tem	Tem Parcialmente	Nao Tem
Agua Encanada	____	____	____
Coleta de Lixo	____	____	____
Canal	____	____	____
Galeria	____	____	____
Ruas Pavimentadas	____	____	____
Quintal Cimentada	____	____	____

Outros Condicoes:

____ Nao ha esgoto a ceu aberta
____ Esgoto a ceu aberta no terreno
____ Esgoto a ceu aberta perto do terreno

____ O terreno inunda algumas vezes
____ A casa inunda algumas vezes
____ Nunca inunda

5-7. *A pesquisadora devera solicitar do(s) morador(es), que lhe mostre onde termina o ramal particular e onde comeca o rede publica. Explique abaixo.*

5-8. *A pesquisadora devera obter os seguintes informacoes.*

Quantos Moram na Residencia Hoje: ____________________________________

Tempo de Residencia: ____________________________________

Tempo no Bairro: ____________________________________

Profissoes dos
Moradores Residentes: ____________________________________

Renda da Residencia: ____________________________________

Quem Construiu a Casa? ________________ Tipo de Posse da Casa: ______________

Materiais de Construcao: ____________________ Topografia: ____________________

Implementação de Sistemas de Esgotos Condominiais no Brasil
Pesquisa pela E. Anaya Nance, Universidade de Stanford, EUA

Guia de Entrevista dos Engenheiros

Empresa: ________________ Cargo: __________________ Local do Entrevista: _______

Nome do Funcionário: _______________________ Consentimento: ________________

Tempo: _________________ Data: ___________________ Caso: __________________

1. **Há quanto tempo você trabalha nesta empresa? Há quanto tempo você está envolvido com trabalho de implementação dos esgotos condominiais?**

   Empresa ____

   Trabalho Condominial ____________________________

2. **Quais são as suas experiências profissionais e formação acadêmica? E quais são as dos seus colegas, aqui nesta empresa, que estão envolvidos com o trabalho de implementação dos esgotos condominiais?**

3. **A seu ver, nesta empresa, tem havido continuidade entre as equipes que lidam com esgotos condominiais?**

   Sim 2 Não 1

4. **Descreva de que forma os esgotos condominiais tem sido implementados por esta organização.**

5. **No seu entendimento, de que forma tem evolvido ou se modificado a implementação de esgotos condominiais, realizado for esta organização ?**

6. **Como você avaliaria o desempenho desta empresa, no trabalho de implementação do esgoto condominial?**

   1980's: Péssimo 1 Regular 2 Bom 3 Muito Bom 4 Ótimo 5

   1990's: Péssimo 1 Regular 2 Bom 3 Muito Bom 4 Ótimo 5

7. **Como você avaliaria o desempenho desta empresa, no trabalho de manutenção do esgoto condominial?**

   1980's: Péssimo 1 Regular 2 Bom 3 Muito Bom 4 Ótimo 5

   1990's: Péssimo 1 Regular 2 Bom 3 Muito Bom 4 Ótimo 5

8. **Descreva, resumidamente, a história do sistema de esgoto condominial nesta cidade, como você a conhece.**

9. **Descreva o seu papel, junto ao sistema de esgoto condominial.**

10. **De que forma tem variado o comprometimento das autoridades eleitas a cada ciclo eleitoral, em relação ao sistema de esgoto condominial?**

11. **De que forma tem variado o compromentimento desta empresa, em relação aos esgotos condominiais?**

12. **Como você carateriza o relationamento entre as organizações que executaram a implementação e manutenção do esgoto condominial?**

 1 Esteveram em competição?

 3 Cooperaram-se entre si?

 2 Agiram independentemente?

13. **Descreva algumas diferenças existentes entre os processos de implementação usados por esta empresa para esgotos convencionais, condominiais, e dreno.**

14. **Como você definiria um esgoto condominial?**

15. **Como você definiria um esgoto convencional?**

16. **Como você definiria um sistema de dreno?**

17. **Para você, é necessário que as casas tenham os seus ramais de esgoto interligados, para que se tenha um esgoto condominial?**

 Sim 2 Não 1

18. **Os usuários dos esgotos condominiais têm, necessariamente, mais trabalho e responsibilidade do que os usuários dos sistemas de esgotos convencionais?**

 Sim 2 Não 1

19. **Quem deveria ser responsável pela construção da interligação da casa ao sistema de esgoto condominial? Porque?**

20. **Na sua opinião, os moradores que desejam pagar por uma infra-estrutura de esgoto, devem ser atendidos em primeiro lugar?**

    Discordo **1** Indiferente **2** Concordo **3**

21. **Na sua opinião, o mau uso do esgoto condominial pelos moradores é a principal causa do seu baixo desempenho?**

    Discordo **1** Indiferente **2** Concordo **3**

22. **De que forma estiveram selecionados os bairros que receberam esgoto condominial?**

23. **De que forma foram selecionados os projetos condominiais que esta empresa aceitou?**

24. **Como esta empresa se comunicou e interagiu com os moradores? Quais os funcionários que são responsáveis pela interação com os moradores?**

25. **De que forma esta empresa obteve informações sobre os moradores, os quais of beneficiarios em potencial dos esgotos condo? (estudos, questionnarios, reunioes, visital, etc.)**

26. **Descreva o relacionamento que esta empresa tem tido, com a população carente desta cidade, e de que forma este relacionamento tem sofrido mudanças ao longo tempo.**

27. **A empresa possui registros das reuniões de bairros, bem como as visitas aos bairros associados aos projetos dos esgotos condominiais?**

    Sim 2 Não 1

28. **Que avaliação você faria sobre o desempenho e funcionamento total do sistema de esgoto condominial desta cidade?**

    Péssimo 1 Regular 2 Bom 3 Muito Bom 4 Ótimo 5

29. **Baseado no real retrato do funcionamento dos projetos de esgoto implantados aqui, como você avaliaria o grau de funcionamento dos esgotos condominiais, em comparação com os sistemas de dreno? Com os esgotos convencionais?**

30. **De acordo com sua experiência, o que mais frequentemente os moradores costumam fazer quando estão insatisfeitos com os serviços do esgoto condominial?**

31. **Você esteve envolvido nos seguintes projetos de esgoto condominial?**

Caso ____________ : Sim **2** Não **1**

Caso ____________ : Sim **2** Não **1**

Caso ____________ : Sim **2** Não **1**

Caso ____________ : Sim **2** Não **1**

Se sim, de que maneria? Se não, quem esteve envolvido?

32. **Como você avaliaria o desempenho dos sequintes projetos de esgoto condominial, hoje?**

Caso ____________ : Péssimo **1** Regular **2** Bom **3** Muito Bom **4** Ótimo **5**

Caso ____________ : Péssimo **1** Regular **2** Bom **3** Muito Bom **4** Ótimo **5**

Caso ____________ : Péssimo **1** Regular **2** Bom **3** Muito Bom **4** Ótimo **5**

Caso ____________ : Péssimo **1** Regular **2** Bom **3** Muito Bom **4** Ótimo **5**

33. Como você avaliaria o desempenho dos sequintes projetos logo ápos a implantação?

Caso ___________ : Péssimo 1 Regular 2 Bom 3 Muito Bom 4 Ótimo 5

Caso ___________ : Péssimo 1 Regular 2 Bom 3 Muito Bom 4 Ótimo 5

Caso ___________ : Péssimo 1 Regular 2 Bom 3 Muito Bom 4 Ótimo 5

Caso ___________ : Péssimo 1 Regular 2 Bom 3 Muito Bom 4 Ótimo 5

34. **Depois da implantação dos projetos de esgoto, como é que você foi informado sobre o funcionamento dos mesmos?**

Implementação de Sistemas de Esgotos Condominiais no Brasil
Pesquisa pela E. Anaya Nance, Universidade de Stanford, EUA

Guia de Entrevista da Equipe de Manutenção

Baseando-se na sua experiência e conhecimento sobre o projecto em Caso__________, indique que possíveis situações você verificou ter acontecido nos mesmos, assinalando nas colunas que lhes correspondem os itens relacionados na tabela abaixo:

1. **Baixa qualidade da construção em geral?**

   Sim 2 Não 1 Não Sabe 3

2. **Tubulações colodas sem o declive do projeto?**

   Sim 2 Não 1 Não Sabe 3

3. **Encaixe das tubulações conectados inapropriademente?**

   Sim 2 Não 1 Não Sabe 3

4. **Material de construção de baixa qualidade ou inadequados?**

   Sim 2 Não 1 Não Sabe 3

5. **Planta da tubulação mal elaborada?**

   Sim 2 Não 1 Não Sabe 3

6. **Diâmetros das tubulações ou declives inadequados?**

   Sim 2 Não 1 Não Sabe 3

7. **Entupimentos na rede básica?**

   Sim 2 Não 1 Não Sabe 3

8. Entupimentos no esgoto condominial?

Sim 2 Não 1 Não Sabe 3

9. Entupimentos nas interligações ou dentro das casas?

Sim 2 Não 1 Não Sabe 3

10. Entupimentos causados por terra ou areia?

Sim 2 Não 1 Não Sabe 3

11. Entupimentos causados por lixo?

Sim 2 Não 1 Não Sabe 3

12. Entupimentos causados por tubulações ou caixas danificadas?

Sim 2 Não 1 Não Sabe 3

13. Entupimentos causados por esgoto?

Sim 2 Não 1 Não Sabe 3

14. Entupimentos causados por inundações?

Sim 2 Não 1 Não Sabe 3

15. Falta de um destino final adequado para o esgoto?

Sim 2 Não 1 Não Sabe 3

16. Falta de manutenção por órgãos públicos?

Sim 2 Não 1 Não Sabe 3

17. Falta de manutenção pelos moradores?

Sim 2 Não 1 Não Sabe 3

18. Falta de desempenho adequado das bombas?

Sim 2 Não 1 Não Sabe 3

19. Falta de desempenho adequado da estação de tratamento?

Sim **2** Não **1** Não Sabe **3**

20. Perda ou dano das tampas?

Sim **2** Não **1** Não Sabe **3**

21. Abandono do sistema de esgoto?

Sim **2** Não **1** Não Sabe **3**

22. Topografia ruim?

Sim **2** Não **1** Não Sabe **3**

23. Má condição do solo?

Sim **2** Não **1** Não Sabe **3**

Implementação de Sistemas de Esgotos Condominiais no Brasil
Pesquisa pela E. Anaya Nance, Universidade de Stanford, EUA

Guia de Entrevista da Equipe de Participação

1. Equipe de Implementação:

   a. **Engenheiros:** **Estado** **Prefeitura** ____________

   b. **Assistentes Sociais:** **Estado** **Prefeitura** ____________

   c. **Técnicos:** **Estado** **Prefeitura** ____________

   d. **Consultores:** **Nome** ____________________

   e. **Construtora:** **Nome** ____________________

   f. **Diretor do Projeto:** **Nome** ____________________

   g. **Outras Equipes:** **Nome** ____________________

2. Participação dos Moradores:

   a. **Moradores foram mobilizados?**

   Sim 2 Não 1 Não Sabe 3

   b. **Moradores foram orientados?**

   Sim 2 Não 1 Não Sabe 3

   c. **Moradores foram educados?**

   Sim 2 Não 1 Não Sabe 3

   d. **Moradores formaram "condomínios"?**

   Sim 2 Não 1 Não Sabe 3

e. **Moradores assistiram reuniões?**

Sim 2 Não 1 Não Sabe 3

f. **Moradores foram visitar de casa em casa?**

Sim 2 Não 1 Não Sabe 3

g. **Moradores receberam panfletos?**

Sim 2 Não 1 Não Sabe 3

h. **Moradores decidiram os esquemas?**

Sim 2 Não 1 Não Sabe 3

i. **Moradores aceitaram o projeto?**

Sim 2 Não 1 Não Sabe 3

j. **Moradores concordaram em fazer manutenção?**

Sim 2 Não 1 Não Sabe 3

k. **Moradores construiram seus ramais?**

Sim 2 Não 1 Não Sabe 3

l. **Moradores pagaram ou contribuiram com materiais?**

Sim 2 Não 1 Não Sabe 3

Explique todas as respostas "Sim".

3. Preparação para Operação e Manutenção:

a. **COMPESA/CAERN aceitou a elaboração do projeto?**

Sim **2** Não **1** Não Sabe **3**

b. **COMPESA/CAERN aceitou a construção do projeto?**

Sim **2** Não **1** Não Sabe **3**

c. **Os moradores aceitaram manutenção dos ramais?**

Sim **2** Não **1** Não Sabe **3**

d. **Os moradores tinham condições para fazer manutenção?**

Sim **2** Não **1** Não Sabe **3**

e. **Sistema de esgoto condominial foi concluido?**

Sim **2** Não **1** Não Sabe **3**

f. **Sistema funcionou logo apois a construção?**

Sim **2** Não **1** Não Sabe **3**

g. **As casa foram ligadas a rede condominial?**

Sim **2** Não **1** Não Sabe **3**

h. **Os esgotos foram ligados a algum tratamento?**

Sim **2** Não **1** Não Sabe **3**

Explique todas as respostas "Não".

4. Outras Informações:

a. **Onde se localiza o destino final desse sistema de esgoto?**

b. **Porque a COMPESA/CAERN aceitou ou não aceitou o projeto?**

c. **Quem se responsabilisou pela construção das interligações?**

d. **Explique os desafios durante a implemantação do projeto?**

Appendix B

Performance and Participation Data

B.1 Performance Data

Data on performance are presented in Tables B-1 through B-13.

B.2 Participation Data

Data on participation are presented in Tables B-14 through B-23.

Table B-1. Raw data on operability from engineering staff interviews in Recife.

Question	No. of Respondents and Sample Size (n/s)			Response Choices	Observed Response Frequency			Percent		
	R1	R2	R3		Case R1	Case R2	Case R3	Case R1	Case R2	Case 3
32 -- How do you rate the operability of the condominial sewer right after it was implemented?	3/13	2/13	2/13	Low	0	2	0	0%	100%	0%
				Med Low	0	0	0	0%	0%	0%
				Medium	1	0	1	33%	0%	50%
				Med High	2	0	1	67%	0%	50%
				High	0	0	0	0%	0%	0%
33 – How do you rate the operability of the condominial sewer today?	2/13	1/13	3/13	Low	0	1	0	0%	100%	0%
				Med Low	0	0	1	0%	0%	33%
				Medium	1	0	1	50%	0%	33%
				Med High	1	0	1	50%	0%	33%
				High	0	0	0	0%	0%	0%

Notes: A sample of 13 engineers in Recife were interviewed about the operability of selected projects. Very few of the interviewees were able to respond to these two rating questions due to a lack of knowledge about project-specific performance subsequent to the implementation period. For Case R1, question 32, 3 of the 13 engineers interviewed in connection with the case offered a response to the question.

Table B-2. Raw data on operability from engineering staff interviews in Natal.

Question	No. of Respondents and Sample Size (n/s)			Response Choices	Observed Response Frequency			Percent		
	N1	N2	N3		Case N1	Case N2	Case N3	Case N1	Case N2	Case N3
32 -- How do you rate the operability of the condominial sewer right after it was implemented?	4/12	4/12	4/12	Low	0	0	0	0%	0%	0%
				Med Low	1	2	3	25%	50%	75%
				Medium	2	2	1	50%	50%	25%
				Med High	1	0	0	25%	0%	0%
				High	0	0	0	0%	0%	0%
33 – How do you rate the operability of the condominial sewer today?	4/12	4/12	4/12	Low	0	0	0	0%	0%	0%
				Med Low	1	1	1	25%	25%	25%
				Medium	2	3	2	50%	75%	50%
				Med High	0	0	1	0%	0%	25%
				High	1	0	0	25%	0%	0%

Notes: A sample of 12 engineers in Natal were interviewed about the operability of selected projects. Very few of the interviewees were able to respond to these two rating questions due to a lack of knowledge about project-specific performance subsequent to the implementation period. For Case N1, question 32, 4 of the 12 engineers interviewed in connection with the case offered a response to the question.

Table B-3. Raw data on operability from maintenance staff interviews in Recife.

Questions	No. of Respondents and Sample Size (n/s)			Response Choices	Observed Response Frequency			Percent		
Operability	**R1**	**R2**	**R3**		**Case R1**	**Case R2**	**Case R3**	**Case R1**	**Case R2**	**Case R3**
7 – Does this project have blockages in the street sewer?	2/2	2/2	3/4	Yes No	1 1	2 0	3 0	50% 50%	100% 0%	100% 0%
8 – Does this project have blockages in the condominial sewer?	2/2	2/2	2/4	Yes No	2 0	2 0	2 0	100% 0%	100% 0%	100% 0%
9 – Does this project have blockages in the house connections?	1/2	2/2	3/4	Yes No	0 1	2 0	3 0	0% 100%	100% 0%	100% 0%
10 – Does this project have blockages caused by soil?	2/2	2/2	3/4	Yes No	2 0	2 0	2 1	100% 0%	100% 0%	67% 33%
11 – Does this project have blockages caused by trash?	2/2	2/2	4/4	Yes No	1 1	2 0	4 0	50% 50%	100% 0%	100% 0%

Continued…

Table B-3. Raw data on operability from maintenance staff interviews in Recife, continued.

12 – Does this project have blockages caused by damaged pipes or manholes?	2/2	2/2	3/4	Yes No	2 0	2 0	3 0	100% 0%	100% 0%	100% 0%
13 – Does this project have blockages caused by sewage?	2/2	2/2	3/4	Yes No	1 1	0 2	0 3	50% 50%	0% 100%	0% 100%
14 – Does this project have blockages caused by storm water?	2/2	1/2	3/4	Yes No	0 2	1 0	1 2	0% 100%	100% 0%	33% 67%
18 – Does this project have a malfunctioning sewage pump station?	2/2	2/2	4/4	Yes No	0 2	1 1	1 3	0% 100%	50% 50%	25% 75%
19 – Did this project have a malfunctioning sewage treatment plant?	2/2	2/2	4/4	Yes No	0 2	2 0	2 2	0% 100%	100% 0%	50% 50%
20 – Did this project have lost or damaged manhole covers?	2/2	2/2	4/4	Yes No	1 1	2 0	3 1	50% 50%	100% 0%	75% 25%

Notes: Samples of 2, 2, and 4 operations and maintenance staff in Recife were interviewed about the operability of case study projects R1, R2, and R3, respectively. Most interviewees were able to respond to all the questions and 27 of the 33 responses yielded a simple majority.

Table B-4. Raw data on operability from maintenance staff interviews in Natal.

Questions	No. of Respondents and Sample Size (n/s)			Response Choices	Observed Response Frequency			Percent		
Operability	**N1**	**N2**	**N3**		**Case N1**	**Case N2**	**Case N3**	**Case N1**	**Case N2**	**Case N3**
7 – Does this project have blockages in the street sewer?	3/4	4/4	4/4	Yes No	1 2	3 1	3 1	33% 67%	75% 25%	75% 25%
8 – Does this project have blockages in the condominial sewer?	4/4	4/4	4/4	Yes No	3 1	4 0	4 0	75% 25%	100% 0%	100% 0%
9 – Does this project have blockages in the house connections?	1/4	2/4	1/4	Yes No	1 0	2 0	1 0	100% 0%	100% 0%	100% 0%
10 – Does this project have blockages caused by soil?	3/4	4/4	4/4	Yes No	2 1	3 1	4 0	67% 33%	75% 25%	100% 0%
11 – Does this project have blockages caused by trash?	3/4	4/4	4/4	Yes No	3 0	4 0	4 0	100% 0%	100% 0%	100% 0%

Continued…

Table B-4. Raw data on operability from maintenance staff interviews in Natal, continued.

12 – Does this project have blockages caused by damaged pipes or manholes?	3/4	4/4	4/4	Yes No	2 1	4 0	4 0	67% 33%	100% 0%	100% 0%
13 – Does this project have blockages caused by sewage?	2/4	3/4	3/4	Yes No	0 2	1 2	1 2	0% 100%	33% 67%	33% 67%
14 – Does this project have blockages caused by storm water?	3/4	4/4	4/4	Yes No	2 1	3 1	3 1	67% 33%	75% 25%	75% 25%
18 – Does this project have a malfunctioning sewage pump station?	2/4	2/4	2/4	Yes No	0 2	0 2	0 2	0% 100%	0% 100%	0% 100%
19 – Did this project have a malfunctioning sewage treatment plant?	1/4	3/4	4/4	Yes No	0 1	1 2	1 3	0% 100%	33% 67%	25% 75%
20 – Did this project have lost or damaged manhole covers?	3/4	3/4	4/4	Yes No	2 1	3 0	4 0	67% 33%	100% 0%	100% 0%

Notes: Samples of 4, 4, and 4 operations and maintenance staff in Natal were interviewed about the operability of case study projects N1, N2, and N3, respectively. Most interviewees were able to respond to all the questions and most of the responses were in agreement (with a few exceptions).

Table B-5. Raw data on operability and impacts from interviews with Case R1 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$)			
						df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Operability									
1.2 - How do you rate the operability of your condominial sewer?	26	Low Med Low Medium Med High High	5.2 5.2 5.2 5.2 5.2	2 8 10 2 4	8% 31% 38% 8% 15%	4	10.154	9.488	Yes
1.3 – How do you rate the operability of the street sewer?	30	Low Med Low Medium Med High High	6 6 6 6 6	2 8 12 4 4	7% 27% 40% 13% 13%	4	10.667	9.488	Yes
1.4 – Describe any sewer problems you have experienced?	31	Yes No	15.5 15.5	17 14	55% 45%	1	0.290	3.841	No
Impacts									
1.6 – How do you rate your level of satisfaction with the sewer system right after it was implemented?	23	Low Med Low Medium Med High High	4.6[b] 4.6 4.6 4.6 4.6	1 1 4 14 3	4% 4% 17% 61% 13%	4	25.478	9.488	Yes

Continued…

Table B-5. Raw data on operability and impacts from interviews with Case R1 residents, continued.

1.7 – How do you rate your level of satisfaction with the sewer systems today?	26	Low Med Low Medium Med High High	5.2 5.2 5.2 5.2 5.2	2 1 5 14 4	8% 4% 19% 54% 15%	4	20.538	9.488	Yes
1.8 – Describe any advantages or disadvantages with your sewer system?	27	Yes No	13.5 13.5	16 11	59% 41%	1	0.926	3.841	No
1.9 – How have health and environment changed in your community as a result of this sewer project?	29	Worsened No Change Improved	9.7 9.7 9.7	16 13 0	55% 45% 0%	2	14.966	5.991	Yes

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*

b. The minimum expected response for a valid Chi-squared goodness-of-fit test is between 2 and 5, although most researchers use 5 as the minimum (Huck, 2000). In this dissertation a minimum expected response of 3 was used.

Notes: Residents were interviewed about project operability and impacts. Most interviewees responded to all the selected questions. Questions were selected that best represented the two performance objectives and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 33 households and population "P" = 239 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the ρ=0.05 level of significance.

Table B-6. Raw data on operability and impacts from interviews with Case R2 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$)			
						df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Operability									
1.2 - How do you rate the operability of your condominial sewer?	23	Low Med Low Medium Med High High	4.6[b] 4.6 4.6 4.6 4.6	11 8 3 0 1	48% 35% 13% 0% 4%	4	11.417	9.488	Yes
1.3 – How do you rate the operability of the street sewer?	41	Low Med Low Medium Med High High	8.2 8.2 8.2 8.2 8.2	25 12 4 0 0	61% 29% 10% 0% 0%	4	54.732	9.488	Yes
1.4 – Describe any sewer problems you have experienced?	38	Yes No	19 19	33 5	87% 13%	1	20.632	3.841	Yes
Impacts									
1.6 – How do you rate your level of satisfaction with the sewer system right after it was implemented?	20	Low Med Low Medium Med High High	4[b] 4 4 4 4	3 4 4 5 4	15% 20% 20% 25% 20%	4	0.250	9.488	No

Continued…

Table B-6. Raw data on operability and impacts from interviews with Case R2 residents, continued.

1.7 – How do you rate your level of satisfaction with the sewer systems today?	24	Low Med Low Medium Med High High	4.8 4.8 4.8 4.8 4.8	9 6 8 1 0	38% 25% 33% 4% 0%	4	3.975	9.488	No
1.8 – Describe any advantages or disadvantages with your sewer system?	21	Yes No	10.5 10.5	16 5	76% 24%	1	5.762	3.841	Yes
1.9 – How have health and environment changed in your community as a result of this sewer project?	39	Worsened No Change Improved	13 13 13	17 13 9	44% 33% 23%	2	2.462	5.991	No

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*

b. The minimum expected response for a valid Chi-squared goodness-of-fit test is between 2 and 5, although most researchers use 5 as the minimum (Huck, 2000). In this dissertation a minimum expected response of 3 was used.

Notes: Residents were interviewed about project operability and impacts. Most interviewees responded to all the selected questions. Questions were selected that best represented the two performance objectives and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 41 households and population "P" = 158 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the ρ=0.05 level of significance.

Table B-7. Raw data on operability and impacts from interviews with Case R3 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$)			
						df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Operability									
1.2 - How do you rate the operability of your condominial sewer?	51	Low Med Low Medium Med High High	10.2 10.2 10.2 10.2 10.2	2 6 33 2 8	4% 12% 65% 4% 16%	4	66.353	9.488	Yes
1.3 – How do you rate the operability of the street sewer?	51	Low Med Low Medium Med High High	10.2 10.2 10.2 10.2 10.2	6 17 23 2 3	12% 33% 45% 4% 6%	4	34.000	9.488	Yes
1.4 – Describe any sewer problems you have experienced?	50	Yes No	25 25	20 30	40% 60%	1	2.000	3.841	No
Impacts									
1.6 – How do you rate your level of satisfaction with the sewer system right after it was implemented?	33	Low Med Low Medium Med High High	6.6 6.6 6.6 6.6 6.6	0 2 5 23 3	0% 6% 15% 70% 9%	4	52.909	9.488	Yes

Continued…

Table B-7. Raw data on operability and impacts from interviews with Case R3 residents, continued.

1.7 – How do you rate your level of satisfaction with the sewer systems today?	51	Low Med Low Medium Med High High	10.2 10.2 10.2 10.2 10.2	1 3 7 32 8	2% 6% 14% 63% 16%	4	61.451	9.488	Yes
1.8 – Describe any advantages or disadvantages with your sewer system?	48	Yes No	24 24	11 37	23% 77%	1	14.083	3.841	Yes
1.9 – How have health and environment changed in your community as a result of this sewer project?	44	Worsened No Change Improved	14.7 14.7 14.7	1 7 36	2% 16% 82%	2	47.773	5.991	Yes

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*

Notes: Residents were interviewed about project operability and impacts. Most interviewees responded to all the selected questions. Questions were selected that best represented the two performance objectives and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 59 households and population "P" = 1349 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the ρ=0.05 level of significance.

Table B-8. Raw data on operability and impacts from interviews with Case N1 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$)			
						df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Operability									
1.2 - How do you rate the operability of your condominial sewer?	16	Low Med Low Medium Med High High	3.2[b] 3.2 3.2 3.2 3.2	0 0 9 2 5	0% 0% 56% 13% 31%	4	18.375	9.488	Yes
1.3 – How do you rate the operability of the street sewer?	39	Low Med Low Medium Med High High	7.8 7.8 7.8 7.8 7.8	3 3 19 5 9	8% 8% 49% 13% 23%	4	23.179	9.488	Yes
1.4 – Describe any sewer problems you have experienced?	20	Yes No	10 10	13 7	65% 35%	1	1.800	3.841	No
Impacts									
1.6 – How do you rate your level of satisfaction with the sewer system right after it was implemented?	14	Low Med Low Medium Med High High	2.8[b, c] 2.8 2.8 2.8 2.8	0 0 1 5 8	0% 0% 7% 36% 57%	4	18.143	9.488	Yes

Continued…

Table B-8. Raw data on operability and impacts from interviews with Case N1 residents, continued.

1.7 – How do you rate your level of satisfaction with the sewer systems today?	15	Low Med Low Medium Med High High	3 3 3 3 3	1 0 1 8 5	7% 0% 7% 53% 33%	4	15.333	9.488	Yes
1.8 – Describe any advantages or disadvantages with your sewer system?	15	Yes No	7.5 7.5	4 11	27% 73%	1	3.267	3.841	No
1.9 – How have health and environment changed in your community as a result of this sewer project?	39	Worsened No Change Improved	13 13 13	1 6 32	3% 15% 82%	2	42.615	5.991	Yes

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*
b. The minimum expected response for a valid Chi-squared goodness-of-fit test is between 2 and 5, although most researchers use 5 as the minimum (Huck, 2000). In this dissertation a minimum expected response of 3 was used.
c. In this instance an expected response of 2.8 (instead of 3 minimum) was accepted so that consistent comparisons could be made across the cases.

Notes: Residents were interviewed about project operability and impacts. Most interviewees responded to all the selected questions. Questions were selected that best represented the two performance objectives and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 39 households and population "P" = 348 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the ρ=0.05 level of significance.

Table B-9. Raw data on operability and impacts from interviews with Case N2 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$)			
						df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Operability									
1.2 - How do you rate the operability of your condominial sewer?	35	Low Med Low Medium Med High High	7 7 7 7 7	1 3 20 6 5	3% 9% 57% 17% 14%	4	32.286	9.488	Yes
1.3 – How do you rate the operability of the street sewer?	46	Low Med Low Medium Med High High	9.2 9.2 9.2 9.2 9.2	3 6 24 7 6	7% 13% 52% 15% 13%	4	30.739	9.488	Yes
1.4 – Describe any sewer problems you have experienced?	38	Yes No	19 19	25 13	66% 34%	1	3.789	3.841	No
Impacts									
1.6 – How do you rate your level of satisfaction with the sewer system right after it was implemented?	35	Low Med Low Medium Med High High	7 7 7 7 7	1 1 5 19 9	3% 3% 14% 54% 26%	4	32.000	9.488	Yes

Continued…

Table B-9. Raw data on operability and impacts from interviews with Case N2 residents, continued.

1.7 – How do you rate your level of satisfaction with the sewer systems today?	35	Low Med Low Medium Med High High	7 7 7 7 7	1 1 7 23 3	3% 3% 20% 66% 9%	4	49.143	9.488	Yes
1.8 – Describe any advantages or disadvantages with your sewer system?	35	Yes No	17.5 17.5	10 25	29% 71%	1	6.429	3.841	Yes
1.9 – How have health and environment changed in your community as a result of this sewer project?	45	Worsened No Change Improved	15 15 15	0 4 41	0% 9% 91%	2	68.133	5.991	Yes

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*

Notes: Residents were interviewed about project operability and impacts. Most interviewees responded to all the selected questions. Questions were selected that best represented the two performance objectives and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 46 households and population "P" = 757 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the ρ=0.05 level of significance.

Table B-10. Raw data on operability and impacts from interviews with Case N3 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$)			
						df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Operability									
1.2 - How do you rate the operability of your condominial sewer?	35	Low Med Low Medium Med High High	7 7 7 7 7	5 2 14 10 4	14% 6% 40% 29% 11%	4	13.714	9.488	Yes
1.3 – How do you rate the operability of the street sewer?	45	Low Med Low Medium Med High High	9 9 9 9 9	3 6 22 11 3	7% 13% 49% 24% 7%	4	28.222	9.488	Yes
1.4 – Describe any sewer problems you have experienced?	35	Yes No	17.5 17.5	28 7	80% 20%	1	12.600	3.841	Yes
Impacts									
1.6 – How do you rate your level of satisfaction with the sewer system right after it was implemented?	33	Low Med Low Medium Med High High	6.6 6.6 6.6 6.6 6.6	0 2 2 15 14	0% 6% 6% 45% 42%	4	32.000	9.488	Yes

Table B-10. Raw data on operability and impacts from interviews with Case N3 residents, continued.

1.7 – How do you rate your level of satisfaction with the sewer systems today?	34	Low Med Low Medium Med High High	6.8 6.8 6.8 6.8 6.8	0 3 3 23 5	0% 9% 9% 68% 15%	4	50.118	9.488	Yes
1.8 – Describe any advantages or disadvantages with your sewer system?	35	Yes No	17.5 17.5	15 20	43% 57%	1	0.714	3.841	No
1.9 – How have health and environment changed in your community as a result of this sewer project?	45	Worsened No Change Improved	15 15 15	1 5 39	2% 11% 87%	2	58.133	5.991	Yes

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*

Notes: Residents were interviewed about project operability and impacts. Most interviewees responded to all the selected questions. Questions were selected that best represented the two performance objectives and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 46 households and population "P" = 964 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the ρ=0.05 level of significance.

Table B-11. Results of direct observations of performance for the case study projects in Recife.

Performance Indicators	Indicator Range	Results of Direct Observations		
Operability		**Case R1**	**Case R2**	**Case R3**
Sealed Street or Sidewalk Manhole Covers	0 to n	o = 39 (n=50, s=50)	o = 8 (n=18, s=18)	o = 74 (n=77, s=77)
5-6h. Intact Household Cleanout Box Covers	0 to n	o = 20 (n=20, s=33)	o = 14 (n=21, s=40)	o = 53 (n=58, s=59)
5-6e. Intact Household Sewer Pipes	0 to n	o = 27 (n=28, s=33)	o = 21 (n=21, s=40)	o = 58 (n=59, s=59)
5-6d. Buried Household Sewer Pipes	0 to n	o = 28 (n=28, s=33)	o = 18 (n=20, s=40)	o = 55 (n=57, s=59)
Impacts				
1-1. Sewered Households	0 to n	o = 26 (n=33, s=33)	o = 19 (n=40, s=40)	o = 59 (n=59, s=59)
Public Graywater	0 = Continual Presence 50=Intermittent Presence 100 = None Present	o = 100 (n= None Present s=50)	o = 0 (n= Continual in 4 places, s=18)	o = 100 (n= None Present, s=77)
Public Sewage	0 = Continual Presence 50=Intermittent Presence 100 = None Present	o = 100 (n= None Present s=50)	o = 0 (n= Continual in 4 places, s=18)	o = 100 (n= None Present s=77)

Notes: Information about the general condition of street sewers was obtained by walking through a case study area, physically inspecting manhole covers and cleanout box covers, and recording observations. Information about the general condition of household sewers was obtained by walking through the yard and home, physically inspecting cleanout box covers and sewer pipes, and recording observations. Household inspections were conducted during resident interviews. Individual scores are presented in terms of percent of the maximum achievable as measured by the selected questions. "o" is the value assigned to the observation, "n" is the number of responses or observations, and "s" is the sample size.

Table B-12. Results of direct observations of performance for the case study projects in Natal.

Performance Indicators	Indicator Range	Results of Direct Observations		
Operability		**Case N1**	**Case N2**	**Case N3**
Sealed Street or Sidewalk Manhole Covers	0 to n	o = 19 (n=21, s=21)	o = 28 (n=31, s=31)	o = 40 (n=41, s=41)
5-6h. Intact Household Cleanout Box Covers	0 to n	o = 16 (n=16, s=39)	o = 32 (n=34, s=46)	o = 35 (n=35, s=46)
5-6e. Intact Household Sewer Pipes	0 to n	o = 17 (n=17, s=39)	o = 36 (n=36, s=46)	o = 37 (n=37, s=46)
5-6d. Buried Household Sewer Pipes	0 to n	o = 17 (n=17, s=39)	o = 35 (n=35, s=46)	o = 34 (n=34, s=46)
Impacts				
1-1. Sewered Households	0 to n	o = 30 (n=39, s=39)	o = 44 (n=46, s=46)	o =35 (n=46, s=46)
Public Graywater	0 = Continual Presence 50=Intermittent Presence 100 = None Present	o = 0 (n= Continual in 3 places, s=21)	o = 0 (n= Continual in 1 place, s=31)	o = 0 (n= Continual in 4 places, s=41)
Public Sewage	0 = Continual Presence 50=Intermittent Presence 100 = None Present	o = 100 (n= None Present , s=21)	o = 100 (n= None Present , s=31)	o = 50 (n= Intermittent in 1 place, s=41)

Notes: Information about the general condition of street sewers was obtained by walking through a case study area, physically inspecting manhole covers and cleanout box covers, and recording observations. Information about the general condition of household sewers was obtained by walking through the yard and home, physically inspecting cleanout box covers and sewer pipes, and recording observations. Household inspections were conducted during resident interviews. Individual scores are presented in terms of percent of the maximum achievable as measured by the selected questions. "o" is the value assigned to the observation, "n" is the number of responses or observations, and "s" is the sample size.

Table B-13. Performance scores for the six case study projects.

OPERABILITY	Case R1	Case R2	Case R3	Case N1	Case N2	Case N3
1.Ratings of Condominial Sewer Operability (Q1-2)	48.0	20.0	54.0	69.0	58.0	54.0
2.Ratings of Street Sewer Operability (Q1-3)	50.0	12.0	40.0	59.0	54.0	53.0
3.Reported Problems with Sewer Operations (Q1-4)	45.0	13.0	60.0	35.0	34.0	20.0
Median from resident interviews	**48.0**	**13.0**	**54.0**	**59.0**	**54.0**	**53.0**
4.Reported Blockages in the Street Sewer (Q7)	50.0	0.0	0.0	67.0	25.0	25.0
5.Reported Blockages in the Condominial Sewer(Q8)	0.0	0.0	0.0	25.0	0.0	0.0
6.Reported Blockages in the House Connections(Q9)	100.0	0.0	0.0	0.0	0.0	0.0
7.Reported Blockages Caused by Soil (Q10)	0.0	0.0	33.0	33.0	25.0	0.0
8.Reported Blockages Caused by Trash (Q11)	50.0	0.0	0.0	0.0	0.0	0.0
9.Reported Blockages Caused by Damaged Pipes or Manholes (Q12)	0.0	0.0	0.0	33.0	0.0	0.0
10.Reported Blockages Caused by Sewage (Q13)	50.0	100.0	100.0	100.0	67.0	67.0
11.Reported Blockages Caused by Storm Water (Q14)	100.0	0.0	67.0	33.0	25.0	25.0
12.Reported Malfunctioning of the Sewage Pump Station (Q18)	100.0	50.0	75.0	100.0	100.0	100.0
13.Reported Malfunctioning of the Sewage Treatment Plant (Q19)	100.0	0.0	50.0	100.0	67.0	75.0
14.Reported Lost or Damaged Manhole Covers (Q20)	50.0	0.0	25.0	33.0	0.0	0.0
Median from maintenance staff interviews	**50.0**	**0.0**	**25.0**	**33.0**	**25.0**	**0.0**
15.Ratings of Condominial Sewer Operability at Time 1 (Q32)	67.0	0.0	63.0	50.0	38.0	31.0
16.Ratings of Condominial Sewer Operability at Time 2 (Q33)	63.0	0.0	50.0	56.0	44.0	50.0
Median from engineering staff interviews	**65.0**	**0.0**	**56.5**	**53.0**	**41.0**	**40.5**

Continued…

Table B-13. Performance scores for the six case study projects, continued.

17.Observed Number of Sealed Street Manhole Covers	78.0	44.4	96.1	90.5	90.3	97.6
18.Observed Number of Intact Household Manhole Covers (Q5-6h)	100.0	90.0	96.0	100.0	100.0	100.0
19.Observed Number of Intact Household Sewer Pipes (Q5-6e)	96.0	100.0	98.0	100.0	100.0	100.0
20.Observed Number of Buried Household Sewer Pipes (Q5-6d)	100.0	67.0	91.0	100.0	94.0	100.0
Median of direct observations	**98.0**	**78.5**	**96.1**	**100.0**	**97.0**	**100.0**
Median Operability Score	**57.5**	**6.5**	**55.3**	**56.0**	**47.5**	**46.8**
IMPACTS	Case R1	Case R2	Case R3	Case N1	Case N2	Case N3
1.Ratings of Satisfaction with Condominial Sewer at Time 1 (Q1-6)	68.0	54.0	70.0	88.0	74.0	81.0
2.Ratings of Satisfaction with Condominial Sewer at Time 2 (Q1-7)	66.0	26.0	71.0	77.0	69.0	72.0
3.Reported Disadvantages of the Condominial Sewer (Q1-8)	41.0	24.0	77.0	73.0	71.0	57.0
4.Reported Improvements to Local Health and Environment(Q1-9)	22.0	40.0	90.0	90.0	96.0	92.0
Median from resident interviews	**53.5**	**33.0**	**74.0**	**82.5**	**72.5**	**76.5**
5.Observed Number of Households with Sewers (Q1-1)	79.0	48.0	100.0	77.0	96.0	76.0
6.Observed Frequency of Public Graywater	100.0	0.0	100.0	0.0	0.0	0.0
7.Observed Frequency of Public Sewage	100.0	0.0	100.0	100.0	100.0	50.0
Median from direct observations	**100.0**	**0.0**	**100.0**	**77.0**	**96.0**	**50.0**
Median Impacts Score	**76.8**	**16.5**	**87.0**	**79.8**	**84.3**	**63.3**
SEWER PERFORMANCE INDEX	67	12	71	68	66	55

Table B-14. Raw data on participation from participation staff interviews in Recife.

Questions	No. of Respondents and Sample Size (n/s)			Response Choices	Observed Response Frequency			Percent		
Mobilizing	**R1**	**R2**	**R3**		**Case R1**	**Case R2**	**Case R3**	**Case R1**	**Case R2**	**Case R3**
8.Residents Were Mobilized (Q2a)	2/2	0	2/2	Yes No	2 0	No Data	1 1	100% 0%	No Data	50% 50%
9.Residents Received Orientation (Q2b)	2/2	0	2/2	Yes No	2 0	No Data	2 0	100% 0%	No Data	100% 0%
10.Residents Received Education Program (Q2c)	2/2	0	2/2	Yes No	2 0	No Data	2 0	100% 0%	No Data	100% 0%
11.User Groups were Formed (Q2d)	2/2	0	2/2	Yes No	2 0	No Data	0 2	100% 0%	No Data	0% 100%
12.Residents Attended Meetings (Q2e)	2/2	0	2/2	Yes No	2 0	No Data	2 0	100% 0%	No Data	100% 0%
13.Residents Were Visited in Their Home (Q2f)	2/2	0	2/2	Yes No	2 0	No Data	2 0	100% 0%	No Data	100% 0%
14.Residents Received Project Literature (Q2g)	2/2	0	2/2	Yes No	2 0	No Data	2 0	100% 0%	No Data	100% 0%

Continued…

Table B-14. Raw data on participation from participation staff interviews in Recife, continued.

Construction	R1	R2	R3		Case R1	Case R2	Case R3	Case R1	Case R2	Case R3
4.Residents Constructed Condominial Sewers (Q2k)	2/2	0	2/2	Yes No	0 2	No Data	0 2	0% 100%	No Data	0% 100%
5.Residents Purchased Materials (Q2l)	2/2	0	2/2	Yes No	1 1	No Data	1 1	50% 50%	No Data	50% 50%
6.Residents Constructed House Connections (Q3g)	2/2	0	2/2	Yes No	2 0	No Data	2 0	100% 0%	No Data	100% 0%
7.Residents were Responsible for Constructing House Connections (Q4c)	2/2	0	2/2	Yes No	0 2	No Data	1 1	0% 100%	No Data	50% 50%
Maintenance	**R1**	**R2**	**R3**		**Case R1**	**Case R2**	**Case R3**	**Case R1**	**Case R2**	**Case R3**
2.Residents Accepted Responsibility for Maintenance (Q2j)	2/2	0	1/2	Yes No	2 0	No Data	1 0	100% 0%	No Data	100% 0%
3.Residents Performed Maintenance (Q3c)	2/2	0	2/2	Yes No	2 0	No Data	2 0	100% 0%	No Data	100% 0%

Continued…

Table B-14. Raw data on participation from participation staff interviews in Recife, continued.

Decisions	R1	R2	R3		Case R1	Case R2	Case R3	Case R1	Case R2	Case R3
2.Residents Decided the Layout of the System (Q2h)	2/2	0	1/2	Yes No	2 0	No Data	0 1	100% 0%	No Data	0% 100%
3.Residents Decided to Accept the Service Level (Q2i)	2/2	0	2/2	Yes No	2 0	No Data	2 0	100% 0%	No Data	100% 0%

Notes: Samples of 2, 0, and 2 participation staff in Recife were interviewed about participation in case study projects R1, R2, and R3, respectively. Most interviewees were able to respond to all of the questions, except in Case R2, where staff was unwilling to be formally interviewed.

Table B-15. Raw data on participation from participation staff interviews in Natal.

Questions	No. of Respondents and Sample Size (n/s)			Response Choices	Observed Response Frequency			Percent		
Mobilizing	**N1**	**N2**	**N3**		**Case N1**	**Case N2**	**Case N3**	**Case N1**	**Case N2**	**Case N3**
8.Residents Were Mobilized (Q2a)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%
9.Residents Received Orientation (Q2b)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%
10.Residents Received Education Program (Q2c)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%
11.User Groups were Formed (Q2d)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%
12.Residents Attended Meetings (Q2e)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%
13.Residents Were Visited in Their Home (Q2f)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%
14.Residents Received Project Literature (Q2g)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%

Continued…

Table B-15. Raw data on participation from participation staff interviews in Natal, continued.

Construction	**N1**	**N2**	**N3**		**Case N1**	**Case N2**	**Case N3**	**Case N1**	**Case N2**	**Case N3**
4.Residents Constructed Condominial Sewers (Q2k)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%
5.Residents Purchased Materials (Q2l)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%
6.Residents Constructed House Connections (Q3g)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%
7.Residents were Responsible for Constructing House Connections (Q4c)	2/2	2/3	2/3	Yes No	2 0	2 0	2 0	100% 0%	100% 0%	100% 0%
Maintenance	**N1**	**N2**	**N3**		**Case N1**	**Case N2**	**Case N3**	**Case N1**	**Case N2**	**Case N3**
2.Residents Accepted Responsibility for Maintenance (Q2j)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%
3.Residents Performed Maintenance (Q3c)	1/2	1/3	1/3	Yes No	1 0	0 1	0 1	100% 0%	0% 100%	0% 100%

Continued…

Table B-15. Raw data on participation from participation staff interviews in Natal, continued.

Decisions	N1	N2	N3		Case N1	Case N2	Case N3	Case N1	Case N2	Case N3
2.Residents Decided the Layout of the System (Q2h)	1/2	1/3	1/3	Yes No	0 1	0 1	0 1	0% 100%	0% 100%	0% 100%
3.Residents Decided to Accept the Service Level (Q2i)	1/2	1/3	1/3	Yes No	1 0	1 0	1 0	100% 0%	100% 0%	100% 0%

Notes: Samples of 2, 3, and 3 participation staff in Natal were interviewed about participation in case study projects N1, N2, and N3, respectively. Few interviewees were able to respond to all of the questions.

Table B-16. Scores assigned by the author to the four categories of participation for the six case study projects.

Participation Indicator	Indicator Range	R1	R2	R3	N1	N2	N3
Level of User Authority in Project Mobilizing	0 = Little or no mobilization of users. 25 = Agency mobilizes users. 50 = Agency mobilizes users with assistance from community/block leaders. 75 = Users mobilize themselves to respond to the agency. 100 = Users mobilize themselves without seeking response from the agency.	50	0	100	25	25	25
Level of User Authority in Service Level Selection	0 = Agency selects and does not inform users. 25 = Agency selects and informs users. 50 = Agency provides service options to users. 75 = Users select and seek agency approval. 100 = Users select and do not seek agency approval.	25	0	25	50	50	25
Level of User Authority in House Connection Construction	0 = Little or no construction of house connections. 25 = Agency constructs and informs users. 50 = Agency constructs with user input. 75 = Users construct with agency assistance. 100 = Users construct without agency assistance.	25	100	75	75	75	75
Level of User Authority in Condominial Sewer Maintenance	0 = Little or no maintenance of condominial sewer. 25 = Agency maintains and informs users. 50 = Agency maintains with user input. 75 = Users maintain with agency assistance. 100 = Users maintain without agency assistance.	50	100	75	50	50	50

Notes: Scores were assigned by the author based on case study project descriptions developed from the author's field research, which included interviews with practitioners and residents, and reviews of project records and literature. Scores represent the degree of user authority in the activity or decision, and are on an ordinal scale from 0 (no authority) to 100 (full authority). I developed this scoring methodology based on Paul's (1987) conceptual framework of participation.

Table B-17. Raw data on the four categories of participation from interviews with Case R1 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$)			
						df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Mobilizing									
3-2i. Did you participate in mobilizing residents to bring the project to the neighborhood?	26	Yes No	13 13	6 20	23% 77%	1	7.538	3.841	Yes
3-2a. Did you participate in project meetings with residents?	26	Yes No	13 13	16 10	62% 38%	1	1.417	3.841	No
3-2b. Did you participate in project meetings with technicians, agency staff, or engineers?	26	Yes No	13 13	6 20	23% 77%	1	7.538	3.841	Yes
3-2c. Did you participate in discussions with technicians, agency staff, or engineers?	26	Yes No	13 13	4 22	15% 85%	1	12.462	3.841	Yes
3-2d. Did you participate in a sanitation education program?	26	Yes No	13 13	3 23	12% 88%	1	15.385	3.841	Yes
3-2e. Did you participate in a health program?	26	Yes No	13 13	0 26	0% 100%	1	26.000	3.841	Yes
3-2g. Did you respond to questionnaires?	26	Yes No	13 13	0 26	0% 100%	1	26.000	3.841	Yes

Continued…

Table B-17. Raw data on the four categories of participation from interviews with Case R1 residents, continued.

Decisions									
3-2h. Were you or anyone in your household directly involved in selecting the layout of the box, pipe, or any aspect of the project?	26	Yes No	13 13	3 23	12% 88%	1	15.385	3.841	Yes
Construction									
3-2j. Did you or your household authorize construction of your house connection?	26	Yes No	13 13	7 19	27% 73%	1	5.538	3.841	Yes
3-2f. Did you or your household construct any part of the project?	26	Yes No	13 13	2 24	8% 92%	1	18.615	3.841	Yes
3-4. Did you or your household contribute money, labor, land, tools, or anything else to the project?	30	Yes No	15 15	14 16	47% 53%	1	0.133	3.841	No
Maintenance									
2-4. Who fixes your household's condominial sewer system when there is a problem, including paying for the expenses?	22	Low Med Low Medium Med High High	4.4[b] 4.4 4.4 4.4 4.4	6 3 9 3 1	27% 14% 41% 14% 5%	4	6.375	9.488	No

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*

b. The minimum expected response for a valid Chi-squared goodness-of-fit test is between 2 and 5, although most researchers use 5 as the minimum (Huck, 2000). In this dissertation a minimum expected response of 3 was used.

Notes: Residents were interviewed about their activities in the project. Most interviewees responded to all the selected questions. Questions were selected that represented a common set of typical project activities and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 33 households and population "P" = 239 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the $\rho=0.05$ level of significance.

Table B-18. Raw data on the four categories of participation from interviews with Case R2 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$)			
						df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Mobilizing									
3-2i. Did you participate in mobilizing residents to bring the project to the neighborhood?	23	Yes No	11.5 11.5	1 22	4% 96%	1	19.174	3.841	Yes
3-2a. Did you participate in project meetings with residents?	23	Yes No	11.5 11.5	6 17	26% 74%	1	5.261	3.841	Yes
3-2b. Did you participate in project meetings with technicians, agency staff, or engineers?	23	Yes No	11.5 11.5	1 22	4% 96%	1	19.174	3.841	Yes
3-2c. Did you participate in discussions with technicians, agency staff, or engineers?	23	Yes No	11.5 11.5	1 22	4% 96%	1	19.174	3.841	Yes
3-2d. Did you participate in a sanitation education program?	23	Yes No	11.5 11.5	3 20	13% 87%	1	12.565	3.841	Yes
3-2e. Did you participate in a health program?	23	Yes No	11.5 11.5	0 23	0% 100%	1	23.000	3.841	Yes
3-2g. Did you respond to questionnaires?	23	Yes No	11.5 11.5	1 22	4% 96%	1	19.174	3.841	Yes

Continued…

Table B-18. Raw data on the four categories of participation from interviews with Case R2 residents, continued.

Decisions									
3-2h. Were you or anyone in your household directly involved in selecting the layout of the box, pipe, or any aspect of the project?	23	Yes No	11.5 11.5	2 21	9% 91%	1	15.696	3.841	Yes
Construction									
3-2j. Did you or your household authorize construction of your house connection?	23	Yes No	11.5 11.5	0 23	0% 100%	1	23.000	3.841	Yes
3-2f. Did you or your household construct any part of the project?	23	Yes No	11.5 11.5	3 20	13% 87%	1	12.565	3.841	Yes
3-4. Did you or your household contribute money, labor, land, tools, or anything else to the project?	22	Yes No	11 11	3 19	14% 86%	1	11.636	3.841	Yes
Maintenance									
2-4. Who fixes your household's condominial sewer system when there is a problem, including paying for the expenses?	23	Low Med Low Medium Med High High	4.6 4.6 4.6 4.6 4.6	0 0 20 3 0	0% 0% 87% 13% 0%	4	59.489	9.488	Yes

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*

b. The minimum expected response for a valid Chi-squared goodness-of-fit test is between 2 and 5, although most researchers use 5 as the minimum (Huck, 2000). In this dissertation a minimum expected response of 3 was used.

Notes: Residents were interviewed about their activities in the project. Most interviewees responded to all the selected questions. Questions were selected that represented a common set of typical project activities and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 41 households and population "P" = 158 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the ρ=0.05 level of significance.

Table B-19. Raw data on the four categories of participation from interviews with Case R3 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$)			
						df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Mobilizing									
3-2i. Did you participate in mobilizing residents to bring the project to the neighborhood?	45	Yes No	22.5 22.5	0 45	0% 100%	1	45.000	3.841	Yes
3-2a. Did you participate in project meetings with residents?	45	Yes No	22.5 22.5	4 41	9% 91%	1	30.422	3.841	Yes
3-2b. Did you participate in project meetings with technicians, agency staff, or engineers?	45	Yes No	22.5 22.5	1 44	2% 98%	1	41.089	3.841	Yes
3-2c. Did you participate in discussions with technicians, agency staff, or engineers?	45	Yes No	22.5 22.5	1 44	2% 98%	1	41.089	3.841	Yes
3-2d. Did you participate in a sanitation education program?	45	Yes No	22.5 22.5	3 42	7% 93%	1	33.800	3.841	Yes
3-2e. Did you participate in a health program?	45	Yes No	22.5 22.5	0 45	0% 100%	1	45.000	3.841	Yes
3-2g. Did you respond to questionnaires?	45	Yes No	22.5 22.5	1 44	2% 98%	1	41.089	3.841	Yes

Continued…

Table B-19. Raw data on the four categories of participation from interviews with Case R3 residents, continued.

Decisions									
3-2h. Were you or anyone in your household directly involved in selecting the layout of the box, pipe, or any aspect of the project?	45	Yes No	22.5 22.5	4 41	9% 91%	1	30.422	3.841	Yes
Construction									
3-2j. Did you or your household authorize construction of your house connection?	45	Yes No	22.5 22.5	1 44	2% 98%	1	41.089	3.841	Yes
3-2f. Did you or your household construct any part of the project?	45	Yes No	22.5 22.5	4 41	9% 91%	1	30.422	3.841	Yes
3-4. Did you or your household contribute money, labor, land, tools, or anything else to the project?	58	Yes No	29 29	3 55	5% 95%	1	46.621	3.841	Yes
Maintenance									
2-4. Who fixes your household's condominial sewer system when there is a problem, including paying for the expenses?	36	Low Med Low Medium Med High High	7.2 7.2 7.2 7.2 7.2	2 0 31 3 0	6% 0% 86% 8% 0%	4	99.278	9.488	Yes

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*

b. The minimum expected response for a valid Chi-squared goodness-of-fit test is between 2 and 5, although most researchers use 5 as the minimum (Huck, 2000). In this dissertation a minimum expected response of 3 was used.

Notes: Residents were interviewed about their activities in the project. Most interviewees responded to all the selected questions. Questions were selected that represented a common set of typical project activities and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 59 households and population "P" = 1349 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the ρ=0.05 level of significance.

Table B-20. Raw data on the four categories of participation from interviews with Case N1 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$) df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Mobilizing									
3-2i. Did you participate in mobilizing residents to bring the project to the neighborhood?	11	Yes No	5.5 5.5	0 11	0% 100%	1	11.000	3.841	Yes
3-2a. Did you participate in project meetings with residents?	11	Yes No	5.5 5.5	1 10	9% 91%	1	7.364	3.841	Yes
3-2b. Did you participate in project meetings with technicians, agency staff, or engineers?	11	Yes No	5.5 5.5	4 7	36% 64%	1	0.818	3.841	No
3-2c. Did you participate in discussions with technicians, agency staff, or engineers?	11	Yes No	5.5 5.5	0 11	0% 100%	1	11.000	3.841	Yes
3-2d. Did you participate in a sanitation education program?	11	Yes No	5.5 5.5	0 11	0% 100%	1	11.000	3.841	Yes
3-2e. Did you participate in a health program?	11	Yes No	5.5 5.5	0 11	0% 100%	1	11.000	3.841	Yes
3-2g. Did you respond to questionnaires?	11	Yes No	5.5 5.5	0 11	0% 100%	1	11.000	3.841	Yes

Continued…

Table B-20. Raw data on the four categories of participation from interviews with Case N1 residents, continued.

Decisions									
3-2h. Were you or anyone in your household directly involved in selecting the layout of the box, pipe, or any aspect of the project?	11	Yes No	5.5 5.5	0 11	0% 100%	1	11.000	3.841	Yes
Construction									
3-2j. Did you or your household authorize construction of your house connection?	11	Yes No	5.5 5.5	3 8	27% 73%	1	2.273	3.841	No
3-2f. Did you or your household construct any part of the project?	11	Yes No	5.5 5.5	0 11	0% 100%	1	11.000	3.841	Yes
3-4. Did you or your household contribute money, labor, land, tools, or anything else to the project?	15	Yes No	7.5 7.5	11 4	73% 27%	1	3.267	3.841	No
Maintenance									
2-4. Who fixes your household's condominial sewer system when there is a problem, including paying for the expenses?	10	Low Med Low Medium Med High High	2[c] 2 2 2 2	1 0 5 3 1	10% 0% 50% 30% 10%	4	4.625	9.488	No

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*

b. The minimum expected response for a valid Chi-squared goodness-of-fit test is between 2 and 5, although most researchers use 5 as the minimum (Huck, 2000). In this dissertation a minimum expected response of 3 was used.

c. This question could have been deleted from the dissertation because of the very low expected response (<3). However, because this is the only instance with an expected response of 2, and because 2 is still within the range of validity, I decided to keep this question.

Notes: Residents were interviewed about their activities in the project. Most interviewees responded to all the selected questions. Questions were selected that represented a common set of typical project activities and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 39 households and population "P" = 384 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the ρ=0.05 level of significance.

Table B-21. Raw data on the four categories of participation from interviews with Case N2 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$)			
						df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Mobilizing									
3-2i. Did you participate in mobilizing residents to bring the project to the neighborhood?	29	Yes No	14.5 14.5	1 28	3% 97%	1	25.138	3.841	Yes
3-2a. Did you participate in project meetings with residents?	29	Yes No	14.5 14.5	5 24	17% 83%	1	12.448	3.841	Yes
3-2b. Did you participate in project meetings with technicians, agency staff, or engineers?	29	Yes No	14.5 14.5	5 24	17% 83%	1	12.448	3.841	Yes
3-2c. Did you participate in discussions with technicians, agency staff, or engineers?	29	Yes No	14.5 14.5	3 26	10% 90%	1	18.241	3.841	Yes
3-2d. Did you participate in a sanitation education program?	29	Yes No	14.5 14.5	1 28	3% 97%	1	25.138	3.841	Yes
3-2e. Did you participate in a health program?	29	Yes No	14.5 14.5	1 28	3% 97%	1	25.138	3.841	Yes
3-2g. Did you respond to questionnaires?	29	Yes No	14.5 14.5	1 28	3% 97%	1	25.138	3.841	Yes

Continued…

Table B-21. Raw data on the four categories of participation from interviews with Case N2 residents, continued.

Decisions									
3-2h. Were you or anyone in your household directly involved in selecting the layout of the box, pipe, or any aspect of the project?	29	Yes No	14.5 14.5	4 25	14% 86%	1	15.207	3.841	Yes
Construction									
3-2j. Did you or your household authorize construction of your house connection?	29	Yes No	14.5 14.5	9 20	31% 69%	1	4.172	3.841	Yes
3-2f. Did you or your household construct any part of the project?	29	Yes No	14.5 14.5	3 26	10% 90%	1	18.241	3.841	Yes
3-4. Did you or your household contribute money, labor, land, tools, or anything else to the project?	26	Yes No	13 13	25 1	96% 4%	1	22.154	3.841	Yes
Maintenance									
2-4. Who fixes your household's condominial sewer system when there is a problem, including paying for the expenses?	28	Low Med Low Medium Med High High	5.6 5.6 5.6 5.6 5.6	7 1 16 1 3	25% 4% 57% 4% 11%	4	24.438	9.488	Yes

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*

b. The minimum expected response for a valid Chi-squared goodness-of-fit test is between 2 and 5, although most researchers use 5 as the minimum (Huck, 2000). In this dissertation a minimum expected response of 3 was used.

Notes: Residents were interviewed about their activities in the project. Most interviewees responded to all the selected questions. Questions were selected that represented a common set of typical project activities and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 46 households and population "P" = 757 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the ρ=0.05 level of significance.

Table B-22. Raw data on the four categories of participation from interviews with Case N3 residents.

Question	Item Response (n)	Response Choices	Expected Response (e)	Observed Response (o)	%	Chi-Squared Goodness-of-Fit ($\rho = 0.05$)			
						df	X^2	$X^2_{critical}$	Significant Result? (Reject H_0)[a]
Mobilizing									
3-2i. Did you participate in mobilizing residents to bring the project to the neighborhood?	30	Yes No	15 15	0 30	0% 100%	1	30.000	3.841	Yes
3-2a. Did you participate in project meetings with residents?	30	Yes No	15 15	1 29	3% 97%	1	26.133	3.841	Yes
3-2b. Did you participate in project meetings with technicians, agency staff, or engineers?	30	Yes No	15 15	9 21	30% 70%	1	4.800	3.841	Yes
3-2c. Did you participate in discussions with technicians, agency staff, or engineers?	30	Yes No	15 15	2 28	7% 93%	1	22.533	3.841	Yes
3-2d. Did you participate in a sanitation education program?	30	Yes No	15 15	0 30	0% 100%	1	30.000	3.841	Yes
3-2e. Did you participate in a health program?	30	Yes No	15 15	0 30	0% 100%	1	30.000	3.841	Yes
3-2g. Did you respond to questionnaires?	30	Yes No	15 15	0 30	0% 100%	1	30.000	3.841	Yes

Continued…

Table B-22. Raw data on the four categories of participation from interviews with Case N3 residents, continued.

Decisions									
3-2h. Were you or anyone in your household directly involved in selecting the layout of the box, pipe, or any aspect of the project?	30	Yes No	15 15	0 30	0% 100%	1	30.000	3.841	Yes
Construction									
3-2j. Did you or your household authorize construction of your house connection?	30	Yes No	15 15	12 18	40% 60%	1	1.200	3.841	No
3-2f. Did you or your household construct any part of the project?	30	Yes No	15 15	0 30	0% 100%	1	30.000	3.841	Yes
3-4. Did you or your household contribute money, labor, land, tools, or anything else to the project?	34	Yes No	17 17	21 13	62% 38%	1	1.882	3.841	No
Maintenance									
2-4. Who fixes your household's condominial sewer system when there is a problem, including paying for the expenses?	28	Low Med Low Medium Med High High	5.6 5.6 5.6 5.6 5.6	4 0 16 6 2	14% 0% 57% 21% 7%	4	24.080	9.488	Yes

a. The null hypothesis, H_0, used for this test is: *The sample population exhibits no preference for any single category.*

b. The minimum expected response for a valid Chi-squared goodness-of-fit test is between 2 and 5, although most researchers use 5 as the minimum (Huck, 2000). In this dissertation a minimum expected response of 3 was used.

Notes: Residents were interviewed about their activities in the project. Most interviewees responded to all the selected questions. Questions were selected that represented a common set of typical project activities and that yielded an expected response, "e," greater than or equal to 3 across all cases. For this case sample size "s" = 46 households and population "P" = 964 households. Chi-Squared goodness-of-fit test results are included for information only. The Chi-squared test results reveal whether or not there was a preference in the overall rating of the resident questions at the ρ=0.05 level of significance.

Table B-23. Participation scores for the six case study projects.

PROJECT MOBILIZING	Case R1	Case R2	Case R3	Case N1	Case N2	Case N3
1.Mobilization of Residents (Q3-2i)	83	3	0	0	3	0
2.Meetings among Residents (Q3-2a)	67	21	33	3	16	3
3.Meetings with Agency Staff (Q3-2b)	25	3	8	11	16	23
4.Discussions with Agency Staff (Q3-2c)	17	3	8	0	9	5
5.Sanitation Education Program for Residents (Q3-2d)	13	10	25	0	3	0
6.Health Program for Residents (Q3-2e)	0	0	0	0	3	0
7.Resident Questionnaires (Q3-2g)	0	3	8	0	3	0
Average from resident interviews	**29**	**6**	**12**	**2**	**8**	**4**
8.Residents Were Mobilized (Q2a)	100	0	50	100	100	100
9.Residents Received Orientation (Q2b)	100	0	100	100	100	100
10.Residents Received Education Program (Q2c)	100	0	100	100	100	100
11.User Groups were Formed (Q2d)	100	0	0	100	100	100
12.Residents Attended Meetings (Q2e)	100	0	100	100	100	100
13.Residents Were Visited in Their Home (Q2f)	100	100	100	100	100	100
14.Residents Received Project Literature (Q2g)	100	0	100	100	100	100
Median from participation staff interviews	**100**	**0**	**100**	**100**	**100**	**100**
15.Level of User Authority in Project Mobilizing	50	0	100	25	25	25
Scores assigned by author	**50**	**0**	**100**	**25**	**25**	**25**
Median Mobilizing Score	**60**	**2**	**71**	**42**	**44**	**43**
PROJECT CONSTRUCTION	Case R1	Case R2	Case R3	Case N1	Case N2	Case N3
1.Residents Authorized Construction (Q3-2j)	37	0	8	10	30	40
2.Residents Constructed System (Q3-2f)	11	25	33	0	10	0
3.Residents Contributed Materials, etc. (Q3-4)	74	25	25	38	83	70
Average from resident interviews	**40**	**17**	**22**	**16**	**41**	**37**
4.Residents Constructed Condominial Sewers (Q2k)	0	0	0	100	100	100
5.Residents Purchased Materials (Q2l)	50	100	50	100	100	100

Continued…

Table B-23. Participation scores for the six case study projects, continued.

6.Residents Constructed House Connections (Q3g)	100	100	100	100	100	100
7.Residents were Responsible for Constructing House Connections (Q4c)	0	100	50	100	100	100
Median from participation staff interviews	**25**	**100**	**50**	**100**	**100**	**100**
8.Level of User Authority in House Connection Construction	0	100	75	75	75	75
Scores assigned by author	**25**	**100**	**75**	**75**	**75**	**75**
Median Construction Score	**30**	**72**	**49**	**64**	**72**	**71**
PROJECT MAINTENANCE	Case R1	Case R2	Case R3	Case N1	Case N2	Case N3
1.Residents Performed Maintenance (Q2-4)	35	100	53	17	36	46
Average from resident interviews	**35**	**100**	**53**	**17**	**36**	**46**
2.Residents Accepted Responsibility for Maint. (Q2j)	100	100	100	100	100	100
3.Residents Performed Maintenance (Q3c)	100	100	100	100	0	0
Median from participation staff interviews	**100**	**100**	**100**	**100**	**50**	**50**
4.Level of User Authority in Condominial Sewer Maint.	50	100	75	50	50	50
Scores assigned by author	**50**	**100**	**75**	**50**	**50**	**50**
Median Maintenance Score	**62**	**100**	**76**	**56**	**45**	**49**
PROJECT DECISIONS	Case R1	Case R2	Case R3	Case N1	Case N2	Case N3
1.Residents Selected Piping Layout (Q3-2h)	16	17	33	0	13	0
Average from resident interviews	**16**	**17**	**33**	**0**	**13**	**0**
2.Residents Decided the Layout of the System (Q2h)	100	0	0	0	0	0
3.Residents Decided to Accept the Service Level (Q2i)	100	0	100	100	100	100
Median from participation staff interviews	**100**	**0**	**50**	**50**	**50**	**50**
4.Level of User Authority in Service Level Selection	25	0	25	50	50	25
Scores assigned by author	**25**	**0**	**25**	**50**	**50**	**25**
Median Decisions Score	**47**	**6**	**36**	**33**	**38**	**25**

Appendix C

Methodology for Measuring Performance

The purpose of this chapter is to present a method for evaluating condominial sewer project performance. This method provides a common set of criteria against which multiple case study projects can be measured. The objectives of the method are to consolidate a wide range of performance information into a sewer performance index, and to distinguish projects into one of at least three levels of performance (bottom third, middle third, and top third).

C.1 Framework for Evaluating Projects

Many frameworks and indicators exist for evaluating project outcome and performance[1], but no standard framework or technique exists for evaluating condominial sewer projects. I developed an evaluation framework suited to the purpose and context of this dissertation. "Hard" data on the functioning, condition, and impacts of condominial sewers was simply not available, and the only information sources practically available to me were direct observations and local perceptions of performance. As a cross-cultural evaluator, I preferred to adopt a broad view of project performance that was a composite of various viewpoints, as opposed to representing the singular viewpoint of any particular stakeholder. To this end, I designed data gathering instruments to compile information from multiple stakeholders (i.e., agencies and beneficiaries) and to systematically record my direct observations.

Three concepts make up the contours of my project evaluation framework: factors that are exogenous to the project, factors that are endogenous to the project, and project performance. Exogenous causal factors are conditions and circumstances that are not immediately controllable within the realm of project management. Exogenous factors include the socio-economic situation of the project area, topographic and geographic conditions, and the state of infrastructure development that existed prior to the project. Endogenous causal factors are immediately controllable activities and decisions within the realm of project management, such as how sewer services are coordinated and implemented, what project components are included, and what inputs are expected from the sewer agency, the beneficiaries, and other project stakeholders. I conceive of project performance as the outcome of exogenous and endogenous causal factors. Visually, these factors are depicted in Figure C-1.

The boxes in Figure C-1 represent postulated endogenous and exogenous causal factors and the circle represents the performance-related outcome. The causal factors listed in the boxes and circle were selected from the literature and from interviews with condominial sewer practitioners (refer to Tables 1-1 and 1-2 in Chapter 1). The arrows in Figure C-1 represent my hypothesis about the direction of the association between exogenous and endogenous causal factors and the resulting performance of a project. I hypothesize that, in general, many factors contribute to project performance, and the salient factors for a particular project are context specific.

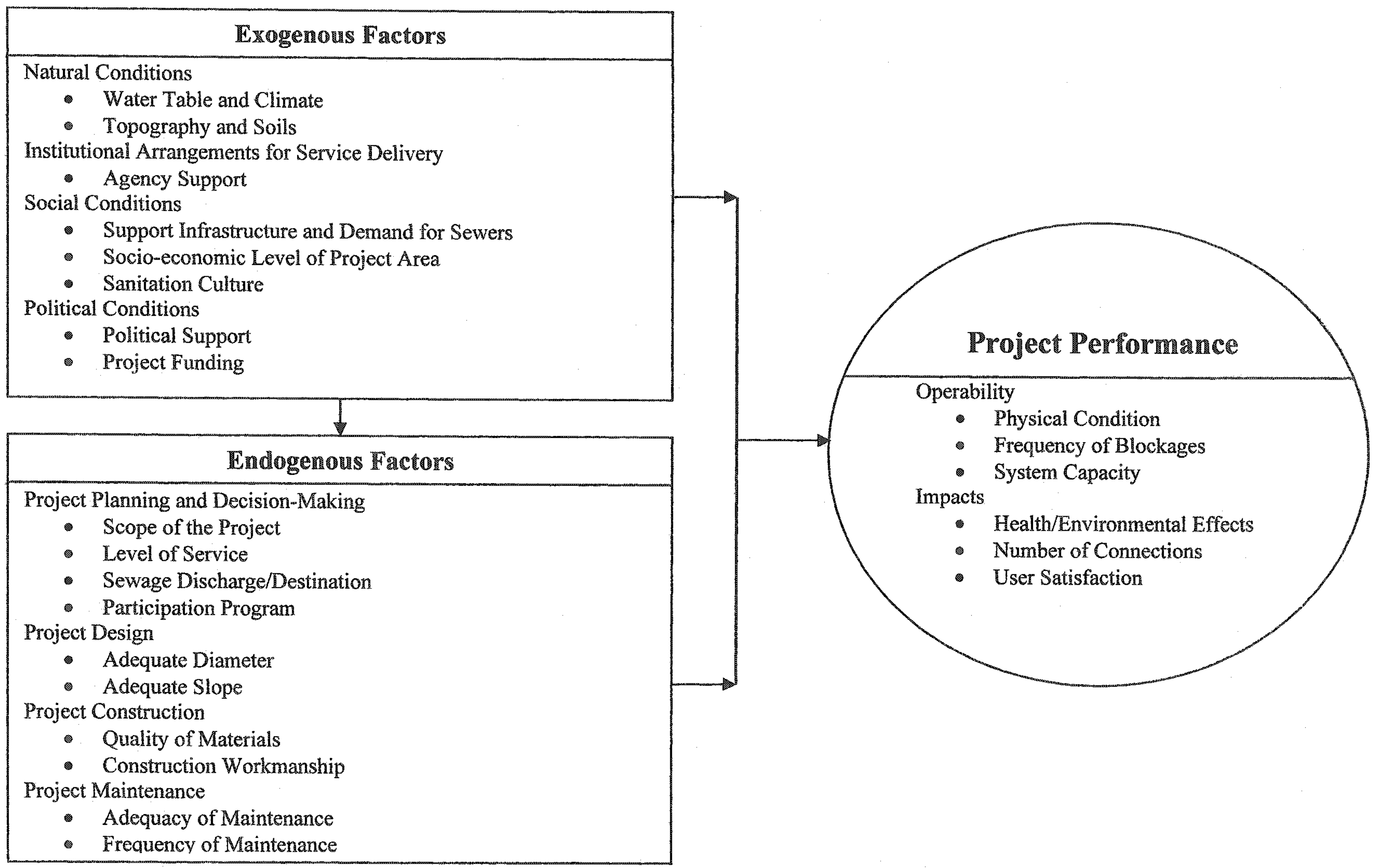


Figure C-1. Conceptual framework for evaluating the performance of condominial sewer projects.

C.2 Practical Measures of Project Performance

In this section, I define and operationalize project performance, present the indicators for measuring performance, and introduce algorithms for scoring data and for deriving a sewer performance index – a single number that represents the level of project performance.

C.2.1 Definition of Project Performance

Condominial sewer projects in Brazil typically are known either by the name of a major street within the project area (e.g., *Rua Metodio Maranhao*), by the name of the housing development in which they are installed (e.g., *Vila Santa Marta*), by the name of the neighborhood in which they are constructed (e.g., *Petropolis*), or, to a lesser degree, by the name of the drainage basin in which they are located followed by the name of the neighborhood(s) (e.g., *Bacia A – Rocas and Santos Reis*). Rather than evaluate a city's entire sewer system, I evaluated a well-defined portion of the city sewer system: a distinct project with a unique set of beneficiaries and clear-cut physical boundaries. In this dissertation, I define a project as the entire sewerage system within the geographical and temporal boundaries of a specific development (including the street sewer, condominial sewer, and house connections), as defined *locally*.

As defined by Schalock (2001), performance assessment is used to "determine whether programs are meeting their stated goals and objectives, and whether they are doing so with some degree of efficiency[2]. The focus of a performance assessment can be project effectiveness (i.e., meets objectives), project efficiency (i.e., cost-effective), or both. My definition of performance focused exclusively on the effectiveness of a sewer project. I excluded the efficiency aspect of project performance because it was not relevant to my conceptual framework and because data to measure it accurately were not readily obtainable[3]. In his evaluation of urban service delivery in South Africa, Abbott (1996) encouraged the separation of project efficiency measures from project effectiveness measures, because project effectiveness exists independently of a project's perceived economic value or the efficiency with which a project recovers costs[4]. My conception of project performance follows Abbott's approach in that I disentangled efficiency concerns from the consideration of effectiveness. In this dissertation, the terms "effectiveness" and "performance" are used interchangeably.

I measured project performance against two universal objectives that are relevant to sewer projects:

Objective 1: Sewer systems shall be *operable* so they can perform their basic function, which is to collect, contain, and transport wastewater from homes to the discharge point.

Objective 2: Sewer systems shall result in beneficial *impacts* to residents, the community, and the local environment.

Operability is a measure of how reliably a sewer system performs its basic function, which is to collect, contain, and transport sewage from homes to the discharge point. The basic function of the house connection component of the sewer system is to collect wastewater from household fixtures and remove it from the home; the basic function of the condominial sewer component is to collect wastewater from lots and remove it from the block; and the basic function of the public street sewer component is to collect wastewater from blocks and remove it from the project area. Impacts refers to the perceivable and observable consequences of a project at the time of the evaluation, and includes factors such as the number of sewer connections realized, community health improvements, local environmental benefits, user satisfaction with system performance, and the extent the project meets the needs and aspirations of users. Projects that exhibit high levels of operability and beneficial impacts are characterized as high performers in this dissertation. These two performance objectives are depicted visually in Figure C-2.

Operability represents the functioning and condition of the physical works of a project. If operability is high, then I would expect to find high ratings of operability by beneficiaries and sewer agency staff. I would expect few reported problems and damage with the system, and I would expect to observe little damage during a site visit. From these expectations, I developed a list of indicators for measuring the operability of a condominial sewer. Likewise, if a project has high beneficial impacts, then I would expect most beneficiaries to report high levels of satisfaction with the sewer. I would expect residents in the project area to ascribe advantages to the project (as opposed to

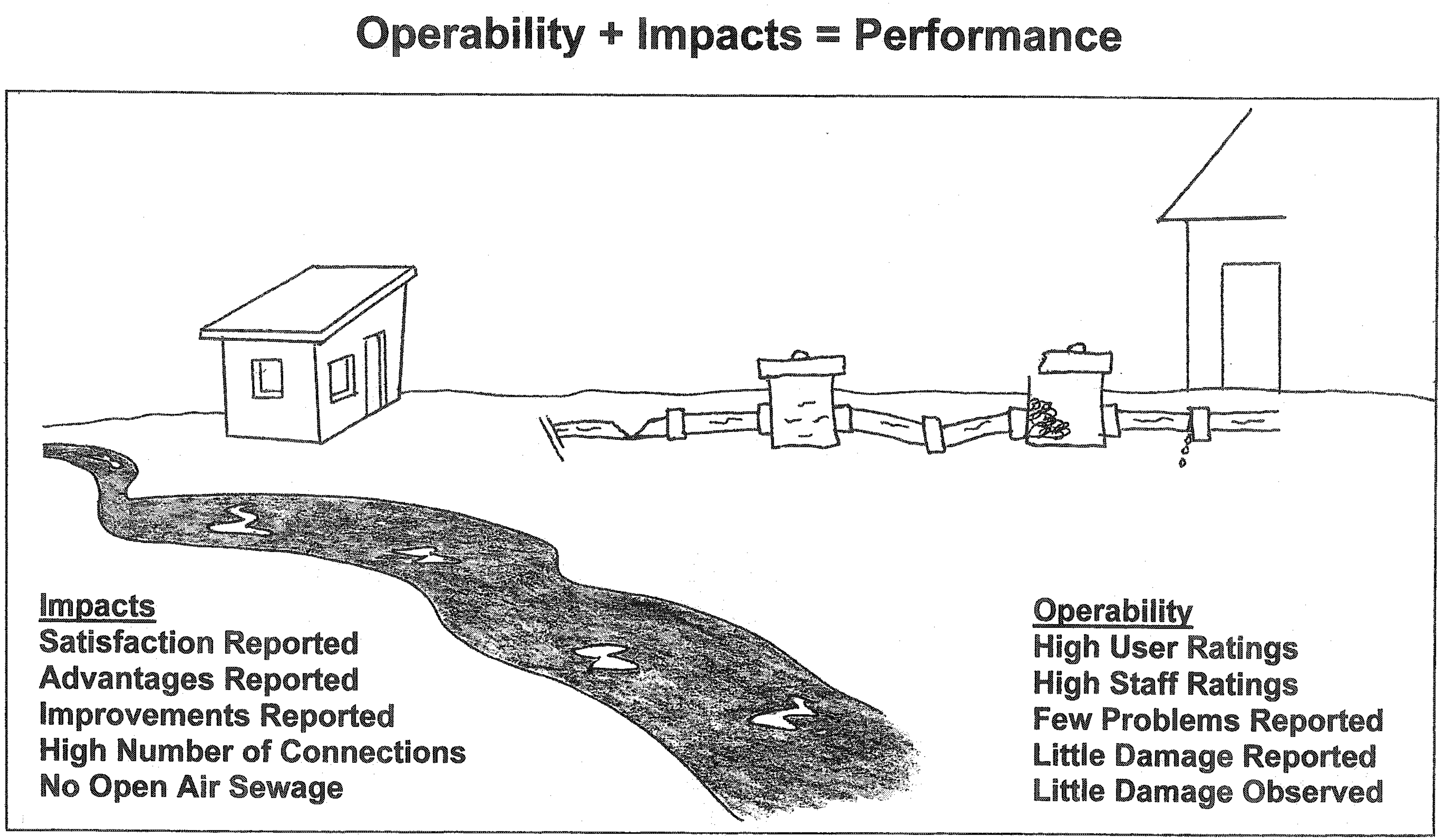


Figure C-2. Illustration of the two project performance objectives (i.e., operability and impacts) and some examples of indicators that can be used to measure each objective in the field.

disadvantages), and be able to identify improvements to local health and environment that resulted from the project. I would also expect to observe relatively clean and dry streets with no public presence of sewage or graywater, and a high rate of connection to the sewer among residents in the project area. These expectations formed the basis for establishing a list of indicators for measuring the local impacts of the project.

My two all-purpose objectives – operability and impacts – establish a common set of criteria for evaluating and comparing performance across projects. Assuming that these two objectives are quasi-independent (i.e., that either objective can be achieved without the other), I operationalized the concept of project performance by adding the results for each objective. Evidence for the quasi-independence of these objectives includes the Grand Favela Project experience. As described in Section 4.3.2 of Chapter 4, the Grand Favela condominial sewer had beneficial impacts on residents, the community, and the local environment even though it functioned badly. In this case, only the second objective – beneficial impacts – was primarily achieved. Given results such as this, the two project performance objectives were considered quasi-independent. Some fraction of each objective is usually achieved, but there are also instances where one objective can dominate[5].

C.2.2 Obtaining Performance Data

Accurate secondary data to measure operability and impacts (such as project level public health data, environmental impact assessments, sewer system infiltration/inflow studies, sewer system videotape data, and as-built drawings) were not readily available in Brazil for most condominial sewer projects. When hard data were available, they were not necessarily accessible for all of the case study projects. For example, project level maintenance records were available in Natal but not in Recife, because Recife officials were sensitive about releasing the information. Also, my access to state water company records was abruptly halted after the election of a new governor in Pernambuco during the middle of my fieldwork. When hard data were available, they were not necessarily accurate or reliable. For example, accurate as-built drawings and current maps were rarely available and, in some cases, drawings and project records were destroyed as political administrations changed hands.

Because of these difficulties, I focused on collecting a wide range of primary data about project performance. I limited my use of secondary data to sewer system drawings, from which I obtained project boundaries, the total count of blocks in the project areas, and the total count of street manholes for each project. These secondary data were verified in the field when possible, especially for the smaller projects. Because of the exploratory goals of this dissertation, I used a variety of interview questions to stimulate in-depth, meaningful discussion with informants, which produced a wealth of primary data.

Four primary data sources were available for measuring the two indicators of project performance: engineering staff, maintenance staff, project area residents (including project beneficiaries and non-beneficiaries), and direct observation (local officials were interviewed as well, but not for the purpose of acquiring project-specific information).

My approach to measuring project performance was to consolidate as much information as possible, including both reported and observed data. Results from residents were designed to be representative, so households were selected randomly and relatively high sample sizes and response rates were sought. On the other hand, representativeness was not necessary for the engineering and maintenance staff data. Other data included direct observations both inside the homes and around the project area.

Input from residents, engineering staff, and maintenance staff was essential. Only these individuals were familiar enough with each case study locale to judge differences in the "before" and "after" conditions of each performance objective. However, my direct observations were also essential as a consistency check from one locale to another, especially across cities. Also, because each case study project area started with a different set of initial conditions, and because each community may have had different aspirations, it was necessary to acquire input from residents on their level of satisfaction with project performance and their judgment of the resulting level of environmental and health improvements (in a qualitative sense).

C.2.3 Screening the Data and Selecting Questions

My first criterion for selecting questions was content matching. This criterion was applied to all of the data. I chose performance-related questions and observations that matched the content of the two performance indicators defined previously in Section C.2.1. Only those questions with response choices that indicated an obviously favorable or unfavorable measure of performance were selected. Ambiguous, poorly worded, and inadequately designed questions were dropped from consideration.

My second criterion was an expected response greater than or equal to 3. This criterion was only applied to the resident interview data. The expected response, which takes into account the number of respondents and the degrees of freedom inherent in the question, is calculated using Equation C-1:

$$e = \frac{n}{(df + 1)} \qquad \textbf{Equation C-1}$$

Where: e = expected response (also called expected frequency)

n = number of respondents

df = degrees of freedom

I used expected response rather than actual response because I had a variety of question formats (rather than a single question format) with varying degrees of freedom ranging from 1 through 4. The minimum expected response for a valid Chi-squared goodness-of-fit test is between 2 and 5, with most researchers choosing 5 as the minimum, because it is *most* restrictive[6]. I selected a *less* restrictive value of 3, because my research did not have a strict statistical orientation and because I wanted to retain more flexibility in question selection. But even with this somewhat more relaxed criterion, there were still some questions that could not pass and were consequently screened out.

The expected response criterion did not apply to the expert subgroups (engineering staff and maintenance staff). The expert subgroups were uniquely identified rather than randomly selected because representativeness was not an objective for these data sets. Consequently, all expert subgroup questions related to performance were selected with no restrictions on the expected response. This was reasonable given the relatively small population of subject matter experts available.

The results of applying these two selection criteria to my data are summarized in Table C-1. The "operability" component of performance was measured by 20 questions, including rating questions (on a 1 to 5 ordinal scale), nominal questions (yes/no), and direct observations comprised of a mix of nominal, ordinal, and numerical data. The "impacts" component was measured by 7 questions, including nominal and ordinal questions, rating questions, and direct observations comprised of ordinal and numerical data. Applying the two selection criteria to my data resulted in 27 data points per case study.

C.2.4 Assigning Scores to the Selected Data

The 27 raw data points were converted into scores on a uniform scale. Scores were expressed as the percent of maximum possible on a 0 to 100 scale, where a score of 100 was most favorable and a score of 0 was least favorable in terms of performance. Scores

Table C-1. Selected questions sorted into groups that correspond to the two performance indicators. The selected questions passed two screening criteria: a) content matching for all questions, and b) expected response ≥ 3 for resident questions. Other questions that did not pass these criteria were not used. Time 1 refers to the time period just after project completion (1988-1991 time frame). Time 2 refers to the time of the interview (1994-1995 time frame).

Sources of Data	Operability (20 questions)	Impacts (7 questions)
Resident Interviews	1. Ratings of House Connection Operability (Q1-2) 2. Ratings of Street Sewer Operability (Q1-3) 3. Reported Problems with the Condominial Sewer and House Connections (Q1-4)	1. Ratings of Satisfaction with Condo. Sewer at Time 1 (Q1-6) 2. Ratings of Satisfaction with Condo. Sewer at Time 2 (Q1-7) 3. Reported Disadvantages of the Condominial Sewer (Q1-8) 4. Reported Improvements to Local Health and Environment (Q1-9)
Maintenance Staff Interviews	4. Reported Blockages in the Street Sewer (Q7) 5. Reported Blockages in the Condominial Sewer (Q8) 6. Reported Blockages in the House Connections (Q9) 7. Reported Blockages Caused by Soil (Q10) 8. Reported Blockages Caused by Trash (Q11) 9. Reported Blockages Caused by Damaged Pipes or Manholes (Q12) 10. Reported Blockages Caused by Sewage (Q13) 11. Reported Blockages Caused by Storm Water (Q14) 12. Reported Malfunctioning of the Sewage Pump Station (Q18) 13. Reported Malfunctioning of the Sewage Treatment Plant (Q19) 14. Reported Lost or Damaged Manhole Covers (Q20)	Not Used
Engineering Staff Interviews	15. Ratings of Condominial Sewer Operability at Time 1 (Q32) 16. Ratings of Condominial Sewer Operability at Time 2 (Q33)	Not Used
Direct Observations	17. Observed Number of Sealed Street Manhole Covers 18. Observed Number of Intact Household Manhole Covers (Q5-6h) 19. Observed Number of Intact Household Sewer Pipes (Q5-6e) 20. Observed Number of Buried Household Sewer Pipes (Q5-6d)	5. Observed Number of Households with Sewers (Q1-1) 6. Observed Frequency of Public Graywater 7. Observed Frequency of Public Sewage

for interview response data were calculated as the item response times the response frequency, normalized to the total number of respondents (which was different for each question) and normalized to the range of possible scores per item (to account for nominal, 3-scale ordinal, and 5-scale ordinal questions). For example, on a rating question with a 1 to 5 rating scale in which all respondents gave a rating of 5, the algorithm would result in a total score of 100 (the highest possible). If all respondents gave a rating of 1, then the total score using the algorithm would be 0 (the lowest possible). The scoring algorithm is presented in Equation C-2.

$$\text{Score} = \frac{R_{int} - S_{min}}{S_{max} - S_{min}} \cdot 100$$

Equation C-2

Where: $R_{int} = \frac{\sum(r \cdot n)}{\sum n}$ = average response or rating from interview questions

$\sum n$ = total number of respondents for the question

n = frequency of the response or rating

r = response or rating

s = question scale (typically 1 to 5, 1 to 3, or 1 to 2)

Equation C-2 was used only on interview questions. The algorithm was applied to the cumulative response for each question rather than to individual respondents because I was interested in group scores (by question), not individual scores (by person). For the numerical data gathered during direct observation, a simpler algorithm was used to convert the raw observations into normalized scores on the same 0 to 100 scale, as presented in Equation C-3.

$$\text{Score} = R_{obs} \cdot 100 \qquad \textbf{Equation C-3}$$

Where: $R_{obs} = \frac{o}{T}$ = average observed value

o = total number of observed values

T = maximum number of observations

C.2.5 Calculating the Sewer Performance Index

Median scores for the two indicators of performance (i.e., operability and impacts) were computed in order to calculate a sewer performance index (SPI) for each project using the algorithm in Equation C-4.

$$SPI = w_o \cdot O + w_i \cdot E \qquad \textbf{Equation C-4}$$

Where: O = Median Operability Score

E = Median Impacts Score

w = weighting factor

$w_o + w_i = 1$

In this dissertation, I used equal weights ($w_o = w_i$) because I had no basis for weighing one indicator more heavily than the other. However, weights were included in the index to allow for tradeoffs between the two objectives. For example, if an evaluator determines that the "impacts" objective is more important than the "operability" objective, then this preference (or tradeoff) can be operationalized by increasing w_i, the impacts weighting factor.

The SPI ranges from 0 to 100; however, the index should be considered to have ordinal (or categorical) properties, and not numerical (or ratio) properties. An SPI ranging from 0 to 33 would indicate the bottom third level of performance, an SPI ranging from 34 to 67 would indicate the middle third level of performance, and an SPI ranging from 68 to 100 would indicate the top third level of performance. The SPI number itself is not meaningful in an absolute sense. The index only reflects the percent of performance within a range of possible scores for the questions and observations that make up the index.

The SPI provides an ordinal measure of perceived performance. It can be used to rank order and compare projects from different contexts using a broad spectrum of available data, and it offers an alternative method for characterizing project performance when "hard" data are not available. Inputs to the SPI include primary information obtained systematically from a variety of sources, which I consider an improvement over characterizations of performance based purely on anecdotal information, secondary data, or expert opinion alone. In this section, I have developed a conceptual framework and empirical method for measuring project performance. In the next section, I present an application of the method using data from one of my case studies.

C.3 Application of the SPI Method

Raw data on operability and impacts from a sample case are summarized in Tables C-2 and C-3, respectively. For the resident questions in Tables C-2 and C-3, the expected response results confirm that the pre-screening criterion was met. These raw data were converted into scores using the previously described algorithms. Tables C-4 and C-5 present a stepwise calculation of scores for the operability and impacts indicators, respectively. A small sample of data from Case R1 (only 6 data points) was selected for use in this example, however a variety of question formats and scales was included to illustrate how scores with a uniform scale could be obtained. The resulting scores in Column I of Tables C-4 and C-5 were labeled to facilitate reference to specific scores in the following discussion, and a median score was also determined for each indicator. Computation of the SPI index based on the median score for each indicator is shown in Table C-6. Medians were computed instead of averages because of the ordinal property of the measures.

Table C-2. Sample of the raw data on "operability" for a sample case using one question per data source.

Sources of Data	Operability Question	Response/Rating (r)	Expected Response (e)	Response Frequency (n)	Total No. of Respondents ($\sum n$)	Sample Size (s)	Response Rate	Population (P)
Resident Interviews	Ratings of Condominial Sewer Operability	1 = Low 2 = Medium Low 3 = Medium 4 = Medium High 5 = High	5.2 5.2 5.2 5.2 5.2	2 8 10 2 4	26	33	78.8%	293 homes
Maintenance Staff Interviews	Reported Blockages in the Condominial Sewer	1 = Yes 2 = No	n/a	2 0	2	2	n/a	n/a
Engineering Staff Interviews	Ratings of Condominial Sewer Operability at Time 1	1 = Low 2 = Medium Low 3 = Medium 4 = Medium High 5 = High	n/a	0 0 1 2 0	3	13	n/a	n/a
Direct Observations	Observed Number of Sealed Street Manhole Covers	n/a	n/a	39	n/a	50	n/a	293 manholes

Note: "n/a" indicates not applicable.

Table C-3. Sample of the raw data on "impacts" for a sample case using one question per data source.

Sources of Data	Operability Question	Response/Rating (r)	Expected Response (e)	Response Frequency (n)	Total No. of Respondents ($\sum n$)	Sample Size (s)	Response Rate	Population (P)
Resident Interviews	Reported Improvements to Local Health and Environment	1 = Worsened 2 = Not Changed 3 = Improved	9.7 9.7 9.7	16 13 0	29	30	96.7%	293 homes
Direct Observations	Observed Frequency of Public Sewage	0=Continually Present 50=Intermittently Present 100=None Present	n/a	0 0 50	50	50	n/a	293 manholes

Note: "n/a" indicates not applicable.

C.2.5 Interpretation of Results

The resulting SPI of 64 (see Table C-6) indicates that the overall performance of this project is most likely within the middle third of the measured range (although it is at the high end of the range). This project exhibited high levels of operability and impacts based on Operability scores #3 and #4, and Impacts score #2 (see Column I in Tables C-4 and C-5, respectively). However, Operability score #1 indicates medium level operability; and Impacts score #1 and Operability score #2 indicate low level performance.

From the case study descriptions in Chapter 5 and Appendix E, we know that Case R1 residents had well-functioning septic tanks prior to the condominial sewer project. Also, the middle income socio-economic level of this community suggests that septic tank cleanout was probably not prohibitively expensive for these residents. All of the sewage discharged from the Case R1 neighborhood sewer system goes to a storm canal without treatment whereas, prior to the project, the sewage went to a mix of relatively well-functioning onsite septic tanks and storm drain connections without treatment. The project did not result in significant improvements to local health and environment compared to the previous condition of the neighborhood, nor did the project bring wider health and environment improvements beyond the project area. These mixed results – low *perceived* impacts and high *observed* impacts, medium *reported* operability and high *observed* operability – are adequately captured by an SPI of 64 in combination with the knowledge provided by the case study description[7].

Table C-4. Using a sample of questions that passed the selection criteria (Column A), the raw data on operability (Column C) are converted into Question Scores expressed on a uniform scale (Column I). The sample of data is from case study R1.

A	B	C	D	E	F	G	H	I
Selected Questions For Operability	**Response or Rating (r)**	**Frequency of Responses (n)**	**Total Responses ($\sum n$)**	**Average Response, R** $\frac{\sum(r \cdot n)}{\sum n}$	**Low End of the Question Scale (s_{min})**	**High End of the Question Scale (s_{max})**	**Normalized Average Response, R** $\frac{R - s_{min}}{s_{max} - s_{min}}$	**Scores Expressed On a Uniform Scale ($R \cdot 100$)**
Ratings of Condominial Sewer Operability by Residents	1 2 3 4 5	2 8 10 2 4	26	2.92	1	5	0.48	48 (Oper. Score #1)
Blockages in Condominial Sewer Reported by O&M Staff	1 2	2 0	2	1.00	1	2	0	0 (Oper. Score #2)
Ratings of Condominial Sewer Operability at Time 1 by Engr. Staff	1 2 3 4 5	0 0 1 2 0	3	3.67	1	5	0.67	67 (Oper. Score #3)
Observed Number of Sealed Street Manhole Covers	n/a	39	50	0.78	0	100	n/a	78 (Oper. Score #4)
							Median Score	**= 67**

Table C-5. Using a sample of questions that passed the selection criteria (Column A), the raw data on impacts (Column C) are converted into Scores expressed on a uniform scale (Column I). The sample of data is from case study R1.

A	B	C	D	E	F	G	H	I
Selected Questions For Impacts	**Response or Rating (r)**	**Frequency of Responses (n)**	**Total Responses ($\sum n$)**	**Average Response, R** $\frac{\sum(r \cdot n)}{\sum n}$	**Low End of the Question Scale (s_{min})**	**High End of the Question Scale (s_{max})**	**Normalized Average Response, R** $\frac{R - s_{min}}{s_{max} - s_{min}}$	**Scores Expressed on a Uniform Scale ($R \cdot 100$)**
Reported Improvements to Local Health and Environment	1 2 3	16 13 0	29	1.45	1	3	0.22	22 (Impacts Score #1)
Observed Frequency of Public Sewage	0 50 100	0 0 50	50	1.00	0	100	n/a	100 (Impacts Score #2)
							Median Score	**= 61**

Table C-6. Computation of the Sewer Performance Index using median scores and equal weighting factors for a sample of data from Case R1.

Median Operability Score (O)	Weighting Factor (w_o)	Median Impacts Score (I)	Weighting Factor (w_i)	SPI = ($w_o \cdot O + w_i \cdot I$)
67	0.5	61	0.5	64

I have presented in this chapter a practical method for evaluating the performance of condominial sewer projects based on the types of on-the-ground data that were actually obtainable. If better, more modern data were available (e.g., accurate as-built drawings, infiltration/inflow studies, sewer videos, and sewer system evaluation reports) then additional data could be included in the measures and the same evaluation method carried out on the larger set of resulting scores. Any set of data can be utilized with this method, including secondary data if they are unbiased and if they are not the sole source of information. The SPI method consolidates as many different sources of data as possible to increase the validity of the performance measure.

The limitations of the SPI method include the instruments used to collect the data. Improvements to these instruments, such as the use of a uniform rating system, would facilitate cumulative scoring and would result in fewer ties. However, a uniform question format would likely reduce the quality of descriptive information obtained from respondents. The resulting SPI values are shallow without the case study knowledge needed to interpret the results. Nevertheless, the SPI is useful for distilling a large amount of diverse qualitative information into one representative number that can be compared across cases.

---

[1]Abbott, 1996; Narayan, 1994; Narayan, 1995; Yepes, 1993; Reader, et. al., 1983; Janssens, et. al., 1996; EPA, 1991; Sullivan, et. al., 1977; Board of Sanitary Engineers, 1980; Esrey, et. al., 1991; Mara and Guimaraes, 1999; Schalock, 2001; and EPA, 1977.

[2]Schalock, 2001:170.

[3]The case study projects evaluated in this dissertation were implemented in the late 1980s, during a period of extremely high inflation throughout Brazil. One condominial sewer project manager I interviewed reported that "by the end of [a] project, no one knew the true cost" of projects implemented at that time. (Informant 96, CAERN civil engineer, interview by author, 22 May 1995, Natal, transcript).

[4]Abbott, 1996.

[5]The case study performance scores in Tables 7-3 and 7-4 of Chapter 7 show that the "impacts" score dominated in all six cases examined in this dissertation.

[6]Huck, 2000.

[7]For the purposes of this chapter, only six data points were used to determine the SPI. In the main body of the dissertation, however, all of the 27 data points available were used, resulting in an SPI of 67 for Case R1.

Appendix D

Methodology for Measuring Participation

The objective of this chapter is to present a method for measuring participation in condominial sewer projects. Section D.1 provides a brief review of the literature on participation in development projects. In Section D.2, I describe my participation framework and operational indicators, and in Section D.3, I apply this method to a sample case study project.

D.1 Participation in the Literature

Participation is a key component of localized approaches to the implementation of infrastructure in developing countries. The concept of participation is widely supported by many different types of development organizations, including NGOs, governments, and international donors[1]. The authors of a recent report to the US Agency for International Development declared that:

> It is now accepted that donors and governments implementing projects need to consider households and communities as partners and . . . be responsive to people's felt needs and genuine demand. (Rosensweig, et. al., 2002:23)

In its broadest sense, participation includes a wide variety of activities, including beneficiaries digging sewer pipe trenches, residents attending project meetings, and citizens demonstrating to express demands. People participate in the development process even when they organize against a project. The concept of participation is pliable enough to be considered acceptable even by governments who may initially be threatened by the idea of participation. This characteristic leads to wide acceptance and at the same time makes participation difficult to define precisely.

There are many ways to define the concept of participation. Moser (1983) presented the notion that participation has two fundamental objectives, and that the relevant definition of participation depends on which of the objectives is primary[2]. One objective of participation is to facilitate the implementation of a project; another objective can be to empower the participants. Paul (1987) states that participation can facilitate projects by improving project effectiveness, by increasing project efficiency, or by bettering project cost sharing[3]. Moser calls this type of participation "means" oriented, in which participation serves as a means to achieving an end (e.g., a successful project).

The second fundamental objective of participation is to improve the conditions of the community via increased community capacity, improved equity, and empowerment. In the second objective, participation is the involvement of people in their own development. Moser calls this second type of participation "ends" oriented, whereby participation serves as an end in itself. Choguill (1996) also provides an ends-oriented definition of participation that is finely tuned to the realities faced by communities in the developing world:

> [C]ommunity participation is not seen as being just a means to enable the people to get . . . the basic needs which, otherwise, would not be available to them, but also as a means to influence decisions in the political arena about issues that affect them. (Choguill, 1996:431)

In this dissertation, I am interested in the association between participation and project success, thus I adopted the first objective, in which the objective of participation is to facilitate implementation of a project.

D.2 Participation Framework

Participation frameworks put forth by Arnstein (1969), Paul (1987), and Choguill (1996) suggest ways to operationalize participation[4]. Arnstein's analysis of participation is perhaps the most widely cited of all, even though it was developed for US programs. Arnstein's, Paul's, and Choguill's conceptual models, summarized in Table D-1, characterize participation as a spectrum of decision making authority held by the participants. Arnstein and Choguill proposed 8-scale model, while Paul proposed a 4-scale model. These three models of participation depict the varying levels of power held by citizens or beneficiaries. Citizen control, initiating action, and empowerment make up the "high" end of the participation scales by Arnstein, Paul, and Choguil, respectively. These scales form the basis for empirical measurement of participation in projects.

Table D-1. Levels of participation as defined by Arnstein, Paul, and Choguill.

Arnstein's Ladder	Paul's Intensity Scale	Choguill's Ladder
1. Manipulation	1. Information Sharing	1. Self-management
2. Therapy	2. Consultation	2. Conspiracy
3. Informing	3. Decision Making	3. Informing
4. Consultation	4. Initiating Action	4. Diplomacy
5. Placation		5. Dissimulation
6. Partnership		6. Conciliation
7. Delegated Power		7. Partnership
8. Citizen Control		8. Empowerment

Sources: Arnstein, 1969; Paul, 1987; and Choguill, 1996.

Comparing Arnstein's and Choguill's ladders, citizen control and self-management are at opposite ends of the scales even though these appear to be similar concepts. Arnstein and Choguill have made different judgments about whether community self-management/citizen control should be at the high or low end of the scale. This conflict also emerged in the condominial sewer experiences of Recife and Natal. In Recife, the state water and sanitation agency was criticized by sewer officials, condominial sewer practitioners, and beneficiaries when it did *not* perform regular maintenance on condominial sewer systems. This perceived lack of institutional support undermined the outcome of many projects. Conversely, in Natal, the state water and sanitation agency was criticized when it *did* perform regular maintenance. This perceived paternalism on the part of the agency undermined the need for beneficiaries to take on maintenance responsibility themselves. The question is to what extent are communities (especially poor communities) formally supported by the government, and to what degree do they manage themselves.

Several researchers have measured participation along a scale (or "ladder") *and* across the various phases of a project: planning, design, construction, and maintenance. In one such study, Narayan (1994) used Paul's (1987) intensity scale to measure the type and extent of participation in decisions during the different phases of the project cycle[5]. In a study by Finsterbusch and Van Wicklin (1989), participation in project work and in project decisions was measured within the context of the project cycle[6]. Esogbue and Ahipo (1982) proposed a measure of participation effectiveness that went beyond involvement in project work and project decisions[7]. Their framework added the notion of "influence on planners" as one of five aspects of participation effectiveness, as follows:

- Level of Involvement in Decision-Making
- Degree of Attendance or Acceptance
- Level of Understanding of the Issues or the Project
- Level of Influence on Planners
- Satisfaction of Participants with the Results of Participation

The operational definitions presented above suggest that the concept of participation can be operationalized in two primary dimensions. The first dimension of participation includes direct *contributions* of labor, money, or materials from beneficiaries to the construction and maintenance of a project. On this dimension, higher participation levels could be measured either by higher amounts of individual contributions or larger numbers of contributors. This is the "contributions" dimension of participation. The second dimension of participation is the *involvement* of beneficiaries in mobilizing residents and in project decision-making. Higher participation levels on this dimension could be measured by higher levels of individual or collective influence, higher levels of decision-making authority by beneficiaries, higher levels of attendance at meetings, higher levels of involvement in a participation program, and the formation of user groups. This is the "involvement" dimension of participation.

To summarize, participation is defined herein as *the contributions and involvement of residents, households, and the community in a project*. Contributions include beneficiary inputs of labor, money, or materials in project construction and project maintenance. Involvement includes beneficiary inputs of time and energy in project mobilizing and project decisions. In keeping with the means-oriented objective of participation mentioned in Section D.1, a project-referenced definition of participation was selected to limit the scope of participation to only those decisions and activities associated with a condominial sewer project, and to limit the potential participants to only those residents who live within the boundaries of a condominial sewer project.

D.3 Measuring Participation

The level or degree of participation achieved was measured using three sources of data: 1) assignment of scores based on the case study descriptions, 2) responses of beneficiaries to interview questions, and 3) responses of participation staff to interview questions. In Sections D.3.1, D.3.2, and D.3.3 below, I describe how participation was scored using each source of data The method results in numerical scores that represent the degree of participation achieved (on a scale from 0 to 100) in each of the four categories of participation.

D.3.1 Using Case Study Descriptions to Assign Values to Participation

In this section, I show how I assigned values to participation using the case study description as a source of data[8], and using Paul's (1987) participation intensity scale (see Table D-1) as the criteria for assigning the scores. The case study descriptions were compiled from the information I obtained from interviews with engineers, participation staff, beneficiaries, and project records (when available). Starting with the mobilizing category of participation as an example, I envisioned four scenarios under which mobilizing could be carried out. In the first scenario of participation in mobilizing, the implementing agency mobilizes the residents. Residents are informed by the agency that they have been selected for a project and their mass acceptance is important. This first scenario is best represented as Information Sharing on Paul's scale (see Table D-1).

In the second scenario of participation in mobilizing, the agency mobilizes users with the assistance of neighborhood leaders. This represents Consultation on Paul's scale (see Table D-1). This is one ordinal step up from Information Sharing because residents provide some input in the mobilizing process. In the third scenario of participation in mobilizing, residents mobilize themselves to better respond to the agency. The third scenario represents Decision-Making on Paul's scale. In the fourth scenario of participation in mobilizing, residents take the initiative to mobilize on their own.

Included in this scenario would be instances where residents organized themselves spontaneously for a project. This represents Initiating Action on Paul's scale.

The three remaining categories of participation – participation in decisions, participation in construction, and participation in maintenance – were similarly categorized into scenarios that corresponded to Paul's scale, plus a fifth category corresponding to no participation whatsoever. All of the possible scenarios are summarized in Table D-2, along with ordinal scores that correspond to each scenario on a scale from 0 (lowest) to 100 (highest).

Table D-2. Decisions, scores, and scenarios used to determine the level of participation in condominial sewer projects. Each decision is divided into four scenarios of participation, plus a "no participation" scenario.

Decisions	Scores[a]	Scenarios
Level of User Authority in Mobilizing Residents	0	0. Little or no mobilization of users.
	25	1. Agency mobilizes users.
	50	2. Agency mobilizes users with assistance from community/block leaders.
	75	3. Users mobilize themselves to respond to the agency.
	100	4. Users mobilize themselves without seeking response from the agency.
Level of User Authority in Service Level Selection	0	0. Agency selects and does not inform users.
	25	1. Agency selects and informs users.
	50	2. Agency provides service options to users.
	75	3. Users select and seek agency approval.
	100	4. Users select and do not seek agency approval.
Level of User Authority in House Connection Construction	0	0. Little or no construction of house connections.
	25	1. Agency constructs and informs users.
	50	2. Agency constructs with user input.
	75	3. Users construct with agency assistance.
	100	4. Users construct without agency assistance.
Level of User Authority in Condominial Sewer Maintenance	0	0. Little or no maintenance of condominial sewer.
	25	1. Agency maintains and informs users.
	50	2. Agency maintains with user input.
	75	3. Users maintain with agency assistance.
	100	4. Users maintain without agency assistance.

a. Scores represent the degree of user authority in the activity or decision, and are on an ordinal scale from 0 (no authority) to 100 (full authority). I developed this scoring methodology based on Paul's (1987) conceptual framework of participation.

The following are selected portions of a sample case study description (i.e., Case R1 is used as the sample case) that support my assignment of values to the four categories of participation.

1. Mobilization of Residents. In 1985-1986, residents mobilized to apply for a pavement project through an existing City program. The community was placed on the City's list of eligible neighborhoods. The City selected this neighborhood from among many applicants and approached the residents with a proposal: the City would pave the neighborhood streets if the residents agreed to accept and pay for a condominial sewer system that would be installed before the pavement was constructed. Two community leaders mobilized residents to help the City convince enough residents to accept a condominial sewer and make the project viable. There were months of house by house discussions between the City and the residents. After construction was complete the residents de-mobilized with regard to the sewer system. [In my judgment, this experience matches scenario 2 most closely (because the agency used local leaders to facilitate the mobilization of residents for the condominial sewer), for a score of 50 (see Table D-2)].

2. Service Level Selection. Initially, the residents accepted a condominial sewer based on a cost comparison with conventional sewers. But later on, when the City presented the layout of the system, the residents resisted the City's interconnected backyard layout because residents would have to communicate and negotiate maintenance activities with their neighbors. The residents were interested in receiving the project, but not in the collective maintenance required by a backyard layout. The majority of residents preferred a sidewalk layout. Nevertheless, the City was only offering a backyard layout. Residents who still wanted to connect to the backyard layout signed an agreement from the City stating they were willing to connect to the sewer and pay a monthly tariff that covered the capital and recurring costs for the service. [In my judgment, this experience matches scenario 1 most closely (because the sewer agency did not offer the residents a choice), for a score of 25 (see Table D-2)].

3. **House Connection Construction.** Because the City wanted to market the benefits of condominial sewers to residents who had no familiarity with the new technology, the City (not the residents) constructed the house connections. Residents who wanted to connect to the system signed an agreement authorizing construction of the house connection in their homes and the condominial sewer on their private property. Sewer and house connection construction was conducted and approved by the City with input from a COMPESA review team and with some scattered input from residents. Materials for the condominial sewer and house connections were pre-selected by the City with no input from residents. [In my judgment, this experience matches scenario 1 most closely (because the agency constructed the house connections without systematic user input), for a score of 25 (see Table D-2)].

4. **Condominial Sewer Maintenance.** Residents who decided to connect signed contracts with the City agreeing to perform their own maintenance on the backyard condominial sewer and on their private house connections. However, in practice, many

users regularly called COMPESA for both condominial sewer and house connection maintenance. [In my judgment, this experience matches scenario 2 most closely (because of the residents' continued level of reliance on the sewer agency, even for in-home maintenance), for a score of 50 (see Table D-2)].

The following table, Table D-3, summarizes the scores assigned to participation for the sample case study.

Table D-3. Scores assigned to participation for the sample case[a].

Categories of Participation	Scores
1. Participation in Mobilizing (mobilization of residents)	50
2. Participation in Decisions (service level selection)	25
3. Participation in Construction (house connection construction)	25
4. Participation in Maintenance (condominial sewer maintenance)	50

a. Scores are on an ordinal scale from 0 to100, where 0 represents no participation whatsoever and 100 represents users initiating the decision or action themselves.

D.3.2 Using Responses from Residents to Measure Participation

A condominial sewer practitioner told me that "good participation means more than residents just wanting a condominial sewer; they must show up for the meetings"[9]. Condominial sewer practitioners who utilized participation tried to get as many residents as possible to attend project meetings, because practitioners believed higher levels of attendance meant better communication and a more widespread interest in the project among residents. Other reasons practitioners encouraged higher levels of resident involvement included the need to educate a larger portion of the community, the need to mobilize residents for mass acceptance and authorization of the project, the need to reach consensus on the level of service, and the potential for a higher number of connection rates. Information from residents about their level of involvement is another source of data that can be used to measure participation.

Resident interview questions related to participation are presented in Table D-4. The number of positive responses to these questions was normalized to the number of respondents, and was expressed on a scale from 0 to 100 using the following algorithm:

$$\text{Score} = \frac{(\sum r) \cdot 100}{n} \qquad \textbf{Equation D-1}$$

Where: r = number of positive responses to the question

n = total number of respondents

Table D-4. Resident interview questions used to determine the level of participation in condominial sewer projects.

Participatory Activities	Interview Questions
Mobilizing Attend Project Meetings	Percentage of positive responses to Questions 3-2.a, b, c, d, e, and g of the resident questions: *"Did you participate in project meetings?"*
Mobilize Residents About the Project	Percentage of positive responses to Question 3-2.i of the resident questions: *"Did you participate in mobilizing residents?*
Be Informed About Opportunities for Involvement	Percentage of positive responses to Question 3-1 of the resident questions: *"Even if you chose not to attend, did you know that residents were participating in the project?"*
Decisions Select Layout	Percentage of positive responses to Question 3-2.h of the resident questions: *"Were you involved in selecting the layout for the project?"*
Construction Purchase Project Materials	Percentage of positive responses to Question 3-2.j of the resident questions: *"Did you authorize project construction?"*
Authorize Construction	Percentage of positive responses to Question 3-4 of the resident questions: *"Did you purchase project materials?"*
Construct House Connections	Percentage of positive responses to Question 3-2.f of the resident questions: *"Did you construct your house connection?"*
Maintenance Maintain Condominial Sewer And House Connection	Percentage of positive responses to Question 2-4 of resident interview: *"Who fixes your household's condominial sewer when there is a problem, including paying for the expense?"*
Be Informed About How to Perform Maintenance	Percentage of positive responses to Question 2-14.a of resident interview: *"Do you or someone in your household know how to fix your household's condominial sewer?"*

The following table, Table D-5, presents a set of responses to the questions that were presented in Table D-4. Table D-5 shows that, overall, 36 percent of the residents interviewed said they were involved in the project activities listed in the table. To properly interpret this result, one must compare it to the levels of involvement actually experienced in condominial sewer projects. According to condominial sewer practitioners I interviewed, the highest levels of involvement actually experienced in projects can range from a typical high of 40-50% up to a rare 100% attendance in certain circumstances[10]. Participation rates above 50% are considered good[11]. Therefore, a score of 36 would indicate a moderate level of participation.

D.3.3 Using Responses from Participation Staff to Measure Participation

The third source of available data about participation in condominial sewer projects is information from participation staff. Participation staff were asked a series of nominal questions about the participation of residents in the case study condominial sewer projects. These questions and a sample of results are presented in Table D-6. The scores indicate the percent of participation staff who said residents were involved in specific aspects of participation in mobilizing, decisions, construction, and maintenance.

Table D-5. Scores for participation based on the percent of residents who participated directly in project events and activities, as measured by selected questions for a sample case[a].

Project Activities	Responses[12] (n/s)
Residents Who Attended Project Meetings	$\frac{14}{25}$
Residents Who Mobilized Around the Project	$\frac{4}{25}$
Residents Who Were Informed About Project Involvement	$\frac{11}{25}$
Residents Who Selected the Sewer Layout	$\frac{4}{19}$
Residents Who Purchased Project Materials	$\frac{11}{19}$
Residents Who Authorized Construction	$\frac{6}{19}$
Residents Who Constructed a House Connection	$\frac{2}{19}$
Residents Who Performed Maintenance	$\frac{12}{22}$
Residents Who Were Informed About Maintenance	$\frac{8}{26}$
Overall Average	36%

a. Scores are on a numerical scale from 0 to 100. "n" is the number residents who participated and "s" is the sample size of residents who were interviewed and who were eligible to respond to the question.

Table D-6. Responses of participation staff to selected questions about resident participation in mobilizing, decisions, construction, and maintenance.

Project Activities	Responses (Yes/No)
Participation in Mobilizing	
Residents Were Mobilized (Q2a)	2/0
Residents Received Orientation (Q2b)	2/0
Residents Received Education Program (Q2c)	2/0
User Groups were Formed (Q2d)	2/0
Residents Attended Meetings (Q2e)	2/0
Residents Were Visited in Their Home (Q2f)	2/0
Residents Received Project Literature (Q2g)	2/0
Participation in Decisions	
Residents Decided the Layout of the System (Q2h)	2/0
Residents Decided to Accept the Service Level (Q2i)	2/0
Participation in Construction	
Residents Constructed Condominial Sewers (Q2k)	0/2
Residents Purchased Materials (Q2l)	1/1
Houses were Connected to the Condominial Sewer (Q3g)	2/0
Residents were Responsible for Constructing House Connections (Q4c)	0/2
Participation in Maintenance	
Residents Accepted Responsibility for Maintenance (Q2j)	2/0
Residents Performed Maintenance (Q3c)	2/0

D.3.4 Combining the Data into Participation Indices

I combined all of the data (i.e., the assigned scores from Section D.3.1, the residents responses from Section D.3.2, and the participation staff responses from Section D.3.3) into a set of participation scores using Equations C-1 and C-2 (see Appendix C)[13]. Equation C-1, which only applied to the resident questions, was used to determine if the response rate to each question met the criteria for statistical validity. Equation C-2 was used to convert question responses into scores on a common scale from 0 to 100.

An index for each of the four categories of participation (i.e., mobilizing, decisions, construction, and maintenance) was computed using the algorithm in Equation D-2.

$$\mathbf{Index} = w_0 \cdot A + w_i \cdot R + w_i \cdot S \qquad \textbf{Equation D-2}$$

Where: A = Assigned Participation Score (from Section D.3.1)
R = Residents Participation Score (from Section D.3.2)
S = Staff Participation Score (from Section D.3.3)
w = weighting factor
$w_A + w_R + w_S = 1$

In this dissertation, I used equal weights ($w_A = w_R = w_S$), because I had no basis for weighing one data source more heavily than the other. The results of applying Equation C-5 are summarized in Table D-7. All four categories of participation were used in the sample case study, but some categories achieved higher levels of participation than others. Table D-7 reveals that the sample case study's highest levels of participation are in mobilizing and maintenance. The lowest levels of participation are in construction.

Table D-7. Indices of the four categories of participation for the sample case study. (100 = maximum participation).

Categories of Participation	Index
Mobilizing	60
Decisions	47
Construction	30
Maintenance	62

---

[1]For example, see Oakley, 1991; Moser, 1983; Paul, 1987; Narayan, 1994; Finsterbusch and Van Wicklin, 1987; Korten, 1980; Korten and Alfonso, 1985; Bryant and White, 1982, and World Bank, 1994.
[2]Moser, 1983.
[3]Paul, 1987.
[4]Arnstein, 1969; Paul, 1987; and Choguill, 1996.
[5]Narayan, 1994:28.
[6]Finsterbusch, 1989:575.
[7]Esogbue and Ahipo, 1982.
[8]An even better technique would be to use several independent people to assign the scores, as Narayan (1994) did. I did not have the resources to use this technique for this dissertation.
[9]Informant 75, CAERN senior civil engineer and sewer construction coordinator. Interviews by author, 23 May 1995, Natal. Transcripts.
[10]Informant 75, CAERN senior civil engineer and sewer construction coordinator. Interviews by author, 23 May 1995, Natal. transcripts; and Informant 120, URBANA civil engineer. Interview by author, 1995, Natal. transcript.
[11]Informant 75, CAERN senior civil engineer and sewer construction coordinator. Interviews by author, 23 May 1995, Natal. Transcripts.
[12]Responses indicate the number of residents who said they were involved in some aspect of project mobilizing, decision-making, construction, and maintenance. Any resident interviewed who originally lived in the project area (called an "*original dweller*") was potentially eligible for participating in project meetings, organizing residents, and becoming knowledgeable about project activities. For these three categories of activities, the denominator was *original dwellers* who responded to the question. Any resident interviewed who was an original dweller and who connected to the condominial sewer system (called an "*original dweller who connected*") was potentially eligible for selecting layouts, authorizing construction, purchasing materials, and constructing house connections. For these four forms of project participation, the denominator was *original dwellers who connected* and who responded to the question. Residents who were connected to the condominial sewer at any time were eligible for performing maintenance and becoming knowledgeable abut maintenance regardless of when they moved in. The denominator for these activities is the number of connected residents who responded to the question.
[13]See Appendix C for a detailed discussion of how each of these equations is used to convert raw data into scores.

Appendix E

Recife Case Study Descriptions

In this appendix I describe, in detail, the three case study projects from Recife: Cases R1, R2, and R3[1].

E.1 Case R1

Case study R1 was installed in a middle income neighborhood in 1986 as part of the City's *Projeto Condominio* program. The project is located in COMPESA's Sul Sewage Treatment Division. The project included backyard and sidewalk condominial sewers, drainage, pavement, and final discharge of the collected sewage (untreated) to a nearby concrete-lined storm drain canal. The project was planned and funded through OBRAS, designed and constructed by an OBRAS contractor, and accepted and maintained (as of 1995) by COMPESA. The entire project was completed in one implementation period.

E.1.1 Neighborhood Description for Case R1

Case R1 is a 12 block area of 75 households that is not served by a public sewer system. Individual sewerage solutions prior to the condominial project included backyard cesspools, leachpits, and septic tanks, a solids-free dreno system that was installed in 1970, and clandestine connections to the storm drain system. These dreno systems, which had been previously installed by COMPESA, consisted of an exit pipe from the backyard septic tank to the storm drain system in the street, with eventual discharge to the nearest drainage canal. Residents connected to the dreno system paid a fee equal to 50% of their water bill. Other households had installed their own pipe to the storm drain system, but these connections were considered illegal because these residents avoided paying the monthly fee to COMPESA. The dreno system was not very extensive, probably because COMPESA was not responsible for cleaning or maintaining the drainage canals – these were the responsibility of the City - and an extensive dreno system had the potential to create conflicts between COMPESA and the City.

Photos E-1 through E-6 show street scenes and the visible condition of the sewer system and neighborhood in 1994-95. The Case R1 area is well-drained and is served by several nearby drainage canals. Urban services include asphalt pavement on main streets, cobblestone pavement on lesser streets, sidewalks, drainage, street sewers, water supply, electricity, and telephone service. There is one unpaved street in the project area; however, all of the streets (paved and unpaved) are wide enough for maintenance trucks to access the street sewer system and all of the streets are normally dry. The majority of homes have a stucco finish. Housing lots are laid out in a planned arrangement. All lots have a backyard and many of the homes are fenced off from the street and from neighbors. Completely fencing off one's property is a common practice in middle-class and upper middle-class Brazilian neighborhoods where people have the resources and the land to create more privacy and a sense of safety. At the time of my fieldwork, there were no invaded areas (i.e., squatter settlements) in this neighborhood. Many Case R1 residents owned cars. Some community leaders and residents in the Case R1 project area had pre-existing informal ties to COMPESA staff and government officials. During the conduct of residential interviews in this area, I found it more difficult to find people home because of the relatively high employment rate compared to the other areas where I conducted interviews. Average monthly household income of those interviewed was R$768.88 (7.69 minimum salaries), with a high of R$2000 and a low of R$200. Based on the average income level this area can be characterized as middle income with some poor households.

This neighborhood experienced a high rate of connection to the condominial sewer. Seventy-nine percent of the sampled residents (26 of 33) were connected to the sewer. This neighborhood experienced a low turnover rate. Seventy-three percent of the sampled residents (24 of 33) had lived in the neighborhood during project implementation, and most of these original dwellers (19 of 33) were connected to the sewer system.

E.1.2 Implementation of Case R1

Some residents in this neighborhood were connected to Joaquim Francisco. In 1985-86 the residents spontaneously mobilized to apply for a pavement project from the City and the neighborhood was placed on the City's list of eligible neighborhoods under the Condominial Program. The City approached the residents with a proposal: the City would pave the neighborhood streets if the residents agreed to accept and pay for a condominial sewer system that would be installed before the pavement was constructed.

Two community leaders mobilized residents to help the City convince enough residents to accept a condominial sewer and make the project viable. There were months of house by house discussions between the City and the residents. Condominial sewers were first installed on two blocks in the neighborhood as a pilot project to demonstrate the technology. Photographs of the pilot system were shown to residents in this and other neighborhoods throughout the city to persuade them to connect. The pilot project did not function well because of a lack of maintenance of the downstream septic tank by COMPESA, but the condominial collection system worked fine[2]. Because the City wanted to market the benefits of condominial sewers to residents who had no familiarity with the technology, the City (not the residents) constructed the house connections in Case R1. Materials for the condominial sewer and house connections were pre-selected by the City with no input from residents.

Initially the residents accepted a condominial sewer based on a cost comparison with conventional sewers. But later on when the City initiated discussions about the layout of the system, the residents resisted the backyard layout which had been planned when they learned that with an interconnected system they would have to communicate and negotiate the maintenance with their neighbors. The people were interested in receiving the project but not in the collective maintenance solution – they preferred a sidewalk system. Nevertheless, the City was only offering a backyard system. Residents were involved in selecting the layout of the condominial sewer in their private backyards and the layout of the house connections in their homes. Layouts went through several design revisions as a result of resident input.

Residents who wanted to connect to the system signed a contract from the City agreeing that they a) were willing to connect to the sewer; b) authorized construction of the condominial sewer on their private property; c) authorized construction of the house connection in their homes and on their private property; d) agreed to perform their own maintenance; and e) were willing to pay a monthly tariff that covered the capital and recurring costs for sewer service. Condominial sewer construction was conducted and approved by the City with input from COMPESA. House connection construction was conducted and approved by the City with input from residents. After construction COMPESA accepted the project and performed regular maintenance of the public sewer, maintenance of the condominial sewer on private lots, and in some cases maintenance on individual house connections. After construction was complete the residents de-mobilized with regards to the sewer system. Some residents performed maintenance while others became accustomed to calling COMPESA for maintenance.

E.1.3 Interpretation of Participation and Performance in Case R1

I assigned scores for project participation to consolidate the available information and to facilitate comparison with other cases. The participation scores are based on data from resident interviews, agency staff interviews, and my own understanding of this case from project documents, informal interviews, and walk-throughs (data are summarized in Appendix B). My methodology for assigning participation scores is described in detail in Appendix D. Four categories of participation were scored on scales from 0 to 100:

mobilization, project decisions, construction, and maintenance. Case R1 received a score of 60 for participation in mobilizing residents for the project, a score of 47 for participation in project decisions, a score of 30 for participation in construction, and a score of 62 for participation in maintenance. These scores indicate that participation in mobilizing, decisions, and maintenance are in the middle third, and participation in construction is in the bottom third of the participation scale. Case R1 residents participated considerably in three of the four categories of participation, as indicated by the three participation scores in the middle third of the participation scale.

I also quantified the level of project performance for each case. Using primary data from resident interviews, engineer interviews, maintenance staff interviews, and direct observation, I developed an index of sewer performance. The performance scores were derived from the data summarized in Appendix B. My methodology for scoring performance is developed and described in Appendix C. Performance was conceived as the combination of operational effectiveness (i.e., operability) and beneficial impacts (i.e., impacts) of a project, and was operationalized on a scale from 0 to 100. Based on operability and impact scores of 58 and 77, respectively, the sewer performance index for Case R1 turned out to be 67, which is in the top third of the performance scale. This project achieved good performance.

Case R1 exhibited a high connection rate, highly perceived project impacts, and relatively high levels of satisfaction, and these facts contributed to the good project performance score. The topography of the neighborhood is such that wastewater flows away from the area even when the downstream collection system is not functioning, giving the appearance of a well-functioning system. These discharge conditions contribute to the perceptions of good performance held by residents and measured by the sewer performance index.

The case study evidence reveals many other contributing factors that may have led to good performance, including existing pavement and drainage infrastructure that support the functioning of the sewer system, and the middle income status of the residents that support high levels of service by government agencies, including COMPESA.

The following is a list of findings for Case R1:

- Beneficiaries participated in all four categories of participation,
- Beneficiaries expressed demand for the project;
- Beneficiaries were willing to pay for the project;
- Implementing agency used a participation approach;
- Implementing agency produced an effective engineering design;
- Implementing agency ensured adequate construction workmanship;
- Good topography and good local discharge conditions;
- Project included supporting infrastructure (pavement);
- Beneficiaries were middle income;
- Beneficiaries were already well-organized;
- Project was implemented by one agency;
- Project was implemented within one political cycle;
- Project was supported by the Mayor;
- Project was supported and accepted for maintenance by COMPESA; and
- Area had supporting infrastructure, including piped water and drainage.

E.2 Case R2

Condominial sewer case study R2 was planned, designed, and installed between 1987 and 1992 in a low income neighborhood as part of the City's *Projeto Grande Recife* program. The project is located in the COMPESA's Cabanga Sewage Treatment Division. The project included condominial sewers (installed in backyards, front yards, sidewalks, pathways, and open areas), treatment of the collected sewage in a community septic tank, and final discharge by pumping to a nearby storm drain. The project was planned and funded through URB in 1987, designed in 1988 and re-designed in 1991 by a local engineering consultant hired by URB. The project was subsequently modified again by COMPESA through the same local engineering consultant, constructed by an URB contractor in 1992, and accepted and maintained by COMPESA in 1992 but subsequently abandoned.

E.2.1 Neighborhood Description for Case R2

Case R2 is located in an unplanned, higher density area surrounded by other neighborhoods that are less dense and more urbanized (as demonstrated by the presence of septic tanks, condominial sewer systems, drainage systems, pavement, and normalized housing lots). In 1981 a local engineering company was hired to design septic tanks, drainage, and pavement for the areas surrounding, but not including, the Case R2 area. Individual sewerage solutions prior to the condominial project in the Case R2 project area included onsite cesspools, leachpits, and septic tanks, open ditches, and clandestine connections to the storm drain system.

Photos E-7 through E-12 show street scenes and the condition of the neighborhood in 1994-95. The Case R2 area is very poorly-drained and many of the homes are subject to flooding. Urban services are provided sporatically, with the perimeter having pavement, drainage, electricity, sewers, water supply, and telephone services and the interior having access primarily to electricity, sewers, and water supply (some by outdoor pipe only). The streets on the perimeter of the project area are paved and wide enough for maintenance trucks. The interior of the project area has no streets (only unpaved pathways), several outdoor bathrooms, and is marked by the presence and stench of open air sewage streams (*valas negras*), which only gets worse every time it rains since the area has no drainage system. Despite having appalling sanitation conditions, the Case R2 area does not have the ubiquitous trash, roaming animals, or substandard housing that are characteristic of Recife's favelas. Nevertheless, the sanitation condition has tremendous negative impact on the life of residents and creates infrastructure-based poverty. Home exteriors include a mix of stucco finishes and unfinished tijolo brick.

The majority of housing lots are not laid out in a planned arrangement; only the houses on the perimeter of the project area have planned lots. Some lots do not have a backyard and many of the homes are not fenced off from the street or from neighbors. There are no invaded areas in this neighborhood. Few Case R2 residents owned cars. Residents in the Case R2 project area had no informal ties or patron-client relations with officials, but its relationship with COMPESA and City agencies could be described as paternalistic. During the conduct of residential interviews in this area, it was very easy to find people home. Average monthly household income of those interviewed was R$333.80 (3.34 minimum salaries), with a high of R$2500 and a low of R$70. Based on the average income level, this area can be characterized as low income with some poor and indigent households.

This neighborhood experienced a low rate of connection to the condominial sewer. Forty-six percent of the sampled residents (19 of 41) were connected to the sewer. This neighborhood experienced a low turnover rate. Seventy-one percent of the sampled residents (29 of 41) had lived in the neighborhood during project implementation; however, few of these original dwellers (12 of 41) were connected to the sewer system.

E.2.2 Implementation of Case R2

The tortuous path of implementation for Case R2 is even worse when one considers the earlier attempts to provide sanitation to the neighborhood. Previously, URB had installed onsite septic tanks in the Case R2 area under the Recife Program, but these did not function because of the high water table (as high as 1 meter below the ground in some areas). The condominial sewer project came later, under the Grand Recife Program, after the onsite septic tanks proved to be unsuccessful.

In 1988 a private local engineering company was contracted by URB to design a condominial sewer project, including sewer piping, a pump station, and a community septic tank. The design was completed within 30 days and submitted to URB. Four years later a separate firm was contracted for the construction. During the four year period between design and construction URB had difficulties acquiring the privately-owned land on which the original pump station and treatment plant was located, so the project was relocated. Moreover, COMPESA mandated modifications to the original design, including putting the pump station underground and eliminating the screens and grit chamber, which were considered high maintenance items. In 1992, URB re-hired the engineering company to make these design modifications. The original design called for PVC pipe, but clay pipe was actually used. I could not confirm whether the change from PVC to clay piping materials was included in the formal design modifications or was made in the field during construction.

Multiple difficulties were experienced during the implementation of this project. The original scope of work did not include resident involvement or work with the community at all, and did not include work with participation staff either. At that time, URB did not fully embrace participation by beneficiaries in its implementation approach. In the field residents were only spoken to in a limited way every now and then regarding the location and layout of the system. There were no project meetings before or during project implementation, and residents were not asked to sign, authorize, or accept the system. Residents were not involved in selecting the level of service, the tariff level, or the system layout.

Topographic information for the area was lacking, and the scope of work did not include surveying because URB considered this to be a low-cost, basic project. URB provided a local topographic map from 1976 and did not perform any field surveys to verify the elevations of the planned route of the pipes. Also the scale of the map was 2000 and many houses were missing. The engineering company conducted a rough field survey anyway without payment. The map was enlarged and the houses were added using only a field tape. A survey instrument was used for the manholes and cleanout boxes. Despite URB's assurances that surveying was not a necessary part of the work, the engineering company felt it was necessary due to the flatness of the area. However the distances were short and it was difficult to visualize the slopes due to the density of the houses. There were only about two hand lengths of overall drop in the project area – very flat.

The staff in URB directing the project had experience with drainage and pavement, but not sewers, per se. The pump station was originally located downstream of the septic tank so solids would drop out before reaching the pumps. This sacrificed the available hydrostatic pressure (i.e., head), but solids removal was important to prevent the pumps from clogging. The pumps were also originally designed with screens for extra protection. Without the screens the pumps were vulnerable. COMPESA removed the screens when they analyzed the design. Sewer overflow capability was provided and the pump elevations were established based on field measures of the water level in the storm drain, rather than peak design values.

Unknown additional changes were made in the field during construction. The design engineer did not accompany the construction and was not involved in approving field changes, and it was years after design that the project was built. The same engineering company also designed all of the condominial sewers for the surrounding neighborhoods. Residents of the adjacent neighborhood were organized into a neighborhood association (*Conselho dos Moradores* or *Associacao dos Moradores*) led by a formally elected president. The Case R2 neighborhood was part of this adjacent neighborhood association, and their president represented residents of the Case R2 project area. There were also two community leaders who lived within the Case R2 neighborhood. Other community organizations in the Case R2 neighborhood included the Council of Mothers (*Conselho de Maes*).

Very little participation was performed during project implementation in the Case R2 area. During project implementation, COMPESA and URB and the neighborhood president held two project meetings in the afternoon, and conducted morning house-by-house conversations with residents. At that time, the majority of residents said they could not afford to build house connections to the condominial sewer. Very few of the residents I interviewed knew about project meetings or participation, and most reported that they were not involved in the project. A project inauguration ceremony was held six months after project completion. Less than a dozen residents attended because so few residents had connected to the sewer system. COMPESA abandoned the project soon afterwards. Residents complained about bad project performance to the neighborhood association president in several community meetings, and mobilized to complain to the

City as well. The neighborhood association president complained verbally, in person, and in writing about ten times to URB and COMPESA. He also gathered signatures of Case R2 residents to accompany his written complaint.

E.2.3 Interpretation of Participation and Performance in Case R2

Case R2 had scores of 2 for participation in mobilizing, 6 for participation in decisions, 72 for participation in construction, and 100 for participation in maintenance. These scores indicate that participation in construction and maintenance are in the top third, and participation in mobilizing and decisions are in the bottom third of the participation scale. Case R2 residents participated considerably in two of the four categories of participation, as indicated by the two scores in the top third of the participation scale. Based on operability and impact scores of 7 and 17, respectively, the sewer performance index for Case R2 was 12, which places this project in the bottom third of the performance scale. This project achieved very low performance.

The residents in Case R2 had not mobilized autonomously prior to the project and did not involve themselves actively in the project during implementation. The case study evidence reveals a disjointed implementation process and a great possibility for fatal flaws in the design and construction of this project. Given the significance of these institutional and engineering failures, the low levels of participation in decisions and mobilizing may not be the primary factors that explain low performance. Notwithstanding this fact, one wonders whether an early outpouring of interest by residents could have increased the accountability of the implementing agencies involved and resulted in a better performing project. But in this case, statements from the residents reveal that many of them had become apathetic because of the failure of previous projects in their neighborhood. It is clear from this description that disjointed implementation and design problems had a great impact on project outcome. Few staff members from URB and COMPESA were willing to acknowledge their involvement or even their knowledge of the existence of this project, even staff who no longer worked for these agencies.

The following is a list of findings for Case R2:

- Beneficiaries participated in two categories of participation,
- Beneficiaries did not express demand for the project,
- Beneficiaries were willing to pay for the project,
- Implementing agency did not use a participatory approach,
- Implementing agency produced an ineffective engineering design,
- Implementing agency did not ensure adequate construction workmanship, and
- Poor topography and poor local discharge conditions.
- Beneficiaries were low income,
- Beneficiaries were not already well-organized,
- Project was implemented by more than one agency,
- Project was implemented over more than one political cycle,
- Project was not consistently supported by the Mayor,
- Project was changed by and later abandoned by COMPESA, and
- Area lacked supporting infrastructure.

E.3 Case R3

Condominial sewer case study R3 was installed in a favela between 1987 and 1990 as part of the State's *Projeto Urbanizacao* program. The project is located in COMPESA's Peixinhos Sewage Treatment Division. The project included complete urbanization of the favela, including planned and regraded lots, pavement, drainage, water supply, electricity, street sewers, condominial sewers, community septic tanks, sewage pump stations, final discharge to a nearby river (Rio Morno), and new homes constructed by the residents. In January 1995 the area received 6 hours of water service every other day. Residents subsequently turned some of the lots into stores and schools, which were not included in the project design. The project was planned and funded through COHAB, designed and constructed by a large engineering and construction company contracted by COHAB, and accepted and maintained (as of 1995) by COMPESA. Approximately 95% of the project was completed in one implementation period.

E.3.1 Neighborhood Description for Case R3

Case R3 is located in the hills of Recife. Individual sewerage solutions prior to the condominial project included onsite cesspools, onsite leachpits, onsite septic tanks, open ditches, and discharge of raw sewage to the storm water canal system. Photos E-13 through E-18 show street scenes and the condition of the neighborhood in 1994-95, five years after the project had been completed. The Case R3 area is in a hilly area and is well-drained, although the soil erodes easily. Most of the streets and paths were blocked off with bollards as part of the project design because they were too weak and too narrow for car or truck access. Most streets were normally dry but some did contain wastewater or drainage water. The housing lots were laid out normally, all lots were designed with a backyard, and some (but not all) of the homes are fenced off from the street and from neighbors. Residents used a variety of construction materials for their homes, including tijolo brick, tijolo brick with a stucco finish, or mud and stick walls with tile or corrugated metal roofs. Some residents installed indoor bathrooms and glass windows. There were some heavily invaded areas within the neighborhood that were characterized by unplanned lots, unpaved paths, poorly constructed homes, and a lack of urban services. A few Case R3 residents owned cars. Residents in the Case R3 project area developed a patron-client relationship with the governor who brought the project.

During the conduct of residential interviews in this area it was very easy to find people home. Average monthly household income of those interviewed was R$246.24 (2.46 minimum salaries), with a high of R$700 and a low of R$40. Based on the average income level this area can be characterized as poor with some indigent households.

This neighborhood experienced a high rate of connection to the condominial sewer. One-hundred percent of the sampled residents (59 of 59) were connected to the sewer. This neighborhood also experienced a high turnover rate. Only twenty percent of the sampled residents (12 of 59) had lived in the neighborhood during project implementation; however, all of these original dwellers (12 of 59) were connected to the sewer system.

E.3.2 Implementation of Case R3

When Miguel Arraes took office as governor of Pernambuco in 1987, poor residents started occupying (i.e., *invading*) the Case R3 area for the purpose of establishing a community with urban services. Residents created an organization called the Occupation Commission (*Comissao de Ocupacao*) to represent their interests, and hoped that

Governor Arraes would provide them with urban services as he had previously in other areas. In the 1960s, during Arraes' first gubernatorial term, there was a large invasion of poor citizens into the "Green Garden" neighborhood (a pseudonym). Arraes legalized the land and provided infrastructure for the inhabitants. So when Arraes took office again in 1987 the people were betting on him giving them a project. Community leaders mobilized the inhabitants to "fight," actually to negotiate, for complete urbanization of the invaded area.

Their mobilization tactics included assembling the votes of the community and negotiating with Arraes for the project. The Occupation Commission was disbanded after the project was completed but, as of 1995, the leader of the community continued to meet with COMPESA directors every month to complain and call attention to the community's water and sewer maintenance needs. As the community evolved, several other organizations were created as of January 1995, including the Union of Residents of Case R3 (*Uniao de Moradores da Caso R3*), the Association of Mothers (*Associacao das Mulheres*), the Nenê Nursery School (*Creche Nana Nenê*), the Machado de Assis Group of Mothers (*Grupo de Maes Machado de Assis*), and the Residents Association of Upper Case R3 (*Associacao dos Moradores de Alto Caso R3*).

COHAB hired a construction contractor to design and construct the public services (water supply, street sewers and condominial sewers, drainage canals, pavement, electricity, etc.). COHAB conducted participation with respect to the improvement of housing lots. Although COHAB's participation program primarily focused on the housing aspect of the project, the program also instructed residents on how to build house connections and how to use the sewer system. COHAB provided construction materials and money for residents to use to build their homes and house connections. Residents signed a contract to repay COHAB over a 25 year period.

During and after construction, as much as 30% of the construction materials were stolen by poor residents for resale. Turnover was high as many residents sold their lots or homes to new residents. One practitioner even noted the existence of "professional invaders" (*invasadores profissionais*) who went from project to project receiving free lots or houses from the government and selling them for profit. Other implementation difficulties included an inconsistent water supply and a lack of reliable project financing (although practitioners said they experienced financing problems on every project).

Residential lots were constructed by creating a series of long plateaus in the hills and regular blocks in the flatter areas and hilltops. A principal sewer collection pipe was constructed on each plateau before homes were built. Because of the variety of topography some lots were interconnected with backyard condominial sewers and some had sidewalk condominial or individual connections to the street sewer. In most cases, COHAB selected the layout of the condominial sewers and the location of the cleanout boxes on individual lots, and when residents arrived these were already built. In cases where they were not already built, residents and COHAB field crews worked together to layout and construct the onsite portion of the system, depending on the interest and skill level of the resident.

During project implementation, COHAB held project meetings and showed educational videos to residents. But as the project was finished in one area after another the sewer system experienced numerous blockages. COHAB personnel believed some residents did not know how to use the system. Social workers from COHAB were then brought in to educate the residents on the use of the sewer system. This education was done through house-to-house visits and distribution of pamphlets.

The pump station was not concluded because of a change of governor at the end of the project construction period. COMPESA staff were present during construction and evaluated the design of the project. COMPESA accepted and, as of 1995, continued to provide regular maintenance of the public street sewer, while residents were expected to perform maintenance within their lots. As new residents moved into the area they requested connection to the sewer system from COMPESA. This growth put higher demands on the sewage system, especially the pumps.

E.3.3 Interpretation of Participation and Performance in Case R3

Case R3 had scores of 71 for participation in mobilizing, 36 for participation in decisions, 49 for participation in construction, and 76 for participation in maintenance. These scores indicate that participation in mobilizing and maintenance are in the top third, and participation in construction and decisions are in the middle third of the participation scale. Case R3 residents participated considerably in all four categories of participation, as indicated by the four scores in the middle or top third of the participation scale. Based on operability and impact scores of 55 and 87, respectively, the sewer performance index for Case R3 was 71, which places this project in the top third of the performance scale. This project achieved good performance.

Case R3 residents expressed great interest in this project by organizing and mobilizing autonomously prior to the project. There was little or no resident involvement in the water, sewer, and drainage parts of the urbanization project, since these services were being provided by the agency while the residents were building their homes. The residents had little or no input in decisions regarding the layout and construction of the condominial sewer, and this reduced level of participation may be attributed to the large scale and multiple objectives of this project. However, many residents did make layout and construction decisions with regard to their house connections and onsite piping. Case R3 residents also exhibited a high level of participation in maintenance. Case R3 achieved an extremely high connection rate, highly perceived project impacts, and relatively high levels of satisfaction, all contributing to the high performance score. As they did prior to the project, community leaders took the initiative to make demands on authorities with regards to ongoing maintenance. Consequently, when the sewer system became plugged or needed maintenance, COMPESA always resolved the problem and the system continued to function (as of 1995).

The following is a list of findings for Case R3:

- Beneficiaries participated in all four categories of participation,
- Beneficiaries expressed demand for the project,

- Beneficiaries were willing to pay for the project,
- Implementing agency used a quasi-participatory approach for the condominial sewer,
- Implementing agency produced an effective engineering design,
- Implementing agency ensured adequate construction workmanship,
- Good topography and good local discharge conditions,
- Project included supporting infrastructure (piped water, drainage, and pavement).
- Beneficiaries were poor and *favelados*,
- Beneficiaries were already well-organized,
- Project was implemented by one agency,
- Project was implemented within one political cycle,
- Project was supported by the Governor, and
- Project was supported and accepted for maintenance by COMPESA.

---

[1]Sources: Interviews with residents and community leaders, Recife, 1994-1995; Interviews with staff from URB, EMLURB, COMPESA, and COHAB, Recife, 1994-1995; Interviews with engineering consultants, Recife, 1994-1995; Focus group discussion with six community leaders/residents from Case R1, Recife, January 26, 1995; Fieldnotes from 5 months of personal communication and direct observation, Recife, 1994-1995; Letter from a Case R1 resident (a community leader) to the Director President of the Secretary of Public Works of Recife (OBRAS), August 22, 1988; *Termo de Autorizacao para Construcao do Ramal Condominial de Esgotos* (19 contracts), June 1987 and August 1988; *Sistema de Esgoto Existente, Cadastramento, Sistema de Drenagem Proposto, e Sistema de Esgoto Proposto* (project proposal), Departamento de Obras Urbanas, Prefeitura do Recife, undated; *Projeto Condominio Aplica 11 Milhoes em Saneamento* (newspaper clipping), Diaro de Pernambuco, undated; Engineering drawings, Recife, 1987; Letter from a Case R1 resident (an engineering professor) to the Manager of Sewer Services of COMPESA; February 13, 1995.

[2]Informant 30, interview by author, 9 March 1995, Recife, transcript.

Appendix F

Natal Case Study Descriptions

In this appendix, I provide detailed descriptions of the three case study projects from Natal: Cases N1, N2, and N3[1].

F.1 Case N1

Condominial sewer case study N1 was installed in 1987. The project included a mix of sidewalk condominial sewers, backyard condominial sewers, and conventional sewers. Final discharge of the collected sewage (untreated) went to the Potengi River (*Rio Potengi*). The project was planned and funded through CAERN, designed and constructed by a CAERN contractor, and accepted and maintained (as of 1995) by CAERN. No other state or city agency was involved in project implementation.

F.1.1 Neighborhood Description for Case N1

Case N1 is located in a high income neighborhood with a nearby conventional sewer system. Individual sanitation solutions prior to the condominial project included backyard septic tanks with leachpits, and graywater disposal to the street. Photos F-1 through F-6 show street scenes and the condition of the neighborhood at the time of my fieldwork. The photos reveal the constant presence of graywater mixed with rainwater flowing down the street gutters. This graywater came from three sources: unsewered households located upstream of the Case N1 project area, project area households that did not connect to the sewer system, and project area households that continue the traditional practice of throwing graywater into the street. The Case N1 area is slightly sloped and well-drained.

Urban services included asphalt pavement on main streets, cobblestone pavement on lesser streets, sidewalks, drainage, street sewers, water supply, electricity, and solid waste collection (3 times per week). In 1995 there were no areas invaded by squatters in this neighborhood. There were not many cars in the neighborhood. All of the streets were wide enough for maintenance truck access. As the photos show, most homes had a stucco finish, many homes were fenced off from the street, housing layouts were regular, and the houses abutted their neighbor's houses on both sides. Front yards, if present, tended to be very small in this neighborhood; however all lots had a backyard. There were few alleys in this neighborhood. As a result, most of the house connections were installed under the floors of homes to transport wastewater from household fixtures to the nearest outdoor cleanout box. In the case of condominial sewers, the nearest outdoor cleanout boxes were located either in the backyard or in the sidewalk. In the case of conventional sewers, the nearest outdoor cleanout box or manhole was located either in the sidewalk or in the street.

This neighborhood did not have a community leader. However, one resident did report that the residents had mobilized once to bring speed bumps to the neighborhood. Average monthly household income of those interviewed was R$1,007.92 (10.08

minimum salaries), with a high of R$4000 and a low of R$175. Based on the average income level this area can be characterized as high income with a few poor households.

This neighborhood experienced a high rate of connection to the condominial sewer. Seventy-seven percent of the sampled residents (30 of 39) were connected to the sewer. This neighborhood experienced a low turnover rate. Ninety percent of the sampled residents (35 of 39) had lived in the neighborhood during project implementation, and most of these original dwellers (29 of 39) were connected to the sewer system.

The Case N1 neighborhood had relatively few maintenance service calls. During the 19-month period from January 1993 to July 1994, a total of 118 sewer system repairs were made in the greater neighborhood area (including the project area). This equates to a maintenance rate of 0.06 service calls per connection, which was far less than the citywide average of 0.25 service calls per connection during the same period[2].

F.1.2 Implementation of Case N1

Case N1 was a relatively small project in a high income neighborhood. A neighboring high income community had gone to CAERN to request a sewer system for households not already served by the existing conventional sewer. CAERN responded with a condominial sewer project and decided to include the Case N1 area located only a few blocks away.

CAERN planned and proposed the condominial sewer, offering residents the option of a backyard or sidewalk system. The majority of residents selected sidewalk connections because they wanted to avoid the possibility of conflict with neighbors. Under the backyard layout, homes were connected to a collective sewer on private, rather than public, property. Residents thought of the backyard option as interconnecting their house with their neighbors houses, making it a less desirable option.

CAERN selected the piping layout and constructed the condominial sewers and street sewers using ceramic materials. Residents paid for and constructed their house connections (typically of PVC pipe), and they paid the condominial sewer tariff, except for some residents who could not or would not pay the tariff. Up to 40% of residents attended project meetings. CAERN tried to create user groups (*condominios*) on each block of the neighborhood as part of its implementation of the project.

F.1.3 Interpretation of Participation and Performance in Case N1

Case N1 had scores of 42 for participation in mobilizing, 33 for participation in decisions, 64 for participation in construction, and 56 for participation in maintenance. These scores indicate that participation in mobilizing, construction, and maintenance are in the middle third, and participation in decisions is just within the bottom third of the participation scale. Case N1 residents participated considerably in three categories of participation, as indicated by the three scores in the middle third of the participation scale. The participation in decisions score is right at 33.33 (rounded to 33), which is at the borderline of the bottom third and middle third. Based on operability and impact scores of 56 and 80, respectively, the sewer performance index for Case N1 was 68, which places this project in the top third of the performance scale. This project achieved good performance.

The following is a list of findings for Case N1:

- Beneficiaries participated in all four categories of participation,
- Beneficiary demand for the project was stimulated by the agency,
- Beneficiaries were willing to pay for the project,
- Implementing agency used a participatory approach for the condominial sewer,
- Implementing agency produced an effective engineering design,
- Implementing agency ensured adequate construction workmanship,
- Good topography and good local discharge conditions,
- Beneficiaries were high income,
- Beneficiaries were not already organized,
- Project was implemented by one agency,
- Project was implemented within one political cycle,
- Project was supported by the Governor, and
- Project was supported and accepted for maintenance by CAERN.
- Area had supporting infrastructure, including piped water, drainage, and pavement.

F.2 Case N2

Condominial sewer case study N2 was installed in 1986 (74% completed in Phase 1). The project included all backyard condominial sewers and final discharge of the collected sewage (untreated) into Natal's stabilization pond treatment plant. The project was planned and funded through CAERN, designed and constructed by a CAERN contractor, and accepted and maintained (as of 1995) by CAERN. No other state or city agency was involved in project implementation. Phase 2 project completion started in 1994.

F.2.1 Neighborhood Description for Case N2

Case N2 is located in a low income neighborhood. Individual sanitation solutions prior to the condominial project included backyard cesspools, leachpits, septic tanks, and open ditches. Photos F-7 through F-12 show street scenes and the condition of the neighborhood at the time of my fieldwork. The Case N2 area is slightly sloped and well-drained. Urban services included asphalt pavement on most of the main streets, cobblestone pavement on some lesser streets, some sidewalks, periodic water supply, and electricity. This neighborhood did not receive water every day and this was a point of great dissatisfaction among residents.

Residents reported that the water supply, street lights, and pavement infrastructure were installed piecemeal as political projects each associated with a different mayor. In some cases, great political conflict would result in the paving of an individual block or street, leaving the unserved residents to wait for the next mayoral election to "fight" again for their piece of infrastructure.

All of the streets were wide enough for maintenance truck access, however some streets were unpaved at the time of my fieldwork. As the photos show, most homes have a stucco finish, many homes are fenced off from the street, and housing layouts are regular. Most homes had ample front and back yards in this neighborhood. In 1995 there were no invaded areas in this neighborhood. There were very few cars in the neighborhood.

This neighborhood has historically had a community president, sometimes two, although there was not always a functioning community association. At the time of my fieldwork in 1995 there were two community presidents and no community association. One reported that the community had grown apathetic about organizing and mobilizing. He said that residents had lost trust in the authorities (of CAERN and the City) and that politicians only provided projects during election time based on their own interests, not those of the people. Average monthly household income of those interviewed was R$306.79 (3.07 minimum salaries), with a high of R$700 and a low of R$70. Based on the average income level this area can be characterized as low income with some poor and indigent households.

This neighborhood experienced a high rate of connection to the condominial sewer. Ninety-six percent of the sampled residents (44 of 46) were connected to the sewer. This neighborhood experienced a low turnover rate. Seventy percent of the sampled residents (32 of 46) had lived in the neighborhood during project implementation, and most of these original dwellers (30 of 46) were connected to the sewer system.

The Case N2 neighborhood had slightly more than the average number of maintenance service calls. During the 19-month period from January 1993 to July 1994, a total of 309 sewer system repairs were made in the greater neighborhood area (including the project area). This equates to a maintenance rate of 0.29 service calls per connection, which was only slightly more than the citywide average of 0.25 service calls per connection during the same period.

F.2.2 Implementation of Case N2

Case N2 is a large project located in a low-income area of Natal. CAERN planned and proposed the condominial sewer, offering residents the option of a backyard or sidewalk system. The community presidents helped CAERN to mobilize residents around the project. Most residents accepted the project, citing as reasons the desire to stop worrying about the collapse or filling up of their septic tank, the fear that a child could die by falling into the septic tank, the vector problem associated with septic tanks (rats, cockroaches, mosquitos, etc.), and the hope that a sewer would increase the value of their homes.

CAERN selected the piping layout and constructed the condominial sewers and street sewers. Residents paid for and constructed their house connections. Residents also paid the condominial sewer tariff. The great majority of the sewer connections were backyard condominial connections. Case N2 residents expressed more interest in the project than the residents in Case N1, and their attendance at project meetings was very good (over 40%). CAERN created user groups (*condominios*) on each block of the neighborhood as part of its implementation of the project.

Project funding stopped abruptly before the project was completed. Approximately 74% of the project was completed. At this point some residents asked CAERN for materials so they could continue constructing parts of the system and their house connections. CAERN provided these residents with the sewer designs to use as a guide.

F.2.3 Interpretation of Participation and Performance in Case N2

Case N2 had scores of 44 for participation in mobilizing, 38 for participation in decisions, 72 for participation in construction, and 45 for participation in maintenance. These scores indicate that participation in construction is in the top third, and participation in mobilizing, decisions, and maintenance are in the middle third of the participation scale. Case N2 residents participated considerably in all four categories of participation, as indicated by the four scores in the middle third or top third of the participation scale. Based on operability and impact scores of 48 and 84, respectively, the sewer performance index for Case N2 was 66, which places this project in the middle third of the performance scale. This project achieved good performance.

The following is a list of findings for Case N2:

- Beneficiaries participated in all four categories of participation,
- Beneficiary demand for the project was stimulated by the agency,
- Beneficiaries were willing to pay for the project,
- Implementing agency used a participatory approach for the condominial sewer,
- Implementing agency produced an effective engineering design,
- Implementing agency ensured adequate construction workmanship,
- Good topography and good local discharge conditions,
- Beneficiaries were low income
- Beneficiaries were not already organized for this project,
- Project was implemented by one agency,

- Project was only partially implemented within one political cycle,
- Project was supported by the initial Governor, and
- Project was supported and accepted for maintenance by CAERN.
- Area had supporting infrastructure, including piped water, drainage, and pavement.

F.3 Case N3

Condominial sewer case study N3 was installed in 1988 (77% completed in Phase 1). The project included backyard condominial sewers and final discharge of the collected sewage (untreated) into Natal's stabilization pond treatment plant. The project was planned and funded through CAERN, designed and constructed by a CAERN contractor, and accepted and maintained (as of 1995) by CAERN. No other state or city agency was involved in project implementation. Phase 2 project completion started in 1994.

F.3.1 Neighborhood Description for Case N3

Case N3 is located in a lower middle income neighborhood. Individual sanitation solutions prior to the condominial project included backyard cesspools, leachpits, septic tanks, and open ditches, with graywater disposal to the street. Photos F-13 through F-18 show street scenes and the condition of the neighborhood at the time of my fieldwork. Parts of the Case N3 area were slightly sloped and well-drained; other parts of the large neighborhood were flat and poorly-drained or even flooded. Urban services included asphalt pavement on the main streets, cobblestone pavement on lesser streets, sidewalks, periodic water supply, and electricity. This neighborhood also did not receive water every day. Most of the streets were wide enough for maintenance truck access; however some streets or paths were unpaved at the time of my fieldwork. As the photos show, most homes had a stucco finish and housing layouts were regular. Most homes had ample front and back yards in this neighborhood. In 1995 there were some invaded areas in this neighborhood. Cars were a frequent sight in the hilly portion of this neighborhood.

This neighborhood historically had a neighborhood association, but at the time of my fieldwork in 1995 the residents could not identify a community president. Average monthly household income of those interviewed was R$516.71 (5.17 minimum salaries), with a high of R$5000 and a low of R$8. Based on the average income, level this area can be characterized as lower middle income with some poor and indigent households.

This neighborhood experienced a high rate of connection to the condominial sewer. Seventy-six percent of the sampled residents (35 of 46) were connected to the sewer. This neighborhood experienced a low turnover rate. Eighty-five percent of the sampled residents (39 of 46) had lived in the neighborhood during project implementation, and most of these original dwellers (30 of 46) were connected to the sewer system.

The Case N3 neighborhood had an average number of maintenance service calls. During the 19-month period from January 1993 to July 1994, a total of 759 sewer system repairs were made in the greater neighborhood area (including the project area). This equates to a maintenance rate of 0.23 service calls per connection, which was about the same as the citywide average of 0.25 service calls per connection during the same period.

F.3.2 Implementation of Case N3

Case N3 is a large project located in a poor area of Natal. CAERN planned and proposed a backyard condominial sewer to the residents. Households had the option of signing up or not, but no choice of service level. CAERN selected the piping layout and constructed the condominial sewers and street sewers. Residents paid for and constructed their house connections. Residents also paid the condominial sewer tariff. The great majority of these connections were backyard condominial connections and a few were individual sidewalk connections. In this neighborhood, residents typically only connected their toilets and showers to the condominial sewer. Other household wastewaters were thrown into the street as was the custom.

Case N3 had high participation compared to other projects implemented in Phase 1. Participation exceeded that of Case N2, with over 40% attendance at project meetings. There was a relatively larger investment in the participation component of this condominial sewer project, and CAERN participation staff had more confidence with the participation work after the experience gained on previous projects[3]. Initially, residents thought they were too poor to afford the system, even though they wanted it. For this reason, CAERN had some difficulty at first mobilizing residents around the project. Project implementation also got off to a slow start because of a delay in receiving project funds at the beginning of project. After the end of the project, during the period when funding for condominial sewer projects was blocked, the residents spontaneously organized themselves into user groups (*condominios*). Because the project was paralyzed the residents became anxious to start and when it finally did get going there was excellent participation.

After about 77% of the blocks were completed, project implementation was abruptly interrupted again due to a lack of funding. This time the project was paralyzed for 5 years, during which residents constructed their house connections. Residents in this neighborhood did not typically perform maintenance on the condominial sewer system; they were accustomed to calling CAERN for assistance.

F.3.3 Interpretation of Participation and Performance in Case N3

Case N3 had scores of 43 for participation in mobilizing, 25 for participation in decisions, 71 for participation in construction, and 49 for participation in maintenance. These scores indicate that participation in construction is in the top third, participation in mobilizing and maintenance are in the middle third, and participation in decisions is in the bottom third of the participation scale. Case N2 residents participated considerably in three categories of participation, as indicated by the three scores in the middle third or top third of the participation scale. Based on operability and impact scores of 47 and 63, respectively, the sewer performance index for Case N2 was 55, which places this project in the middle third of the performance scale. This project achieved good performance.

The following is a list of findings for Case N3:

- Beneficiaries participated in all four categories of participation,
- Beneficiary demand for the project was stimulated by the agency (slow start),
- Beneficiaries were willing to pay for the project,
- Implementing agency used a participatory approach for the condominial sewer,
- Implementing agency produced an effective engineering design,
- Implementing agency ensured adequate construction workmanship,
- Good topography and good local discharge conditions,
- Beneficiaries were lower middle income
- Beneficiaries were not already organized,
- Project was implemented by one agency,
- Project was partially implemented within one political cycle,
- Project was supported by initial Governor, and
- Project was supported and accepted for maintenance by CAERN.
- Area had supporting infrastructure, including piped water, drainage, and pavement.

---

[1]Sources: Interviews with residents and community leaders, Natal, 1995; Interviews with staff from CAERN and URBANA, Natal, 1994-1995; Fieldnotes from 5 months of personal communication and direct observation, Natal, 1995; *Protocolo e Controle da Execucao de Servico*, CAERN, January 1993 to July 1994; *Manual de Procedimentos, Anexo VIII – Tabela de Servicos*, MOD. 105/GMI – DEOR, CAERN, Setembro, 1986 (valid through July 1994); *Relatorio de Desempenho Comercial*, CAERN, Novembro, 13, 1993; and CAERN engineering drawings.

[2]During this time period, total sewer connections were 2068 (Case N1 neighborhood), 1066 (Case N2 neighborhood), 3361 (Case N3 neighborhood), and 27,055 (Natal), respectively.

[3]Informant 85, CAERN participation staff, interview by author, 11 May 1995, Natal, transcript.

Bibliography

Abbott, John. *Sharing the City: Community Participation in Urban Management.* London: Earthscan Publications Ltd., 1996.

Altschuler, Alan and David Luberoff. *Mega-Projects: The Changing Politics of Urban Public Investment.* Washington, D.C.: Brookings Institution Press, 2003.

American Society of Civil Engineers and Water Pollution Control Federation. *Design and Construction of Sanitary and Storm Sewers: WPCF Manual of Practice No. 9 and ASCE Manual on Engineering Practice No. 37.* New York: American Society of Civil Engineers, 1969. Alexandria: Water Pollution Control Federation, 1970. Reprint, Alexandria: Water Pollution Control Federation, 1982.

American Society of Civil Engineers and Water Pollution Control Federation. *Gravity Sanitary Sewer Design and Construction.* New York: American Society of Civil Engineers, 1982. Alexandria: Water Pollution Control Federation, 1982.

Annis, Sheldon and Peter Hakim, eds. *Direct to the Poor: Grassroots Development in Latin America.* Boulder and London: Lynne Rienner Publishers, 1988.

AquaPlan, *Planejamento dos Esgotos de Natal,* CAERN, Outubro 1987.

Arnstein, S. R. "A Ladder of Citizen Participation." *Journal of the American Institute of Planners*, vol. 35, no. 4. (1969).

Azevedo-Netto, Jose M. "Simplified Sewerage System: Technical Aspects." Documento No. 37. Seminario Latino-Americano sobre Saneamento para Populacao de Baixa Renda em Comunidades Rurais e Periurbanas, Recife Palace Hotel, 29 Set. a 5 Out. 1988.

________. "Innovative and Low Cost Technologies Utilized in Sewerage." *Pan American Health Organization/World Health Organization (PAHO/WHO) Technical Series no. 29. Environmental Health Program.* March 1992.

Babbie, Earl R. *The Practice of Social Research*, 6th ed. Belmont, CA: Wadsworth, Inc., 1992.

Bakalian, Alexander, and N. Vijay Jagannathan. "Institutional Aspects of the Condominial Sewer System." *Water and Sanitation No. SW-6, World Bank Infrastructure Notes*, August 1991.

Bakalian, Alexander, Albert M. Wright, Richard J. Otis, and Jose M. de Azevedo Netto. "Simplified Sewerage Meets Demands." *Water Environment and Technology*, (March 1993): 58-62.

________. "Simplified Sewerage: Design Guidelines." *UNDP-World Bank Water and Sanitation Program, Water and Sanitation Report No. 7.* Washington, D.C.: The World Bank, 1994.

Baltar, Luis. EMOPER Engineer, letter to Sergio Pimentel, 1 June 1988, attached to COMPESA memorandum CM 110/88 – DT 26/88, 10 June 1988, Recife.

Bernard, H. Russell. *Research Methods in Anthropology: Qualitative and Quantitative Approaches*, 2d ed. Thousand Oaks, CA: Sage Publications, Inc., 1994.

Bhatnagar, N. and A. Williams, eds. "Participatory Development and the World Bank: Potential Directions for Change." *World Bank Discussion Paper 183*. Washington, D.C.: World Bank, 1992.

Binswanger, Hans P. and Swaminathan S. Aiyar. "Scaling Up Community-Driven Development: Theoretical Underpinnings and Program Design Implications." *Policy Research Working Paper Series No. 3039*. Africa Regional Office, Africa: The World Bank, 2003.

Board of Sanitary Engineers, Great Lakes-Upper Mississippi River. *Recommended Standards for Individual Sewage Systems.* The 1980 Edition. Member States Printing Office, 1980.

Boschi, Renato R. *The Art of Associating: Social Movements, The Middle Class, and Grassroots Politics in Urban Brazil.* Final Report to the Tinker Foundation. 1984.

Brazil-Small Municipalities Integrated Water Supply and Sanitation, Latin America and Caribbean Region.

Briscoe, John. "When the Cup is Half Full: Improving Water and Sanitation Services in the Developing World." *Environment 35*, no. 4 (May 1993): 7-37.

Briscoe, John and Harvey A. Garn. "Financing Water Supply and Sanitation Under Agenda 21." *Natural Resources Forum 19*,.no. 1. Elsevier Science Ltd., (1995): 59-70.

Bryant, Coralie and Louise G. White. *Managing Development in the Third World.* Boulder, CO: Westview Press, 1982.

Cabrera, Ricardo. "Review of 'Rural Water and Sanitation Project' Evaluations in Latin America." *Report to CARE*. August, 1995. (Manuscript).

CAERN. *A Solucao Vem da Uniao*. CAERN, undated.

CAERN. *Ampliacao do Sistema de Esgotamento Sanitario de Natal – Bacias "D" e "I".* CAERN, undated.

CAERN. *Bacias de Esgotamento Sanitario, Planto Diretor de Esgoto Sanitarios*. Natal, Rio Grande Do Norte, Maio, 1994.

CAERN. *Cadastros e Overlays dos Projetos*. Natal, undated.

CAERN. *Carta de Adesao, Diretoria de Engenharia*. CAERN, Fevereiro, 1994.

CAERN. *Cartilha o Projeto de Recomendacoes Tecnicos para Implantacao de Sistema Condominial para Cidade Esperanca e Cidade Nova*. CAERN, 1993.

CAERN. *Condominial System: A Technical Note*. CAERN, undated.

CAERN. *Detalhes da Caixa de Passagem de Esgotos (Para Ligacao do Esg. Condominial)*. CAERN GME-DIAU-SEPE, Fevereiro, 1991.

CAERN. *Listagem de Usuarios*. Natal, undated.

CAERN. *Manual de Procedimentos, Anexo VIII – Tabela de Servicos, MOD 105/GMI-DEOR*. Setembro 1986 (valid through July 1994).

CAERN, *Organograma Geral*. CAERN, Janeiro, 1995.

CAERN. *Plano de Melhoria do Relacionamento CAERN/COMUNIDADE*. CAERN, Dezembro, 1993.

CAERN. *Plano Diretor de Esgoto*. Natal, undated.

CAERN. *Planta de Divisao dos Bacias de Esgotos*. Natal, undated.

CAERN, *Planta de Divisao dos Bairros*. Natal, undated.

CAERN, *Planta de Divisao dos Setores de Agua*. Natal, undated.

CAERN. *Programa de Esgotamento Sanitario do Rio Grande do Norte*. CAERN, Junho, 1990.

CAERN. *Programa Estadual de Esgotamento Sanitario, Gerencia de Projetos de Esgotos*. CAERN, 1987.

CAERN. *Programa Estadual de Esgotamento Sanitario, Grupo de Esgotamento Sanitario do Interior*. CAERN, 1986.

CAERN. *Projeto Executivo do Sistema de Esgotamento Sanitario da Bacia "D", Natal (RN), Gerencia de Projetos de Esgotos – GPE, Divisao de Projetos de Esgoto do Natal – DPEN*. CAERN, Agosto, 1988.

CAERN. *Projeto Executivo – Bacia "D",Sistema de Esgotamento Sanitario, Natal – RN, GPR - Gerencia de Projetos de Esgotos, DPRE - Divisao de Projetos de Esgotos*. CAERN, Junho, 1993.

CAERN. *Protocolo e Controle da Execucao de Servico*. Janeiro 1993 a Julho 1994.

CAERN. *Relatorio de Desempenho Comercial*. CAERN, Novembro 13, 1993.

CAERN, *Relatorio de Pesquisa Interligacao (Bacia E)*. Natal, undated.

CAERN. *Relatorio Final da Avaliacao da Divulgacao Sobre o Sistema Condominial de Esgoto na Bacia de Quintas*. CAERN, Novembro, 1986.

CAERN. *Tabela de Tarifas*. CAERN, 21 de Junho, 1994.

CAERN. *Termo de Autorizacao*. CAERN, undated.

CAERN. *Termo de Permissao*. CAERN, undated.

CAERN. *Termo de Responsabilidade*. CAERN, undated.

CAERN, (computerized billing records), Natal, accessed in 1995.

Cairncross, Sandy, Jorge E. Hardoy, and David Satterthwaite, (eds.). *The Poor Die Young: Housing and Health in Third World Cities*. London: Earthscan Publications Ltd., 1990.

Cardoso, Fernando Henrique. "Associated-Dependent Development and Democratic Theory," in *Democratizing Brazil: Problems of Transition and Consolidation*, edited by Alfred Stepan. New York and Oxford: Oxford University Press, (1989): 299-326.

Cernea, Michael M. ed. *Putting People First: Sociological Variables in Rural Development*. London and New York: Oxford University Press, 1985.

________. "The Building Blocks of Participation: Testing Bottom-Up Planning." *World Bank Discussion Paper 166*. Washington, D.C.: The World Bank, 1992.

Choguill, Marisa B. Guaraldo. "A Ladder of Community Participation for Underdeveloped Countries." *Habitat International* 20, no. 3 (1996): 431-444.

COHAB. *Sistema de Abastecimento de Agua e Esgotamento Sanitario: Vila Buriti*. Volume I. Setembro, 1990.

COMPESA. *Gerencia de Manutencao de Esgoto, Gerencia 16-GME.* COMPESA-SIA. Novembro 23, 1994:1.

COMPESA. *Gerencia de Manutencao de Esgoto, Gerencia 16-GME.* COMPESA-SIA. Dezembro 16, 1994:1.

COMPESA. *Gerencia Metropolitana de Esgotos-GME, Desempenho Global Demonstrativo de Atendimento as Solicitacoes de Ras Emitidas, Periodo 11/01/1994 a 11/30/1994.* Dezembro 14, 1994:1.

COMPESA. *Informacoes Basicas para o Publico Usuario.* DIP-COMPESA, undated (ca. 1990).

COMPESA. *No. de Ligacoes – Regional Recife.* Assessoria de Planejamento Financeira, (table, 3 pages), undated.

COMPESA. *Planta Geral dos Elos, Diretoria Comercial e Financeira.* Recife, Pernambuco, Maio, 1993.

COMPESA/OBRAS. *Projeto: Diagnostico dos Sistemas de Esgotos Condominiais do Recife e Grand Recife.* COMPESA Grupo de Coordenacao de Projetos Especiais e Empresa de Obras Publicas Cidade do Recife, (report, 19 pages), undated.

COMPESA. *Tarifas.* Assessoria de Planejamento Financeira, (tables, 3 pages), May 1994.

COMPESA, *Relatorios R11 e R12.* (computerized billing records), Recife, accessed in 1994.

Corbitt, Robert A. ed. *Standard Handbook of Environmental Engineering.* New York, NY: McGraw-Hill, Inc., 1990.

Creswell, John W. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* 2nd ed. Thousand Oaks, CA: Sage Publications, Inc., 2003.

Della Cava, Ralph. " Brazilian Messianism and National Institutions: A Reappraisal of Canudos and Joaseiro." *HAHR* XLVIII, no. 3 (August 1968): 402-420.

Departamento de Estadual de Imprensa, Estado do Rio Grande do Norte, (electronic mail), August 2000.

Diario de Pernambuco, Recife: (newspaper clipping), January 8, 1995.

Diario de Pernambuco, "Projeto Condominio Aplica 11 Milhoes em Saneamento," Recife: (newspaper clipping), undated.

Dillinger, William. "Decentralization and Its Implications for Urban Service Delivery." *Urban Mangement Program Discussion Paper no. 16.* Washington, D.C.: The World Bank, 1994.

Eisenhardt, Kathleen M. "Building Theories from Case Study Research." *Academy of Management Review* (1989): 532-550.

Ellerman, David P. "Helping People Help Themselves: Autonomy-Compatible Assistance." *The World Bank Operations Evaluation Department no.7.* Washington, D.C.: The World Bank, 2000.

Elmendorf, Mary and Patricia Buckles. "Sociocultural Aspects of Water Supply and Excreta Disposal." *Appropriate Technology for Water Supply and Sanitatio, Vol. 5.* Washington D.C.: The World Bank, 1980.

EMLURB. "Convocacao Esgoto Condominial." Prefeitura da Cidade do Recife, (community meeting invitation re: condominial sewer maintenance, 1 page), undated.

EMLURB. "Questionarios Esgoto Condominial." Prefeitura da Cidade do Recife, (cover letter and completed questionnaires re: COHAB condominial sewer projects, 6 pages), May 1994.

EMLURB – Empresa Municipal de Limpeza Urbana <http://www.facepe.br/pesquisa/instit.htm>

EMLURB. "Esgoto Condominial Resumo (Mais de 100 Ligacoes)." Prefeitura da Cidade do Recife, (table, 1 page), November 1994.

EMLURB. "Regioes Politico-Administrativos por Bairros." Prefeitura da Cidade do Recife, (table, 1 page), undated.

EMLURB. "Relatorio da Situacao dos Sistemas de Esgotos Condominiais do Recife." Prefeitura da Cidade do Recife, (report, 7 pages), December 1993.

EMLURB. "Relatorio da Situacao dos Sistemas de Esgotos Condominiais do Recife." Prefeitura da Cidade do Recife, (computer printout, 2 pages), March 1994.

EMLURB. "Relatorio da Situacao dos Sistemas de Esgotos Condominiais do Recife." Prefeitura da Cidade do Recife, (computer printout, 2 pages), November 1994.

EMLURB. "Sistema Condominial de Esgotos – Termo de Compromisso." Recife, undated.

Escoda, Maria do Socorro Quirino, Andrea Souza, Fabiana Oliveira, Ligia Filgueira, Tatianne Azevedo, Lilia Pereira, and Simone Cavalcanti. "Seguranca, Cesta Basica, e Planejamento," 2001, <http://www.ufrnet.br/~scorpius /39-Cesta%20basica%20e%20seg%20alim.htm#CESTA%20B¡SICA>, accessed on May 17, 2004.

Esogbue, Augustine O. and Zikehi M. Ahipo. "A Fuzzy Sets Model for Measuring the Effectiveness of Public Participation in Water Resources Planning." *Water Resources Bulletin 18*, no. 3, (June 1982): 451-456.

Esrey, Steven A., James B. Potash, Leslie Roberts, and Clive Shiff. "Quantifying the Health Effects of Water and Sanitation Projects." *Water and Sanitation No. WS-4.* World Bank Infrastructure Notes, February 1991.

Fainstein, Susan S., Norman I. Fainstein, Richard Child Hill, Dennis R. Judd, and Michael Peter Smith. *Restructuring the City: The Political Economy of Urban Redevelopment.* New York and London: Longman Inc., 1983.

Farias, Maria Geny Formiga de and Serio Bezerra Pinheiro. "Sistema Condominial – Resgate da Parceria na Resolucao dos Probelmas Operacionais." 17th Congresso Brasileiro de Engenharia Sanitaria e Ambiental, Natal, Rio Grande do Norte, CAERN, de 19 a 23 de Setembro de 1993.

Finsterbusch, Kurt and Warren A. Van Wicklin. "Beneficiary Participation in Development Projects: Empirical Tests of Popular Theories." *Economic Development and Cultural Change 37*, no. 3 (1989): 573-593.

________. "The Contribution of Beneficiary Participation to Development Project Effectiveness." *Public Administration and Development 7.* (1987): 1-23.

Garn, Harvey A., economic advisor to the World Bank, personal communication with author, July 1994, Washington, D.C.

Gay, Robert. "Neighborhood Associations and Political Change in Rio de Janeiro." *Latin American Research Review XXV*, no. 1 (1990): 102-118.

Gelting, Richard J. Operation and Maintenance of Rural Drinking Water Supply Systems in Honduras: Factors Influencing Long Term Performance." Ph.D. diss., Stanford University, 1995.

Gerschman, Silvia. "The Role of Social Movements in the Formulation of Health Policy in Brazil." *Presented at the Center for Latin American Studies*. Stanford University, March 3, 1993.

Gerson, Philip R. "Popular Participation in Economic Theory and Practice." *December 1993, Human Resources Development and Operations Policy Working Paper No. 18.* The World Bank, 1993. (internal working paper).

Golladay, Fredrick L. "Meeting the Needs of the Poor for Water Supply and Waste Disposal." *Appropriate Technology for Water Supply and Sanitation,* Vol. 13. Washington, D.C.: The World Bank, 1983.

Gorell, Richard A. "Families in Shantytowns in Sao Paulo, Brazil, 1945-1984: The Rural-Urban Connection." Ph.D. diss., University of Kansas, 1990.

Hagopian, Frances and Scott Mainwaring. "Democracy in Brazil: Origins, Problems, Prospects." *The Helen Kellogg Institute of International Studies. Working Paper No. 100.* Notre Dame, IN: University of Notre Dame, 1987.

Hahner, June E. "Poverty and Politics: The Urban Poor in Brazil, 1870-1920." Albuquerque, NM: University of New Mexico Press, 1986.

Hinton, Perry R. *Statistics Explained: A Guide for Social Science Students*. London: Routledge, 1995. Reprint, East Sussex and Philadelphia, PA: Routledge, 2001.

Hochstetler, Kathryn. "Democratizing Pressures from Below? Social Movements in the New Brazilian Democracy," in *Democratic Brazil: Actors, Institutions, and Processes*, edited by Peter R. Kingstone and Timothy J. Power. Pittsburgh, PA: University of Pittsburgh Press, 2000: 162-182.

Hoffman, Helga. "Poverty and Prosperity in Brazil: What is Changing?" in *Social Change in Brazil, 1945-1985: The Incomplete Transition,* edited by Edmar L. Bacha and Herbert S. Klein. Albuquerque, MN: University of New Mexico Press, 1989.

<http://www.defato.com/eleicoes/0174.htm> accessed on November, 2003.

<http://www.fundaj.gov.br/docs/pe/pe0036.html> accessed on November, 2003.

<http://www.neylopes.com.br/reports/1999/990804.htm> accessed on November, 2003.

<http://www.pernambuco.gov.br/governo_galeriadosgoves.htm> accessed on November, 2003.

<https://www.planalto.gov.br/Infger_07/governadores/GOV-RN.htm> accessed on November, 2003.

<http://www.recife.pe.gov.br/pr/galeria/index.php4>
accessed on November, 2003.

<http://www.natal.rn.gov.br/gapre/paginas/prefeito.htm>
accessed on November, 2003.

<http://www.terrapotiguar.com.br/governadores.htm>
accessed on November, 2003.

<http://www.tribunadonorte.com.br/anteriores/020416/politica/poli5.html>
accessed on November, 2003.

<http://www.tribunadonorte.com.br/anteriores/020721/politica/poli4.html>
accessed on November, 2003.

<http://www.ie.ufu.br/cepes/tabelas/outros/salario_minimo_brasil.PDF>,
accessed on May 17, 2004.

Huck, Schuyler W. *Reading Statistics and Research,* 3d ed. New York: Addison Wesley Longman, Inc., 2000.

IBGE. Base de Informacoes Municipais - Malha Municipal Digital 1997,
<http://www.ibge.gov.br/cidadesat/xtras>, accessed on Sept. 19, 2003.

IBGE. Censo Demografico 2000 - Malha Municipal Digital do Brasil 1997,
<http://www.ibge.gov.br/cidadesat/xtras>, accessed on Sept. 19, 2003.

IBGE Censo Demografico 2000, <http://www.ibge.gov.br/home/estatistica
/populacao/censo2000/trabalho_rendimento/tabela_regioes.shtm?c=2>,
accessed on May 17, 2004.

IBGE. National Household Sample Survey - PNAD 1999,
<http://www.ibge.gov.br/english/estatistica/populacao/trabalhorendimento
/pnad99/planotabular/tabbr4_1.shtm>, accessed on Sept. 19, 2003.

IBGE. National Household Sample Survey - PNAD 1999,
<http://www.ibge.gov.br/english/estatistica/populacao/trabalhorendimento
/pnad99/planotabular/tabbr7_6a.shtm>, accessed on Sept. 19, 2003.

IBGE. National Household Sample Survey - PNAD 1999,
<http://www.ibge.gov.br/english/estatistica/populacao/trabalhorendimento
/pnad99/sintese/tab7_1_15.shtm>, accessed on Sept. 19, 2003.

IBGE. National Household Sample Survey - PNAD 2001,
<http://www.ibge.gov.br/english/presidencia/noticias/12062003indic2002
.shtm>, accessed on March 29, 2004.

Informant 1, engineering consultant, former city official, and former state official. Interviews by author, 1994-1995, Recife. Transcripts.

Informant 2, engineer of a civil engineering company. Interview by author, May 17, 1994, Recife. Transcript.

Informant 3, architect, assistant to the president of a Recife sewer agency, former director of a condominial sewer program, and former COMPESA staff member. Interviews by author, 1994-1995, Recife. Transcripts.

Informant 4, sociologist, former EMLURB staff member, former director of a condominial sewer program, and former COMPESA staff member. Interviews by author, 1994-1995, Recife. Transcripts.

Informant 5, URB director of condominial sewer development. Interview by author, May 1994, Recife. Transcript.

Informant 7, URB sanitation department chief. Interviews by author, 1994-1995, Recife. Transcripts.

Informant 8, City of Recife official. Interview by author, 1994-1995, Recife. Transcript.

Informant 9, EMLURB engineer and former COMPESA staff member. Interviews by author, 1994-1995, Recife. Transcripts.

Informant 10, assistant to the COMPESA financial planning directorate. Interview by author, 1994, Recife. Transcript.

Informant 11, COMPESA engineer. Interview by author, 1994, Recife. Transcript.

Informant 12, COMPESA engineer, former chief of the COMPESA alternative technology division, and member of COMPESA design review committees. Interviews by author, 1994-1995, Recife. Transcripts.

Informant 13, COMPESA engineer. Interview with author, 1994, Recife. Transcript.

Informant 15, Secretary of Infrastructure official. Interview by author, 1994, Recife. Transcript.

Informant 16, president of a Recife sewer agency. Interview by author, 1995, Recife. Transcript.

Informant 17, engineer and professor of the Recife technical school. Interview by author, 1994, Recife. Transcript.

Informant 20, URB participation staff member and former COHAB participation staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 22, EMLURB social worker. Interview by author, 1994-1995, Recife. Transcript.

Informant 23, EMLURB staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 24, Federal University of Pernambuco professor and former architect for a Recife engineering company. Interview by author, 1994, Recife. Transcript.

Informant 29, COMPESA operations and maintenance coordinator. Interview by author, December 1994, Recife. Transcript.

Informant 30, engineer and assistant to the president of a Recife sewer agency. Interview by author, 9 March 1995, Recife. Transcript.

Informant 31, consulting engineer. Interview by author, 3 March 1995, Recife. Transcript.

Informant 37, COMPESA technical director. Interview by author, 23 November 1994, Recife. Transcript.

Informant 38, EMLURB condominial sewer intern. Interview by author, 1994-1995, Recife. Transcript.

Informant 39, EMLURB condominial sewer intern. Interview by author, 1994-1995, Recife. Transcript.

Informant 40, EMLURB condominial sewer staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 41, COMPESA maintenance staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 43, COMPESA billing division staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 44, COMPESA billing division staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 46, URB participation staff member and former COHAB participation staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 51, COMPESA computer information division staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 52, URB participation staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 53, COMPESA maps division staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 54, COMPESA maps division director. Interview by author, 1994-1995, Recife. Transcript.

Informant 58, COHAB staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 59, COMPESA division chief. Interview by author, 1994-1995, Recife. Transcript.

Informant 62, URB maps division staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 63, URB maps division staff member. Interview by author, 1994-1995, Recife. Transcript.

Informant 64, Case R3 community leader and resident. Interviews by author, 1994-1995, Recife. Transcripts.

Informant 65, Case R3 community leader and resident. Interviews by author, 1994-1995, Recife. Transcripts.

Informant 67, Case R2 community leader. Interview by author, 1994-1995, Recife. Transcript.

Informant 68, Case R2 community leader. Interview by author, 1994-1995, Recife. Transcript.

Informant 73, Case R1 community leader and resident. Interviews by author, 1994-1995, Recife. Transcripts.

Informant 73, Case R1 community leader and resident. Letter to the Director President of the Secretary of Public Works of Recife (OBRAS), 22 August 1988, Recife.

Informant 75, CAERN senior civil engineer and sewer construction coordinator. Interviews by author, 1994-1995, Natal. Transcripts.

Informant 76, CAERN social worker. Interviews by author, 1994-1995, Natal. Transcripts.

Informant 77, CAERN civil engineer. Interviews by author, 1994-1995, Natal, Transcripts.

Informant 78, CAERN sewer projects division chief. Interviews by author, 1994-1995, Natal. Transcripts.

Informant 79, CAERN planning division chief. Interview by author, 1995, Natal. Transcript.

Informant 81, CAERN billing division staff member. Interview by author, 1995, Natal. Transcript.

Informant 83, CAERN engineering director. Interview by author, 1995, Natal. Transcript.

Informant 84, CAERN maintenance division chief and engineer. Interview by author, 1995, Natal. Transcript.

Informant 85, CAERN participation staff member. Interview by author, 1995, Natal. Transcript.

Informant 87, CAERN engineer. Interview by author, 1995, Natal. Transcript.

Informant 88, CAERN maintenance technician. Interview by author, 1995, Natal. Transcript.

Informant 89, CAERN senior maintenance technician. Interview by author, 1995, Natal. Transcript.

Informant 90, Federal University of Rio Grande do Norte professor and engineering consultant. Interview by author, 1994-1995, Natal. Transcript.

Informant 91, CAERN staff member. Interview by author,1995, Natal. Transcript.

Informant 92, CAERN participation staff member. Interview by author,1995, Natal. Transcript.

Informant 94, CAERN maintenance technician. Interview by author, 1995, Natal. Transcript.

Informant 96, CAERN civil engineer. Interview by author, 25 May 1995, Natal. Transcript.

Informant 98, director/president of a Natal sewer agency. Interview by author, 1995, Natal. Transcript.

Informant 99, elected official. Interview by author, 27 June 1995, Natal. Transcript.

Informant 100, president of an engineering company. Interview by author, 19 March 1995, Recife. Transcript.

Informant 101. civil engineer for an engineering company. Interview by author, 1995, Recife. Transcript.

Informant 102. civil engineer for an engineering company. Interview by author, 1995, Recife. Transcript.

Informant 103. URB infrastructure department engineering manager. Interview by author, 1995, Recife. Transcript.

Informant 105. COMPESA operations supervisor. Interview by author, 1995, Recife. Transcript.

Informant 106. COMPESA maintenance staff member. Interview by author, 1995, Recife. Transcript.

Informant 107, engineering professor and Case R1 resident. Letter to the Manager of Sewer Services for COMPESA, 13 February 1995, Recife.

Informant 120, URBANA civil engineer. Interview by author, 1995, Natal. Transcript.

Informant 121, CAERN sewer construction division manager. Interview by author, 1995, Natal. Transcript.

Informant 122, CAERN staff member. Interview by author, 1995, Natal. Transcript.

Informant 123, CAERN civil engineer. Interview by author, 1995, Natal. Transcript.

Instituto Brasileiro de Geographica e Estatistica (IBGE). *Anuario Estatistico do Brasil.* Brazil, 1992.

Instituto Brasileiro de Geographica e Estatistica (IBGE). Brazil, 2001, <www.IBGE.gov.br/english/presidencia/noticias/12062003indic2002.shtm>

Isham, Jonathan, Deepa Narayan, and Lant Pritchett. "Does Participation Improve Project Performance? Establishing Causality with Subjective Data. " *World Bank Policy Research Working Paper 1357* (internal working paper), Washington D.C.: The World Bank, September 1994.

Israel, Arturo. "Institutional Development: Incentives to Performance" *A World Bank Publication,* Baltimore, MD: The Johns Hopkins University Press, 1987.

________. "Issues for Infrastructure Management in the 1990s." *World Bank Discussion Paper No. 171*. Washington, D.C.: The World Bank, 1992.

Janssens, J.G., L. Pintelon, A. Cotton, and L. Gelders. "Development of a Framework for the Assessment of Operation and Maintenance (O&M) Performance of Urban Water Supply and Sanitation." *Water Supply 14*, no. 1 (1996): 21-33. Amsterdam.

Katzman, Martin T. "Urbanization Since 1945." in *Social Change in Brazil, 1945-1985: The Incomplete Transition,* edited by Edmar L. Bacha and Herbert S. Klein. Albuquerque, NM: University of New Mexico Press, 1989.

Keck, Margaret E. "The New Unionism in the Brazilian Transition," in *Democratizing Brazil: Problems of Transition and Consolidation*, edited by Alfred Stepan. New York and Oxford: Oxford University Press, (1989): 252-296.

Kingstone, Peter B, Timothy J. Power and Thomas E. Skidmore. *Democratic Brazil: Actors, Institutions, and Processes*. Pittsburgh: University of Pittsburgh Press, 2000.

Kinley, David. "Bringing Village People into Planning." *UNDP Source 4*, no. 1 (July 1992): 14-18.

Korten, David C. and Felipe B. Alfonso, eds. *Bureaucracy and the Poor: Closing the Gap.* West Hartford: Kumarian Press, 1985.

Korten, David C. "Community Organization and Rural Development: A Learning Process Approach." *Public Administration Review 40* (1980): 480-511.

Langenscheidt's Pocket Portuguese Dictionary. New York, NY: Langenscheidt Publishers, Inc., 1989.

Leeds, Anthony. "Lower-Income Urban Settlement Types: Processes, Structures, Policies," in *The Residential Circumstances of the Urban Poor in Developing Countries. United Nations Centre for Human Settlements*, New York, NY: Praeger Publishers, 1981.

Lei das Concessoes, Brazil Federal Government, March 1995.

Mainwaring, Scott. "Grassroots Popular Movements and the Struggle for Democracy: Nova Iguacu," in *Democratizing Brazil: Problems of Transition and Consolidation*, edited by Alfred Stepan. New York and Oxford: Oxford University Press, (1989): 168-204.

________. *Rethinking Party Systems in the Third Wave of Democratization: The Case of Brazil.* Stanford: Stanford University Press, 1999.

________. "Grassroots Popular Movements, Identity, and Democratization in Brazil." *Helen Kellogg Institute for International Studies Working Paper No. 84*, Notre Dame, IN: University of Notre Dame, 1986.

Mara, D.D. and A.S.P. Guimaraes. "Simplified Sewerage: Potential Applicability in Industrialized Countries." *Urban Water 1*, (1999): 257-259. Elsevier Science Ltd.

Martone, Celso L. "Macroeconomic Policies, Debt Accumulation, and Adjustments in Brazil: 1965-1984." *World Bank Discussion Paper No. 8*, Washington, D.C.: The World Bank, 1987.

M[c]Common, Carolyn, Dennis Warner, and David Yohalem. "Community Management of Rural Water Supply and Sanitation Services." *UNDP-World Bank Water and Sanitation Program Discussion Paper No.4. Water and Sanitation for Health Project Technical Report No. 67.* Washington, D.C.: The World Bank, 1990.

McGranahan, Gordon, Jacob Songsore, and Marianne Kjellan. "Sustainability, Poverty and Urban Environmental Transitions," in *Sustainability, the Environment and Urbanization*, edited by Cedric Pugh. London: Earthscan Publications, (1996): 103-134.

Mejia, A. *et al*., "Designing a Water and Sanitation Project to the Urban Poor in Brazil: The PROSANEAR Approach," unpublished manuscript. Washington, D.C.: The World Bank, 1993.

Mejia, Abel, L. C. Tavares, A. Bakalian, and V. Jagannathan. "Water and Sanitation Services for the Urban Poor in Brazil: The PROSANEAR Approach." *Water and Sanitation No. SW-9.* World Bank Infrastructure Notes, September 1993.

Melo, Jose Carlos. "Sistema Condiminial de Esgotos: Razoes, Teoria, e Pratica. 1994. (Draft manuscript received from the author).

Melo, Jose Carlos Rodrigues de. "Sistemas Condominiais de Esgotos." *Engenharia Sanitaria 24*, no. 2 (Abr/Jun, 1985): 237-238. Rio De Janeiro, Brasil.

Menéndez, Aurelio. "Access to Basic Infrastructure by the Urban Poor." *Economic Development Institute of the World Bank, Policy Seminar Report No. 28.* Washington, D.C.: The World Bank, 1991.

Metsch, Jonathan M. and James E. Veney. "Measuring the Outcome of Consumer Participation." *Journal of Health and Social Behavior 14*. (December 1973): 368-374.

Montanari, F.W., T.P. Thompson, T.P. Curran, and W. Saukin (eds). "Resource Mobilization for Drinking Water and Sanitation in Developing Nations."

Proceedings of the American Society of Civil Engineers International Conference. San Juan, Puerto Rico, May 26-29, 1987. New York, NY: American Society of Civil Engineers, 1987.

Moser, Caroline O.N. "The Problem of Evaluating Community Participation in Urban Development," in Moser, Caroline O.N. (ed). Evaluating Community Participation in Urban Development Projects. *Development Planning Unit, Working Paper No. 14.* London, 1983.

Nance, Earthea B. Notes from focus group with six Case R1 residents, 26 January 1995, Recife, transcripts.

________. Fieldnotes, Recife, May 1994 and October 1994 to March 1995.

________. Fieldnotes, Natal, May 1994 and April 1995 to July 1995.

________. Interviews with condominial sewer beneficiaries and project area residents in Recife, 1995, Recife, transcripts.

________. Interviews with condominial sewer beneficiaries and project area residents in Natal, 1995, Natal, transcripts.

________. Interviews with condominial sewer practitioners and officials in Recife, 1994-1995, Recife, transcripts.

________. Interviews with condominial sewer practitioners and officials in Natal, 1994-1995, Natal, transcripts.

Narayan, Deepa. "The Contribution of People's Participation: Evidence from 121 Rural Water Supply Projects." *UNDP - World Bank Water and Sanitation Program (TWUWU) and Social Policy and Resettlement (ENVSP).* World Bank, 1994. (Internal working document).

________. "The Contribution of People's Participation: Evidence from 121 Rural Water Supply Projects." *Environmentally Sustainable Development Occasional Paper, Series No. 1.* Washington, D.C.: The World Bank, 1995.

Neto, Cicero Onofre de Andrade and Aldo da Fonseca Tinoco Filho. "Sistema Condominial de Esgotos de Rocas/Santos Reis, Analise Critica Mediante Pesquisa de Acompanhamento." *13º Congresso Brasileiro de Engenharia Sanitaria e Ambiental*, Maceio, CAERN, de 18 a 23 de Agosto de 1985.

Neto, Cicero Onofre de Andrade, Hercilia Coelho de Medeiros, and Jose Carlos Rodrigues de Melo. "Currais Novos – Uma Solucao de Esgotos com as Menores Perdas." *12th Congresso Brasileiro de Engenharia Sanitaria e Ambiental*, Balneario Camboriu, Santa Catarina, CAERN, de 20 a 25 de Novembro de 1983.

Oakley, Peter, et al. *Projects with People*: *The Practice of Participation in Rural Development.* Geneva: International Labour Organization, 1991.

OBRAS (Departamento de Obras Urbanas), Sistema de Esgoto Existente, Cadastramento, Sistema de Drenagem Proposto, e Sistema de Esgoto Proposto (Case R1 project proposal), undated, Prefeitura da Cidade do Recife.

OBRAS (Departamento de Obras Urbanas), Termo de Autorizacao para Construcao do Ramal Condominial de Esgotos (19 contracts for the Case R1 project), June 1987 and August 1988, Prefeiturada Cidade do Recife.

Ortolano, Leonard. *Environmental Regulation and Impact Assessment.* New York: John Wiley & Sons, Inc., 1997.

Ostrom, E. et al. *Institutional Incentives and Sustainable Development.* Westview Press, 1993.

Ostrom, Elinor. *Crafting Institutions for Self-Governing Irrigation Systems.* San Francisco: ICS Press, 1992.

Pan American Health Organization (PAHO). "Country Health Profile - Brazil" from "Health in the Americas," 1998 <http://www.paho.org/english/sha/prflbra.htm>, accessed on March 29,2004.

Pan American Health Organization/World Health Organization (PAHO/WHO). "Regional Report on the Evaluation 2000 in the Region of the Americas. Water Supply and Sanitation Current Status and Prospects." Washington, D.C.: September 2001. <http://www.cepis.ops-oms.org>, accessed in March 2004.

Pan American Health Organization (PAHO). "Special Program for Health Analysis Linear Interpolation based on UN Data: World Urbanization Prospects, the 1999 Revision." 1999. <www.paho.org>, accessed in March 2004.

Pan American Health Organization Special Program for Health Analysis (PAHO/SHA) and Program on Communicable Diseases (PAHO/HCP/HCT), "Charts on the Morbidity Situation of Children Under Five in the Region of the Americas." 2001.

Parlatore, Antonio Carlos. "Privatization of the Water Utility Sector in Brazil. " Undated, <http://www.bndes.gov.br/english/studies/ensa/0-8.pdf>, accessed in 2003.

Patton, Michael Quinn. *Qualitative Research & Evaluation Methods*. Thousand Oaks: Sage Publications, Inc., 2002.

Paul, Samuel. "Community Participation in Development Projects: The World Bank Experience." *World Bank Discussion Paper No. 6*. Washington, D.C.: The World Bank: 1987.

Perlman, Janice E. "Strategies for Squatter Settlements: The State of the Art as of 1977. in The Residential Circumstances of the Urban Poor in Developing Countries." *United Nations Centre for Human Settlements*. New York, NY: Praeger Publishers, 1981.

________. *The Myth of Marginality: Urban Poverty and Politics in Rio de Janeiro.* Berkeley, CA: University of California Press, 1976.

Picciotto, Robert. "Participatory Development: Myths and Dilemmas." *Policy Research Working Papers Series No. 930.* Washington, D.C: The World Bank, 1992.

Pich, Michael T., Christoph H. Loch, and Arnoud De Meyer. "On Uncertainty, Ambiguity, and Complexity in Project Management." *Management Science* vol. 48, no. 8 (August 2002): 1008-1023.

Pinheiro, Sergio and Geny Formiga, Resgate da Parceria na Resolucao dos Problemas Operacionais, URBANA and CAERN.

Pitman, George Keith. "Bridging Troubled Waters: Assessing the World Bank Water Resource Strategy." *World Bank Operation Evaluation Department.* Washington, D.C.: The World Bank, 2002.

Populstat, <http://www.library.uu.nl/wesp/populstat/Americas/brazilc.htm>, modified on April 22, 2003, accessed on September 19, 2003.

Populstat, <http://www.library.uu.nl/wesp/populstat/Americas/brazilg.htm>, modified on April 22, 2003, accessed on September 19, 2003.

Populstat, <http://www.library.uu.nl/wesp/populstat/Americas/brazilp.htm>, modified on April 22, 2003, accessed on September 19, 2003.

Power, Timothy J., and J. Timmons Roberts. "A New Brazil? The Changing Sociodemographic Context of Brazilian Democracy," in *Democratic Brazil: Actors, Institutions, and Processes,* edited by Peter R. Kingstone and Timothy J. Power. Pittsburgh, PA: University of Pittsburgh Press, (2000): 236-262.

Prefeitura da Cidade do Recife, <http://www.recife.pe.gov.br/pr/galeria/index.php4>, accessed on November 2003.

Prefeitura da Cidade do Recife, Programa Prefeitura hos Bairros-PPB, Recife, 1995.

Prefeitura da Cidade do Recife. "Situacao Atual da Infra-Estrutura Urbana." Secretaria de Infra-Estrutura e Servicos Publicos, Prefeitura da Cidade do Recife, (report, 68 pages), Fevereiro 1994.

Prefeitura da Cidade do Recife. "*Recife 1979-1983: Urbanizacao de Favelas*." Secretaria de Planejamento e Urbanismo, Empresa de Urbanizacao do Recife, Prefeitura da Cidade do Recife, Fevereiro de 1983.

Prefeitura do Natal, <http://www.natal.rn.gov.br/gapre/paginas/prefeito.htm>, accessed on November 2003.

Project Appraisal Document on a Proposed Loan in the Amount of US$46 Million to the State of Pernambuco, Brazil with the Guarantee of the Federal Republic of Brazil for the Recife Urban Upgrading Project, Latin America and Caribbean Region, April 2003.

Prokopy, Linda S. "The Relationship Between Participation and Project Outcomes: A Study of Rural Drinking Water Projects in India." Ph.D. diss., University of North Carolina, 2002.

Pugh, Cedric, ed. *Sustanability, the Environment and Urbanization*. London: Earthscan Publications Ltd., 1996.

Reader, N.F., G. Tremey, A. Kempe, P. Friis, and M. Garcia-Poveda. "Performance Indicators." *Water Supply 1*, nos. 2/3 (1983): SS21-1 to SS21-4.

Regiao da Grande Natal, Rio Grande do Norte, State Maps 16-53, 16-61, 16-69, and 16-77, scale 1:10,000.

Rivett, Patrick. *Model Building for Decision Analysis*. Chichester: John Wiley & Sons Ltd., 1980.

Rocha, Sonia. "Poverty in Brazil in the Eighties: A Review," presented at the Seminar on Poverty Statistics, Santiago, 7-9 May 1997, <http://www.ibge.gov.br/poverty /pdf/brasil3.pdf>, accessed on May 17, 2004.

Rondon, Eliana Beatriz Nunes. "A Critical Evaluation of Shallow Sewerage Systems: A Case Study in Cuiaba, Brazil." Master's Thesis, The University of Leeds, England Department of Public Health Engineering, September 1990.

Rosensweig, Fred, and Eduardo Perez with Jeanine Corvetto and Scott Tobias. "Improving Sanitation in Small Towns in Latin America and the Caribbean: Practical Methodology for Designing a Sustainable Sanitation Plan." *Environmental Health Project Strategic Report 3*. Washington, D.C.: U.S. Agency for International Development, August 2002.

Samuels, David. "Reinventing Local Government? Municipalities and Intergovernmental Relations in Democratic Brazil." in *Democratic Brazil: Actors, Institutions, and Processes,* edited by Peter R. Kingstone and Timothy J. Power. Pittsburgh, PA: University of Pittsburgh Press, (2000): 77-98.

Santos, Carlos Alberto dos and Adejalmo Figueiredo Gazen. "Estudo Comparativo Entre Redes Coletoras de Esgotos do Tipo Convencional e Nao Convencional." Convenio ASFAMAS-PVC e ABIVINILA, Artigo Tecnico, Setembro de 1987.

Schalock, Robert L. *Outcome-Based Evaluation* , 2d ed. New York: Kluwer Academic/Plenum Publishers, 2001.

Schiller, Eric J. and Ronald L. Droste. *Water Supply and Sanitation in Developing Countries*. Ann Arbor, MI: Ann Arbor Science Publishers, 1982.

Schubeler, Peter. "Participative Strategies for Improving Urban Infrastructure and Services in Developing Countries." (Manuscript). Workshop for Architecture and Planning, UNCHS Habitat, Nairobi, Kenya, March 1993.

"Seven Case Studies of Rural and Urban Fringe Areas in Latin America." *Appropriate Technology for Water Supply and Sanitation* vol. 8. Washington, D.C.: The World Bank.

Silva, R.T., Nucci Rodrigues, and A.K. Abiko. "Latin America - the situation in Brazil, and the impact of peri-urban development technically, financially and socially." *Water Supply 14,* nos. 3/4, (1996): 19-34. Blackwell Science Ltd.

Simpson-Hebert, M. "Methods for Gathering Socio-cultural Data for Water Supply and Sanitation Projects." *TAG Technical Note no. 1.* Washington, D.C.: The World Bank, 1983.

Sinnatamby, Gehan S. "Low Cost Sanitation," in *The Poor Die Young: Housing and Health in Third World Cities*, by Sandy Cairncross, Jorge E. Hardoy, and David Satterthwaite (eds.). London: Earthscan Publications Ltd., 1990:127-157.

Sinnatamby, Gehan S. "Low Cost Sanitation Systems for Urban Peripheral Areas in Northeast Brazil." Ph.D. diss., The University of Leeds, England, 1983.

Skidmore, Thomas E. "Brazil's Slow Road to Democratization: 1974-1985," in *Democratizing Brazil: Problems of Transition and Consolidation*, edited by Alfred Stepan. New York and Oxford: Oxford University Press, (1989): 5-42.

Soares, Luiz Carlos Rangel, ed. "Regional Report on the Evaluation 2000 in the Region of the Americas: Water Supply and Sanitation, Current Status and Prospects." *Division of Health and Environment.* Washington, D.C.: Pan American Health Organization (PAHO)/World Health Organization (WHO), September, 2001.

Solo, Tova Maria, Eduardo Perez, and Steven Joyce. "Constraints in Providing Water and Sanitation Services to the Urban Poor." *Water and Sanitation for Health Technical Report No. 85.* US Agency for International Development, March 1993.

Stepan, Alfred. *Democratizing Brazil: Problems of Transition and Consolidation.* New York and Oxford: Oxford University Press, 1989.

Tamm, Gordon and Sarkis Garabedian. "Institutional Framework of Small Community Water Supply Systems in the United States: A Review of Experiences and Lessons for Developing Countries." *UNDP-World Bank Water and Sanitation Program Discussion Paper, No. 7.* Washington, D.C.: The World Bank, 1991.

Tolosa, ,Hamilton C. "Causes of Urban Poverty in Brazil." *World Development 6*, no. 9/10 (1978): 1087-1101.Great Britain: Pergamon Press.

Turabian, Kate L. *A Manual for Writers of Term Papers, Theses, and Dissertations, 6th ed.* Chicago and London: The University of Chicago Press, 1996.

UFRJ-NCE Noticias. Federal University of Rio de Janeiro Electronic Computer News, 1993.

URB, Empresa de Planejamento Urbano do Recife <http://www.facepe.br/pesquisa/instit.htm>

URB, Programa de Esgoto Condominial Dossie-Tamarineira, Directoria de Integracao Urbanistica, undated (ca. 1992).

U.S. Central Intelligence Agency World Factbook <www.odci.gov/cia/publications/factbook/geos/br.html>

U.S. Department of Agriculture. Soil Conservation Service. *Soils Suitable for Septic-Tank Filter Fields*. Report prepared by Soil Conservation Service. Agriculture Information Bulletin No. 243.

U.S. Department of Health, Education and Welfare. Committee on Rural Sanitation. *Manual of Septic-Tank Practice.* Report prepared by the National Technical Information Services. Publication no. 526. 1967.

U.S. Environmental Protection Agency. "Sewer System Evaluation, Rehabilitation, and New Construction: A Manual of Practice." *Environmental Protection Technology Series Report No. EPA - 600/2-77-017d.* Cincinnati, OH: December 1977,

U.S. Environmental Protection Agency. "Sewer System Infrastructure Analysis and Rehabilitation." *Office of Research and Development, EPA/625/6-91/030.* Cincinnati, OH: October 1991, Valente, Gustavo, Brazilian citizen and civil engineer. Personal communication with author. Tracy CA: Transcript, November 2003.

Vines, Marcus, Bob Reed, ,and John Pick ford. "Reduced Cost Sewerage for Developing Countries." *Water, Engineering, and Development Centre, Overseas Development Administration*. March 12, 1990.

Reed, R. and M. Vines. "Condominial Sewerage in Basin 'E', Natal, Rio Grande do Norte State, Brazil." *Water, Engineering, and Development Centre, Overseas Development Administration*. January, 1992.

Wagner, Susan F. Ph.D. *Harper Collins College Outline: Introduction to Statistics*. New York: HarperCollins Publishers, Inc., 1992.

Watson, Gabrielle, development consultant. Personal communication with author. Washington, D.C.: Transcript, July 1993.

Watson, Gabrielle. "Condominial Sewer System in Brazil – An Evaluation." (Draft manuscript received from the author). 1993.

________. "Good Sewers Cheap?: Agency-Customer Interactions in Low-Cost Urban Sanitation in Brazil," *Water and Sanitation Currents. UNDP-World Bank Water and Sanitation Program*. Washington, D.C.: The World Bank, 1995.

________. "Water and Sanitation in Sao Paulo, Brazil: Successful Strategies for Service Provision in Low-Income Communities." Master's Thesis, Massachusetts Institute of Technology, 1992. Cambridge, MA.

Wilson, James Q. Bureaucracy: What Government Agencies Do and Why They Do It. USA: Basic Books, Inc., 1989.

World Bank. *FY91 Sector Review of Water Supply and Sanitation*. Washington, D.C.: The World Bank, 1991.

World Bank. "Latin American and Caribbean Seminar on Water and Sanitation for Low-Income Groups." *Report. Recife, Sept. 29 to October 5, 1988*. World Bank Water and Sanitation Division, 1989.

World Bank. "Project Appraisal Document . . . for the Recife Urban Upgrading Project." *Report No. 23331-BR*. Washington, D.C.: The World Bank, 2003.

World Bank. *World Development Report 1992*: *Development and the Environment*. Oxford University Press, 1992.

World Bank. *World Development Report 1994: Infrastructure for Development.* Oxford University Press, 1994.

World Health Organization. "Global Water Supply and Sanitation Assessment 2000 Report." 2000. <http://www.who.int/docstore/water_sanitation_health/Globassessment/Global1.htm#1.1>, accessed on March 29, 2004.

WPCF. "Design and Construction of Sanitary and Storm Sewers." *Water Pollution Control Federation Manual of Practice No. 9 and American Society of Civil Engineers Manual on Engineering Practice No. 37*, 5th printing, (1982). (ISBN No. 0-943244-09-9).

Wright, Albert M. "Strategic Sanitation Planning." *Water and Sanitation No. SW-1.* World Bank Infrastructure Notes, March 1990.

________, "Toward a Strategic Sanitation Approach: Improving the Sustainability of Urban Sanitation in Developing Countries." *UNDP-World Bank Water and Sanitation Program* (internal working document). Washington, D.C.: The World Bank, November 1997.

Wright, Albert M. and Alexander E. Bakalian. "Intermediate Sanitation: Cost Efficient Sewerage." *Water and Sanitation No. SW-4.* World Bank Infrastructure Notes, July 1990.

Yepes, Guillermo. "Management and Operational Practices of Municipal and Regional Water and Sewerage Companies in Latin America and the Caribbean." *World Bank Infrastructure and Urban Development Department Report INU 61*, 1989.

_________. "Performance Indicators: Water and Sanitation Utilities. Set 1: Operational Indicators." *Water and Sanitation Division (TWUWS)*, August 1993, The World Bank (internal working document).

_________. "Water Supply Services in the LAC Region: The Costs of Maintenance Neglect and Options for Improvement." *Water and Sanitation No. WS-7.* World Bank Infrastructure Notes, November 1991.

Yepes, Guillermo, and Augusta Dianderas. "Performance Indicators: Water and Sanitation Utilities. Set 2: Financial Indicators and Overview of Service Rates." *Water and Sanitation Division (TWUWS).* The World Bank (internal working document), June 1994.

Yin, Robert K. "Case Study Research: Design and Methods. Vol. 5." *Applied Social Research Methods Series.* Newbury Park, CA: Sage Publications, 1989.