Control of Water and Coastal Pollution: An Appraisal for Espirito Santo, Brazil

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Abstract

A shortage of clean drinking water, the lack of an adequate sewage system, and rapid environmental degradation from waste dumping have prompted the State of Espirito Santo in Brazil to consider expanding the water supply and sewage disposal systems in the region. This paper reports on the findings of a study to appraise the viability of a project to alleviate some of the shortfall in potable water and sewage services in the state. Recommendations are developed for improved investment and operational strategies through an integrated analysis of the financial, economic, distributive and risk aspects of the project.

Results of the study indicate that even though the project, in its current state, is not likely to be financially profitable, it is expected to create significant economic gains for society through the reduction in environmental pollution. Furthermore, improvements in operation and management practices that address the issues of water leakage, invoicing and collections are key to improving the financial viability, and perhaps ultimately, the economic viability of the system. A particular challenge provided by the study has been the measurement of intangible environmental benefits and their inclusion in the project's analysis of discounted net economic benefits. Without the measure of these benefits the overall economic value produced by this project would be seriously understated.

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Keywords: Brazil, water, sewerage, environmental, investment, contingent valuation, distribution.

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I. Introduction and Background

1. Introduction

The State Government is spearheading a multi-million dollar project to build water and sewage treatment plants in the state of Espirito Santo of Brazil. This ambitious project is a classic example of the challenge facing the public sector in rapidly expanding urban areas where there is a need for public services, despite very scarce public resources. This project is expected to bring significant benefits to the residents of the state by meeting the rapidly increasing needs for clean drinking water while reducing pollution and preventing water-borne diseases and other health hazards. Such projects in Brazil have typically required government subsidies and loan guarantees because they have been proven to be financially nonviable. Many of the benefits to society are either intangible or not directly tied to the operation of the treatment plants. Hence, Government support may be critical for financing the investment.

The project evaluated here includes one water treatment and supply plant and one sewage collection and disposal plant. Together, the two plants comprise a R$ 30 million investment.[1] The water supply plant is expected to serve new customers by establishing new connections and expanding the capacity of the water supply to meet the concurrent increase in demand. This component of the project should account for 34% of the total investments. The wastewater collection-and-treatment plant is designed to restore the quality of water sources in the region by installing 36,000 new connections which should be able to collect over 11 million cubic meters of sewage per year. In addition to providing basic water and sewage services, the project aims to establish an effective pricing mechanism which should distribute costs more efficiently. The water utility company that will operate the plants, CESAN, hopes to achieve financial self-sufficiency over the long run. Evaluation of the two plants will begin with an

[1] These projects are to be financed as a part of a larger World Bank loan facility

analysis of the financial and economic costs and benefits expected to be generated by the project. [2]

This study utilizes an operational method of measuring environmental and health benefits in monetary terms. Without practical valuation methods, decision makers would lack vital information necessary for making informed decisions. For the estimation of non-use values[3], this study uses information derived from a contingent valuation method based on willingness-to-pay surveys.

This study also addresses the issue of the fair allocation of costs and benefits among public sector projects. For example, one objective of the water treatment project is to make drinking water and sewage services affordable for the poor. Equally important is the project's obligation to sustain a minimum level of financial return in order to reduce the Government's burden of financing.

2. Current State of Environmental Pollution in Brazil

Over the past several decades, Brazil has enjoyed rapid economic growth accompanied by industrialization and urbanization, leading per capita income to grow to $3000. The cost of Brazil's rapid economic expansion and urbanization has included substantial degradation and pollution of the environment, particularly of the land, air and water of districts located near major urban areas. Brazil's environmental pollution is driven by two factors. First, the rapid pace of environmentally uncontrolled industrialization creates more demand for water and waste treatment, which is not being met by existing treatment systems. Second, Brazil has been unable to expand its urban sanitation and potable water supply infrastructure fast enough in order to keep pace with the needs of rapid industrialization and the increased concentration of its population in urban areas. The poorest segments of the new urban population establish residence in vacant areas close to water sources with no sanitation infrastructure.[4] The

[2] The cost-benefit analysis is based on the Harberger-Jenkins appraisal method, which was developed for evaluating public sector projects.

[3] The intangible value of a good or service that is not captured by market price.

[4] The World Bank, "Staff Appraisal Report: Espirito Santo Water and Coastal Pollution Management Project," p. 2.

deterioration in environmental conditions has led to a noticeable decline in the quality of life in major metropolitan areas and to a concomitant increase in various health problems, including water-borne diseases and high levels of infant mortality. The environmental deterioration also poses a threat to the tourist industry which is important to the national economy.

The contamination of vital water sources has been identified by the Government of Brazil as an urgent environmental problem. Since the establishment of the National Water and Sanitation Program in 1971, the Government increased infrastructure investment and urban water supply coverage from 45% of households in 1970 to 84% in the early 1990s. However, the rate of spending from 1991-1997 has declined. Those people who do have access to water connections today are often rationed to only a few hours of supply each day. Investment in sewage treatment and waste disposal has also lagged behind, leading to large-scale dumping of waste materials and the contamination of water sources.[5]

Brazilian water systems have become increasingly polluted in recent years, because wastewater is discharged by households and industries into rivers and oceans without any form of sewage treatment to remove pollutants. Currently, only 13% of total wastewater receives some form of treatment.[6] Similarly, insufficient municipal solid waste collection and disposal has caused major land, water and air pollution. The situation is further aggravated by the spiraling demand for waste disposal sites that stems from rapid industrialization, which in turn has outstripped the rate of expansion of the existing infrastructure for water treatment in metropolitan areas. In recent years, environmental pollution has reached dangerous levels. Still, the Government has not initiated strong measures in order to regulate waste disposal and to provide environmentally safe alternatives. An accumulation of industrial and residential waste in the environment has contaminated the drinking water dangerously, and current water treatment capabilities are not able to cope with this increased level of contamination. Potent chemicals and contaminants have begun to cripple ecosystems in the river

[5] The World Bank Staff Appraisal Report, p. 3.
[6] Ibid., p. 2.

basins and coastal regions, killing much of the wildlife and threatening the well being of residents in the area.[7]

Espirito Santo’s water supply and waste disposal problems are typical of those in the rest of the country. Despite rapid urbanization and industrialization during the last two decades, only 87% of Espirito Santo has an adequate water supply. Most of this access is restricted by long ”black-out” times each day. Waste collection and disposal problems are far more severe than the problem of water supply coverage. In Grande Vitoria, Espirito Santo’s industrial capital, only about 11% of the population is connected to a sewerage network, and only about 9% of the collected wastewater receives some form of treatment prior to its discharge. Most of the collected solid waste is dumped untreated into uncontrolled landfills, streams and the ocean. Water pollution, which has been dramatically worsened by the contamination of land, has become a major cause of water-borne diseases and infant mortality. Enteritis and diarrheal diseases, for example, have become major problems, while infant mortality has reached 6% of live births in many of the State’s municipalities.[8]

FIGURE 1: Map of Brazil

The water sources for Grande Vitória and Guarapari are still in relatively good condition. However, substantial amounts of untreated waste are being released into rivers, as only 15% of the population in the region is connected to the sewage collection and disposal network. Safe solid waste disposal is virtually non-existent. Although about 30% of solid waste are actually collected, most of it is thrown into unregulated landfills, dumps, streams and the ocean. There are already signs of rapidly

7 Ibid., p. 13.

8 For comparison, the infant mortality rate in the US is less than 1%.

deteriorating conditions in the ecosystem of the coastal lagoons, rivers, and beaches. The assimilation of organic waste has kept the water from reaching poisonous levels in water sources, but coliform levels already exceed standards set by the federal government. The effects of pollution are clearly exhibited by the depletion of oxygen in the water and by the amount of solid waste evident in it. As a result, the quality of the region's water resources has deteriorated markedly.[9] Although a number of large industrial companies have recently begun to dispose of their waste properly, many small and medium industries still do not.

The World Bank has agreed to provide financing to the Government of Brazil, the State Secretary for the Environment (SAEMA), and the State Water Company (CESAN) to improve the country's water and sewage treatment and disposal systems by upgrading the technical capabilities of existing treatment systems and by investing in the construction and operation of new treatment plants.

[9] The World Bank Staff Appraisals Report, p. 2.

II. Financial and Economic Analyses

1. Methodology

The general approach adopted in this study is to appraise the expected impact of the proposed project, which comprise of a water treatment and supply and sewage collection and treatment plant, in the Guarapari Drainage area from three different points of view: financial, economic and distributive.[10] Since each approach focuses on different costs and benefits of the project, it is important to distinguish between each and consider them separately. The four main players in the project - the World Bank, the state of Espirito Santo, the country of Brazil, and CESAN - have different interests and stakes in the project. Each stakeholder places varying degrees of emphasis on the different variables. The banker's point-of-view and owner's point-of-view reflect the viewpoints of the World Bank as the financing institution and of CESAN as the operating company, respectively. Although lending institutions and equity holders generally focus on the financial viability of a project, the World Bank and CESAN, as public institutions, should also emphasize net economic benefits.

The financial analysis is conducted based on a discounted cash flow analysis. The Net Present Value (NPV) of the project is estimated from the equity point-of-view of CESAN. We also assess the total investment point-of-view by evaluating the project from an unleveraged perspective. Such an analysis helps financial institutions, such as the World Bank, assess the financial robustness of the project and its ability to repay any debt obligations. We conduct this analysis for both the water supply and sewage collection projects.

Following the financial analysis, we estimate the economic prices for inputs and outputs to derive the statement of net economic benefits. While the financial analysis focuses on the net financial benefits for the subgroup of population directly affected by the project, the economic analysis considers all benefits to and costs for the entire

[10] Jenkins, Glenn P., "The Valuation of Stakeholder Impacts in Cost-Benefit Analysis", Development Discussion Paper #631, HIID, Cambridge, MA, April 1998.

economy.[11] Furthermore, we calculate national economic parameters for Brazil, which include the economic cost of foreign exchange and the economic cost of capital. The commodity-specific conversion factors are estimated for the major inputs and outputs of the project. Applying these variables, the financial cash flow statement is converted to reflect the economic resource flows generated by the project.

We further expand the analysis in order to identify the different groups in society who are expected to reap the benefits and to incur the costs of the proposed project. Since the goal of the project is not only to be self-sufficient but also to provide basic water and sanitation services to the inhabitants of the region, the distributive analysis becomes an important measure for gauging the success of the project. Since the public sector will bear much of the financial burden and risk of the project in order to enhance people's living standards, it is important to clarify how the benefits will be allocated among the inhabitants of the region.

Risk analysis improves the usefulness of the financial, economic and distributive analyses. It helps with decision making by assessing the likelihood of certain key variables and their expected effects on the project's outcome. Project parameters, such as real exchange rates, input prices, and the rate of inflation are important in determining future returns of the project. To measure the extent of various risks, a Monte Carlo analysis[12] is used to model a probable distribution of each variable. The risk analysis assesses the impact of changing major microeconomic and macroeconomic conditions on the project's outcome.

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[11] Harberger and Jenkins, Manual 1997

[12] Using Crystal Ball risk analysis software developed by Decisioneering Inc., Denver, Colorado.

2. Financial Analysis

A. Investment and Operating Parameters

1. The project is expected to operate for 30 years.
2. The water treatment and supply plant has a supply capacity of 4.8 million cubic meters of water per annum. The sewerage system will add over 36,000 connections during the project, collecting over 11 million cubic meters of sewage for treatment and disposal.
3. Project financing: The World Bank's variable interest rate is calculated using the real cost of funds, a risk premium for the borrowing country, and the inflation rate of the loan disbursing country. The real rate of interest is estimated at 7%.
4. The real price of service is expected to remain constant, but all data are adjusted to reflect the effects of inflation. In the sewage collection project, CESAN plans to raise the real tariff on service over the life of the project. This is modeled in the analysis.
5. Labor is separated into skill categories. The wage rates are considered to be the prevailing government wage rates, which are significantly higher than the market rates for equivalent labor.
6. Tertiary labor is taken as a percentage of the total labor.
7. It is assumed that there is a 2% rise in real wages during each year of the project's life.
8. The total investment in the two projects (water supply and sewerage collection) is R$34 million. Over two-thirds of this total is attributed to the water supply component. Other than the land, all other investments are assumed to be completely depreciated and devoid of any residual value. The residual value of land is assumed to have the same real value as its initial value. The investment table for the two projects is as follows:

TABLE 1: INVESTMENT TABLES (*in R$*)

Water Supply Project

	1997	1998	1999
Labor	1,034,000	1,364,880	822,558
Raw Water Intake, Transmission & Pumping	1,687,190	2,136,611	1,275,479
Treatment	898,141	1,148,211	657,948
Treated Water Transmission and Pumping	1,337,692	1,694,383	980,287
Reservoirs & Distribution	1,575,233	1,994,807	1,153,840
Connections	111,765	141,557	43,935
Cost of Land	110,000	-	-
Total Investment Costs	**6,754,021**	**8,480,448**	**4,934,046**

Sewage Collection and Disposal Project

	1997	1998	1999
Labor	449,900	867,570	907,742
Connections	131,820	244,650	245,538
Collectors & Interceptors	630,158	1,169,360	1,173,422
Pumping Stations & Raw Sewage Pressure Pipes	300,667	557,838	559,675
Treatment and Outfall Pipes	594,804	1,103,846	1,107,777
Cost of Land	165,000	-	-
Total Investment Costs	**2,272,350**	**3,943,265**	**3,994,154**

Combined Project Investment

	1997	1998	1999
TOTAL INVESTMENT	***9,026,371***	***12,423,713***	***8,928,200***

The equity for the project will be provided by CESAN. The World Bank is expected to provide financial support by means of a loan that covers half of the investment costs. The loan principal will be repaid in 10 equal installments after a grace period of five years. In addition, CESAN will pay back the interest accrued each year at the World Bank's variable interest rate.

TABLE 2: PROJECT FINANCING

Year	**1997**	**1998**	**1999**
Total Investment	**R$ 9.00 MM**	**R$ 12420 MM**	**R$ 8.90 MM**
Loan Financing (WORLD BANK)	R$ 4.50 MM	R$ 6.20 MM	R$ 4.45 MM
Equity Financing (CESAN)	R$ 4.50 MM	R$ 6.20 MM	R$ 4.45 MM

B. Analytical Perspectives

The financial viability of the project is appraised from the total investment point-of-view and the equity point-of-view. The total investment point-of-view, (otherwise known as the banker's perspective,) excludes the cost of financing, and is used to assess the financial potential of the project without the loan component. By separating out the effect of loan financing, bankers can more accurately assess the project's ability to meet its debt obligations. The equity point-of-view, alternatively referred to as the owner's perspective, includes the cost of loan financing, and is used to assess the net financial benefits of the project after the loan is received and loan payments are made. The initial loan received for investment is treated as a cash inflow, while repayments of interest and principal are treated as cash outflows.[13]

[13] Harberger and Jenkins Manual, Chapter 6.

C. Methodology

The analyses conducted from the two points of view are converted from nominal terms to real terms using the current price deflator in order to measure the impact of inflation. The real impacts of inflation are both direct and indirect. Indirect impacts, also known as tax impacts, do not effect this project, because CESAN is not expected to pay corporate income tax.[14] The direct real impacts of inflation on the net income of the project are observed through the changes in accounts payable and receivable, changes in real cash balances, and the real interest expense.[15]

The total investment point-of-view analyzes the debt-service ratios of the net cash flows in order to determine CESAN's ability to meet loan repayment requirements. From the point of view of CESAN(the owner), the net financial value of the project is calculated by summing up the present values of the projected stream of annual cash flows. The net cash flows from each year are discounted by the appropriate discount rate to arrive at the net present value (NPV) of the projects. To obtain this result from the real cash flows, we use a discount rate of 10% to reflect the target real rate of return on equity for the utility.

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[14] Although CESAN is technically liable for taxes, the company has never paid taxes, due to constant financial losses. Even if it were to make a profit in the coming years, it is unlikely that they would be liable for taxes in the near future, due to a large accumulation value of loss-carried-forward.

[15] Harberger and Jenkins Manual, Chapter 6.

TABLE 3: FINANCIAL CASHFLOW STATEMENT for WATER SUPPLY PROJECT

Equity Point-of-View

Year	1996	1997	1998	1999	2000	...2005	...2010	...2015	...2020	...2025	...2027
CASH INFLOWS											
Revenue Collected from Water	-	147,840	323,390	512,431	2,816,410	2,926,424	2,978,219	2,978,219	2,978,219	2,978,219	-
change in A/R	-	(20,698)	(26,459)	(30,582)	(329,079)	(40,456)	(41,230)	(37,905)	(37,905)	(37,905)	379,046
Salvage Value of Land	-	-	-	-	-	-	-	-	-	-	100,000
Loan Received from World Bank	-	3,070,009	3,504,318	1,853,511	-	-	-	-	-	-	-
Total Inflows	**-**	**3,197,152**	**3,801,249**	**2,335,360**	**2,487,331**	**2,885,968**	**2,936,990**	**2,940,315**	**2,940,315**	**2,940,315**	**479,046**
CASH OUTFLOWS											
Investment Costs											
Labor											
Non-Semi-skilled Labor	-	552,000	662,000	363,000	-	-	-	-	-	-	-
Semi-skilled Labor	-	388,000	466,000	255,000	-	-	-	-	-	-	-
Raw Water Intake, Transmission & Pumping					-	-	-	-	-	-	-
Materials	-	1,281,100	1,479,263	809,876	-	-	-	-	-	-	-
Equipment	-	252,709	286,531	148,410	-	-	-	-	-	-	-
Treatment											
Materials	-	681,849	787,362	415,251	-	-	-	-	-	-	-
Equipment	-	134,644	161,572	79,074	-	-	-	-	-	-	-
Treated Water Transmission and Pumping											
Materials	-	1,013,916	1,171,092	617,776	-	-	-	-	-	-	-
Equipment	-	202,168	229,225	118,728	-	-	-	-	-	-	-
Reservoirs & Distribution											
Materials	-	1,195,696	1,380,642	728,109	-	-	-	-	-	-	-
Equipment	-	236,334	267,959	138,788	-	-	-	-	-	-	-
Connections											
Materials	-	84,791	97,925	23,134	-	-	-	-	-	-	-
Equipment	-	16,814	19,064	9,875	-	-	-	-	-	-	-
Cost of Land	-	100,000	-	-	-	-	-	-	-	-	-
Loan Repayment to World Bank	-	-	-	-	-	1,752,777	1,061,820	-	-	-	-
Operational Costs											
Total Cost of Labor Required by Project	-	50,051	81,126	113,423	146,980	367,289	617,811	916,502	1,221,110	1,608,258	-
Total Cost of Tertiary Labor Required by Project	-	25,526	38,129	52,175	63,201	139,570	234,768	348,271	464,022	611,138	-
Total Cost of Chemicals	-	7,207	14,484	21,808	113,906	114,377	114,377	114,377	114,377	114,377	-
Total Energy Costs	-	28,185	58,148	86,790	446,958	448,800	448,800	448,800	448,800	448,800	-
Total Other Service Costs	-	27,742	47,972	68,549	192,761	267,509	353,939	456,988	562,077	695,643	-
Total Maintenance Costs	-	68,800	68,800	69,800	69,800	71,020	69,800	67,580	64,140	60,700	-
Total Replacement Investments	-	-	-	-	-	-	-	-	-	-	-
change in A/P	-	(13,871)	(11,376)	(12,469)	(65,222)	(18,600)	(23,081)	(33,730)	(36,452)	(43,420)	326,430
change in CB	-	11,097	9,101	9,975	52,178	14,880	18,465	26,984	29,161	34,736	(261,144)
Total Outflows	**-**	**6,344,756**	**7,315,019**	**4,117,074**	**1,020,562**	**3,157,623**	**2,896,699**	**2,345,772**	**2,867,237**	**3,530,233**	**65,286**
Net Cash Flow	**-**	**(3,147,605)**	**(3,513,770)**	**(1,781,714)**	**1,466,768**	**(271,655)**	**40,291**	**594,543**	**73,078**	**(589,918)**	**413,760**
Net Present Value (NPV) **@ 10.0%**	**(5,570,846)**										

TABLE 4: FINANCIAL CASHFLOW STATEMENT for SEWAGE COLLECTION PROJECT

Equity Point-of-View

Year	1996	1997	1998	1999	2000	...2005	...2010	...2015	...2020	...2025	...2027
CASH INFLOWS											
Revenue Collected from Sewage Collection	-	29,493	64,645	113,902	1,938,303	2,584,741	2,689,281	2,736,183	2,773,671	2,803,718	-
change in A/R	-	(4,129)	(5,297)	(7,719)	(256,866)	(37,444)	(38,581)	(35,913)	(36,173)	(36,383)	357,5
Salvage Value of Land	-	-	-	-	-	-	-	-	-	-	150,0
Loan Received from World Bank	-	1,032,886	1,629,448	1,500,433	-	-	-	-	-	-	-
Total Inflows	**-**	**1,058,251**	**1,688,797**	**1,606,617**	**1,681,437**	**2,547,297**	**2,650,700**	**2,700,271**	**2,737,498**	**2,767,335**	**507,5**
CASH OUTFLOWS											
Investment Costs											
Labor											
Non-Qualified Labor	-	325,000	570,000	542,000	-	-	-	-	-	-	-
Qualified Labor	-	84,000	147,000	140,000	-	-	-	-	-	-	-
Connections											
Materials	-	105,770	178,783	163,438	-	-	-	-	-	-	-
Equipment	-	14,067	23,407	21,038	-	-	-	-	-	-	-
Collectors & Interceptors											
Materials	-	504,089	851,990	778,795	-	-	-	-	-	-	-
Equipment	-	68,783	114,423	102,814	-	-	-	-	-	-	-
Pumping Stations & Raw Sewage Pressure Pipes											
Materials	-	240,817	406,928	371,885	-	-	-	-	-	-	-
Equipment	-	32,517	54,095	48,607	-	-	-	-	-	-	-
Treatment and Outfall Pipes											
Materials	-	477,558	807,149	737,806	-	-	-	-	-	-	-
Equipment	-	63,173	105,121	94,483	-	-	-	-	-	-	-
Cost of Land	-	150,000	-	-	-	-	-	-	-	-	-
Loan Repayment to World Bank	-	-	-	-	-	850,918	515,480	-	-	-	-
Operational Costs											
Total Cost of Labor Required by Project	-	35,309	36,016	36,736	95,934	110,460	136,013	155,706	195,158	234,387	-
Total Cost of Tertiary Labor Required by Project	-	18,008	16,927	16,899	41,252	41,975	51,685	59,168	74,160	89,067	-
Total Cost of Chemicals	-	-	-	-	-	-	-	-	-	-	-
Total Energy Costs	-	4,038	8,133	13,483	565,442	659,052	750,811	840,608	926,506	1,007,020	-
Total Other Service Costs	-	13,192	14,047	15,437	161,604	186,642	215,857	242,761	275,040	306,009	-
Total Maintenance Costs	-	11,800	10,800	10,821	10,842	10,955	11,079	11,217	11,368	11,536	-
Total Replacement Investments	-	-	-	-	-	-	-	-	-	-	-
change in A/P	-	(7,055)	(1,099)	(1,426)	(78,918)	(11,519)	(12,947)	(14,252)	(16,765)	(17,333)	151,2
change in CB	-	5,644	879	1,141	63,135	9,215	10,358	11,402	13,412	13,866	(120,9
Total Outflows	**-**	**2,146,709**	**3,344,600**	**3,093,958**	**859,290**	**1,857,699**	**1,678,337**	**1,306,609**	**1,478,879**	**1,644,553**	**30,2**
Net Cash Flow	**-**	**(1,088,459)**	**(1,655,804)**	**(1,487,341)**	**822,147**	**689,598**	**972,363**	**1,393,662**	**1,258,619**	**1,122,782**	**477,2**

Net Present Value (NPV) **@ 10.0% 3,127,013**

D. Results

TABLE 5 : Breakdown of Results from Financial Analysis

	Water Supply Project	Sewage Collection Project
NPV of project* (PV of benefits - PV of costs)	**R$ -5.6 MM**	**R$ 3.1 MM**
PV of benefits*	**R$ 27.6 MM**	**R$ 20.9 MM**
PV of costs*	**R$ 33.2 MM**	**R$ 17.8 MM**

* Discounted sum of values from year 0 to year 30.

Table 5 summarizes the results from the financial analysis based on the discounted cash flow analysis. The financial NPV is negative for the water supply plant, but positive for the sewage disposal plant (R$ -5.6 MM and 3.1 MM, respectively). The high costs that are reflected in the negative NPV of the water supply project are largely due to the high initial investment and to the significant labor costs associated with the operation of water supply. The sewage collection project requires only half the investment cost, and also notably less labor than the water supply project. Furthermore, the sewage collection project is able to collect a service surcharge (applied to water consumption) on CESAN's entire supply of water, because the benefits generated by the project accrue to all residents who are connected to the sewage system. The water revenue attributed to the project, on the other hand, is only for water service purchased from the new project, exclusive of existing supply. Many of the operational costs of sewage supply reflect the high levels of energy required to operate the plant. In summary, the large initial fixed cost of building extensive water carriage infrastructure and treatment facilities is one of the main reasons for the poor financial performance of the water project. Conversely, the smaller investment and operational costs render the sewage project more financially viable.

The biggest cost component of the investments is the purchase of building materials such as bricks, steel and cement, which accounts for over 65% of the total investment in both projects. The remaining costs are comprised of equipment and labor for the construction of the two plants.

Sensitivity of NPV to Cost Overruns

The financial effects of decreasing or increasing the estimated costs are analyzed in the table below. A 10 percent increase in investment costs would reduce the NPV of the project by more than 20%, since investment costs comprise a significant financial outlay in infrastructure projects of this nature. Conversely, it is possible to improve the financial condition by managing the investment costs of the project. These investment costs, however, reflect technical specifications and fair market values, which do not allow for significant reductions. Regional experience in similar infrastructure projects suggests that costs might actually be expected to surpass forecasts, rather than to fall short of them. Material costs are also sensitive to foreign exchange fluctuations, since over 50% of materials and equipment are imported directly. Therefore, a real devaluation of the Real (R$) during the investment phase could negatively affect the project by increasing the cost of financing the two plants.

Sensitivity of NPV to Cost Overruns

		Water Financial NPV	Sewerage Financial NPV
Percentage of Cost overruns	-6%	(4,763,947)	3,516,980
	-4%	(5,032,913)	3,386,991
	-2%	(5,301,879)	3,257,002
	0%	(5,570,846)	3,127,013
	2%	(5,839,812)	2,997,024
	4%	(6,108,778)	2,867,035
	6%	(6,377,745)	2,737,046
	8%	(6,646,711)	2,607,057
	10%	(6,915,677)	2,477,068

Sensitivity of NPV to Changes in Real Growth in Wages

The financial viability of the water project is expected to be affected by increases in the real wage rate, as labor accounts for more than 50% of operating costs. Furthermore, the state of Espirito Santo and CESAN pay their workers 25% to 40% above market rates for similar work. The real wage is expected to rise at a rate of 2% per annum, following the current trend in Brazil. However, a single percentage point change in the real growth rate of wages could alter the projects' financial NPV by as much as 20%. It is difficult to envision a lowering of the existing wage rate structure, reflecting inherent political factors associated with a government utility. Therefore, it is important to ensure strong worker productivity through effective management practices. The sewerage project's NPV should be less affected by the level of labor productivity, as it utilizes less labor for its operations.

Sensitivity of NPV to Changes in Real Growth in Wages

		Water Financial NPV	Sewerage Financial NPV
Percentage Change in Growth of Real Wage Rate	1.00%	(4,626,989)	3,317,240
	1.20%	(4,802,435)	3,281,544
	1.40%	(4,984,281)	3,244,717
	1.60%	(5,172,783)	3,206,715
	1.80%	(5,368,206)	3,167,496
	2.00%	(5,570,828)	3,127,013
	2.20%	(5,780,939)	3,085,221
	2.40%	(5,998,840)	3,042,069
	2.60%	(6,224,843)	2,997,507
	2.80%	(6,459,277)	2,951,481
	3.00%	(6,702,482)	2,903,937
	3.20%	(6,954,812)	2,854,817

Sensitivity of NPV to Changes in Invoicing and Collection Efficiency

Both projects' revenues should be significantly affected by CESAN's current problems in managing the process of invoicing and collecting revenue that is owed to the utility. These effects are critical in the case of the water project, as it compromises its financial viability. Inadequate management is harmful to the sewage project as well, despite its financial buoyancy, because of poor invoicing and collection of revenue.

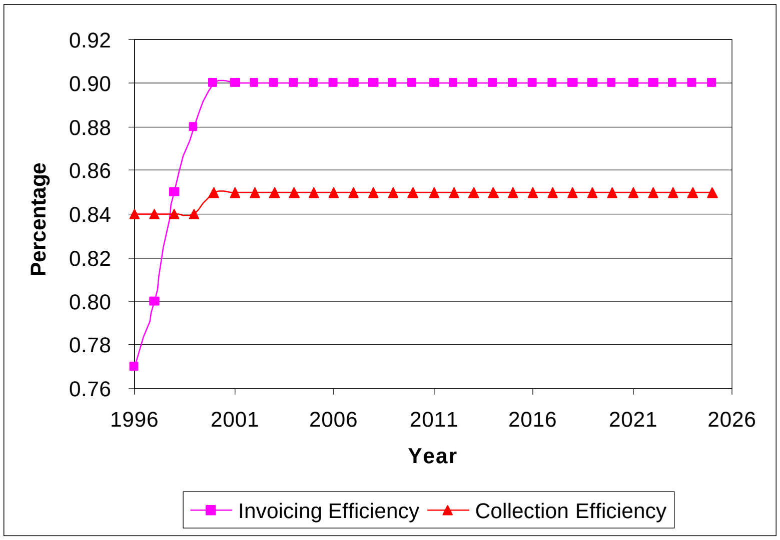
CESAN is unable to invoice many water consumers, since it does not employ an effective system for reading meters for water usage. The current targets for improvement are not expected to be high enough in order to make the water project financially feasible. Further improvements, if they were significant enough, could vastly improve the financial condition of the project. For example, a 10% increase in invoicing should improve the NPV by 37%, or by over R$2 million. However, even a 15% increase from the current target level would be insufficient to generate adequate revenue from the water project in order to finance its costs. Furthermore, implementing such major organizational changes may prove to be a significant managerial challenge.

<u>Sensitivity of NPV to Changes in Invoicing or Collection Efficiency</u>

		Water Financial NPV	Sewerage Financial NPV
Change in the level of currently expected Collection or Invoicing Efficiency (0%=base case)	-15%	(8,652,783)	506,191
	-10%	(7,625,470)	1,379,799
	-5%	(6,598,158)	2,253,406
	0%	(5,570,846)	3,127,013
	5%	(4,543,533)	4,000,620
	10%	(3,516,221)	4,874,228
	15%	(2,488,909)	5,747,835

CESAN also faces a formidable task with regard to collecting revenues for water service. Improving the current level of collection should lead to a notable influx of additional revenue that would enhance the financial viability of the project. However, the current institutional development strategy of CESAN is formulated to focus on the invoicing efficiency rather than on the collections, as illustrated in the following figure. However, it is clear that improved invoicing alone will not financially revitalize the water project. In other words, invoicing more customers for service, without being able to collect sufficient payments is not likely to result in revenue increases that are adequate. In addition, it would be difficult to sharply improve the already ambitious targets for invoicing set by CESAN. The current target for improving collections of arrears, however, only reaches 85% at its peak. Therefore, it is imperative that CESAN attempt to further improve collection efficiency targets, while attempting modest gains through improvements in the current invoicing targets. In fact, CESAN should consider employing a dual strategy to focus both on improving its invoicing and on expanding the collection of fees for its services.

FIGURE 2: CESAN'S Targets for Improving Invoicing and Collection Efficiency for Water and Sewage Service



The tables below illustrate that the water supply project is not expected to attain financial self-sufficiency, despite a collective improvement of 10% in invoicing and collections. Any administrative improvement in CESAN, however, should have a positive impact on the sewage project as well. Therefore, when viewing the combined NPV of the projects, the project is viable with a modest 5% increase in the current targets for invoicing and collections. In fact, CESAN should also be able to maintain its current target for invoicing, while improving collections by 10%, in order to obtain a NPV of R$1.35 MM. It is important to note that CESAN must also consider the additional costs that could be incurred in the process of increasing its administrative efficiency.

Sensitivity of NPV of Water Project to Changes in Invoicing and Collection Efficiency

		Collection Efficiency					
		-15%	**-10%**	**-5%**	**0%**	**5%**	**10%**
Invoicing Efficiency	**-15%**	(11,272,429)	(10,399,214)	(9,525,998)	(8,652,783)	(7,779,567)	(6,906,352)
	-10%	(10,399,214)	(9,474,633)	(8,550,052)	(7,625,470)	(6,700,889)	(5,776,308)
	-5%	(9,525,998)	(8,550,052)	(7,574,105)	(6,598,158)	(5,622,211)	(4,646,265)
	0%	(8,652,783)	(7,625,470)	(6,598,158)	(5,570,846)	(4,543,533)	(3,516,221)
	5%	(7,779,567)	(6,700,889)	(5,622,211)	(4,543,533)	(3,464,855)	(2,386,177)
	10%	(6,906,352)	(5,776,308)	(4,646,265)	(3,516,221)	(2,386,177)	(1,256,134)

<u>Sensitivity of NPV of Combined (Water and Sewage) Project to Changes in Invoicing and Collection Efficiency</u>

		Collection Efficiency					
		-15%	**-10%**	**-5%**	**0%**	**5%**	**10%**
	-15%	(12,993,936)	(11,378,155)	(9,762,373)	(8,146,591)	(6,530,810)	(4,915,028)
	-10%	(11,378,155)	(9,667,327)	(7,956,499)	(6,245,672)	(4,534,844)	(2,824,016)
Invoicing Efficiency	**-5%**	(9,762,373)	(7,956,499)	(6,150,626)	(4,344,752)	(2,538,879)	(733,005)
	0%	(8,146,591)	(6,245,672)	(4,344,752)	(2,443,833)	(542,913)	**1,358,007**
	5%	(6,530,810)	(4,534,844)	(2,538,879)	(542,913)	**1,453,053**	**3,449,018**
	10%	(4,915,028)	(2,824,016)	(733,005)	**1,358,007**	**3,449,018**	**5,540,030**

The biggest cost components of the project's investment are materials and labor. Operationally, labor, energy and administrative services are the largest costs. Wages in investment and operations of the two plants, which add up to 32.5% and 20.5% of total costs, respectively, are unusually high since the state of Espirito Santo and CESAN pay their workers 25% to 40% above market rates for equivalent labor. In addition, the real wages for the project are estimated to increase at 2% per year, which will further increase the cost of the labor component. Materials, which make up nearly 30 percent of the total costs, include basic building materials such as bricks and cement. This cost component reflects its fair market value and therefore allows for little, if any, cost reduction. Material costs are sensitive to foreign exchange fluctuations, because 20% of materials are imported directly from abroad, and a significant share of the other material items are tradable goods. Hence, it is difficult to further reduce initial investment costs, since much of the cost is determined by market prices and technological issues relating to the two plants. There may be additional opportunities to increase cost-efficiency in the operational stages of the project. For instance, one important operational cost, the cost of electricity, may be lowered through upgrading equipment in order to increase energy efficiency.

Sensitivity of NPV to Changes in Leakage and Stolen Water

Currently, CESAN does not receive any financial benefit from 28% percent of the water it supplies, due to water leakage and stealing through illegal connections. The Utility hopes to reduce the percentage of non-revenue water to 13% over the life of the project. Any additional efforts to limit water leakage and to prevent illegal use should further enhance the financial viability of the project. However, the gains should be modest, since the benefits from supplying additional water to paying customers will continue to be offset by weak invoicing and collections. For example, CESAN can improve the financial situation by only R$0.4MM through harnessing 15% more water that would otherwise escape its water supply system. Reducing the level of non-revenue water also helps the financial position of the sewage collection plant, as its revenues are directly affected by the quantity of water supplied to paying customers. Despite CESAN's inability to significantly alter its financial situation, a reduction in stolen and leaked water could turn out to be quite effective when combined with continued improvements in the levels of invoicing and collections.

Sensitivity of NPV to Changes in Leakage and Stolen Water

		Water Financial NPV	Sewerage Financial NPV
Change in the level of currently expected level for Leakage and Stolen Water (0%=base case)	-15%	(5,290,330)	3,436,103
	-10%	(5,366,911)	3,338,073
	-5%	(5,469,433)	3,231,851
	0%	(5,570,846)	3,127,013
	5%	(5,701,237)	3,014,940
	10%	(5,835,597)	2,902,706
	15%	(5,968,169)	2,791,934

* lower percentage = less leakage, base case assumes current target for level of leakage and stolen water

Sensitivity of NPV to Changes in Water Tariff

On the revenue side, CESAN cannot raise prices further for two reasons. First, one objective of the project is to provide affordable basic services to all residents in the region. Second, the projected price is already close to revenue maximizing rates. The sensitivity analysis illustrates that an initial rise in the real water tariff to R$1.05 would raise the financial NPV of the water project by R$ 1.4 MM. Any cutback in consumption should be more than offset by the increase in revenue per cubic meter of water consumed. Further increases in the water tariff beyond this point would induce cutbacks by consumers, which would cause revenue to fall. Therefore, the NPV of the water project would be decreased by increases in the water tariff beyond R$ 1.05.

A reduction in the water tariff would increase the quantity of sales by CESAN. The utility, however, is unable to supply the additional water demanded by consumers at the lower tariff. This is due to the fixed capacity of CESAN's water supply. The financial outcome of the project would be considerably weakened, since revenues decrease rapidly when the price per cubic meter is reduced.

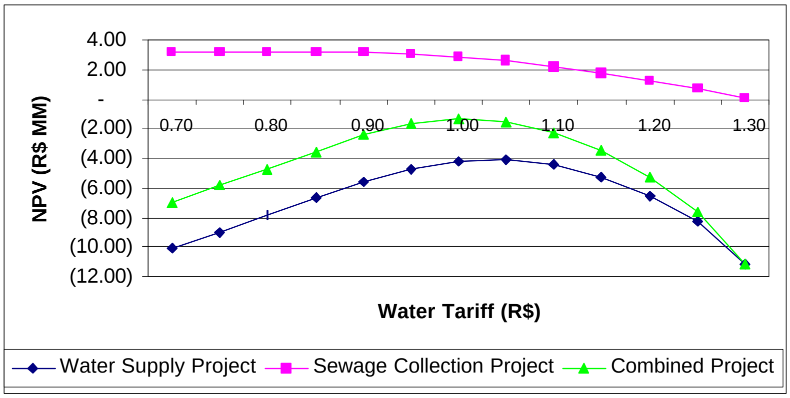
The sewage revenue is affected directly by the quantity of water supplied to paying customers. A lower water tariff does not alter the financial viability of the sewage project, since the fixed supply of water prevents CESAN from increasing its supply, and the sewage surcharge remains unchanged. Increases in the water tariff gradually begin to reduce the quantity of water consumed, which, in turn, leads to a reduction in revenue collected through the sewage surcharge. Therefore, it is important to be aware of this implication for both projects when designing the tariff structure for the water supply project.

Sensitivity of NPV to Changes in Water Tariff

R$	**Water Financial NPV**	**Sewerage Financial NPV**
0.70	(10,132,609)	3,128,664
0.75	(8,990,720)	3,128,664
0.80	(7,848,831)	3,128,664
0.85	(6,706,941)	3,128,664
0.90	(5,570,846)	3,127,013
0.95	(4,712,758)	3,044,716
1.00	(4,236,003)	2,855,485
1.05	(4,153,497)	2,574,130
1.10	(4,477,210)	2,212,343
1.15	(5,261,592)	1,767,930
1.20	(6,507,181)	1,252,834
1.25	(8,295,303)	678,823
1.30	(11,155,806)	43,540

A financially optimal water tariff, which would maximize revenues under the present circumstances, is estimated in the following graph. A tariff of R$ 1.05 per cubic meter of water provides the most promising financial prospect for the combined project. Such a tariff should provide a substantial amount of additional water revenue, despite a small drop in revenue from the sewage surcharge. It is important to note, however, that a higher tariff level would negatively affect one objective of the project, namely the provision of water to the poorer residents of the area, as they may be unable to afford the service.

FIGURE 3: Optimal Water Pricing for Maximizing Financial NPV



Sensitivity of NPV to Changes in Sewerage Surcharge

Consumers react to a rise in the sewerage charge as they would respond to a rise in the price of water. This is due to the fact that sewerage fees are applied as a surcharge on water, rather than as separate charges for sewage collection. The NPVs (following a 0.05 rise in water or sewage, for example) differ, however, because the change in revenue due to changes in the sewage surcharge is attributed only to the sewage project. The effect on the water project is due to the corresponding cutback in water consumption as the price of water services is perceived to be rising. Alternatively, lowering the sewage fee (by between R$ 0.14 and R$ 0.17) has no effect on the NPV of the water project, as the existing network cannot supply the increase in demand for water service. However, small reductions in the sewage surcharge have a significant impact on the NPV of the sewage project. In fact, the project would not be financially viable if the surcharge were lowered to R$ 0.14.

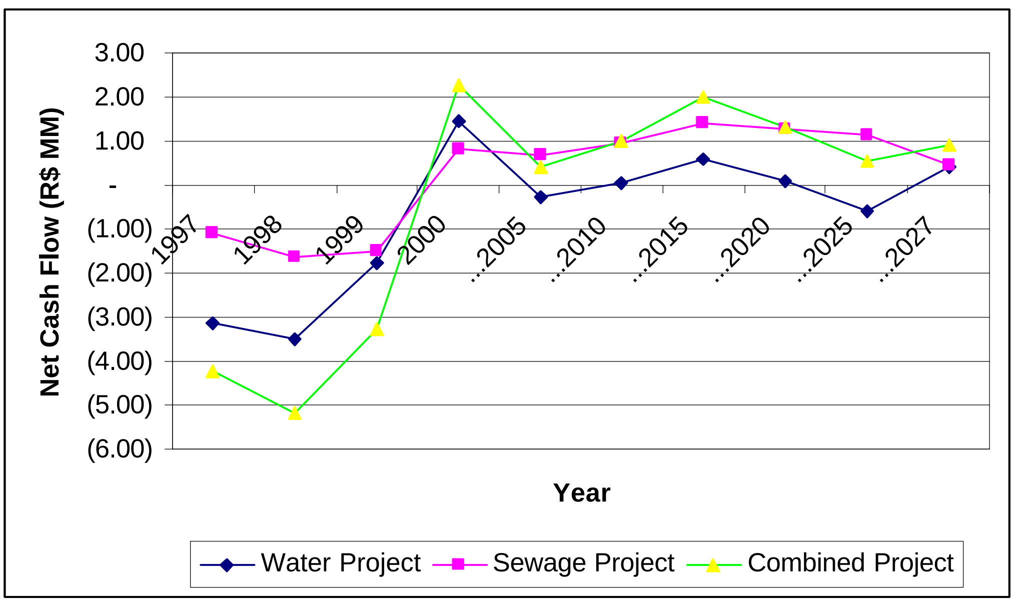
Sensitivity of NPV to Changes in Sewerage Surcharge

R$	Water Financial NPV	Sewerage Financial NPV
0.14	(5,565,031)	(754,401)
0.15	(5,565,031)	216,365
0.16	(5,565,031)	1,187,132
0.17	(5,565,031)	2,157,898
0.18	(5,570,828)	3,127,013
0.19	(5,603,981)	4,087,714
0.20	(5,637,135)	5,047,366
0.21	(5,692,565)	5,996,676
0.22	(5,756,756)	6,940,221
0.23	(5,834,597)	7,875,229

FIGURE 4- NET FINANCIAL CASH FLOW PROFILE OF PROJECT

Equity Point-of-View

Water NPV	Sewage NPV	Combined NPV
R$ -5.6 MM	**R$ 3.1 MM**	**R$ -2.4 MM**



The above graph illustrates the cash flow profiles of the water supply plant, the sewage disposal plant, and the combined project. The graph shows that the cash flow for the sewage disposal project is greater and more consistent than for the water supply project. It also illustrates the effect if the two plants were treated as one project. For the combined project, the financial outcome is more promising. In fact, the total project is able to meet all its financial obligations during the years of operation, despite its inability to earn a normal rate of return on its equity. The financial rate of return that it does earn from its operations, however, may be sufficient, in light of the public sector nature of the project. Combining the two projects effectively causes the sewage project to subsidize part of the water project's losses. It is important to realize, however, that the sewage revenues and amount of sewage collected (which will determine the operational costs) are functions of the water supply. This relationship between the two components of the project makes it reasonable to ultimately evaluate the two plants as one project.

3. The Economic Analysis

A. General Approach

The economic analysis changes all major cash flow items from financial terms to economic terms by utilizing conversion factors.[16] The net economic value of a project is defined as the sum of all economic benefits from the project minus all resource costs, applied to all residents in Brazil. We use the price level in domestic currency as the numeraire for measuring both financial and economic values. To conduct the economic analysis, we first estimate the national economic parameters, including the economic cost of foreign exchange and the economic cost of capital. We then proceed with the estimation of the economic benefit of the clean water service and the sewage collection and disposal services. Finally, we estimate the economic value of all inputs of the project. We then utilize all derived economic values to transform the statement of net financial cash flows into a statement of net economic benefits.

B. Conversion from Net Financial Benefits to Net Economic Benefits

The economic rate of foreign exchange deviates from the financial rate of foreign exchange due to distortions created by tariffs and quotas[17]. The economic premium on foreign exchange in Brazil is estimated to be 12.06% above the current market exchange rate.[18] The economic cost of capital (EOCK), which is the discount rate used

[16] Harberger and Jenkins, Manual 1997, Chapters 7,8,9,10, and 11.

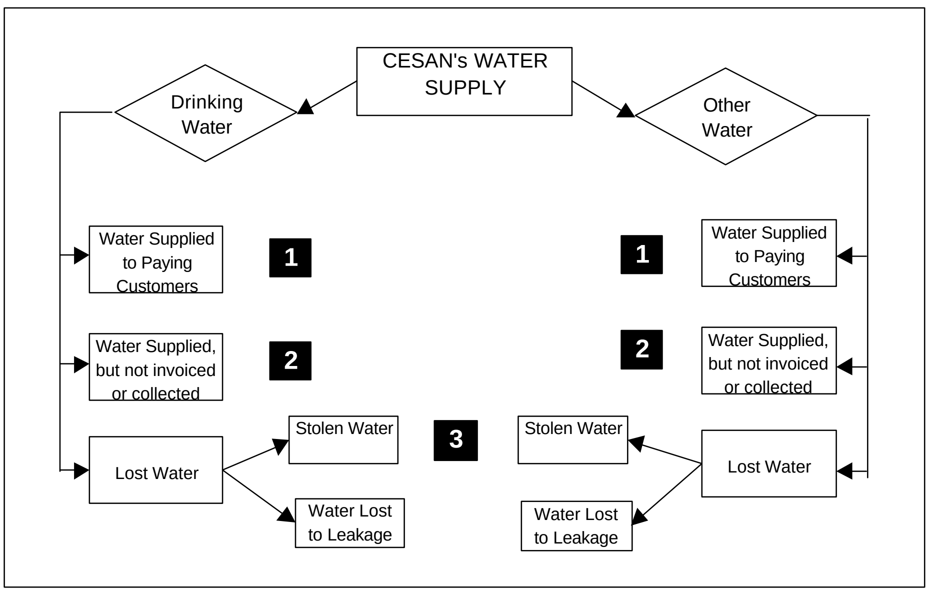
[17] Jenkins, Glenn P., Pastor Lorenzo Jr., Gangadhar Shukla, "Potable Water Supply Expansion: The Manila South Water Distribution Project," HIID, Feb. 1996.

[18] Table 12.2 in Spreadsheet Tables – Water Supply Project.

for the economic analysis, measures the real opportunity cost of resources in Brazil. The effects of the returns from domestic savings, returns on investment in different sectors and the costs of foreign borrowing are brought into the calculation of the economic cost of capital. The current economic cost of capital in Brazil is calculated at 12.17%.[19]

Economic Valuation of Outputs

FIGURE 5: Breakdown of Economic Valuation of Water

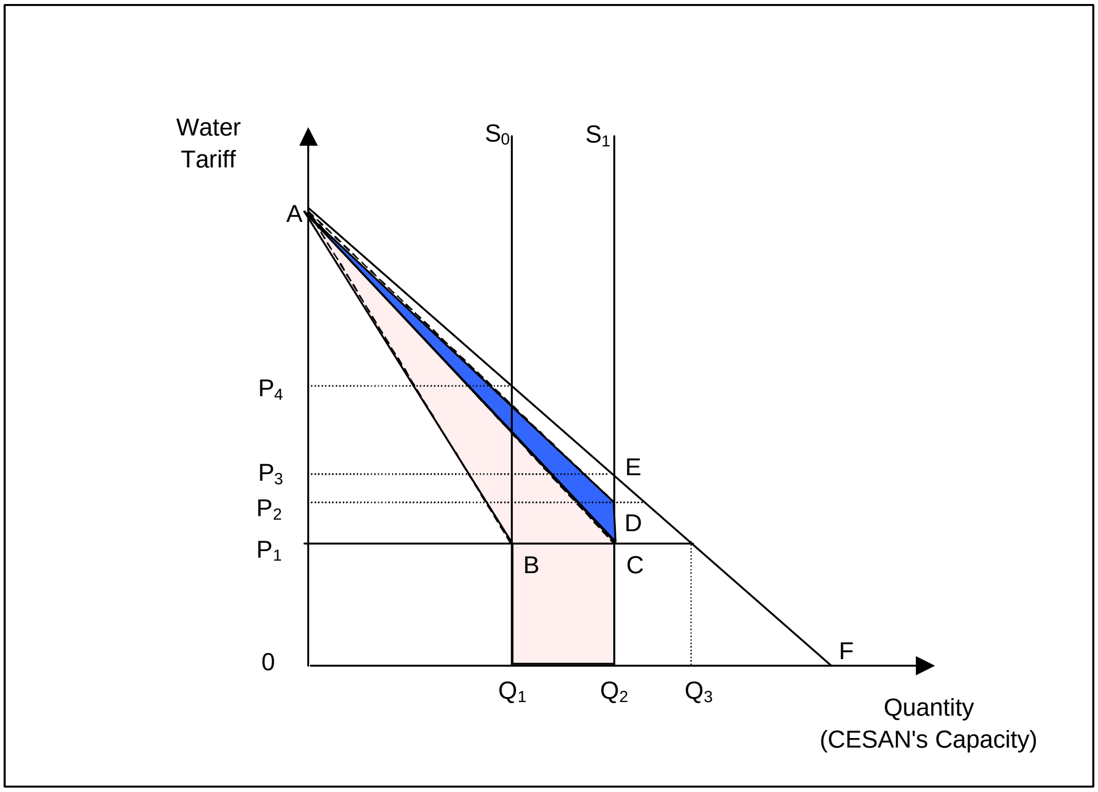


The economic value of water is assessed in the following manner: First, we separate drinking water and water used for other purposes. The economic values for the two separate uses of water are significantly different, unlike the financial valuation, which is uniform. Furthermore, if the water tariff were to change, the customers' reaction to the modified price would be based on their specific use of the water. The elasticity of demand for drinking water with respect to its price is significantly less than for water used for other purposes. The consumers of water are divided into three distinct groups. The first group consists of customers who pay for CESAN's water supply (#1 in figure below). For this group, the economic value of consumption is an adjustment to the

[19] Table 12.1 in Spreadsheet Tables – Water Supply Project.

financial revenue from water. The second group is made up of the customers serviced by CESAN, who do not pay, due to the lack of invoicing and collection (#2 in figure below). Finally, we separate stolen water (#3 in figure below), which is further divided into lost water and water lost as a result of leakage in the water supply network. The former has some economic value, despite the lack of any financial benefit, while the latter is a loss in both economic and financial terms. Thus, we estimate the economic valuation associated with drinking water and water used for other purposes for paying customers, for non-paying (i.e. non-invoiced) customers, and for stolen water.

FIGURE 6: Economic Valuation of Water for Paying Customers



The above graph illustrates the economic valuation of drinking water for paying users. The demand for water service in the Guarapari region is reflected by the demand curve AF, and the price for water service is established by CESAN at P_1. Thus, there exists a shortage of water service, as the demand for water at P_1 is Q_3, yet CESAN's capacity enables only a supply of Q_1 cubic meters of water. If water prices were not fixed, but determined by market forces, the equilibrium level would be P_4.

Suppose that rather than allowing the price of water to rise so that demand equals supply, the utility maintains the price at P and rations the water proportionally to all its customers. Under this scenario, the rationed services decrease the total consumers' benefits, which are now depicted by the effective demand curve, written as AB.

By expanding capacity, CESAN shifts the quantity of water supplied to Q_2. The rationing of water can then be reduced, although there will still be a water shortage at the price of P_1. In this case, the gross economic benefit to paying water consumers from CESAN's service is estimated by the area ACQ_2Q_1B[20].

This method of economic valuation can be applied both to drinking water and to water used for other purposes by paying customers. The maximum willingness-to-pay, however, would be much higher for drinking water than for water used for other purposes (R$3.90 and R$1.95 respectively), but CESAN's water tariff and capacity remain identical in both cases. In this case, we think it is reasonable to value the maximum willingness-to-pay for water used for other purposes at 50 percent of the maximum willingness-to-pay for drinking water (R$ 3.90 for drinking and R$1.95 for other uses, respectively).

It is important to note that in a shortage situation, a rise in the water tariff would also increase the gross economic benefits. The marginal consumption of water at that price would be reduced. The released quantity of water, however, would offset some of the existing shortages by being channeled to consumers who's willingness-to-pay for the service is greater than that of customers who relinquished the additional water. Suppose CESAN maintains the current water tariff at P_1, and the water service capacity is Q_2, as we see in Figure 6. If the water price were raised to P_2, the gross economic benefit would increase by the amount of area ADC, without any change in the total quantity of water produced. Further price increases would have the same effect up to point E (price P_3), at which point the water market would be in equilibrium, and the shortage would be eliminated. Any further increases in the water tariff would cause

[20] In order to calculate the area ACQ_2Q_1B, we use the formula $[(A+P_1)/2]*[Q_2-Q_1]$. A is the maximum willingness to pay for water service (R$ 3.90 for drinking water and R$ 1.95 for other uses of water) and P_1 is CESAN's water tariff (R$ 0.90). Q_1-Q_2 is the quantity of water supplied by the project.

consumers to reduce their usage, which would lead, in turn, to a decrease in the total gross economic benefits.

The total economic value of water in our analysis is significantly greater than the financial value. Individuals who obtain service through illegal means also derive some economic benefit, although CESAN is unable to recover any financial remuneration from such consumers. Thus, an adjustment has to be made in order to estimate the true economic impact of the project. It would be incorrect to assume that the economic value of water which generates no revenue is equal to the market price of water for all units of water consumed, because many of the non-paying consumers may value the service below the current price of water. Some consumers may actually value their water at a level higher than that of CESAN's water tariff, but pay nothing due to the method of acquisition. The valuation of water which generates no revenue is assessed at 50 percent of the total between the maximum willingness-to-pay and the price[21], due to this dispersion in valuation. Since the price of non-revenue water is zero, the economic value is simply 50 percent of the maximum willingness-to-pay[22]. Of course, water that is lost through leakage is devoid of any economic value. With these adjustments, the total economic value of water more closely reflects the true sum of all the benefits which it offers to society.

The economic value can include a value that is not evident in the individual consumer's willingness-to-pay for the service. The value associated with water used for non-drinking purposes reflects the value of the social externalities that are associated with the product. For example, treated water can reduce waterborne diseases that anyone may be susceptible to, yet an individual consumer may not consider the full value, as he may not realize the total benefit he is receiving. Therefore, the market demand function that measures private willingness-to-pay will undervalue the service.

The externality associated with non-drinking water in this situation is small, because there are only a few repercussions expected for people who do not use the

[21] $(P_{max} + P_1)/2$

[22] $(P_{max} + P_1)/2$, but P_1 is 0 for non-paying users. Thus, $P_{max}/2$ is the economic value of non-revenue water.

service. Research done by the World Bank indicates that the incidence of illnesses in Guarapari due to water-borne diseases is very low.[23] Nevertheless, the total economic value of water in our analysis is noticeably greater than the total financial value because of the shortage of supply and the value placed on unpaid-for and illegally acquired water.

The external benefits from sewage collection and disposal, however, are significant. The non-use value can be classified into two main categories. The first category includes the externalities generated through sewage disposal to the entire society, including the benefits that arise from living in a cleaner environment. The second category includes the benefits to consumers that are not typically attributed to the service. For example, many people are not aware that the sewage service will help to maintain the purity of water sources from which drinking water is drawn. The resulting cleaner aquifers lead to a reduction in waterborne diseases, for which many consumers would be willing to spend financial resources, if they realized that this decrease in illness was a direct result of the sewage service. The unrealized nature of the benefits is not reflected in the consumer's willingness-to-pay for the project's services.

The study utilizes a contingent valuation (CV) survey in order to assess the consumer's valuation. The CV analysis is based on an extensive survey conducted by the World Bank designed to measure people's willingness-to-pay for water supply and sewage disposal services, and for any recreational and environmental benefits that could be attributed to the project.[24] Unlike the financial price in the water supply component, the financial price for the sewage disposal does not give us a basis for calculation of the consumers' valuation of the sewage service. People's willingness-to-pay for sewage, in fact, is an indication of their valuation of water, since the sewage fee is applied as a surcharge on water. Therefore, our economic valuation of the sewage service was based on the results of the household survey.

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23 Frannie Humplick, The World Bank, Washington D.C.

24 Conducted by Frannie Humplick, the survey encompasses 54 questions, and included 900 observations.

The study indicates that the residents in Guarapari were willing to pay approximately R$0.49 per cubic meter for the proper disposal of sewage, when all the benefits of the service are considered. They place an additional value of R$0.35 per cubic meter on the environmental recuperation benefits derived from properly discarded sewage. The total environmental externality comprises a larger benefit to society, since the benefits are derived by the populace of the entire region, while the direct benefits of the sewage service are only enjoyed by the paying consumers.

Economic Valuation of Inputs

In order to obtain the economic resource costs of all the inputs of the project, we calculated a conversion factor for each input item. Conversion factors eliminate the various market distortions created by taxes and subsidies that are reflected in the financial prices and add the premium on foreign exchange to the list of tradable components of an item.[25] Furthermore, conversion factors account for any changes in the domestic prices of non-traded goods that may occur as a result of the project. Table 6 lists conversion factors for all the major inputs. As illustrated in the table, the economic resource costs of inputs are all lower than their financial costs, due to high taxes and tariffs in Brazil, which offset any increase in economic burden by subsidies and the foreign exchange premium. Since taxes and tariffs are merely transfer payments from consumers to the government, they are not treated as a resource cost to society. Electricity, as a case in point, bears the dual economic burdens of a large foreign exchange premium on its major input item, petroleum, and the government subsidy provided to stimulate production. Therefore, the resource cost of consuming electricity is slightly higher than the financial cost, despite high taxes and tariffs that partially offset the foreign exchange premium and subsidy [26].

[25] See the manual by Harberger and Jenkins on how to calculate conversion factors for inputs

[26] 17% and 10%, respectively.

TABLE 6: Conversion Factors

CEMENT	0.873
STEEL	0.798
WOOD	0.873
BRICKS	0.952
SAND	0.945
600mm PIPES	0.820
PVC PIPES	0.941
MOTOR PUMPS	0.767
PUMP CONTROLLER	0.767
TRANSFORMERS	0.771
LABOR	0.462
CHEMICALS	0.825
ELECTRICITY	1.051
OTHER SERVICES	0.700

B. Results of Economic Analysis

The conversion factor for electricity is close to one, because there are four large market distortions, which tend to cancel each other out. In the case of labor, the extent to which the project is affected is evident. Labor has a low conversion factor of .462, not only because of high income tax rates, but also because of the protected-sector wage received by Government workers. Labor's resource cost to society is much less than the financial cost incurred by the projects, since the market value of wages paid to similar labor is much lower than the wages paid by CESAN.

All other conversion factors reflect slightly smaller economic resource costs versus financial costs, largely due to market distortions caused by taxes and tariffs.

The results of the economic analysis indicate that, this project generates considerable net economic benefits for the country as a whole – as illustrated in Table 7, 8, and 9. The sewage project proves to be a potentially attractive investment for the economy, as the value of the service, coupled with the environmental benefits, far exceeds the resource costs of building and operating the project. The NPV of the project is equal to almost 350 percent of the present value of the economic costs of investment and operations.

The economic analysis indicates that, for the country as a whole, the water project also is very attractive. It has a substantial NPV that is approximately 125 percent of the present value of all of the economic costs incurred to build and operate the project.

TABLE 7: Results of the Economic Analysis

(in million R$)	**Water Supply Project**	**Sewage Collection Project**
NPV of project* (PV of benefits - PV of costs)	**R$ 22.9 MM**	**R$ 35.1 MM**
PV of benefits*	**R$ 41.2 MM**	**R$ 45.8MM**
PV of costs*	**R$ 18.3 MM**	**R$ 10.7MM**

* Sum of values from 1997 to 2027

TABLE 8: ECONOMIC NET BENEFIT FLOW STATEMENT for WATER SUPPLY PROJECT

(1996 Price Level)

Year	Converion Factors	1996	1997	1998	1999	2000	...2005	...2010	...2015	...2020	...2025	...2027
ECONOMIC BENEFIT FLOW												
Value of Water for Paying Customers		-	282,128	617,135	977,888	2,816,410	5,584,593	5,683,435	5,683,435	5,683,435	5,683,435	-
Valuation of Stolen Water		-	155,759	287,183	406,168	1,972,074	1,884,252	1,833,715	1,833,715	1,833,715	1,833,715	-
change in A/R		-	(39,498)	(50,492)	(58,360)	(329,079)	(77,204)	(78,680)	(72,335)	(72,335)	(72,335)	-
Salvage Value of Land	**1.000**	-	-	-	-	-	-	-	-	-	-	100,000
Total Inflows		**-**	**398,389**	**853,826**	**1,325,696**	**4,459,405**	**7,391,641**	**7,438,471**	**7,444,816**	**7,444,816**	**7,444,816**	**100,000**
ECONOMIC COST FLOW												
Investment Costs												
Labor												
Non-Semi-skilled Labor	**0.462**	-	254,776	305,547	167,543	-	-	-	-	-	-	-
Semi-skilled Labor	**0.462**	-	179,082	215,083	117,696	-	-	-	-	-	-	-
Raw Water Intake, Transmission & Pumping												
Materials	**0.892**	-	1,142,931	1,319,722	722,530	-	-	-	-	-	-	-
Equipment	**0.795**	-	200,806	227,681	117,928	-	-	-	-	-	-	-
Treatment												
Materials	**0.895**	-	610,020	704,418	371,507	-	-	-	-	-	-	-
Equipment	**0.794**	-	106,963	128,356	62,818	-	-	-	-	-	-	-
Treated Water Transmission and Pumping												
Materials	**0.906**	-	918,656	1,061,065	559,734	-	-	-	-	-	-	-
Equipment	**0.795**	-	160,644	182,144	94,343	-	-	-	-	-	-	-
Reservoirs & Distribution												
Materials	**0.892**	-	1,066,738	1,231,737	649,581	-	-	-	-	-	-	-
Equipment	**0.783**	-	185,030	209,790	108,660	-	-	-	-	-	-	-
Connections												
Materials	**0.905**	-	76,717	88,601	20,932	-	-	-	-	-	-	-
Equipment	**0.873**	-	14,675	16,639	8,619	-	-	-	-	-	-	-
Cost of Land	**1.000**	-	100,000	-	-	-	-	-	-	-	-	-
Operational Costs												
Total Cost of Labor Required by Project	**0.462**	-	23,101	37,444	52,351	67,839	169,523	285,151	423,013	563,605	742,293	-
Total Cost of Tertiary Labor Required by Project	**0.462**	-	11,782	17,599	24,081	29,171	64,419	108,357	160,745	214,170	282,071	-
Total Cost of Chemicals	**0.825**	-	5,945	11,948	17,989	93,957	94,345	94,345	94,345	94,345	94,345	-
Total Energy Costs	**1.051**	-	29,623	61,115	91,218	469,759	471,695	471,695	471,695	471,695	471,695	-
Total Other Service Costs	**0.700**	-	19,413	33,568	47,967	134,884	187,188	247,667	319,774	393,310	486,772	-
Total Maintenance Costs	**1.000**	-	68,800	68,800	69,800	69,800	71,020	69,800	67,580	64,140	60,700	-
Total Replacement Investments	**1.000**	-	-	-	-	-	-	-	-	-	-	-
change in A/P	**0.653**	-	(9,054)	(7,425)	(8,139)	(42,571)	(12,140)	(15,065)	(22,016)	(23,792)	(28,340)	213,064
change in CB	**1.000**	-	11,097	9,101	9,975	52,178	14,880	18,465	26,984	29,161	34,736	(261,144)
Total Outflows		-	5,177,745	5,922,932	3,307,132	875,015	1,060,930	1,280,416	1,542,121	1,806,635	2,144,273	(48,081)
Net Economic Benefit Flow		***-***	***(4,779,356)***	***(5,069,105)***	***(1,981,436)***	***3,584,390***	***6,330,712***	***6,158,056***	***5,902,696***	***5,638,182***	***5,300,543***	***148,081***
ECONOMIC NPV @	**12.17%**	***22,920,055***										

TABLE 9: ECONOMIC NET BENEFIT FLOW STATEMENT for SEWAGE COLLECTION PROJECT

(1996 Price Level)

Year	CF	1996	1997	1998	1999	2000	..2005	...2010	...2015	...2020	...2025	...2027
ECONOMIC BENEFIT FLOWS												
Sewage Collection Benefits		-	21,536	43,370	65,354	3,008,843	3,508,049	3,997,384	4,476,251	4,934,330	5,363,694	-
Environmental Recuperation Benefits		-	-	-	-	4,395,640	4,554,347	4,634,955	4,634,955	4,634,955	4,634,955	-
Salvage Value of Land	**1.000**	-	-	-	-	-	-	-	-	-	-	150,000
Total Inflows		**-**	**21,536**	**43,370**	**65,354**	**7,404,484**	**8,062,396**	**8,632,339**	**9,111,206**	**9,569,284**	**9,998,649**	**150,000**
ECONOMIC COSTS												
Investment Costs												
Labor												
Non-Qualified Labor	**0.462**	-	150,004	263,084	250,161	-	-	-	-	-	-	-
Qualified Labor	**0.462**	-	38,770	67,848	64,617	-	-	-	-	-	-	-
Connections												
Materials	**0.912**	-	96,443	163,019	149,027	-	-	-	-	-	-	-
Equipment	**0.828**	-	11,653	19,390	17,428	-	-	-	-	-	-	-
Collectors & Interceptors												
Materials	**0.908**	-	457,821	773,791	707,314	-	-	-	-	-	-	-
Equipment	**0.777**	-	53,454	88,924	79,902	-	-	-	-	-	-	-
Pumping Stations & Raw Sewage Pressure Pipes												
Materials	**0.904**	-	217,646	367,774	336,103	-	-	-	-	-	-	-
Equipment	**0.777**	-	25,258	42,019	37,756	-	-	-	-	-	-	-
Treatment and Outfall Pipes												
Materials	**0.908**	-	433,399	732,514	669,583	-	-	-	-	-	-	-
Equipment	**0.819**	-	51,734	86,086	77,375	-	-	-	-	-	-	-
Cost of Land	**1.000**	-	150,000	-	-	-	-	-	-	-	-	-
Operational Costs												
Total Cost of Labor Required by Project	**0.462**	-	16,297	16,623	16,956	44,278	50,983	62,777	71,866	90,075	108,182	-
Total Cost of Tertiary Labor Required by Proje	**0.462**	-	8,312	7,813	7,800	19,040	19,374	23,855	27,309	34,229	41,109	-
Total Cost of Chemicals	**0.825**	-	-	-	-	-	-	-	-	-	-	-
Total Energy Costs	**1.051**	-	4,244	8,548	14,171	594,287	692,673	789,113	883,491	973,771	1,058,392	-
Total Other Service Costs	**0.700**	-	9,231	9,830	10,802	113,082	130,602	151,045	169,870	192,457	214,128	-
Total Maintenance Costs	**1.000**	-	11,800	10,800	10,821	10,842	10,955	11,079	11,217	11,368	11,536	-
Total Replacement Investments	**1.000**	-	-	-	-	-	-	-	-	-	-	-
change in A/P	**0.881**	-	(6,218)	(969)	(1,257)	(69,554)	(10,152)	(11,411)	(12,561)	(14,776)	(15,276)	133,269
change in CB	1.000	-	5,644	879	1,141	63,135	9,215	10,358	11,402	13,412	13,866	(120,968)
Total Outflows		**-**	**1,735,493**	**2,657,973**	**2,449,698**	**775,109**	**903,650**	**1,036,817**	**1,162,594**	**1,300,537**	**1,431,937**	**12,301**
Net Cash Flow		**-**	***(1,713,958)***	***(2,614,603)***	***(2,384,344)***	***6,629,374***	***7,158,746***	***7,595,522***	***7,948,612***	***8,268,748***	***8,566,712***	***137,699***

Net Present Value (NPV) @ **12.17%** **35,103,958**

Sensitivity of Economic NPV to Changes in Water Tariff

The economic valuation of the water project increases as the water tariff[27] is varied from R$0.70 to R$0.85. The increase in price induces consumers who are willing to pay for water below the new tariff level to reduce the quantity that they consume. However, other consumers will be willing to pay the higher tariff and consume the released water. Since the new consumers of the released water value the service more than the previous consumers, the value of the total benefits generated by the water project should increase. Further price increases, however, should begin to reduce the economic NPV of the project, once the current shortage is completely relieved. Once the water tariff is raised to a level that relieves the shortage, further price increases will induce consumers to curtail their use of CESAN's water service. The economic value of water will be lower, since less water is consumed. The lower consumption of water from the project causes the economic NPV to diminish. If the tariff is raised as high as R$ 1.30, the reduction in water consumption would reduce the economic benefits to such an extent that the project would have a negative economic NPV.

Upon completion of the investment and the commencement of its full-scale operation, the project should be able to satisfy the total demand for water supply in the region for a short period. The growth in demand for water, however, should eventually reintroduce the shortage.

The economic NPV of the sewage service remains unchanged in the initial price range of R$0.70 to $0.85, because the quantity of water supplied remains unchanged. The lower price of water does increase the demand for the service, yet CESAN is unable to provide additional water, due to its fixed capacity. The economic value, therefore, remains unchanged, since the amount of water provided by the project remains the same. Once water consumption is reduced due to price increases, the economic value of the sewage service diminishes, as there is less sewage requiring proper disposal.

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[27] Real Water Tariff

Sensitivity of Economic NPV to Changes in Water Tariff

R$	Water Economic NPV	Sewerage Economic NPV
0.70	22,530,858	35,107,507
0.75	22,989,166	35,107,507
0.80	23,447,474	35,107,507
0.85	23,905,782	35,107,507
0.90	22,920,055	35,103,958
0.95	20,278,988	34,943,907
1.00	17,720,135	34,609,673
1.05	15,155,507	34,133,156
1.10	12,511,056	33,538,606
1.15	9,262,040	32,828,999
1.20	6,277,511	32,026,404
1.25	2,255,875	31,152,556
1.30	(2,635,690)	30,213,886

Sensitivity of NPV to Changes in Sewage Surcharge

Changing the sewage surcharge has a similar effect to altering the price of water, since the charge is added to the water tariff. Therefore, an increase in price that induces cutbacks in consumption of water will reduce the economic benefits of the project. For example, as the surcharge is increased beyond R$ 0.17, the resulting rise in the price consumers pay for water will cause the economic NPV to decrease. This is a consequence of the cutback in the amount of water acquired from the project. Of course, lower water consumption leads to less sewage disposal, which, in turn, leads to a lower economic benefit from the sewage project as well. Sewage surcharges that cause water usage to be transferred to consumers with a higher willingness-to-pay enhance the water project's economic NPV, due to the alleviation of shortages.

Sensitivity of Economic NPV to Changes in Sewage Surcharge

R$	Water Units Economic NPV	Sewerage Economic NPV
0.14	24,364,090	35,107,507
0.15	24,364,090	35,107,507
0.16	24,364,090	35,107,507
0.17	24,364,090	35,107,507
0.18	22,920,055	35,103,958
0.19	22,855,146	35,083,651
0.20	22,790,237	35,063,344
0.21	21,258,323	35,029,695
0.22	21,138,796	34,990,797
0.23	19,711,614	34,943,907

Sensitivity of NPV to Changes in Maximum Willingness-To-Pay for Water

The economic valuation of the water project would be significantly different if the maximum willingness-to-pay for water service in Guarapari were different from the survey estimate. Since there is a rationing of water due to the shortage, the maximum willingness to pay, along with the water tariff, determines the economic value of the water service[28]. A higher maximum willingness-to-pay would result in a higher valuation of the service by water consumers. Nevertheless, the economic NPV of the water project remains robust even if the assessments are as low as \$2.00 for drinking water and \$1.00 for the other uses of water. In fact, the consumer's valuation of water must be lower than R\$ 1.12 and R\$ 0.56 for drinking and other water, respectively, in order to render the project economically unfeasible.

[28] Economic value = $(P_{max} + P_1)/2$, where P_{max} is the maximum willingness-to-pay.

<u>Sensitivity of NPV to Changes in Maximum Willingness-to-Pay for Water</u>

Other Water (R$)	Drinking Water (R$)	Water Economic NPV
1.05	2.10	8,062,896
1.20	2.40	10,539,089
1.35	2.70	13,015,282
1.50	3.00	15,491,475
1.65	3.30	17,967,669
1.80	3.60	20,443,862
1.95	3.90	22,920,055
2.10	4.20	25,396,248
2.25	4.50	27,872,441
2.40	4.80	30,348,634
2.00	4.00	23,745,453
2.05	4.10	24,570,850
2.10	4.20	25,396,248

Sensitivity of NPV to Changes in Proportion of Drinking Water to Other Water

The base case analysis assumes that 30% of the water supplied by CESAN is consumed as drinking water, while the remaining 70% is used for other purposes. Consumers place a substantially higher valuation on drinking water than on water used for other purposes, due to its basic-needs nature. Therefore, if consumers were to use a larger percentage of water for drinking purposes, then the total economic value of the project would be greater. For example, the base case estimates the economic value of drinking water to be R$ 2.40, while the value placed on other uses of water is R$ 1.43. Conversely, a reduction in the percentage of water used for drinking, which will increase the amount of water used for other purposes, will reduce the economic benefits of the project. Despite the significant impact this may have on the project, we found the project to be remarkably robust.

Sensitivity of NPV to Changes in Proportion of Drinking Water to Other Water

	Water Economic NPV
15%	19,205,765
20%	20,443,862
25%	21,681,958
30%	22,920,055
35%	24,158,151
40%	25,396,248
45%	26,634,345
50%	27,872,441

Sensitivity of Economic NPV to Changes in the Valuation of Non-Revenue Water

The economic value of non-revenue water is estimated to be the average between the maximum that people are willing to pay for drinking and other uses of water and zero, which is the price these people pay for the service. Therefore, the economic NPV can be significantly affected if the actual consumer valuation of stolen, un-invoiced, or unpaid water is different than the initial estimate. For example, if the economic value of non-revenue water were reduced to 70% of the estimate (R$ 1.37 for drinking water and R$ 0.68 for other uses) in the base case, the net economic gain to society could be reduced by almost 15%. Alternatively, the project's economic NPV would receive a significant boost, if the valuation were to rise.

Sensitivity of Economic NPV to Changes in Valuation of Non-Revenue Water

Percentage of Original Estimate	**WTP for Drinking Water**	**WTP for Other Water**	**Water Economic NPV**
70%	1.37	0.68	19,567,015
80%	1.56	0.78	20,684,695
90%	1.76	0.88	21,802,375
100%	1.95	0.98	22,920,055
110%	2.15	1.07	24,037,735
120%	2.34	1.17	25,155,415
130%	2.54	1.27	26,273,095
140%	2.73	1.37	27,390,775

Sensitivity of NPV to Changes in Real Wage Increase

The effect of an increase in the cost of labor is less significant in the economic analysis than in the financial analysis. The reason for the smaller effect is that the economic cost of labor is substantially less than the financial expenditure on workers' salaries.

<u>Sensitivity of NPV to Changes in Real Wage Increase</u>

	Water Economic NPV	Sewerage Economic NPV
1.00%	23,259,621	35,175,939
1.20%	23,196,231	35,162,375
1.40%	23,130,664	35,148,409
1.60%	23,062,838	35,134,028
1.80%	22,992,665	35,119,216
2.00%	22,920,055	35,103,958
2.20%	22,844,914	35,088,239
2.40%	22,767,144	35,072,042
2.60%	22,686,644	35,055,351
2.80%	22,603,307	35,038,147
3.00%	22,517,023	35,020,411
3.20%	22,427,678	35,002,127

Sensitivity of NPV to Changes in Contingent Valuation Assessment

The valuation of the sewage service and the gain in environmental benefits forecast by the survey conducted in Guarapari is an important factor, which contributes to the high economic return on the investment in the sewage project. One can also see from the sensitivity analysis that the values are significant enough to the NPV substantially if the estimates were different. Nevertheless, if the estimate of the benefits of the service and the corresponding environmental recuperation benefits were lowered by R$ 0.25 and R$ 0.20 per cubic meter respectively, the sewage component of the project would still be economically feasible.

Sensitivity of NPV to Changes in Contingent Valuation Assessment

		Contingent Valuation of Sewage Service (R$ per M^3)						
		0.25	0.30	0.35	0.40	0.45	0.50	0.55
Contingent Valuation of Environmental Recuperation Benefits (R$ per M^3)	0.20	14,413,945	16,524,800	18,635,654	20,746,509	22,857,363	24,968,217	27,079,072
	0.25	18,058,584	20,169,439	22,280,293	24,391,148	26,502,002	28,612,856	30,723,711
	0.30	21,703,223	23,814,078	25,924,932	28,035,787	30,146,641	32,257,496	34,368,350
	0.35	25,347,862	27,458,717	29,569,571	31,680,426	33,791,280	35,902,135	38,012,989
	0.40	28,992,501	31,103,356	33,214,210	35,325,065	37,435,919	39,546,774	41,657,628
	0.45	32,637,140	34,747,995	36,858,849	38,969,704	41,080,558	43,191,413	45,302,267
	0.50	36,281,779	38,392,634	40,503,488	42,614,343	44,725,197	46,836,052	48,946,906
	0.55	39,926,418	42,037,273	44,148,127	46,258,982	48,369,836	50,480,691	52,591,545

TABLE 10:Comparing Results from Financial Analysis and Economic Analysis

	Economic Analysis		Financial Analysis	
(in million R$)	**Water**	**Sewage**	**Water**	**Sewage**
NPV of project* (PV of benefits - PV of costs)	**R$ 22.9 MM**	**R$ 35.1 MM**	**R$ -5.6 MM**	**R$ 3.1 MM**
PV of benefits*	**R$ 41.2 MM**	**R$ 45.8MM**	**R$ 27.6 MM**	**R$ 20.9 MM**
PV of costs*	**R$ 18.3 MM**	**R$ 10.7MM**	**R$ 33.2 MM**	**R$ 17.8 MM**

Table 10 compares the results of the financial and economic analysis of the two project components. The economic value of the benefits of water is greater than the financial benefits accruing from the project, due to the higher economic value placed on water service by consumers. Moreover, the economic valuation of costs is also significantly different from their financial assessment. The economic resource costs are almost half those of the financial costs associated with the project, mainly due to the lower economic valuation of labor. Furthermore, many other input costs also have a lower economic valuation, due to distortions created by taxes and tariffs.

The sewage project shows an even greater divergence between the economic and the financial analysis. Much of this discrepancy is due to all the environmental benefits and unrealized values associated with sewage service that the financial markets are unable to reflect accurately. A less significant reason for the difference is that the economic costs are also approximately 40% less than the financial costs of the project.

The economic benefits of water are estimated to be higher than the financial values, by approximately 90 percent[29]. The economic price of labor and the lower economic valuation of other inputs also combine to lower the total economic cost and render a positive NPV. This is in contrast to the financial analysis, which yields a negative NPV.

4. Distributional or Stakeholder Analysis

TABLE 11: Distribution of Externalities

	Total Externalities	Government	Consumers	Workers	Society[30]
Water Supply Plant	R$ 29.9 MM	R$ 2.9 MM	R$ 24.7 MM	R$ 2.3 MM	R$ 0.0
Sewage Disposal Plant	R$ 35.1 MM	R$1.0 MM	R$ 6.3 MM	R$1.0 MM	R$25.2 MM
Combined Project	R$ 65.0 MM	R$ 3.9 MM	R$ 31.0 MM	R$ 3.3 MM	R$ 25.2 MM

The distribution of positive externalities - the difference between net economic benefits and net financial benefits, both discounted at the economic discount rate - illustrates who obtains benefits without bearing equivalent costs and vice versa.[31] In table 11, we find that the values of the total externalities produced by the sewage disposal plant (R$ 35.1 MM) and for the water supply plant (R$ 29.9 MM) are very substantial.

In both projects, the Government reaps direct financial benefits (R$ 3.9MM) through the collection of taxes and tariffs that are imposed on the inputs of the projects. Water consumers realize significant benefits(R$ 24.7 MM) since the project alleviates much of the burden caused by the pre-project water shortage and the resulting rationing of service. Additional externality benefits are obtained by those who steal water, since they do not pay for the services they acquire. The benefits to workers come mostly in the form of a wage premium that the Government pays over the supply price for equivalent labor. Since the water supply project is labor intensive, the benefits to the

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[29] Based on an average between drinking and other uses of water.

[30] Society includes water consumers as well as all other inhabitants of Guarapari.

workers are greater in this project than in the sewage disposal project (R$ 2.3 MM and R$ 1.0 MM, respectively). Nevertheless, consumers of the sewage service also obtain a consumer surplus of R$ 3.6 MM. The positive externalities captured by society at large from the operation of the sewage disposal plant reaches R$ 25.2 MM, which is much greater than the total financial cost of the project (R$ 17.8 MM). This positive externality is due to the large amount of benefit obtained through environmental improvement that the project is unable to show financially.

In the final analysis, the consumers are the biggest gainers in the water supply project, but the government and workers also realize a good share of the benefits from the positive externalities. In the case of the sewage disposal project, most of the benefits accrue to all of the residents of the region of Guarapari, while the direct consumers, workers and the government also realize some gains. Finally, in both projects, there are no net negative externalities inflicted on any stakeholder.

5. Risk Analysis

The cash flow projections in the static model of the financial and economic analyses do not account for the uncertainties and fluctuations in the real world. Monte Carlo simulations, a form of risk analysis, provide one of the most practical methods to approximate the dynamics and uncertainties of the real world. The risk analysis repeats the financial and economic analyses many times using distributions for the values of the most sensitive variables that affect the project. In preparation for these simulations, we conducted sensitivity analyses to identify the variables that significantly affect the outcomes of the projects. After identifying the sensitive variables, we distinguished from among them those that are within limited or full control of management and those that fall outside the control of CESAN. For example, the invoicing efficiency is a variable that clearly has an impact on the projects' financial viability. It also happens to be under CESAN's control. On the other hand, inflation can affect the outcome of the project, but CESAN cannot influence the inflation rate in Brazil. Furthermore, the contingent valuation estimates could be uncertain due to errors of estimation. All these variables

[31] Refer to Table 15 in Spreadsheet Tables – Water Supply Project, Sewage Collections Project.

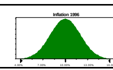
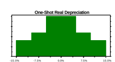
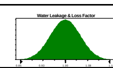
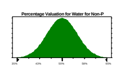
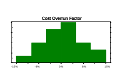
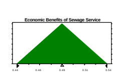
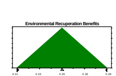
contribute to the uncertainty of future project outcomes. Thus, they qualify as risk variables.

TABLE 12: Risk Variables and their Impact and Risk Significance

Risk variables	Impact and risk significance
Inflation	Large effects on working capital and interest rate on loans. Beyond management control; based on economic factors and policies.
Devaluation of real exchange rate	Large effects on the costs of tradable inputs, particularly on initial investment costs. Beyond management control.
Level of lost water	Effects financial as well as economic analysis. Larger amounts of lost water reduces financial revenue. Also effects economic benefits since stolen water is valued differently from bought water.
Valuation of non-revenue water	Value placed by consumers on water stolen from CESAN's network. No financial revenue is realized, but has economic value.
Ratio of Drinking Water to Total Water	Effects economic valuation of water project since consumers place a different economic value on drinking water than other uses of water
Real increase in wages	Large effects on the costs of labor. Influenced by government policies and market conditions; beyond management control.
Collection efficiency	Direct effect on revenues and profitability. The management controls the efficiency to a large extent.
Invoicing efficiency	Direct effect on revenues and profitability. The management controls the efficiency to a large extent.
Investment cost overruns	Direct increase of investment costs. Management can control it to a large extent.
Maximum willingness-to-pay for water	Determines economic value of water when there is rationing. Uncertainty is related to inaccuracy in estimate.
Valuation of sewerage service	Value derived from contingent valuation survey. Uncertainty is related to survey bias that may exist. Effects economic valuation of sewage.
Environmental recuperation benefits	Large effect on the economic valuation of environmental protection. Beyond management control; based on people's preferences.

The objective of the risk analysis is to assess the impact of the variables in Table 12 on the project's outcome. Thereafter, the project managers can make their best efforts to optimize variables within their control and to reduce the risks faced by the project. An analyst can also determine the project's ability to withstand the impacts of variables such as inflation that are beyond the control of project managers. To evaluate the impact of the risk variables on the project outcomes under various circumstances, we used a computer software package to generate random values for the variables, whose behavior was assessed through research and analysis.[32] We simulated 2,500 trials in our analysis. These simulations approximate the range of possible scenarios in real life, thereby giving us a probability distribution of financial and economic NPV of the two projects.

TABLE 13: Risk Variables and their Impact and Risk Significance

VARIABLE	DISTRIBUTION	RANGE
Inflation Rate	Normal 	Mean 10.00% Standard Dev. 2.00%
Devaluation of real exchange rate (average over life of project)	Custom/ Step 	-15.0% to –10.0% 0.10 -10.0% to -5.0% 0.15 -5.0% to 0.0% 0.25 0.0% to 5.0% 0.25 5.0% to 10.0% 0.15 10.0% to 15.0% 0.10
Level of lost water (as ratio of target level)	Normal 	Mean 1.00 Standard Dev. 0.05
Valuation of non-revenue water (as percentage of maximum willingness-to –pay)	Normal 	Mean 50% Standard Dev. 5%
Ratio of Drinking Water to Total Water	Normal 	Mean 30% Standard Dev. 3%
Real increase in wages	Custom/ Step 	1% to 2% 0.20 2% to 3% 0.50 3% to 4% 0.20 4% to 5% 0.10
Invoicing efficiency	Custom/ Step 	0.90 to 0.95 0.20 0.95 to 1.00 0.25 1.00 to 1.05 0.30 1.05 to 1.10 0.15 1.10 to 1.15 0.10
Investment cost overruns	Custom/ Step 	-15% to –10% 0.05 -10% to –5% 0.15 -5% to 0% 0.25 0% to 5% 0.30 5% to 10% 0.15 10% to 15% 0.10
Maximum willingness-to-pay for water	Triangular 	Minimum 3.50 Likeliest 3.90 Maximum 4.30
Valuation of sewerage service	Triangular 	Minimum 0.44 Likeliest 0.49 Maximum 0.54
Environmental recuperation benefits	Triangular 	Minimum 0.31 Likeliest 0.35 Maximum 0.38

[32] The computer software package we used is Crystal Ball produced by Decioneering Corporation, Denver, CO.

Once identified, we also estimate a distribution and a range for each risk variable. Table 13 summarizes the specification we estimated for the variables.

TABLE 14: Economic and Financial NPV Based on Risk Analysis[33]

	Water Supply Financial	Water Supply Economic	Sewage Disposal Financial	Sewage Disposal Economic
Expected NPV	R$ -5.8 MM	R$ 23.4MM	R$ 3.28 MM	R$ 35.0 MM
Standard Deviation	R$ 2.4 MM	R$ 2.4 MM	R$ 1.7 MM	R$ 1.4 MM
Probability of NPV > 0	0.87%	100%	98.7%	100%

Table 14 summarizes the results of our risk analysis. The expected NPV of the financial analysis of the water project alone is a negative R$ 5.8 MM, with no probability of the outcome being positive. The opposite is true for the Sewage Disposal plant, where the expected financial NPV is slightly positive. The expected NPV is significantly above zero, in the economic analysis of both the water and sewerage disposal project. The probability of a negative return is also zero, given the assumptions surrounding the specification of the variables. Similarly, the expected economic value of the sewage project is high enough so that there is no probability of a negative outcome, given the assumptions used in the risk analysis. In other words, both projects are quite certain to provide a significant return to the economy of Espirito Santo. It is important to note, however, that much of the economic variability in the project stems from the uncertainty that may exist in the contingent valuation study.[34]

Since the expected NPVs for both projects are quite different from a break-even situation, changes in each of the projects NPV's may alter the viability of the combined project.

[33] Based on 2500 simulation trials. For further information, refer to reference readings or Appendix D.

[34] There are many biases that may exist in a contingent valuation that may lead to overvalued or undervalued results. For a more detailed explanation, refer to the following: Asian Development Bank, Economic Evaluation of Environmental Impacts, Manila, Philippines, 1996.

TABLE 15: Risk Analysis of the Combined (Water & Sewage) Project Financial NPV

Expected NPV	R$ -2.6 MM
Standard Deviation (σ)	R$ 4.0 MM
Probability of NPV > 0	26.33%

The expected value of the combined financial NPV is R$ -2.6 MM. There is, however, significant volatility in this estimate, as indicated by the high standard deviation. Furthermore, the probability of obtaining a positive NPV is only 26 percent. In fact, the results indicate that the possible NPVs can range from R$ –13.9 MM to R$10.3 MM.

The financial NPV and its' standard deviation is not a sufficient indicator of the risks associated with this project, due to its public sector nature. A policy maker's likely objective in undertaking this project is to have it earn the minimum financial rate of return that would allow it to be sustainable, while generating the large economic benefits. Therefore, evaluating the risks associated with the yearly financial cash flows is more useful.

The investment stage risks are critical, since any changes in the estimated expenses will alter the required amounts of debt and equity. The highest investment costs occur in 1998, where the volatility in the expected costs is also large. The final year of investment (1999), however, may be more critical to the success of the project. The relative variability with respect to the expected NCF, indicated by the coefficient of variation, is at its highest in the third year of investment. Moreover, the expected financing may not be available in 1999, since resources may have already been utilized to finance shortfalls during the previous two years.

The expected net cash flows show that during the operational period, the combined project is able to financially sustain itself. There is still a certain amount of uncertainty regarding the project's ability to meet its financial obligations, especially during the phases of reinvestment. Volatility during the period surrounding year 2005 can have a significant impact, since the project cash flows are not robust because of repayment of the loan. The project's financial condition also begins to deteriorate after the year 2020, as the financial revenues are unable to cover the real increase in the cost of labor. Therefore, volatility in the projects' estimated variables could have a significant impact on financial self-sufficiency.

TABLE 16: Risk Analysis of the Yearly Real Net Cash Flows for Combined (Water & Sewage) Project from the Equity Point-of-View

	Investment Stage			Operational Stage						
Year	**1997**	**1998**	**1999**	**2000**	**…2005**	**…2010**	**…2015**	**…2020**	**…2025**	**…2027**
Expected NCF (R$ MM)	-4.28	-5.22	-3.29	2.31	0.42	1.01	1.94	1.20	0.27	0.89
Standard Deviation (R$ MM)	0.35	0.44	0.29	0.38	0.57	0.56	0.60	0.74	0.99	0.07
Coefficient of Variation	0.08	0.08	0.09	0.16	1.35	0.56	0.31	0.61	3.62	0.08
Probability of NCF>0	0.0%	0.0%	0.0%	100.0%	75.4%	97.5%	100.0%	93.5%	65.9%	100.0%

The variability of the stakeholder impact estimations is also important in determining the success of a public sector project. The largest volatility is associated with the externalities obtained by consumers and society. Much of the variability in the surplus obtained by water consumers is due to some uncertainty in the estimation of their valuation of water. For example, the uncertainty in the estimate of maximum willingness-to-pay for water, which is a key determinant of the consumers' economic valuation of water, will cause far greater uncertainty than the original stakeholder estimate. The variability of the sewage project's impact on consumers and society is based on any biases pertaining to the contingent valuation study. Consumers and society still stand to gain significantly despite the large volatility, due to the magnitude of the original assessment. The gains to government and labor are more constant, since they are based on more certain estimates of investment and of the labor required to operate the two plants.

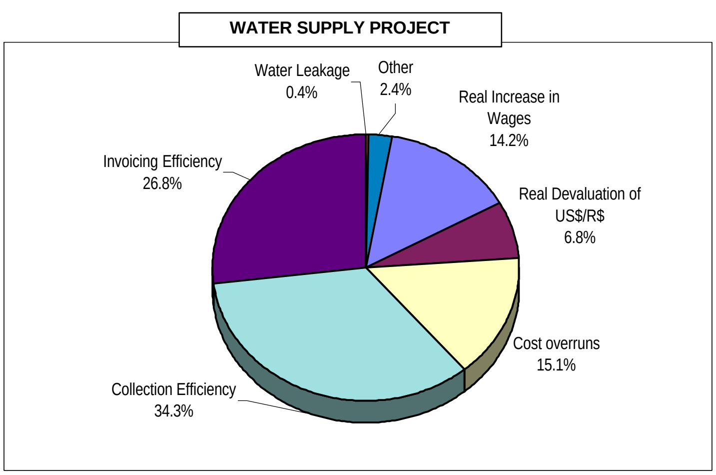
TABLE 17: Risk Analysis of the Stakeholder Impacts

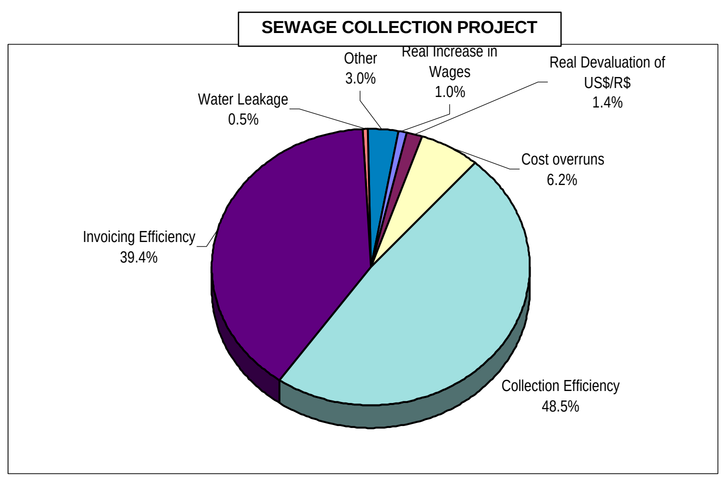
	Government	Consumers	Labor	Society*
WATER PROJECT				
Expected Externality	2.99	25.22	2.33	
Standard Deviation	0.19	2.13	0.21	
SEWAGE PROJECT				
Expected Externality	1.02	6.17	1.02	25.20
Standard Deviation	0.06	1.55	0.06	1.04

* Consumers are also part of the society

The variables that have the largest impact on the economic NPV can be easily identified. The largest impacts in both projects reflect possible variability in the level of invoicing and collection efficiency. Additionally, the water project is significantly affected by changes in the real exchange rate and cost overruns, due to the larger investment required. It is affected by variability in wages due to its large requirement of labor as well.

FIGURE 7: Estimate of Breakdown of Variance[35] in the Financial Analysis





35 The analysis is an approximation of the breakdown in variance, not an exact decomposition of variance. For more information, refer to the Crystal Ball User's Manual.

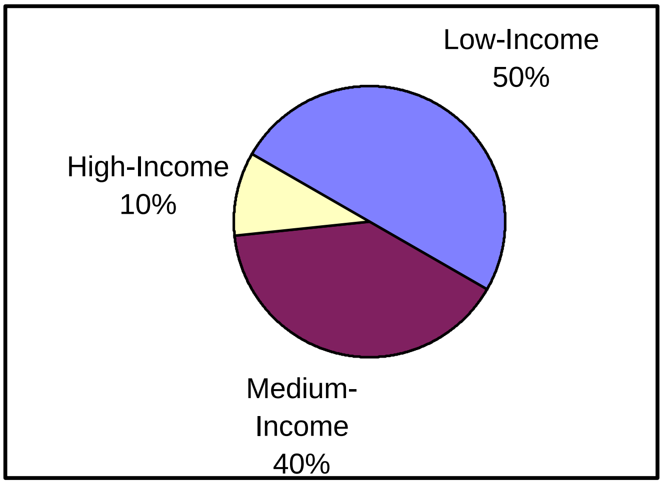
III. Conclusions

1. Evaluation of the Project

The State of Espirito Santo's objectives for undertaking the water supply project and the sewage disposal project in the Guarapari region are five-fold: 1) to increase the supply of clean water for the residents in the region in order to alleviate current shortages; 2) to enhance sanitation services in the region by increasing sewage collection and treatment rates; 3) to improve environmental protection by treating sewage prior to discharge into regional water systems; 4) to improve financial self-sufficiency and management efficiency of CESAN; and 5) to make the water supply and sewage disposal services affordable for low income residents.

The water supply project effectively eliminates the shortage of clean water in the region by increasing the number of connections between residences and public water utilities and by expanding the supply made available to the existing connections. By implementing the project, CESAN is expected to achieve connections to over 98% of the residential areas and to increase the quantity of water supplied by 68%, which will eliminate much of the need for water rationing. Figure 8 identifies the breakdown of new connections. The biggest beneficiaries from the new connections should be the low-income families, who make up 50% of the new connections. CESAN expects to provide 52 cubic meters of water per person per year, falling only slightly below the current demand of 54 cubic meters. However, because the price is set as one fixed rate, the service may not be affordable for the lowest income segments of the population; this is one of the reasons why there are persistent problems of free riders and uncollected bills. Hence, it might be advisable to alter the billing structure in such a way that might levy an access fee per month that could be differentiated by the approximate income of households, coupled with a lower marginal rate per cubic meter of water.

FIGURE 8: Breakdown of New Water Supply Connections

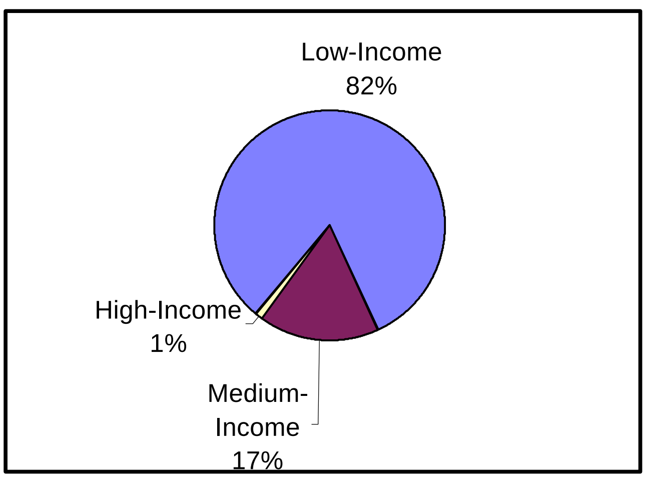


The risk analysis and the deterministic model, both indicate that the water supply project should produce net economic benefits for society. The consumers of CESAN's water service reap most of the external benefits(R$ 24.7MM) produced by the project. The remaining externality is shared between the government (R$ 2.9MM) and workers (R$2.3). Due to the public sector rationale of the project, the government may want to use general public sector revenue in order to subsidize the financial loss of the project. The society as a whole, however, will benefit not only from eliminating water shortages, but also from the external economic gains received by consumers and workers.

There may be some non-use value of clean water that will become more evident in the future. Clean water supply prevents water-borne diseases, particularly as water sources become more contaminated by discharge of untreated waste. At present, health officials do not record a noticeable increase in water-borne diseases, because the water system in the project area has yet to reach the hazardous conditions found in the rest of the region. Nevertheless, even with the new sewage disposal project in full operation, more than 40% of the waste will still not be treated before it is discharged. Hence, the economic value of water may be undervalued in our analyses, since externalities from supplying clean water might increase significantly in the near future. This possible undervaluation strengthens the case for the water supply project, despite its poor financial performance.

The sewage disposal project is expected to significantly improve the conditions of the water systems in the region by reducing the volume of untreated waste discharged into rivers and into the ocean by 6 million cubic meters per year. The project plans to expand the collection capacity to over 11 million cubic meters over the life of the plant. The project increases the share of the population connected to sewage service from 13% to 46%. In addition, the project makes the service affordable for most low-income families by maintaining the utility prices at a relatively low R$ 0.18 per cubic meter. Figure 9 shows that the low-income families are expected to reap most of the benefits from the expansion of sewage services; they represent 82% of the new connections. Perhaps the sewage service is not affordable to all low-income people, since the problems of illegal connections and unpaid utility bills are currently serious. Still, a relatively low usage fee would attract more people into the public sewage network and help maintain cleaner water systems from which the drinking water is drawn. In turn, this larger pool of customers should keep CESAN's cost of treating potable water low by requiring fewer chemicals to eradicate contaminants in the water supply.

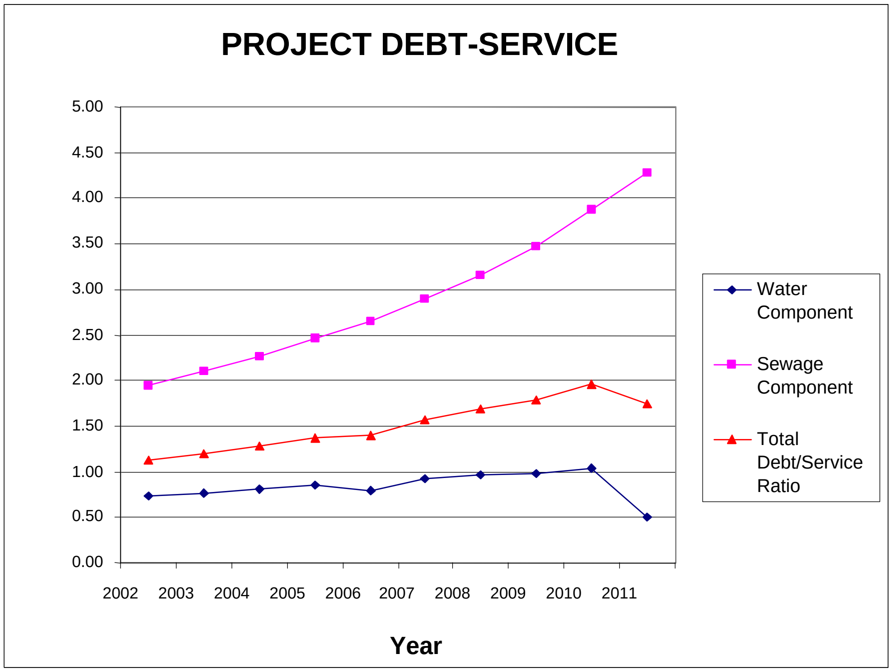
FIGURE 9: Breakdown of New Sewage Connections



The strongest case for undertaking the sewage disposal project is the enormous economic benefits it is expected to generate for society by preventing environmental degradation. While the financial NPV for the project is sound, the economic NPV is extremely robust. The positive externalities alone are greater than the total costs of investment and operations. The figures from our risk analysis - a mean financial NPV of

R$ 3.1 MM and a mean economic NPV of R$ 35.0 MM – confirm our original hypothesis. After incorporating for the dynamics of the real world, we have a financially viable project that also produces large benefits for society. Hence, even if we use a lower contingent valuation proxy for the non-use value of benefits, the project remains highly attractive.[36]

FIGURE 10: Debt-Service Ratios for Project Financing



Despite the strong economic prospect, it is still critical for the project to be financially self-sufficient. Espirito Santo cannot expect outlays from the federal government to cover serious financial shortfalls, mainly because inflation in recent years has prompted the central government to curtail subsidies. The preceding graph illustrates the debt service ratios for the two project components. The sewage project can clearly repay its portion of the loan, since the net cash flows before deducting financing costs are more than double those of the repayments. The robustness in the debt-service ratio in the sewage project is due to the lower loan amount (due to smaller investment costs) and the consistently high operational profits. The water project, on the other hand, is unable to make most payments through its operational surpluses. In

[36] We, in fact, varied the CV value when conducting our risk analysis.

other words, an additional infusion of equity is needed in order to sustain the payments without defaulting on the loan. A combined project scenario presents a debt service ratio that is greater than one, implying that the loan repayments can be sustained through operational profits. However, there is reason for caution, as the project is barely able to make the loan repayments during the initial years of operation. Such a low debt-service ratio indicates that a small variation in operating income could place the project in financial difficulty.

Assessment of efficiency and profitability of the two projects should be focused on four key issues: invoicing efficiency, collection efficiency, water leakage and losses, and the cost of labor. In our static financial analysis, the water project has a negative financial NPV. Despite the positive financial NPV, the sewage project can also be further improved by effectively changing the above mentioned factors. To raise the revenues, CESAN has to increase the rate at which it invoices and collects bills for the services that it renders. Currently, CESAN expects to improve its invoicing efficiency from 77% to 90% and its collection efficiency from 84% to 85% over the life of the project. Clearly, this rate of increase in efficiency is not sufficient to make the water project financially profitable. By having one flat rate for services[37], CESAN neither harness possible revenues from customers on the upper end of the demand curve nor attracts potential consumers on the lower end of the demand curve. An improved pricing policy via block pricing can also enhance the profitability of the projects directly.

On the expense side, the high cost of labor is the main reason for generating inadequate financial net benefits from the projects. The cost of labor is higher in public sector projects than in private sector operations because CESAN is paying a significant premium above-market rates to its workers. The premium is not justified on any market principle, yet it is maintained for political reasons. Since labor costs make up over 33% of total costs in the water supply project and 12% of the sewage disposal project, paying

[37] At present, CESAN has charges a flat rate for everyone regardless of how much people use the service, because they do not have water meters. This promotes inefficiency and waster, because people who cannot pay for the rate will not become connected and people who are already connected will use as much as they can because they pay the same rate. The poor pricing policy thus contributes to shortages. The project proposes to put in water meters and charge a flat rate of R$ .9 per cubic meter of water. Again, although this fixed rate eliminates the problem of abuse, it does not capture the demand effectively at the lower and upper ends.

the workers at 25% to 40% above the market rate easily turns a profitable venture into a financial failure.

In conclusion, CESAN is not expected to achieve financial self-sufficiency and management efficiency in this water project, because its performance in the four important areas described above is expected to remain below par. Furthermore, the sewage project also falls short of achieving an optimal financial return. As long as the combined project is unable to post a positive NPV, CESAN cannot reduce the price of the utility's services to make them more accessible to the poorest segments of society. Ironically, attaining self-sufficiency is associated with being able to provide basic services to every resident. In other words, if CESAN were able to capture additional revenues through improved collections and invoicing efficiency, they would be able to reduce the water tariff. A lower price of water would increase the accessibility to water service for lower income consumers in Guarapari.

BIBLIOGRAPHY

Asian Development Bank, Economic Evaluation of Environmental Impacts, Manila, Philippines, 1996.

Brealy, R., S. Myers, Principles of Corporate Finance, McGraw Hill, 1991.

Diamond, Peter A. and Jerry A. Hausman, “Contingent Valuation: Is Some Number Better than No Number?" Journal of Economic Perspectives 8, 1994, pp. 45-64.

Harberger, Arnold C., Glenn P. Jenkins, Manual: Cost Benefit Analysis of Investment Decisions, Harvard Institute for International Development, Cambridge, MA, 1997.

Humplick, Frannie, Alyse Kudat, Samer Madanat, “Modeling Household Responses to Water Supply: A Service Quality Approach” Working Paper, World Bank, Washington DC, 1993.

Humplick, Frannie, “Valuing Direct and Indirect Benefits of Water Supply and Sanitation Projects: Application to Project Investment Analysis”, World Bank, Washington DC, 1995.

Jenkins, Glenn P., "The Valuation of Stakeholder Impacts in Cost-Benefit Analysis", Development Discussion Paper #631, HIID, Cambridge, MA, April 1998.

Jenkins, Glenn P., Pastor Lorenzo Jr., Gangadhar P. Shukla, “Potable Water Supply Expansion: The Manila South Water Distribution Project”, Harvard Institute for International Development, Cambridge, MA, 1996.

Pearce, David W., Anil Markandya, Environmental Policy Benefits: Monetary Evaluation, OECD, Paris, 1989, pp. 35-47.

Portney, Paul R. “The Contingent Valuation Debate: Why Economists Should Care”, Journal of Economic Perspectives 8, 1994, pp. 19-43.

Savvides, Savvakis, “Risk Analysis in Investment Appraisal”, Project Appraisal, Beach Tree Publishing, 1994.

Stavins, Robert N., *Saving the Tuolumne*, case study, John F. Kennedy School of Government, Harvard University, Cambridge, MA, 1986.

Tietenberg, Tom, Environmental and Natural Resource Economics, Harper Collins Inc, New York, NY, 1996.

World Bank, Staff, Appraisal Report (SAR): Espirito Santo Water and Coastal Pollution Management Project, World Bank, Washington DC, 1996.

CONTROL OF WATER AND COASTAL POLLUTION: AN APPRAISAL FOR ESPIRITO SANTO, BRAZIL

SPREADSHEET TABLES

WATER TREATMENT AND SUPPLY COMPONENT
SEWAGE COLLECTION DISPOSAL COMPONENT

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November, 1998

CONTROL OF
WATER AND COASTAL POLLUTION: AN APPRAISAL FOR ESPIRITO SANTO, BRAZIL

WATER TREATMENT AND SUPPLY COMPONENT

TABLE 1: TABLE OF PARAMETERS

Table 1.1: Macroeconomic Parameters

	1996		1996
Federal Consumption Tax	5%	**or**	8%
State Administered VAT	17%	**or**	17%
Total Consumption Tax Rate	22%	**or**	25%
1996 Exchange Rate US$/R$	1.00		
One-Shot Real Depreciation	0.0%		
Inflation in Brazil	10.0%		
Inflation in the US	3.0%		

Import Tariff Rates	1996		1996
Cement	10%	Motor Pumps	18%
Steal	16%	Pump Controller	18%
Wood	10%	Transformer	18%
600mm pipes	10%	Watermeters	18%
PVC pipes	10%	Chemicals	12%
150mm pipes	10%	Petroleum	18%
50mm PVC pipes	10%		

Table 1.2: Project Financing

Loan Amount as % Investment Costs	50%	
Real Interest Rate	5.0%	
Risk Premium	2.0%	
Grace Period on Payments	5	years
Payback Period	10	years
Financial Real Discount Rate	10.0%	

Table 1.3: CESAN'S Working Capital

Accounts Receivable	14.0%
Accounts Payable	10.0%
Cash Balances	8.0%

Table 1.4: Operational Cost Parameters

Population Serviced per connection	5.54	persons
Water Demand per person	54.15	M^3 per year
Maximum Willingness to Pay for Drinking Water	3.90	Rs/M^3
Maximum Willingness to Pay for WashingWater	1.95	Rs/M^3
Initial Tariff on Water w/ Sewage Surcharge	1.08	Rs/M^3
Cesan's Proposed Water Tariff	0.90	Rs/M^4
Cesan's Proposed Sewage Surcharge	0.18	
Cesan's Water Tariff w/ sewage surcharge	1.08	Rs/M^3
Valuation ofWater for Non-Paying Customers	50%	as % of Max. Willingness to Pay
Demand Elasticity of Drinking Water	-0.3	
Demand Elasticity of Other Water	-1.0	
Proportion of Drinking Water to Total Water	30%	'000 M^3
Maximum Capacity of CESAN w/o project	10,880	'000 M^3
Maximum Capacity of CESAN w/ project	12,772	
CESAN water capacity per person w/o project	38.74	
CESAN water capacity per person w/ project	52.26	

Water Leakage and Loss Factor>>>>>>	1.00
Invoice Efficiency - Risk Variable>>>>>>	1.00
Collection Efficiency - Risk Variable>>>>	1.00

Labor	**1996**		***% total employees***		***Tax on Labor***
Salaries					
Unskilled Labor	316.69	R$	46%		35%
Semi-skilled Labor	887.71	R$	50%		35%
Skilled Labor	1680.36	R$	4%		45%
Number of employees	3.5	per	1,000	connections	
Real Increase in Labor	2%	per year			

Cost of Chemicals		**1996**	
CIF Value of Chemicals		0.20	R$/kg
Tariff on Chemicals	12%	0.02	R$/kg
Tax on Chemicals	22%	0.05	R$/kg
Port & Handling Charges	3%	0.01	R$/kg
Total Cost of Chemicals		0.28	R$/kg
Chemicals Required		70	grams per M^3

Energy Costs	**1996**	
Cost per Installed Capacity	4.45	R$
Cost of Consumed Energy	0.0649	R$
kW per M^3 Water	1.41	kW
Subsidy on Electricity	10%	

Other Service Costs	**1996**	**1997-2026**
as % of general operational costs	23%	25%

Complimentary Investment Costs	**1996**
Labor (non-qualified)	2,000
Materials	4,000

Replacement Investments ('96 prices)	**2006**	**2011**	**2021**
Labor			
Non-Semi-skilled Labor	6,000	23000	6000
Semi-skilled Labor	6,000	23000	6000
Materials	25,000	94000	25000
Equipment	88,000	328000	88000
Cost Overun Factor	0%		

TABLE 2: MACROECONOMIC TABLES

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2027**
Population											
Population in the Guarapari Drainage Area	224,130	230,466	236,864	243,317	249,821	282,890	315,300	347,019	377,362	405,798	
Inflation in Brazil											
Rate of Inflation in Brazil	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
Inflation Index in Brazil	1.00	1.10	1.21	1.33	1.46	2.36	3.80	6.12	9.85	15.86	19.19
Inflation in the United States											
Rate of Inflation in the U.S.	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Inflation Index in the U.S.	1.00	1.03	1.06	1.09	1.13	1.30	1.51	1.75	2.03	2.36	2.50
Relative Price Index Brazil/U.S.	1	1.07	1.14	1.22	1.30	1.81	2.51	3.49	4.85	6.73	7.68
Change in Brazilian R$/US $	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Expected Exchange Rate US$/R$	1.00	1.07	1.14	1.22	1.30	1.81	2.51	3.49	4.85	6.73	7.68

TABLE 3: INVESTMENT COSTS

Table 3.1: UNADJUSTED INVESTMENT COSTS (1996 currency)

Year	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
Labor											
Non-Semi-skilled Labor	0	552,000	662,000	363,000							
Semi-skilled Labor	0	388,000	466,000	255,000							
Raw Water Intake, Transmission & Pumping											
Materials											
Domestic (R$)	-	520,836	625,004	342,181							
Imported (US$)	-	487,692	547,989	300,016							
Equipment											
Domestic (R$)	-	33,753	40,503	22,191							
Imported (US$)	-	126,419	142,048	72,875							
Treatment											
Materials											
Domestic (R$)	-	277,779	333,335	182,496							
Imported (US$)	-	260,102	292,261	149,826							
Equipment											
Domestic (R$)	-	18,001	21,602	11,835							
Imported (US$)	-	67,423	80,908	38,866							
Treated Water Transmission and Pumping											
Materials											
Domestic (R$)	-	416,669	500,003	273,745							
Imported (US$)	-	390,154	438,391	224,739							
Equipment											
Domestic (R$)	-	27,002	32,402	17,753							
Imported (US$)	-	101,135	113,639	58,300							
Reservoirs & Distribution											
Materials											
Domestic (R$)	-	486,115	583,335	319,370							
Imported (US$)	-	455,180	511,455	262,197							
Equipment											
Domestic (R$)	-	31,502	37,803	20,712							
Imported (US$)	-	117,991	132,579	68,016							
Connections											
Materials											
Domestic (R$)	-	34,722	41,667	22,812							
Imported (US$)	-	32,513	36,533	209							
Equipment											
Domestic (R$)	-	2,250	2,700	1,479							
Imported (US$)	-	8,428	9,470	4,858							
Cost of Land		100,000									
Cost Overruns (%)	0%	0%	0%	0%							

Table 3.2: INVESTMENT COSTS ADJUSTED FOR INFLATION (in R$)

	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
Labor											
Non-Semi-skilled Labor	-	607,200	801,020	483,153							
Semi-skilled Labor	-	426,800	563,860	339,405							
Raw Water Intake, Transmission & Pumping											
Materials	-	1,409,210	1,789,908	1,077,945							
Equipment	-	277,980	346,702	197,534							
Treatment											
Materials	-	750,033	952,708	552,700							
Equipment	-	148,108	195,502	105,248							
Treated Water Transmission and Pumping											
Materials	-	1,115,308	1,417,021	822,259							
Equipment	-	222,384	277,362	158,027							
Reservoirs & Distribution											
Materials	-	1,315,265	1,670,576	969,113							
Equipment	-	259,967	324,231	184,727							
Connections											
Materials	-	93,270	118,490	30,792							
Equipment	-	18,495	23,068	13,143							
Cost of Land	-	110,000	-	-							
Total Investment Costs	**-**	**6,754,021**	**8,480,448**	**4,934,046**							

TABLE 4: PROJECT FINANCING

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2027**
Loan Disbursement by the World Bank (US$)	**-**	**3,162,110**	**3,717,730**	**2,025,381**	**-**	**-**	**-**	**-**	**-**	**-**	
Loan Repayment Schedule											
Nominal Interest Rate	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%
Loan at Start of Year (US$)	-	3,162,110	7,202,692	9,963,468	10,980,738	9,336,231	2,667,494	(0)	(0)	(0)	
Interest (US$)	-	322,851	735,395	1,017,270	1,121,133	953,229	272,351				
Loan Repayment on Principle & Accumulated Interest '97-'99(US$)	-	-	-	-	-	1,333,747	1,333,747				
Interest Payments(US$)						953,229	272,351				
Outstanding Loan at End of Year	-	3,484,961	7,938,086	10,980,738	12,101,871	8,002,483	1,333,747	(0)	(0)	(0)	
Loan Repayment in domestic currency (R$)	**-**	**-**	**-**	**-**	**-**	**4,132,956**	**4,032,261**				

TABLE 5: RESIDUAL VALUE OF CAPITAL INVESTMENTS

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2027**
Land											
Real Value of Land	-	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Market Value of Land		110,000	121,000	133,100	146,410	235,795	379,750	611,591	984,973	1,586,309	**1,919,434**

TABLE 6: WATER SERVICE IN GUARAPARI

Year	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
Population Serviced											
Population in the Guarapari Drainage Area	224,130	230,466	236,864	243,317	249,821	282,890	315,300	347,019	377,362	405,798	
Population Serviced in the Guarapari Drainage Area	219,401	225,605	231,866	238,181	244,386	276,922	308,650	339,702	369,402	397,240	
Additional Population Serviced due to Project	-	6,205	12,465	18,781	24,985	57,522	89,249	120,301	150,001	177,840	
Total Residential Connections	39,603	40,723	41,853	42,993	44,113	49,986	55,713	61,318	66,679	71,704	
New Residential Connections of Project	-	1,120	1,130	1,140	1,120	1,178	1,140	1,105	1,048	975	
Total Residential Connections of Project	-	1,120	2,250	3,390	4,510	10,383	16,110	21,715	27,076	32,101	
Expected Water Demand (Thousands M^3)											
Drinking Water Demanded	16.25	16.25	16.25	16.25	16.25	16.25	16.25	16.25	16.25	16.25	
Other Water Demanded	37.91	37.91	37.91	37.91	37.91	37.91	37.91	37.91	37.91	37.91	
Total Water Demanded per Person (M^3)	54.15	54.15	54.15	54.15	54.15	54.15	54.15	54.15	54.15	54.15	
Expected Water Demand by Consumers at Metered Location	11,881	12,217	12,556	12,898	13,234	14,995	16,713	18,395	20,003	21,511	
Actual Water Leakage and Losses	28%	26%	23%	21%	19%	15%	13%	13%	13%	13%	
Percentage of Water Leakage and Losses (%)	28%	26%	23%	21%	19%	15%	13%	13%	13%	13%	
Total Water Demand including leakages and losses	15,207	15,393	15,443	15,606	15,748	17,245	18,886	20,786	22,604	24,307	
Expected Water Supply (Thousands M^3)											
Water Supply Capacity of CESAN	10,880	11,188	11,499	11,812	15,768	15,768	15,768	15,768	15,768	15,768	
Water Supplied by CESAN	10,880	11,188	11,499	11,812	15,748	15,768	15,768	15,768	15,768	15,768	
Water Consumption from CESAN	8,500	8,879	9,349	9,762	13,234	13,711	13,954	13,954	13,954	13,954	
Water Leakage & Losses	2,380	2,309	2,150	2,050	2,514	2,057	1,814	1,814	1,814	1,814	
Water Supply from Project	***-***	***308***	***619***	***932***	***4,868***	***4,888***	***4,888***	***4,888***	***4,888***	***4,888***	
Water Consumed from Project	***-***	***244***	***503***	***770***	***4,091***	***4,250***	***4,326***	***4,326***	***4,326***	***4,326***	
Water Leakages and Losses from Project	***-***	***64***	***116***	***162***	***777***	***638***	***562***	562	562	562	
Water Supplied by CESAN per each consumer	38.74	39.36	40.32	40.99	54.15	49.51	45.21	41.08	37.77	35.13	
Water Supplied by project per each consumer	***-***	***1.08***	***2.17***	***3.23***	***16.74***	***15.35***	***14.01***	***12.73***	***11.71***	***10.89***	
Water Shortage (Thousands M^3)	***4,327***	***4,205***	***3,944***	***3,794***	***-***	***1,477***	***3,118***	***5,018***	***6,836***	***8,539***	
Revenue from Water											
Real Tariff on Water	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
Nominal Water Tariff	0.90	0.99	1.09	1.20	1.32	2.12	3.42	5.50	8.86	14.28	17.27
Billable Drinking Water Supplied by Project	-	73	151	231	1,227	1,275	1,298	1,298	1,298	1,298	
Billable Other Water Supplied by Project	-	171	352	539	2,863	2,975	3,028	3,028	3,028	3,028	
Total Billable Water supplied by Project	-	244	503	770	4,091	4,250	4,326	4,326	4,326	4,326	
Risk Variable for Invoicing Efficiency	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Estimated Invoice Efficiency	0.77	0.80	0.85	0.88	0.90	0.90	0.90	0.90	0.90	0.90	
Actual Invoicing Efficiency (%)	0.77	0.80	0.85	0.88	0.90	0.90	0.90	0.90	0.90	0.90	
Billed Water from Project	-	196	428	678	3,682	3,825	3,893	3,893	3,893	3,893	
Risk Variable for Collection Efficiency	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Estimated Collections Efficiency	0.84	0.84	0.84	0.84	0.85	0.85	0.85	0.85	0.85	0.85	
Actual Collection Efficiency (%)	0.84	0.84	0.84	0.84	0.85	0.85	0.85	0.85	0.85	0.85	
Revenue Collected from Drinking Water	-	48,787	117,390	204,614	1,237,052	2,070,107	3,392,935	5,464,356	8,800,400	14,173,132	
Revenue Collected from Other Water	-	113,837	273,911	477,432	2,886,454	4,830,249	7,916,848	12,750,164	20,534,266	33,070,641	
Revenue Collected from Water	**-**	**162,624**	**391,302**	**682,045**	**4,123,505**	**6,900,356**	**11,309,783**	**18,214,519**	**29,334,666**	**47,243,772**	

TABLE 7: CESAN'S WORKING CAPITAL FOR THE WATER SUPPLY PROJECT

Accounts Receivable											
Revenue from Water	-	162,624	391,302	682,045	4,123,505	6,900,356	11,309,783	18,214,519	29,334,666	47,243,772	-
A/R at start of year	0	22,767	54,782	95,486	577,291	966,050	1,583,370	2,550,033	4,106,853	6,614,128	-
change in A/R		(22,767)	(32,015)	(40,704)	(481,804)	(95,394)	(156,569)	(231,821)	(373,350)	(601,284)	7,275,541
Accounts Payable											
Recurring Expenses of the Project	-	152,583	290,230	456,195	1,411,109	3,153,863	6,720,414	13,974,474	27,681,561	55,175,272	-
A/P at start of year	0	15,258	29,023	45,619	141,111	315,386	672,041	1,397,447	2,768,156	5,517,527	-
change in A/P		(15,258)	(13,765)	(16,597)	(95,491)	(43,858)	(87,649)	(206,287)	(359,039)	(688,771)	6,265,618
Cash Balances											
CB at Start of the year	-	12,207	23,218	36,496	112,889	252,309	537,633	1,117,958	2,214,525	4,414,022	-
change in CB		(12,207)	(11,012)	(13,277)	(76,393)	(35,086)	(70,119)	(165,030)	(287,232)	(551,016)	5,012,494

TABLE 8: OPERATIONAL COSTS OF WATER SUPPLY PROJECT

LABOR											
Labor Requirements for the Operation of the Project											
Wages											
Unskilled Labor	3,800	4,264	4,784	5,368	6,023	10,709	19,042	33,859	60,207	107,055	134,770
Semi-skilled Labor	10,653	11,952	13,410	15,046	16,882	30,018	53,377	94,911	168,764	300,086	377,773
Skilled Labor	20,164	22,624	25,385	28,481	31,956	56,822	101,038	179,659	319,457	568,037	715,092
Quantity											
Unskilled Labor	0	2	4	6	8	17	26	35	44	52	
Semi-skilled Labor	0	2	4	6	8	19	29	39	48	57	
Skilled Labor	0	1	1	1	1	2	3	4	4	5	
Total Labor Demanded	0	5	9	13	17	38	58	78	96	114	
Total Cost of Labor for Operation of Project											
Unskilled Labor	-	8,528	19,136	32,207	48,181	182,054	495,095	1,185,081	2,649,091	5,566,879	
Semi-skilled Labor	-	23,904	53,641	90,278	135,056	570,350	1,547,927	3,701,530	8,100,693	17,104,881	
Skilled Labor	-	22,624	25,385	28,481	31,956	113,645	303,113	718,634	1,277,827	2,840,184	
Total Cost of Labor Required by Project	**-**	**55,056**	**98,162**	**150,966**	**215,193**	**866,049**	**2,346,135**	**5,605,245**	**12,027,611**	**25,511,944**	
Labor Requirements for the Tertiary Costs of the Project											
Quantity of Tertiary Labor											
Unskilled Labor	0	1	2	3	3	6	10	13	17	20	
Semi-skilled Labor	0	1	2	3	3	7	11	15	18	22	
Skilled Labor	0	1	1	1	1	1	1	2	2	2	
Cost of Tertiary Labor											
Tertiary Costs as % of Total Personnel Costs	54%	51%	47%	46%	43%	38%	38%	38%	38%	38%	
Unskilled Labor	-	4,349	8,994	14,815	20,718	69,181	188,136	450,331	1,006,654	2,115,414	
Semi-skilled Labor	-	12,191	25,211	41,528	58,074	216,733	588,212	1,406,581	3,078,263	6,499,855	
Skilled Labor	-	11,538	11,931	13,101	13,741	43,185	115,183	273,081	485,574	1,079,270	
Total Cost of Tertiary Labor Required by Project	**-**	**28,079**	**46,136**	**69,444**	**92,533**	**329,099**	**891,531**	**2,129,993**	**4,570,492**	**9,694,539**	

Chemical Requirements (kg)											
Price of Chemicals (US$)	0.20	0.21	0.21	0.22	0.23	0.26	0.30	0.35	0.41	0.47	
CIF Price	0.20	0.22	0.24	0.27	0.29	0.47	0.76	1.22	1.97	3.17	
Tariff, Tax, Port Handling & Freight	0.07	0.08	0.09	0.10	0.11	0.17	0.28	0.45	0.73	1.17	
Price of Chemicals	0.27	0.30	0.33	0.36	0.40	0.65	1.04	1.68	2.70	4.35	
Chemical Requirements (kg)	-	21,560	43,330	65,240	340,751	342,160	342,160	342,160	342,160	342,160	
Cost of Chemicals	-	6,498	14,366	23,793	136,697	221,062	356,022	573,378	923,431	1,487,194	
Tax on Chemicals	-	1,430	3,160	5,234	30,073	48,634	78,325	126,143	203,155	327,183	
Total Cost of Chemicals	**-**	**7,928**	**17,526**	**29,027**	**166,770**	**269,696**	**434,347**	**699,521**	**1,126,585**	**1,814,377**	
Energy Requirements											
Price per installed KW	4.45	4.90	5.38	5.92	6.52	10.49	16.90	27.22	43.83	70.59	
Price per consumed KW	0.0649	0.0714	0.0785	0.0864	0.0950	0.1530	0.2465	0.3969	0.6392	1.0295	
Total Installed Capacity	2,955	2,955	3,293	3,293	3,293	3,293	3,293	3,293	3,293	3,293	
Installed KW Capacity of Project	-	-	338	338	338	338	338	338	338	338	
KW Consumed by the Project	-	434,280	872,790	1,314,120	6,863,695	6,892,080	6,892,080	6,892,080	6,892,080	6,892,080	
Total Energy Costs	**-**	**31,003**	**70,359**	**115,518**	**654,391**	**1,058,247**	**1,704,318**	**2,744,821**	**4,420,561**	**7,119,358**	
Other Service Costs											
Total General Operational Costs	-	122,066	232,184	364,956	1,128,887	2,523,090	5,376,332	11,179,579	22,145,249	44,140,217	
Other Service Costs as % of General Operational Costs	23%	25%	25%	25%	25%	25%	25%	25%	25%	25%	
Total Other Service Costs	**-**	**30,517**	**58,046**	**91,239**	**282,222**	**630,773**	**1,344,083**	**2,794,895**	**5,536,312**	**11,035,054**	
Maintenance Costs											
Real Prices											
Labor											
Non-Qualified		15,000	15,000	15,000	15,000	15,000	15,000	15,000	14,000	13,000	
Qualified		5,000	5,000	6,000	6,000	6,000	6,000	5,000	5,000	5,000	
Materials		15,000	15,000	15,000	15,000	15,000	15,000	15,000	14,000	13,000	
Equipment		25000	25000	25000	25000	26000	25000	24000	23000	22000	
Nominal Prices											
Labor											
Non-Qualified		16,500	18,150	19,965	21,962	35,369	56,962	91,739	137,896	206,220	
Qualified		5,500	6,050	7,986	8,785	14,148	22,785	30,580	49,249	79,315	
Materials		16,500	18,150	19,965	21,962	35,369	56,962	91,739	137,896	206,220	
Taxes on Material		3,630	3,993	4,392	4,832	7,781	12,532	20,182	30,337	45,368	
Equipment		27,500	30,250	33,275	36,603	61,307	94,937	146,782	226,544	348,988	
Taxes on Equipment		6,050	6,655	7,321	8,053	13,487	20,886	32,292	49,840	76,777	
Total Maintenance Costs		**75,680**	**83,248**	**92,904**	**102,194**	**167,461**	**265,065**	**413,313**	**631,762**	**962,890**	
Replacement Investments											
Labor											
Non-Semi-skilled Labor											
Semi-skilled Labor											
Materials											
Taxes on Material											
Equipment											
Taxes on Equipment											
Total Replacement Investments	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

TABLE 9: FINANCIAL PRO-FORMA CASH FLOW STATEMENTS

TABLE 9.1: TOTAL INVESTMENT POINT OF VIEW (Nominal)

Year	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
CASH INFLOWS											
Revenue Collected from Water	-	162,624	391,302	682,045	4,123,505	6,900,356	11,309,783	18,214,519	29,334,666	47,243,772	-
change in A/R	-	(22,767)	(32,015)	(40,704)	(481,804)	(95,394)	(156,569)	(231,821)	(373,350)	(601,284)	7,275,541
Salvage Value of Land											1,919,434
Total Inflows	**-**	**139,857**	**359,287**	**641,341**	**3,641,701**	**6,804,962**	**11,153,214**	**17,982,698**	**28,961,315**	**46,642,488**	**9,194,975**
CASH OUTFLOWS											
Investment Costs											
Labor											
Non-Semi-skilled Labor	-	607,200	801,020	483,153	-	-	-	-	-	-	-
Semi-skilled Labor	-	426,800	563,860	339,405	-	-	-	-	-	-	-
Raw Water Intake, Transmission & Pumping											
Materials	-	1,409,210	1,789,908	1,077,945	-	-	-	-	-	-	-
Equipment	-	277,980	346,702	197,534	-	-	-	-	-	-	-
Treatment					-	-	-	-	-	-	-
Materials	-	750,033	952,708	552,700	-	-	-	-	-	-	-
Equipment	-	148,108	195,502	105,248	-	-	-	-	-	-	-
Treated Water Transmission and Pumping											
Materials	-	1,115,308	1,417,021	822,259	-	-	-	-	-	-	-
Equipment	-	222,384	277,362	158,027	-	-	-	-	-	-	-
Reservoirs & Distribution					-	-	-	-	-	-	-
Materials	-	1,315,265	1,670,576	969,113	-	-	-	-	-	-	-
Equipment	-	259,967	324,231	184,727	-	-	-	-	-	-	-
Connections					-	-	-	-	-	-	-
Materials	-	93,270	118,490	30,792	-	-	-	-	-	-	-
Equipment	-	18,495	23,068	13,143	-	-	-	-	-	-	-
Cost of Land	-	110,000	-	-	-	-	-	-	-	-	-
Operational Costs											
Total Cost of Labor Required by Project	-	55,056	98,162	150,966	215,193	866,049	2,346,135	5,605,245	12,027,611	25,511,944	-
Total Cost of Tertiary Labor Required by Project	-	28,079	46,136	69,444	92,533	329,099	891,531	2,129,993	4,570,492	9,694,539	-
Total Cost of Chemicals	-	7,928	17,526	29,027	166,770	269,696	434,347	699,521	1,126,585	1,814,377	-
Total Energy Costs	-	31,003	70,359	115,518	654,391	1,058,247	1,704,318	2,744,821	4,420,561	7,119,358	-
Total Other Service Costs	-	30,517	58,046	91,239	282,222	630,773	1,344,083	2,794,895	5,536,312	11,035,054	-
Total Maintenance Costs	-	75,680	83,248	92,904	102,194	167,461	265,065	413,313	631,762	962,890	-
Total Replacement Investments	-	-	-	-	-	-	-	-	-	-	-
change in A/P	-	(15,258)	(13,765)	(16,597)	(95,491)	(43,858)	(87,649)	(206,287)	(359,039)	(688,771)	6,265,618
change in CB	-	12,207	11,012	13,277	76,393	35,086	70,119	165,030	287,232	551,016	(5,012,494)
Total Outflows	**-**	**6,979,232**	**8,851,173**	**5,479,825**	**1,494,205**	**3,312,553**	**6,967,950**	**14,346,529**	**28,241,515**	**56,000,407**	**1,253,124**
Net Cash Flow	**-**	**(6,839,375)**	**(8,491,886)**	**(4,838,484)**	**2,147,496**	**3,492,409**	**4,185,264**	**3,636,169**	**719,800**	**(9,357,919)**	**7,941,852**

TABLE 9.2: EQUITY POINT OF VIEW (Nominal)

Year	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
CASH INFLOWS											
Revenue Collected from Water	-	162,624	391,302	682,045	4,123,505	6,900,356	11,309,783	18,214,519	29,334,666	47,243,772	-
change in A/R	-	(22,767)	(32,015)	(40,704)	(481,804)	(95,394)	(156,569)	(231,821)	(373,350)	(601,284)	7,275,541
Salvage Value of Land											1,919,434
Loan Received from World Bank		3,377,010	4,240,224	2,467,023	-	-	-	-	-	-	-
Total Inflows	**-**	**3,516,867**	**4,599,511**	**3,108,364**	**3,641,701**	**6,804,962**	**11,153,214**	**17,982,698**	**28,961,315**	**46,642,488**	**9,194,975**
CASH OUTFLOWS											
Investment Costs											
Labor											
Non-Semi-skilled Labor	-	607,200	801,020	483,153	-	-	-	-	-	-	-
Semi-skilled Labor	-	426,800	563,860	339,405	-	-	-	-	-	-	-
Raw Water Intake, Transmission & Pumping											
Materials	-	1,409,210	1,789,908	1,077,945	-	-	-	-	-	-	-
Equipment	-	277,980	346,702	197,534	-	-	-	-	-	-	-
Treatment					-	-	-	-	-	-	-
Materials	-	750,033	952,708	552,700	-	-	-	-	-	-	-
Equipment	-	148,108	195,502	105,248	-	-	-	-	-	-	-
Treated Water Transmission and Pumping											
Materials	-	1,115,308	1,417,021	822,259	-	-	-	-	-	-	-
Equipment	-	222,384	277,362	158,027	-	-	-	-	-	-	-
Reservoirs & Distribution					-	-	-	-	-	-	-
Materials	-	1,315,265	1,670,576	969,113	-	-	-	-	-	-	-
Equipment	-	259,967	324,231	184,727	-	-	-	-	-	-	-
Connections					-	-	-	-	-	-	-
Materials	-	93,270	118,490	30,792	-	-	-	-	-	-	-
Equipment	-	18,495	23,068	13,143	-	-	-	-	-	-	-
Cost of Land	-	110,000	-	-	-	-	-	-	-	-	-
Loan Repayment to World Bank	-	-	-	-	-	4,132,956	4,032,261	-	-	-	-
Operational Costs											
Total Cost of Labor Required by Project	-	55,056	98,162	150,966	215,193	866,049	2,346,135	5,605,245	12,027,611	25,511,944	-
Total Cost of Tertiary Labor Required by Project	-	28,079	46,136	69,444	92,533	329,099	891,531	2,129,993	4,570,492	9,694,539	-
Total Cost of Chemicals	-	7,928	17,526	29,027	166,770	269,696	434,347	699,521	1,126,585	1,814,377	-
Total Energy Costs	-	31,003	70,359	115,518	654,391	1,058,247	1,704,318	2,744,821	4,420,561	7,119,358	-
Total Other Service Costs	-	30,517	58,046	91,239	282,222	630,773	1,344,083	2,794,895	5,536,312	11,035,054	-
Total Maintenance Costs	-	75,680	83,248	92,904	102,194	167,461	265,065	413,313	631,762	962,890	-
Total Replacement Investments	-	-	-	-	-	-	-	-	-	-	-
change in A/P	-	(15,258)	(13,765)	(16,597)	(95,491)	(43,858)	(87,649)	(206,287)	(359,039)	(688,771)	6,265,618
change in CB	-	12,207	11,012	13,277	76,393	35,086	70,119	165,030	287,232	551,016	(5,012,494)
Total Outflows	**-**	**6,979,232**	**8,851,173**	**5,479,825**	**1,494,205**	**7,445,509**	**11,000,211**	**14,346,529**	**28,241,515**	**56,000,407**	**1,253,124**
Net Cash Flow	**-**	**(3,462,365)**	**(4,251,662)**	**(2,371,461)**	**2,147,496**	**(640,547)**	**153,003**	**3,636,169**	**719,800**	**(9,357,919)**	**7,941,852**
Net Present Value (NPV) **@ 21.0%**	**(5,570,846)**										

Year	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
Inflation Index in Brazil	1.00	1.10	1.21	1.33	1.46	2.36	3.80	6.12	9.85	15.86	19.19

TABLE 9.3: TOTAL INVESTMENT POINT OF VIEW (Real)

Year	1996	1997	1998	1999	2000	...2005	...2010	...2015	...2020	...2025	...2027
CASH INFLOWS											
Revenue Collected from Water	-	147,840	323,390	512,431	2,816,410	2,926,424	2,978,219	2,978,219	2,978,219	2,978,219	-
change in A/R	-	(20,698)	(26,459)	(30,582)	(329,079)	(40,456)	(41,230)	(37,905)	(37,905)	(37,905)	379,046
Salvage Value of Land	-	-	-	-	-	-	-	-	-	-	100,000
Total Inflows	**-**	**127,142**	**296,931**	**481,849**	**2,487,331**	**2,885,968**	**2,936,990**	**2,940,315**	**2,940,315**	**2,940,315**	**479,046**
CASH OUTFLOWS											
Investment Costs											
Labor											
Non-Semi-skilled Labor	-	552,000	662,000	363,000	-	-	-	-	-	-	-
Semi-skilled Labor	-	388,000	466,000	255,000	-	-	-	-	-	-	-
Raw Water Intake, Transmission & Pumping					-	-	-	-	-	-	-
Materials	-	1,281,100	1,479,263	809,876	-	-	-	-	-	-	-
Equipment	-	252,709	286,531	148,410	-	-	-	-	-	-	-
Treatment											
Materials	-	681,849	787,362	415,251	-	-	-	-	-	-	-
Equipment	-	134,644	161,572	79,074	-	-	-	-	-	-	-
Treated Water Transmission and Pumping											
Materials	-	1,013,916	1,171,092	617,776	-	-	-	-	-	-	-
Equipment	-	202,168	229,225	118,728	-	-	-	-	-	-	-
Reservoirs & Distribution											
Materials	-	1,195,696	1,380,642	728,109	-	-	-	-	-	-	-
Equipment	-	236,334	267,959	138,788	-	-	-	-	-	-	-
Connections											
Materials	-	84,791	97,925	23,134	-	-	-	-	-	-	-
Equipment	-	16,814	19,064	9,875	-	-	-	-	-	-	-
Cost of Land	-	100,000	-	-	-	-	-	-	-	-	-
Operational Costs											
Total Cost of Labor Required by Project	-	50,051	81,126	113,423	146,980	367,289	617,811	916,502	1,221,110	1,608,258	-
Total Cost of Tertiary Labor Required by Project	-	25,526	38,129	52,175	63,201	139,570	234,768	348,271	464,022	611,138	-
Total Cost of Chemicals	-	7,207	14,484	21,808	113,906	114,377	114,377	114,377	114,377	114,377	-
Total Energy Costs	-	28,185	58,148	86,790	446,958	448,800	448,800	448,800	448,800	448,800	-
Total Other Service Costs	-	27,742	47,972	68,549	192,761	267,509	353,939	456,988	562,077	695,643	-
Total Maintenance Costs	-	68,800	68,800	69,800	69,800	71,020	69,800	67,580	64,140	60,700	-
Total Replacement Investments	-	-	-	-	-	-	-	-	-	-	-
change in A/P	-	(13,871)	(11,376)	(12,469)	(65,222)	(18,600)	(23,081)	(33,730)	(36,452)	(43,420)	326,430
change in CB	-	11,097	9,101	9,975	52,178	14,880	18,465	26,984	29,161	34,736	(261,144)
Total Outflows	**-**	**6,344,756**	**7,315,019**	**4,117,074**	**1,020,562**	**1,404,846**	**1,834,879**	**2,345,772**	**2,867,237**	**3,530,233**	**65,286**
Net Cash Flow	**-**	**(6,217,614)**	**(7,018,088)**	**(3,635,225)**	**1,466,768**	**1,481,122**	**1,102,111**	**594,543**	**73,078**	**(589,918)**	**413,760**

TABLE 9.4: EQUITY POINT OF VIEW (Real)

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**...2005**	**...2010**	**...2015**	**...2020**	**...2025**	**...2027**
CASH INFLOWS											
Revenue Collected from Water	-	147,840	323,390	512,431	2,816,410	2,926,424	2,978,219	2,978,219	2,978,219	2,978,219	-
change in A/R	-	(20,698)	(26,459)	(30,582)	(329,079)	(40,456)	(41,230)	(37,905)	(37,905)	(37,905)	379,046
Salvage Value of Land	-	-	-	-	-	-	-	-	-	-	100,000
Loan Received from World Bank	-	3,070,009	3,504,318	1,853,511	-	-	-	-	-	-	-
Total Inflows	**-**	**3,197,152**	**3,801,249**	**2,335,360**	**2,487,331**	**2,885,968**	**2,936,990**	**2,940,315**	**2,940,315**	**2,940,315**	**479,046**
CASH OUTFLOWS											
Investment Costs											
Labor											
Non-Semi-skilled Labor	-	552,000	662,000	363,000	-	-	-	-	-	-	-
Semi-skilled Labor	-	388,000	466,000	255,000	-	-	-	-	-	-	-
Raw Water Intake, Transmission & Pumping					-	-	-	-	-	-	-
Materials	-	1,281,100	1,479,263	809,876	-	-	-	-	-	-	-
Equipment	-	252,709	286,531	148,410	-	-	-	-	-	-	-
Treatment											
Materials	-	681,849	787,362	415,251	-	-	-	-	-	-	-
Equipment	-	134,644	161,572	79,074	-	-	-	-	-	-	-
Treated Water Transmission and Pumping											
Materials	-	1,013,916	1,171,092	617,776	-	-	-	-	-	-	-
Equipment	-	202,168	229,225	118,728	-	-	-	-	-	-	-
Reservoirs & Distribution											
Materials	-	1,195,696	1,380,642	728,109	-	-	-	-	-	-	-
Equipment	-	236,334	267,959	138,788	-	-	-	-	-	-	-
Connections											
Materials	-	84,791	97,925	23,134	-	-	-	-	-	-	-
Equipment	-	16,814	19,064	9,875	-	-	-	-	-	-	-
Cost of Land	-	100,000	-	-	-	-	-	-	-	-	-
Loan Repayment to World Bank	-	-	-	-	-	1,752,777	1,061,820	-	-	-	-
Operational Costs											
Total Cost of Labor Required by Project	-	50,051	81,126	113,423	146,980	367,289	617,811	916,502	1,221,110	1,608,258	-
Total Cost of Tertiary Labor Required by Project	-	25,526	38,129	52,175	63,201	139,570	234,768	348,271	464,022	611,138	-
Total Cost of Chemicals	-	7,207	14,484	21,808	113,906	114,377	114,377	114,377	114,377	114,377	-
Total Energy Costs	-	28,185	58,148	86,790	446,958	448,800	448,800	448,800	448,800	448,800	-
Total Other Service Costs	-	27,742	47,972	68,549	192,761	267,509	353,939	456,988	562,077	695,643	-
Total Maintenance Costs	-	68,800	68,800	69,800	69,800	71,020	69,800	67,580	64,140	60,700	-
Total Replacement Investments	-	-	-	-	-	-	-	-	-	-	-
change in A/P	-	(13,871)	(11,376)	(12,469)	(65,222)	(18,600)	(23,081)	(33,730)	(36,452)	(43,420)	326,430
change in CB	-	11,097	9,101	9,975	52,178	14,880	18,465	26,984	29,161	34,736	(261,144)
Total Outflows	**-**	**6,344,756**	**7,315,019**	**4,117,074**	**1,020,562**	**3,157,623**	**2,896,699**	**2,345,772**	**2,867,237**	**3,530,233**	**65,286**
Net Cash Flow	**-**	**(3,147,605)**	**(3,513,770)**	**(1,781,714)**	**1,466,768**	**(271,655)**	**40,291**	**594,543**	**73,078**	**(589,918)**	**413,760**
Net Present Value (NPV) **@ 10.0%**	**(5,570,846)**										

TABLE 10: NATIONAL ECONOMIC PARAMETERS

TABLE 10.1: Economic Cost of Capital (EOCK)

Market Interest Rate (nominal)	22.50%
Interest on Foreign Borrowing	9.50%
Market Interest Rate (real)	15.24%
	5.80%
Inflation Rate (domestic)	10.00%
Inflation Rate (foreign)	3.00%
Proportion of debt rolled over in short-term (K)	85.00%

Savers or Suppliers of Funds:

Group	Tax	Marginal Rate	Elasticity Es	Share	r nominal	r real	weights
Low Income	tp	0.00	0.05	0.070	22.50%	11.36%	0.004
Med. Income	tp	0.25	0.30	0.200	16.88%	6.25%	0.060
High Income	tp	0.35	0.45	0.350	14.63%	4.20%	0.158
Foreign	tw	0.35	1.10	0.180		6.68%	0.198
Net Govt. Sav.	-			0.200	22.50%	11.36%	0.000
				1			0.419

Investors or Demanders of Funds:

Group	Tax	Marginal Rate	Elasticity Nd	Share	PI nominal	PI real	weights
Corporate	tc	0.40	-0.90	0.350	37.50%	25.00%	-0.315
Non-Corporate	tb	0.25	-0.50	0.150	30.00%	18.18%	-0.075
Housing	pt	0.03	-0.50	0.150	24.84%	13.50%	-0.075
	sb	0.03					
Agriculture	sb	0.40	-0.60	0.350	13.50%	3.18%	-0.210
				1			-0.675

EOCK = 12.17%

TABLE 10.2: Economic Cost of Foreign Exchange

Exports FOB	39,000,000		
Exports FOB - tax (QX)	39,000,000		
Tax Revenue	0		
Export Tax Rate(tx)	0.0%	(1-tx)	100%
Imports CIF (QI)	26,000,000		
Imports CIF + tax	28,626,000	(QI/QX)	0.667
Tariff Revenue	2,626,000		
Import Tariff (T)	10.10%	(1+T)	110%
Local Consumption			
Importables (Qd1)	57,592,500	(Qd1/QI)	2.012
Exportables (Qd2)	44,037,000	Qd2/QX)	1.129
Total	101,629,500		
Sales Tax Revenue	12,805,317		
Sales Tax (ts)	12.60%	(1+ts)	112.60%
Local Supply			
Importables (Qs1)	28,966,500	(Qs1/QI)	1.012
Exportables (Qs2)	83,037,000	(Qs2/QX)	2.129
Elasticities			
Supply of Exportables (Es2)	0.8		
Supply of Importables (Es1)	0.7		
Demand of Exportables (Nd2)	-1.1		
Demand for Importables (Nd1)	-1.3		
Em (R$/US$) =	1		
Ee/Em =	1.121		
Ee (R$/US$)	1.121		
Foreign Exchange Premium	**12.06%**		

TABLE 11: CONVERSION FACTORS

Economic Value of Water Revenue

Total Water Consumed from Project	-	164	359	569	3,129	3,252	3,309	3,309	3,309	3,309	
Drinking Water											
Financial Value (Real) of Drinking Water	-	44,352	97,017	153,729	844,923	877,927	893,466	893,466	893,466	893,466	
Maximum Willingness to Pay	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	
Water Tariff	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
Economic Value of Drinking Water	2.40	2.40	2.40	2.40	0.90	2.40	2.40	2.40	2.40	2.40	
Financial Value of Drinking Water	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
Conversion Factor for Revenue Collected from Drinking Water	2.67	2.67	2.67	2.67	1.00	2.67	2.67	2.67	2.67	2.67	
Drinking Water Supplied to Paying Customers	-	49	108	171	939	975	993	993	993	993	
Total Economic Value of Drinking Water to Paying Customers	**-**	**118,272**	**258,712**	**409,944**	**844,923**	**2,341,139**	**2,382,576**	**2,382,576**	**2,382,576**	**2,382,576**	
Other Water											
Financial Value (Real) of Other Water	-	103,488	226,373	358,701	1,971,487	2,048,497	2,084,754	2,084,754	2,084,754	2,084,754	
Maximum Willingness to Pay	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	
Water Tariff	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
Economic Value of Other Water	1.43	1.43	1.43	1.43	0.90	1.43	1.43	1.43	1.43	1.43	
Financial Value of Other Water	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
Conversion Factor for Revenue Collected from Other Water	1.58	1.58	1.58	1.58	1.00	1.58	1.58	1.58	1.58	1.58	
Other Water Supplied to Paying Customers	-	115	252	399	2,191	2,276	2,316	2,316	2,316	2,316	
Total Economic Value of Other Water to Paying Customers	**-**	**163,856**	**358,424**	**567,944**	**1,971,487**	**3,243,454**	**3,300,860**	**3,300,860**	**3,300,860**	**3,300,860**	
Conversion Factor for Revenue from Water		**1.908**	**1.908**	**1.908**	**1.000**	**1.908**	**1.908**	**1.908**	**1.908**	**1.908**	
Economic Valuation of Non-Revenue Water											
Water Leakage and Losses from Project	-	64	116	162	777	638	562	562	562	562	-
Stolen Water from Leakage and Losses	-	43	83	120	595	488	430	430	430	430	-
Non-Revenue Water due to Inadequate Invoicing & Collections	-	80	144	201	961	999	1,017	1,017	1,017	1,017	
Total Non-Revenue Water used as drinking water	-	37	68	96	467	446	434	434	434	434	-
Total Non-Revenue Water used for other purposes	-	86	159	224	1,089	1,041	1,013	1,013	1,013	1,013	-
Valuation of Stolen Water	***-***	***155,759***	***287,183***	***406,168***	***1,972,074***	***1,884,252***	***1,833,715***	***1,833,715***	***1,833,715***	***1,833,715***	***-***

CEMENT

	Financial Value	Conversion Factor	Unadjusted Economic Value	Percentage Tradable	Foreign Ex. Premium	Economic Value
CIF price at local port	5.50	1.00	5.50	100%	0.66	6.16
Tariff	0.55	0.00	0.00	0%	0.00	0.00
Sales Tax	1.03	0.00	0.00	0%	0.00	0.00
Port charges and handling	0.17	0.95	0.16	30%	0.01	0.16
Transportation to project	0.28	0.78	0.21	80%	0.02	0.24
Financial Value	**7.52**	per 50 kg		**Economic Value**		**6.56**
		Conversion Factor **0.873**				

STEEL

	Financial Value	Conversion Factor	Unadjusted Economic Value	Percentage Tradable	Foreign Ex. Premium	Economic Value
CIF price at local port	660.00	1.00	660.00	100%	79.56	739.56
Tariff	105.60	0.00	0.00	0%	0.00	0.00
Sales Tax	168.43	0.00	0.00	0%	0.00	0.00
Port charges and handling	19.80	0.95	18.81	30%	0.68	19.49
Transportation to project	29.70	0.78	23.17	80%	2.23	25.40
Financial Value	**983.53**	per ton		**Economic Value**		**784.45**
		Conversion Factor **0.798**				

WOOD

	Financial Value	Conversion Factor	Unadjusted Economic Value	Percentage Tradable	Foreign Ex. Premium	Economic Value
CIF price at local port	178.00	1.00	178.00	100%	21.46	199.46
Tariff	17.80	0.00	0.00	0%	0.00	0.00
Sales Tax	33.29	0.00	0.00	0%	0.00	0.00
Port charges and handling	5.34	0.95	5.07	30%	0.18	5.26
Transportation to project	8.90	0.78	6.94	80%	0.67	7.61
Financial Value	**243.33**	per 50 kg		**Economic Value**		**212.33**
		Conversion Factor **0.873**				

BRICKS

Price Demanded (Pd)	33.93	M3
Price Supplied (Ps)	29.00	M3
Demand Weight (Wd)	0.667	
Supply Weight (Ws)	0.333	
Economic Price (Pe)	32.29	M3
		Conversion Factor **0.952**

SAND

Price Demanded (Pd)	35.10	M3
Price Supplied (Ps)	30.00	M3
Demand Weight (Wd)	0.620	
Supply Weight (Ws)	0.380	
Economic Price (Pe)	33.16	M3
		Conversion Factor **0.945**

600mm PIPES

	Financial Value	Conversion Factor	Unadjusted Economic Value	Percentage Tradable	Foreign Ex. Premium	Economic Value
CIF price at local port	220.00	1.00	220.00	100%	26.52	246.52
Tariff	22.00	0.00	0.00	0%	0.00	0.00
Sales Tax	60.50	0.00	0.00	0%	0.00	0.00
Port charges and handling	6.60	0.95	6.27	30%	0.23	6.50
Transportation to project	11.00	0.78	8.58	80%	0.83	9.41
Financial Value	**320.10**	per m		**Economic Value**		**262.43**

Conversion Factor
0.820

PVC PIPES

	Financial Value	Conversion Factor	Unadjusted Economic Value	Percentage Tradable	Foreign Ex. Premium	Economic Value
CIF price at local port	95.00	1.00	95.00	100%	11.45	106.45
Tariff	9.50	0.00	0.00	0%	0.00	0.00
Sales Tax	8.36	0.00	0.00	0%	0.00	0.00
Port charges and handling	2.85	0.95	2.71	30%	0.10	2.81
Transportation to project	4.75	0.78	3.71	80%	0.36	4.06
Financial Value	**120.46**	per m		**Economic Value**		**113.32**

Conversion Factor
0.941

50mm PVC PIPES

	Financial Value	Conversion Factor	Unadjusted Economic Value	Percentage Tradable	Foreign Ex. Premium	Economic Value
CIF price at local port	12.16	1.00	12.16	100%	1.47	13.63
Tariff	1.22	0.00	0.00	0%	0.00	0.00
Sales Tax	3.34	0.00	0.00	0%	0.00	0.00
Port charges and handling	0.36	0.95	0.35	30%	0.01	0.36
Transportation to project	0.61	0.78	0.47	80%	0.05	0.52
Financial Value	**17.69**	per m		**Economic Value**		**14.50**

Conversion Factor
0.820

MOTOR PUMPS

	Financial Value	Conversion Factor	Unadjusted Economic Value	Percentage Tradable	Foreign Ex. Premium	Economic Value
CIF price at local port	6913.00	1.00	6913.00	100%	833.36	7746.36
Tariff	1244.34	0.00	0.00	0%	0.00	0.00
Sales Tax	2039.34	0.00	0.00	0%	0.00	0.00
Port charges and handling	207.39	0.95	197.02	30%	7.13	204.15
Transportation to project	345.65	0.78	269.61	80%	26.00	295.61
Financial Value	**10,749.72**	per unit		**Economic Value**		**8246.12**

Conversion Factor
0.767

PUMP CONTROLLER

	Financial Value	Conversion Factor	Unadjusted Economic Value	Percentage Tradable	Foreign Ex. Premium	Economic Value
CIF price at local port	11750.00	1.00	11750.00	100%	1416.47	13166.47
Tariff	2115.00	0.00	0.00	0%	0.00	0.00
Sales Tax	3466.25	0.00	0.00	0%	0.00	0.00
Port charges and handling	352.50	0.95	334.88	30%	12.11	346.99
Transportation to project	587.50	0.78	458.25	80%	44.19	502.44
Financial Value	**18,271.25**	per unit		**Economic Value**		**14015.90**

Conversion Factor
0.767

TRANSFORMER

	Financial Value	Conversion Factor	Unadjusted Economic Value	Percentage Tradable	Foreign Ex. Premium	Economic Value
CIF price at local port	8500.00	1.00	8500.00	100%	1024.68	9524.68
Tariff	1530.00	0.00	0.00	0%	0.00	0.00
Sales Tax	2507.50	0.00	0.00	0%	0.00	0.00
Port charges and handling	425.00	0.95	403.75	30%	14.60	418.35
Transportation to project	595.00	0.78	464.10	80%	44.76	508.86
Financial Value	**13,557.50**	per unit		**Economic Value**		**10451.89**

Conversion Factor
0.771

CHEMICALS

	Financial Value	Conversion Factor	Unadjusted Economic Value	Percentage Tradable	Foreign Ex. Premium	Economic Value
CIF price at local port	0.20	1.00	0.20	100%	0.02	0.22
Tariff	0.02	0.00	0.00	0%	0.00	0.00
Sales Tax	0.05	0.00	0.00	0%	0.00	0.00
Port charges and handling	0.01	0.95	0.01	30%	0.00	0.01
Financial Value	**0.28**	per kg		**Economic Value**		**0.23**

Conversion Factor
0.825

ELECTRICITY

Price Demanded (Pd)	0.0649	per kw
Price Supplied (Ps)	0.0714	per kw
Demand Weight (Wd)	0.667	
Supply Weight (Ws)	0.333	
Petroleum Input (%)	40.0%	
FOREX Premium	12.1%	
Economic Price (Pe)	0.0682	per kw

Conversion Factor
1.051

Raw Water Intake, Transmission & Pumping

MATERIALS

	Weight	Conversion Factor	For Financial Analysis: Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
Cement	48%	0.873	4.80%	10.56%	1.44%
Steel	10%	0.798	1.60%	2.20%	0.30%
Wood	5%	0.873	0.50%	1.10%	0.15%
Bricks	5%	0.952	0.00%	1.10%	0.00%
Sand	32%	0.945	0.00%	7.04%	0.00%
	100%		6.90%	22.00%	1.89%

Conversion Factor
0.892

EQUIPMENT

	Weight	Conversion Factor	For Financial Analysis: Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
600mm Pipes	50%	0.820	5.00%	12.50%	1.50%
PVC Pipes	0%	0.941	0.00%	0.00%	0.00%
50mm PVC Pipes	0%	0.820	0.00%	0.00%	0.00%
Motor Pumps	0%	0.767	0.00%	0.00%	0.00%
Pump Controller	20%	0.767	3.60%	5.00%	0.60%
Transformer	30%	0.771	5.40%	7.50%	1.50%
	100%		14.00%	25.00%	3.60%

Conversion Factor
0.795

Treatment

MATERIALS

	Weight	Conversion Factor	For Financial Analysis: Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
Cement	45%	0.873	4.50%	9.90%	1.35%
Steel	10%	0.798	1.60%	2.20%	0.30%
Wood	5%	0.873	0.50%	1.10%	0.15%
Bricks	10%	0.952	0.00%	2.20%	0.00%
Sand	30%	0.945	0.00%	6.60%	0.00%
	100%		6.60%	22.00%	1.80%

Conversion Factor
0.895

EQUIPMENT

	Weight	Conversion Factor	For Financial Analysis: Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
600mm Pipes	50%	0.820	5.00%	12.50%	1.50%
PVC Pipes	0%	0.941	0.00%	0.00%	0.00%
50mm PVC Pipes	0%	0.820	0.00%	0.00%	0.00%
Motor Pumps	10%	0.767	1.80%	2.50%	0.30%
Pump Controller	15%	0.767	2.70%	3.75%	0.45%
Transformer	25%	0.771	4.50%	6.25%	1.25%
	100%		14.00%	25.00%	3.50%

Conversion Factor
0.794

Treated Water Transmission and Pumping

MATERIALS

	Weight	Conversion Factor	For Financial Analysis: Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
Cement	36%	0.873	3.60%	7.92%	1.08%
Steel	8%	0.798	1.28%	1.76%	0.24%
Wood	4%	0.873	0.40%	0.88%	0.12%
Bricks	28%	0.952	0.00%	6.16%	0.00%
Sand	24%	0.945	0.00%	5.28%	0.00%
	100%		5.28%	22.00%	1.44%

Conversion Factor
0.906

EQUIPMENT

	Weight	Conversion Factor	For Financial Analysis: Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
600mm Pipes	50%	0.820	5.00%	12.50%	1.50%
PVC Pipes	0%	0.941	0.00%	0.00%	0.00%
50mm PVC Pipes	0%	0.820	0.00%	0.00%	0.00%
Motor Pumps	0%	0.767	0.00%	0.00%	0.00%
Pump Controller	20%	0.767	3.60%	5.00%	0.60%
Transformer	30%	0.771	5.40%	7.50%	1.50%
	100%		14.00%	25.00%	3.60%

Conversion Factor
0.795

Reservoirs & Distribution

MATERIALS

	Weight	Conversion Factor	For Financial Analysis: Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
Cement	48%	0.873	4.80%	10.56%	1.44%
Steel	10%	0.798	1.60%	2.20%	0.30%
Wood	5%	0.873	0.50%	1.10%	0.15%
Bricks	5%	0.952	0.00%	1.10%	0.00%
Sand	32%	0.945	0.00%	7.04%	0.00%
	100%		6.90%	22.00%	1.89%

Conversion Factor
0.892

EQUIPMENT — **For Financial Analysis**

	Weight	Conversion Factor	Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
600mm Pipes	30%	0.820	3.00%	7.50%	0.90%
PVC Pipes	0%	0.941	0.00%	0.00%	0.00%
50mm PVC Pipes	0%	0.820	0.00%	0.00%	0.00%
Motor Pumps	70%	0.767	12.60%	17.50%	2.10%
Pump Controller	0%	0.767	0.00%	0.00%	0.00%
Transformer	0%	0.771	0.00%	0.00%	0.00%
	100%		15.60%	25.00%	3.00%

Conversion Factor
0.783

Connections

MATERIALS — **For Financial Analysis**

	Weight	Conversion Factor	Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
Cement	9%	0.873	0.90%	1.98%	0.27%
Steel	5%	0.798	0.80%	1.10%	0.15%
Wood	40%	0.873	4.00%	8.80%	1.20%
Bricks	40%	0.952	0.00%	8.80%	0.00%
Sand	6%	0.945	0.00%	1.32%	0.00%
	100%		5.70%	22.00%	1.62%

Conversion Factor
0.905

EQUIPMENT — **For Financial Analysis**

	Weight	Conversion Factor	Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
600mm Pipes	0%	0.820	0.00%	0.00%	0.00%
PVC Pipes	60%	0.941	6.00%	15.00%	1.80%
50mm PVC Pipes	0%	0.820	0.00%	0.00%	0.00%
Motor Pumps	0%	0.767	0.00%	0.00%	0.00%
Pump Controller	0%	0.767	0.00%	0.00%	0.00%
Transformer	40%	0.771	7.20%	10.00%	2.00%
	100%		13.20%	25.00%	3.80%

Conversion Factor
0.873

LABOR

Skilled Labor

Market Wage (gross of tax)	1092.23
Project Wage	1680.36
Average Tax Rate	45%
EOCL (skilled)	1356.89
Conversion factor for skilled labor	0.8075

Semi-Skilled & Unskilled Labor

	Semi Skilled	*Unskilled*	
Market Wage (gross of tax)	577.01	205.85	0.65
Project Wage	887.71	316.69	
Average Tax Rate	35%	35%	
EOCL (semi-skilled & unskilled)	375.06	133.80	
Conversion factor for skilled labor	0.4225	0.4225	

WEIGHTED COST OF LABOR	*Weight*	*CF*	*Financial Cost*	*Economic Cost*
Unskilled Labor	46%	0.4225	316.69	133.80
Semi-skilled Labor	50%	0.4225	887.71	375.06
Skilled Labor	4%	0.8075	1680.36	1356.89

Economic Cost of Labor	303.35
Financial Cost of Labor	657.25

Conversion Factor
0.462

Accounts Payable

Total Cost of Labor Required by Project	-	50,051	81,126	113,423	146,980	367,289	617,811	916,502	1,221,110	1,608,258	-
Total Cost of Tertiary Labor Required by Project	-	25,526	38,129	52,175	63,201	139,570	234,768	348,271	464,022	611,138	-
Total Cost of Chemicals	-	7,207	14,484	21,808	113,906	114,377	114,377	114,377	114,377	114,377	-
Total Energy Costs	-	28,185	58,148	86,790	446,958	448,800	448,800	448,800	448,800	448,800	-
Total Other Service Costs	-	27,742	47,972	68,549	192,761	267,509	353,939	456,988	562,077	695,643	-

	Weight	CF	Wight * CF
Total Cost of Labor Required by Project	38.78%	**0.462**	0.179
Total Cost of Tertiary Labor Required by Project	14.82%	**0.462**	0.068
Total Cost of Chemicals	5.36%	**0.825**	0.044
Total Energy Costs	21.04%	**1.051**	0.221
Total Other Service Costs	20.00%	**0.700**	0.140
Conversion Factor	**0.653**		

TABLE 11.1: SUMMARY TABLE OF CONVERSION FACTORS

CEMENT	0.873
STEEL	0.798
WOOD	0.873
BRICKS	0.952
SAND	0.945
600mm PIPES	0.820
PVC PIPES	0.941
50mm PVC PIPES	0.820
MOTOR PUMPS	0.767
PUMP CONTROLLER	0.767
TRANSFORMER	0.771
LABOR	0.462
TERTIARY LABOR	0.462
CHEMICALS	0.825
ELECTRICITY	1.051
OTHER SERVICES	0.700
MAINTENANCE COSTS	1.000
REPLACEMENT INVESTMENTS	1.000
INVESTMENT COMPONENTS	
Raw Water Intake, Transmission & Pumping	
MATERIALS	0.892
EQUIPMENT	0.795
Treatment	
MATERIALS	0.895
EQUIPMENT	0.794
Treated Water Transmission and Pumping	
MATERIALS	0.906
EQUIPMENT	0.795
Reservoirs & Distribution	
MATERIALS	0.892
EQUIPMENT	0.783
Connections	
MATERIALS	0.905
EQUIPMENT	0.873
Land	1.000
Change in Accounts Receivable	
Change in Accounts Payable	0.653
Change in Cash Balances	1.000

TABLE 12: NET ECONOMIC BENEFIT STATEMENT

Year	Converion Factors	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
ECONOMIC BENEFIT FLOW												
Value of Water for Paying Customers		-	282,128	617,135	977,888	2,816,410	5,584,593	5,683,435	5,683,435	5,683,435	5,683,435	-
Valuation of Stolen Water		-	155,759	287,183	406,168	1,972,074	1,884,252	1,833,715	1,833,715	1,833,715	1,833,715	-
change in A/R		-	(39,498)	(50,492)	(58,360)	(329,079)	(77,204)	(78,680)	(72,335)	(72,335)	(72,335)	-
Salvage Value of Land	**1.000**	-	-	-	-	-	-	-	-	-	-	100,000
Total Inflows		**-**	**398,389**	**853,826**	**1,325,696**	**4,459,405**	**7,391,641**	**7,438,471**	**7,444,816**	**7,444,816**	**7,444,816**	**100,000**
ECONOMIC COST FLOW												
Investment Costs												
Labor												
Non-Semi-skilled Labor	**0.462**	-	254,776	305,547	167,543	-	-	-	-	-	-	-
Semi-skilled Labor	**0.462**	-	179,082	215,083	117,696	-	-	-	-	-	-	-
Raw Water Intake, Transmission & Pumping												
Materials	**0.892**	-	1,142,931	1,319,722	722,530	-	-	-	-	-	-	-
Equipment	**0.795**	-	200,806	227,681	117,928	-	-	-	-	-	-	-
Treatment												
Materials	**0.895**	-	610,020	704,418	371,507	-	-	-	-	-	-	-
Equipment	**0.794**	-	106,963	128,356	62,818	-	-	-	-	-	-	-
Treated Water Transmission and Pumping												
Materials	**0.906**	-	918,656	1,061,065	559,734	-	-	-	-	-	-	-
Equipment	**0.795**	-	160,644	182,144	94,343	-	-	-	-	-	-	-
Reservoirs & Distribution												
Materials	**0.892**	-	1,066,738	1,231,737	649,581	-	-	-	-	-	-	-
Equipment	**0.783**	-	185,030	209,790	108,660	-	-	-	-	-	-	-
Connections												
Materials	**0.905**	-	76,717	88,601	20,932	-	-	-	-	-	-	-
Equipment	**0.873**	-	14,675	16,639	8,619	-	-	-	-	-	-	-
Cost of Land	**1.000**	-	100,000	-	-	-	-	-	-	-	-	-
Operational Costs												
Total Cost of Labor Required by Project	**0.462**	-	23,101	37,444	52,351	67,839	169,523	285,151	423,013	563,605	742,293	-
Total Cost of Tertiary Labor Required by Project	**0.462**	-	11,782	17,599	24,081	29,171	64,419	108,357	160,745	214,170	282,071	-
Total Cost of Chemicals	**0.825**	-	5,945	11,948	17,989	93,957	94,345	94,345	94,345	94,345	94,345	-
Total Energy Costs	**1.051**	-	29,623	61,115	91,218	469,759	471,695	471,695	471,695	471,695	471,695	-
Total Other Service Costs	**0.700**	-	19,413	33,568	47,967	134,884	187,188	247,667	319,774	393,310	486,772	-
Total Maintenance Costs	**1.000**	-	68,800	68,800	69,800	69,800	71,020	69,800	67,580	64,140	60,700	-
Total Replacement Investments	**1.000**	-	-	-	-	-	-	-	-	-	-	-
change in A/P	**0.653**	-	(9,054)	(7,425)	(8,139)	(42,571)	(12,140)	(15,065)	(22,016)	(23,792)	(28,340)	213,064
change in CB	**1.000**	-	11,097	9,101	9,975	52,178	14,880	18,465	26,984	29,161	34,736	(261,144)
Total Outflows		-	5,177,745	5,922,932	3,307,132	875,015	1,060,930	1,280,416	1,542,121	1,806,635	2,144,273	(48,081)
Net Economic Benefit Flow		**-**	***(4,779,356)***	***(5,069,105)***	***(1,981,436)***	***3,584,390***	***6,330,712***	***6,158,056***	***5,902,696***	***5,638,182***	***5,300,543***	***148,081***

ECONOMIC NPV @ **12.17%** ***22,920,055***

TABLE 13: DISTRIBUTIVE (STAKEHOLDER) ANALYSIS

	PV Financial @ Economic . Rate of 12.17%	PV Economic @ Economic . Rate of 12.17%	PV of Externalities	GOVERNMENT	CONSUMERS	LABOR
ECONOMIC BENEFIT FLOW						
Revenue Collected from Water	16,952,615	30,735,508	13,782,893		13,782,893	
Valuation of Stolen and Uncollected Water		11,176,801	11,176,801		11,176,801	
change in A/R	(449,924)	(690,360)	(240,436)		(240,436)	
Salvage Value of Land	2,840	2,840	-			
Total Benefits	**16,505,531**	**41,224,788**	**24,719,257**			
ECONOMIC COST FLOW						
Investment Costs						
Labor						
Non-Semi-skilled Labor	1,275,371	588,649	(686,722)	156,229		530,493
Semi-skilled Labor	896,890	413,961	(482,929)	217,318		265,611
Raw Water Intake, Transmission & Pumping						
Materials	2,891,436	2,579,590	(311,846)	311,846		
Equipment	558,139	443,503	(114,636)	114,636		
Treatment						
Materials	1,527,774	1,366,831	(160,942)	160,942		
Equipment	304,457	241,867	(62,591)	62,591		
Treated Water Transmission and Pumping						
Materials	2,272,242	2,058,759	(213,483)	213,483		
Equipment	446,511	354,803	(91,709)	91,709		
Reservoirs & Distribution						
Materials	2,678,995	2,390,061	(288,934)	288,934		
Equipment	521,965	408,655	(113,309)	113,309		
Connections						
Materials	169,801	153,634	(16,167)	16,167		
Equipment	37,135	32,412	(4,723)	4,723		
Cost of Land	89,147	89,147	-			
Operational Costs						
Total Cost of Labor Required by Project	2,894,247	1,335,843	(1,558,404)	571,855		986,549
Total Cost of Tertiary Labor Required by Project	1,132,611	522,758	(609,853)	138,742		471,111
Total Cost of Chemicals	668,771	551,642	(117,129)	117,129		
Total Energy Costs	2,625,987	2,759,950	133,962	(133,962)		
Total Other Service Costs	1,830,404	1,280,814	(549,590)	549,590		
Total Maintenance Costs	552,008	552,008	-			
Total Replacement Investments	154,291	154,291	-			
change in A/P	(173,497)	(113,243)	60,254	(60,254)		
change in CB	138,797	138,797	-	-		
Total Costs	**23,493,482**	**18,304,734**	**(5,188,749)**			
NET BENEFITS	***(6,987,951)***	***22,920,055***	***29,908,006***	***2,934,985***	***24,719,257***	***2,253,764***

CONTROL OF
WATER AND COASTAL POLLUTION: AN APPRAISAL FOR
ESPIRITO SANTO, BRAZIL

SEWAGE COLLECTION
DISPOSAL COMPONENT

TABLE 1: TABLE OF PARAMETERS

Table 1.1: Macroeconomic Parameters

	1996		
Federal Consumption Tax	5%	**or**	8%
State Administered VAT	17%	**or**	17%
Total Consumption Tax Rate	22%	**or**	25%
1996 Exchange Rate US$/R$	1.00		
One-Shot Real Depreciation	0.0%		

Tariff Rates	1996		
Cement	10%	Motor Pumps	18%
Steal	16%	Pump Controller	18%
Wood	10%	Transformer	18%
600mm pipes	10%	Watermeters	18%
PVC pipes	10%	Chemicals	12%
150mm pipes	10%	Petroleum	18%
50mm PVC pipes	10%		

Table 1.2: Project Financing

Loan Amount as % Investment Costs	50%	
Real Interest Rate	5.0%	
Risk Premium	2.0%	
Grace Period on Payments	5	years
Payback Period	10	years
Financial Real Discount Rate	10.0%	

Table 1.3: CESAN'S Working Capital

Accounts Receivable	14.0%
Accounts Payable	10.0%
Cash Balances	8.0%

Operational Cost Parameters

Sewerage Breakdown between Residential & Non-Residential		
% Residential Sewage	87.0%	
% Non-Residential Sewage	13.0%	
Population Serviced per connection	5.54	persons
Sewerage Capacity Volume	306	M^3 per connection per year

	1996	
CESAN's Sewerage Capacity	1,514	000 M^3 per year

Table 1.4: Operational Cost Parameters

Discharge Factor		0.80	
Infiltration Factor		1.20	
Current Tariff on Collection of Sewage		0.18	Rs/M^3
Demand Elasticity of Sewage Collection		-1.3	
Sewerage Collection Demand		34.28	M3 per person
Invoicing Efficiency		77.0%	
Collection Efficiency		84.0%	

Labor	**1996**		***% total employees***	
Salaries				
Non Qualified Labor	316.69	R$	46%	
Qualified Labor	887.71	R$	50%	
Superior Qualified Labor	1680.36	R$	4%	
Number of employees	0.4	per	1,000	connections
Real Increase in Labor	2%	per year		

	1996-98	**1999**	**2000**	**2001**	**2001-27**
CESAN's real surcharge rate changes	0.00%	11.11%	25%	20%	0%

Cost of Chemicals		**1996**	
Cost of Chemicals		0.20	R$/kg
Tariff on Chemicals	12%	0.02	R$/kg
Tax on Chemicals	22%	0.05	R$/kg
Port & Handling Charges	3%	0.01	R$/kg
Total Cost of Chemicals		0.28	R$/kg
Chemicals Required		0.00	grams per M3

Energy Costs	**1996**	
Cost per Installed Capacity	4.45	R$
Cost of Consumed Energy	0.0649	R$
kW per M^3 of Sewage	1.41	kW

Other Service Costs	**1996-2026**
as % of general operational costs	23%

Complimentary Investment Costs	**1996**
Labor	
Non-Qualified Labor	1,000
Qualified Labor	1,000
Materials	4,000
Equipment	4,000

Replacement Investments ('96 prices)	**2006**	**2016**	**2021**
Labor			
Non-Qualified Labor	1,000	4000	1000
Qualified Labor	1,000	4000	1000
Materials	2,000	7000	2000
Equipment	7,000	22000	7000

Non-Use Economic Benefits (R$)	**1996**
Economic Benefit per M^3 Sewage Collected	0.49
Environmental Recuperation Benefits per M^3	0.35

TABLE 2: MACROECONOMIC TABLES

Year	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
Population											
Population in the Guarapari Drainage Area	224,130	230,466	236,864	243,317	249,821	282,890	315,300	347,019	377,362	405,798	-
Inflation in Brazil											
Rate of Inflation in Brazil	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Inflation Index in Brazil	1.00	1.10	1.21	1.33	1.46	2.36	3.80	6.12	9.85	15.86	19.19
Inflation in the United States											
Rate of Inflation in the U.S.	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Inflation Index in the U.S.	1.00	1.03	1.06	1.09	1.13	1.30	1.51	1.75	2.03	2.36	2.50
Relative Price Index Brazil/U.S.	1.00	1.07	1.14	1.22	1.30	1.81	2.51	3.49	4.85	6.73	7.68
Change in Brazilian R$/US $	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Expected Exchange Rate US$/R$	1.00	1.07	1.14	1.22	1.30	1.81	2.51	3.49	4.85	6.73	7.68

TABLE 3: INVESTMENT COSTS

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2027**

Table 3.1: UNADJUSTED INVESTMENT COSTS (1996 currency)

Labor				
Non-Qualified Labor	-	325,000	570,000	542,000
Qualified Labor	-	84,000	147,000	140,000
Connections				
Materials				
Domestic (R$)	-	42,055	73,919	70,195
Imported (US$)	-	39,379	64,811	57,629
Equipment				
Domestic (R$)	-	1,904	3,352	3,186
Imported (US$)	-	7,130	11,756	10,464
Collectors & Interceptors				
Materials				
Domestic (R$)	-	199,761	351,117	333,426
Imported (US$)	-	187,049	307,851	273,737
Equipment				
Domestic (R$)	-	9,042	15,922	15,136
Imported (US$)	-	33,867	55,840	49,704
Pumping Stations & Raw Sewage Pressure Pipes				
Materials				
Domestic (R$)	-	94,623	166,318	157,939
Imported (US$)	-	88,602	145,824	129,665
Equipment				
Domestic (R$)	-	4,283	7,542	7,170
Imported (US$)	-	16,042	26,450	23,544
Treatment and Outfall Pipes				
Materials				
Domestic (R$)	-	189,247	332,637	315,877
Imported (US$)	-	177,204	291,648	259,329
Equipment				
Domestic (R$)	-	8,566	15,084	14,339
Imported (US$)	-	32,084	52,901	47,088
Cost of Land	-	150,000	-	-
Cost Overruns (%)	0%	0%	0%	0%

Table 3.2: INVESTMENT COSTS ADJUSTED FOR INFLATION

Labor				
Non-Qualified Labor	-	357,500	689,700	721,402
Qualified Labor	-	92,400	177,870	186,340
Connections				
Materials	-	116,346	216,328	217,536
Equipment	-	15,474	28,323	28,002
Collectors & Interceptors				
Materials	-	554,497	1,030,908	1,036,576
Equipment	-	75,661	138,452	136,845
Pumping Stations & Raw Sewage Pressure Pipes				
Materials	-	264,898	492,383	494,979
Equipment	-	35,769	65,455	64,696
Treatment and Outfall Pipes				
Materials	-	525,313	976,650	982,020
Equipment	-	69,491	127,196	125,757
Cost of Land	-	165,000	-	-
Total Investment Costs	**-**	**2,272,350**	**3,943,265**	**3,994,154**

TABLE 4: PROJECT FINANCING

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2027**
Loan Disbursement by the World Bank (US$)	**-**	**1,063,873**	**1,728,682**	**1,639,564**	**-**	**-**	**-**	**-**	**-**	**-**	
Loan Repayment Schedule											
Nominal Interest Rate	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%	10.21%
Principle at Start of Year (US$)		1,063,873	2,901,176	4,836,950	5,330,803	4,532,446	1,294,985	0	0	0	
Interest (US$)	-	108,621	296,210	493,853	544,275	462,763	132,218				
Loan Repayment on Principle & Accumulated Interest '97-'99(US$)	-	-	-	-	-	647,492	647,492				
Interest Payments(US$)						462,763	132,218				

Outstanding Loan at End of Year	-	1,172,494	3,197,386	5,330,803	5,875,078	3,884,954	647,492	0	0	0	
Loan Repayment (R$)	**-**	**-**	**-**	**-**	**-**	**2,006,420**	**1,957,536**				

TABLE 5: SALVAGE VALUE OF CAPITAL INVESTMENTS

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2027**
Land											
Real Value of Land	-	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Market Value of Land		165,000	181,500	199,650	219,615	353,692	569,625	917,386	1,477,460	2,379,464	**2,879,151**

TABLE 6: SEWAGE COLLECTION IN GUARAPARI

Year	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
Expected Population in Guarapari	224,130	230,466	236,864	243,317	249,821	282,890	315,300	347,019	377,362	405,798	
Total Population Serviced by CESAN	28,254	29,052	29,861	30,675	139,713	158,206	176,333	194,072	211,041	226,946	
Total Population Serviced by Project	-	798	1,607	2,421	111,459	129,952	148,079	165,818	182,787	198,692	
Sewerage Discharge											
Residential Sewerage	7,099	7,416	7,808	8,153	11,053	11,452	11,654	11,654	11,654	11,654	
Non-Residential Sewerage	1,061	1,108	1,167	1,218	1,652	1,711	1,741	1,741	1,741	1,741	
Total Sewerage in Gurapari	8,160	8,524	8,975	9,372	12,704	13,163	13,396	13,396	13,396	13,396	
Number of Total Connections	5,100	5,244	5,390	5,537	25,219	28,557	31,829	35,031	38,094	40,965	
CESAN'S Total Sewerage Collection Capacity (000 M^3)	1,514	1,558	1,603	1,648	7,680	8,703	9,705	10,687	11,625	12,505	
Number of Connections from Project	**-**	**144**	**290**	**437**	**20,119**	**23,457**	**26,729**	**29,931**	**32,994**	**35,865**	
Percentage of Connections from Project	**0%**	**3%**	**5%**	**8%**	**80%**	**82%**	**84%**	**85%**	**87%**	**88%**	
Total Sewerage Capacity due to Project (000 M^3)	-	44	89	134	6,166	7,189	8,191	9,173	10,111	10,991	
Sewerage Collected by Project	-	44	89	134	6,166	7,189	8,191	9,173	10,111	10,991	
Revenue from Sewage											
Water Consumption from CESAN	8,500	8,879	9,349	9,762	13,234	13,711	13,954	13,954	13,954	13,954	
Real Surcharge on Sewerage Collections	0.18	0.18	0.18	0.20	0.24	0.30	0.30	0.30	0.30	0.30	
Real Increase in Sewerage Surcharge	0.00%	0.00%	0.00%	11.11%	20.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Nominal Surcharge on Sewerage Collections	0.18	0.20	0.22	0.27	0.35	0.71	1.14	1.83	2.95	4.76	
Billable Sewage Collected by Project (000 M3)	8,500	8,879	9,349	9,762	13,234	13,711	13,954	13,954	13,954	13,954	
Invoicing Efficiency (%)	0.77	0.80	0.85	0.88	0.90	0.90	0.90	0.90	0.90	0.90	
Billed Sewage Collected from Project (000 M3)	6,545	7,103	7,946	8,591	11,910	12,340	12,559	12,559	12,559	12,559	
Collection Efficiency (%)	0.84	0.84	0.84	0.84	0.85	0.85	0.85	0.85	0.85	0.85	
Revenue Collected from Sewage	**-**	**32,443**	**78,220**	**151,604**	**2,837,870**	**6,094,684**	**10,212,541**	**16,734,249**	**27,319,915**	**44,475,646**	

TABLE 7: CESAN'S WORKING CAPITAL FOR THE SEWAGE COLLECTION PROJECT

	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
Accounts Receivable											
Revenue from Sewage Collection	-	32,443	78,220	151,604	2,837,870	6,094,684	10,212,541	16,734,249	27,319,915	44,475,646	-
A/R at start of year	0	4,542	10,951	21,225	397,302	853,256	1,429,756	2,342,795	3,824,788	6,226,590	-
change in A/R		(4,542)	(6,409)	(10,274)	(376,077)	(88,291)	(146,512)	(219,638)	(356,294)	(577,149)	6,862,083
Accounts Payable											
Recurring Expenses of the Project	-	77,602	90,899	109,881	1,265,321	2,353,537	4,383,705	7,939,932	14,487,613	25,959,691	-
A/P at start of year	0	7,760	9,090	10,988	126,532	235,354	438,371	793,993	1,448,761	2,595,969	-
change in A/P		(7,760)	(1,330)	(1,898)	(115,544)	(27,160)	(49,167)	(87,164)	(165,131)	(274,954)	2,902,374
Cash Balances											
CB at Start of the year	-	6,208	7,272	8,790	101,226	188,283	350,696	635,195	1,159,009	2,076,775	-
change in CB		(6,208)	(1,064)	(1,519)	(92,435)	(21,728)	(39,334)	(69,731)	(132,105)	(219,963)	2,321,899

TABLE 8: OPERATIONAL COSTS OF SEWAGE COLLECTION PROJECT

LABOR											
Labor Requirements for the Operation of the Project											
Wages											
Non Qualified Labor	3,800	4,264	4,784	5,368	6,023	10,709	19,042	33,859	60,207	107,055	134,770
Qualified Labor	10,653	11,952	13,410	15,046	16,882	30,018	53,377	94,911	168,764	300,086	377,773
Superior Qualified Labor	20,164	22,624	25,385	28,481	31,956	56,822	101,038	179,659	319,457	568,037	715,092
Quantity											
Non Qualified Labor	0	1	1	1	4	5	5	6	7	7	
Qualified Labor	0	1	1	1	5	5	6	6	7	8	
Superior Qualified Labor	0	1	1	1	1	1	1	1	1	1	
Total Labor Demanded	0	3	3	3	10	11	12	13	15	16	
Total Cost of Labor for Operation of Project											
Non Qualified Labor	-	4,264	4,784	5,368	24,091	53,545	95,211	203,157	421,446	749,388	
Qualified Labor	-	11,952	13,410	15,046	84,410	150,092	320,261	569,466	1,181,351	2,400,685	
Superior Qualified Labor	-	22,624	25,385	28,481	31,956	56,822	101,038	179,659	319,457	568,037	
Total Cost of Labor Required by Project	**-**	**38,840**	**43,579**	**48,896**	**140,457**	**260,460**	**516,509**	**952,281**	**1,922,254**	**3,718,109**	
Labor Requirements for the Tertiary Costs of the Project											
Quantity of Tertiary Labor											
Non Qualified Labor	0	1	1	1	2	2	2	2	3	3	
Qualified Labor	0	1	1	1	2	2	2	2	3	3	
Superior Qualified Labor	0	1	1	1	1	1	1	1	1	1	
Cost of Tertiary Labor											
Tertiary Costs as % of Total Personnel Costs	54%	51%	47%	46%	43%	38%	38%	38%	38%	38%	
Non Qualified Labor	-	2,175	2,249	2,469	10,359	20,347	36,180	77,200	160,150	284,767	
Qualified Labor	-	6,096	6,303	6,921	36,296	57,035	121,699	216,397	448,913	912,260	
Superior Qualified Labor	-	11,538	11,931	13,101	13,741	21,592	38,394	68,270	121,394	215,854	
Total Cost of Tertiary Labor Required by Project	**-**	**19,809**	**20,482**	**22,492**	**60,396**	**98,975**	**196,273**	**361,867**	**730,457**	**1,412,882**	
Chemical Requirements (kg)											
Price of Chemicals (US$)	0.20	0.21	0.21	0.22	0.23	0.26	0.30	0.35	0.41	0.47	
CIF Price	0.20	0.22	0.24	0.27	0.29	0.47	0.76	1.22	1.97	3.17	
Tariff, Tax, Port Handling & Freight	0.07	0.08	0.09	0.10	0.11	0.17	0.28	0.45	0.73	1.17	
Price of Chemicals	0.27	0.30	0.33	0.36	0.40	0.65	1.04	1.68	2.70	4.35	
Chemical Requirements (kg)	-	-	-	-	-	-	-	-	-	-	
Cost of Chemicals	-	-	-	-	-	-	-	-	-	-	
Tax on Chemicals	-	-	-	-	-	-	-	-	-	-	
Total Cost of Chemicals	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	
Energy Requirements											
Price per installed kW	4.45	4.90	5.38	5.92	6.52	10.49	16.90	27.22	43.83	70.59	
Price per consumed kW	0.0649	0.0714	0.0785	0.0864	0.0950	0.1530	0.2465	0.3969	0.6392	1.0295	
Total Installed Capacity	201	201	201	477	477	477	477	477	477	477	
Installed KW Capacity of Project	-	-	-	276	276	276	276	276	276	276	
KW Consumed by the Project	-	62,224	125,311	188,831	8,693,584	10,135,962	11,549,819	12,933,430	14,256,977	15,497,560	
Total Energy Costs	**-**	**4,442**	**9,841**	**17,946**	**827,863**	**1,554,010**	**2,851,205**	**5,141,081**	**9,125,837**	**15,974,449**	

Other Service Costs											
Total General Operational Costs	-	63,091	73,902	89,334	1,028,717	1,913,445	3,563,988	6,455,229	11,778,547	21,105,440	
Other Service Costs as % of General Operational Costs	23%	23%	23%	23%	23%	23%	23%	23%	23%	23%	
Total Other Service Costs	**-**	**14,511**	**16,997**	**20,547**	**236,605**	**440,092**	**819,717**	**1,484,703**	**2,709,066**	**4,854,251**	
Maintenance Costs											
Labor			-	-	-	-	-	-	-	-	
Non-Qualified Labor		1,122	1,259	1,412	1,585	2,818	5,011	8,910	15,843	28,170	
Qualified Labor		1,122	-	-	-	-	-	-	-	-	
Materials		4,400	4,840	5,324	5,856	9,432	15,190	24,464	39,399	63,452	
Taxes on Material		968	1,065	1,171	1,288	2,075	3,342	5,382	8,668	13,960	
Equipment		4,400	4,840	5,324	5,856	9,432	15,190	24,464	39,399	63,452	
Taxes on Equipment		968	1,065	1,171	1,288	2,075	3,342	5,382	8,668	13,960	
Total Maintenance Costs	**-**	**12,980**	**13,068**	**14,403**	**15,874**	**25,832**	**42,074**	**68,601**	**111,976**	**182,994**	
Replacement Investments											
Labor											
Non-Qualified Labor											
Qualified Labor											
Materials											
Taxes on Material											
Equipment											
Taxes on Equipment											
Total Replacement Investments	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

TABLE 9: FINANCIAL PRO-FORMA CASH FLOW STATEMENTS

TABLE 9.1:TOTAL INVESTMENT POINT OF VIEW (Nominal)

CASH INFLOWS											
Revenue Collected from Sewarage Collection	-	32,443	78,220	151,604	2,837,870	6,094,684	10,212,541	16,734,249	27,319,915	44,475,646	-
change in A/R	-	(4,542)	(6,409)	(10,274)	(376,077)	(88,291)	(146,512)	(219,638)	(356,294)	(577,149)	6,862,083
Salvage Value of Land											2,879,151
Total Inflows	**-**	**27,901**	**71,812**	**141,330**	**2,461,792**	**6,006,393**	**10,066,029**	**16,514,611**	**26,963,621**	**43,898,496**	**9,741,235**
CASH OUTFLOWS											
Investment Costs											
Labor											
Non-Qualified Labor	-	357,500	689,700	721,402	-	-	-	-	-	-	-
Qualified Labor	-	92,400	177,870	186,340	-	-	-	-	-	-	-
Connections											
Materials	-	116,346	216,328	217,536	-	-	-	-	-	-	-
Equipment	-	15,474	28,323	28,002	-	-	-	-	-	-	-
Collectors & Interceptors											
Materials	-	554,497	1,030,908	1,036,576	-	-	-	-	-	-	-
Equipment	-	75,661	138,452	136,845	-	-	-	-	-	-	-
Pumping Stations & Raw Sewage Pressure Pipes											
Materials	-	264,898	492,383	494,979	-	-	-	-	-	-	-
Equipment	-	35,769	65,455	64,696	-	-	-	-	-	-	-
Treatment and Outfall Pipes											
Materials	-	525,313	976,650	982,020	-	-	-	-	-	-	-
Equipment	-	69,491	127,196	125,757	-	-	-	-	-	-	-
Cost of Land	-	165,000	-	-	-	-	-	-	-	-	-
Operational Costs											
Total Cost of Labor Required by Project	-	38,840	43,579	48,896	140,457	260,460	516,509	952,281	1,922,254	3,718,109	-
Total Cost of Tertiary Labor Required by Project	-	19,809	20,482	22,492	60,396	98,975	196,273	361,867	730,457	1,412,882	-
Total Cost of Chemicals	-	-	-	-	-	-	-	-	-	-	-
Total Energy Costs	-	4,442	9,841	17,946	827,863	1,554,010	2,851,205	5,141,081	9,125,837	15,974,449	-
Total Other Service Costs	-	14,511	16,997	20,547	236,605	440,092	819,717	1,484,703	2,709,066	4,854,251	-
Total Maintenance Costs	-	12,980	13,068	14,403	15,874	25,832	42,074	68,601	111,976	182,994	-
Total Replacement Investments	-	-	-	-	-	-	-	-	-	-	-
change in A/P	-	(7,760)	(1,330)	(1,898)	(115,544)	(27,160)	(49,167)	(87,164)	(165,131)	(274,954)	2,902,374
change in CB	-	6,208	1,064	1,519	92,435	21,728	39,334	69,731	132,105	219,963	(2,321,899)
Total Outflows	**-**	**2,361,380**	**4,046,967**	**4,118,058**	**1,258,087**	**2,373,937**	**4,415,946**	**7,991,100**	**14,566,563**	**26,087,695**	**580,475**
Net Cash Flow	**-**	**(2,333,479)**	**(3,975,155)**	**(3,976,727)**	**1,203,705**	**3,632,456**	**5,650,083**	**8,523,511**	**12,397,058**	**17,810,802**	**9,160,760**

TABLE 9.2: EQUITY POINT OF VIEW (Nominal)

CASH INFLOWS											
Revenue Collected from Sewage Collection	-	32,443	78,220	151,604	2,837,870	6,094,684	10,212,541	16,734,249	27,319,915	44,475,646	-
change in A/R	-	(4,542)	(6,409)	(10,274)	(376,077)	(88,291)	(146,512)	(219,638)	(356,294)	(577,149)	6,862,083
Salvage Value of Land											2,879,151
Loan Received from World Bank	-	1,136,175	1,971,632	1,997,077	-	-	-	-	-	-	-
Total Inflows	**-**	**1,164,076**	**2,043,444**	**2,138,407**	**2,461,792**	**6,006,393**	**10,066,029**	**16,514,611**	**26,963,621**	**43,898,496**	**9,741,235**
CASH OUTFLOWS											
Investment Costs											
Labor											
Non-Qualified Labor	-	357,500	689,700	721,402	-	-	-	-	-	-	-
Qualified Labor	-	92,400	177,870	186,340	-	-	-	-	-	-	-
Connections											
Materials	-	116,346	216,328	217,536	-	-	-	-	-	-	-
Equipment	-	15,474	28,323	28,002	-	-	-	-	-	-	-
Collectors & Interceptors											
Materials	-	554,497	1,030,908	1,036,576	-	-	-	-	-	-	-
Equipment	-	75,661	138,452	136,845	-	-	-	-	-	-	-
Pumping Stations & Raw Sewage Pressure Pipes											
Materials	-	264,898	492,383	494,979	-	-	-	-	-	-	-
Equipment	-	35,769	65,455	64,696	-	-	-	-	-	-	-
Treatment and Outfall Pipes											
Materials	-	525,313	976,650	982,020	-	-	-	-	-	-	-
Equipment	-	69,491	127,196	125,757	-	-	-	-	-	-	-
Cost of Land	-	165,000	-	-	-	-	-	-	-	-	-
Loan Repayment to World Bank	-	-	-	-	-	2,006,420	1,957,536	-	-	-	-
Operational Costs											
Total Cost of Labor Required by Project	-	38,840	43,579	48,896	140,457	260,460	516,509	952,281	1,922,254	3,718,109	-
Total Cost of Tertiary Labor Required by Project	-	19,809	20,482	22,492	60,396	98,975	196,273	361,867	730,457	1,412,882	-
Total Cost of Chemicals	-	-	-	-	-	-	-	-	-	-	-
Total Energy Costs	-	4,442	9,841	17,946	827,863	1,554,010	2,851,205	5,141,081	9,125,837	15,974,449	-
Total Other Service Costs	-	14,511	16,997	20,547	236,605	440,092	819,717	1,484,703	2,709,066	4,854,251	-
Total Maintenance Costs	-	12,980	13,068	14,403	15,874	25,832	42,074	68,601	111,976	182,994	-
Total Replacement Investments	-	-	-	-	-	-	-	-	-	-	-
change in A/P	-	(7,760)	(1,330)	(1,898)	(115,544)	(27,160)	(49,167)	(87,164)	(165,131)	(274,954)	2,902,374
change in CB	-	6,208	1,064	1,519	92,435	21,728	39,334	69,731	132,105	219,963	(2,321,899)
Total Outflows	**-**	**2,361,380**	**4,046,967**	**4,118,058**	**1,258,087**	**4,380,357**	**6,373,482**	**7,991,100**	**14,566,563**	**26,087,695**	**580,475**
Net Cash Flow	**-**	**(1,197,304)**	**(2,003,522)**	**(1,979,651)**	**1,203,705**	**1,626,035**	**3,692,547**	**8,523,511**	**12,397,058**	**17,810,802**	**9,160,760**
***Net Present Value (NPV)* @ 21.00%**	**3,127,013**										

Year	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
Inflation Index in Brazil	1.00	1.10	1.21	1.33	1.46	2.36	3.80	6.12	9.85	15.86	19.19

TABLE 9.3: TOTAL INVESTMENT POINT OF VIEW (Real)

Year	1996	1997	1998	1999	2000	2005	2010	2015	2020	2025	2027
CASH INFLOWS											
Revenue Collected from Sewage Collection	-	29,493	64,645	113,902	1,938,303	2,584,741	2,689,281	2,736,183	2,773,671	2,803,718	-
change in A/R	-	(4,129)	(5,297)	(7,719)	(256,866)	(37,444)	(38,581)	(35,913)	(36,173)	(36,383)	357,506
Salvage Value of Land	-	-	-	-	-	-	-	-	-	-	150,000
Total Inflows	**-**	**25,364**	**59,348**	**106,184**	**1,681,437**	**2,547,297**	**2,650,700**	**2,700,271**	**2,737,498**	**2,767,335**	**507,506**
CASH OUTFLOWS											
Investment Costs											
Labor											
Non-Qualified Labor	-	325,000	570,000	542,000	-	-	-	-	-	-	-
Qualified Labor	-	84,000	147,000	140,000	-	-	-	-	-	-	-
Connections											
Materials	-	105,770	178,783	163,438	-	-	-	-	-	-	-
Equipment	-	14,067	23,407	21,038	-	-	-	-	-	-	-
Collectors & Interceptors											
Materials	-	504,089	851,990	778,795	-	-	-	-	-	-	-
Equipment	-	68,783	114,423	102,814	-	-	-	-	-	-	-
Pumping Stations & Raw Sewage Pressure Pipes											
Materials	-	240,817	406,928	371,885	-	-	-	-	-	-	-
Equipment	-	32,517	54,095	48,607	-	-	-	-	-	-	-
Treatment and Outfall Pipes											
Materials	-	477,558	807,149	737,806	-	-	-	-	-	-	-
Equipment	-	63,173	105,121	94,483	-	-	-	-	-	-	-
Cost of Land	-	150,000	-	-	-	-	-	-	-	-	-
Operational Costs											
Total Cost of Labor Required by Project	-	35,309	36,016	36,736	95,934	110,460	136,013	155,706	195,158	234,387	-
Total Cost of Tertiary Labor Required by Project	-	18,008	16,927	16,899	41,252	41,975	51,685	59,168	74,160	89,067	-
Total Cost of Chemicals	-	-	-	-	-	-	-	-	-	-	-
Total Energy Costs	-	4,038	8,133	13,483	565,442	659,052	750,811	840,608	926,506	1,007,020	-
Total Other Service Costs	-	13,192	14,047	15,437	161,604	186,642	215,857	242,761	275,040	306,009	-
Total Maintenance Costs	-	11,800	10,800	10,821	10,842	10,955	11,079	11,217	11,368	11,536	-
Total Replacement Investments	-	-	-	-	-	-	-	-	-	-	-
change in A/P	-	(7,055)	(1,099)	(1,426)	(78,918)	(11,519)	(12,947)	(14,252)	(16,765)	(17,333)	151,210
change in CB	-	5,644	879	1,141	63,135	9,215	10,358	11,402	13,412	13,866	(120,968)
Total Outflows	**-**	**2,146,709**	**3,344,600**	**3,093,958**	**859,290**	**1,006,781**	**1,162,857**	**1,306,609**	**1,478,879**	**1,644,553**	**30,242**
Net Cash Flow	**-**	**(2,121,345)**	**(3,285,252)**	**(2,987,774)**	**822,147**	**1,540,516**	**1,487,843**	**1,393,662**	**1,258,619**	**1,122,782**	**477,264**

TABLE 9.4: EQUITY POINT OF VIEW (Real)

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**...2005**	**...2010**	**...2015**	**...2020**	**...2025**	**...2027**
CASH INFLOWS											
Revenue Collected from Sewage Collection	-	29,493	64,645	113,902	1,938,303	2,584,741	2,689,281	2,736,183	2,773,671	2,803,718	-
change in A/R	-	(4,129)	(5,297)	(7,719)	(256,866)	(37,444)	(38,581)	(35,913)	(36,173)	(36,383)	357,506
Salvage Value of Land	-	-	-	-	-	-	-	-	-	-	150,000
Loan Received from World Bank	-	1,032,886	1,629,448	1,500,433	-	-	-	-	-	-	-
Total Inflows	**-**	**1,058,251**	**1,688,797**	**1,606,617**	**1,681,437**	**2,547,297**	**2,650,700**	**2,700,271**	**2,737,498**	**2,767,335**	**507,506**
CASH OUTFLOWS											
Investment Costs											
Labor											
Non-Qualified Labor	-	325,000	570,000	542,000	-	-	-	-	-	-	-
Qualified Labor	-	84,000	147,000	140,000	-	-	-	-	-	-	-
Connections											
Materials	-	105,770	178,783	163,438	-	-	-	-	-	-	-
Equipment	-	14,067	23,407	21,038	-	-	-	-	-	-	-
Collectors & Interceptors											
Materials	-	504,089	851,990	778,795	-	-	-	-	-	-	-
Equipment	-	68,783	114,423	102,814	-	-	-	-	-	-	-
Pumping Stations & Raw Sewage Pressure Pipes											
Materials	-	240,817	406,928	371,885	-	-	-	-	-	-	-
Equipment	-	32,517	54,095	48,607	-	-	-	-	-	-	-
Treatment and Outfall Pipes											
Materials	-	477,558	807,149	737,806	-	-	-	-	-	-	-
Equipment	-	63,173	105,121	94,483	-	-	-	-	-	-	-
Cost of Land	-	150,000	-	-	-	-	-	-	-	-	-
Loan Repayment to World Bank	-	-	-	-	-	850,918	515,480	-	-	-	-
Operational Costs											
Total Cost of Labor Required by Project	-	35,309	36,016	36,736	95,934	110,460	136,013	155,706	195,158	234,387	-
Total Cost of Tertiary Labor Required by Project	-	18,008	16,927	16,899	41,252	41,975	51,685	59,168	74,160	89,067	-
Total Cost of Chemicals	-	-	-	-	-	-	-	-	-	-	-
Total Energy Costs	-	4,038	8,133	13,483	565,442	659,052	750,811	840,608	926,506	1,007,020	-
Total Other Service Costs	-	13,192	14,047	15,437	161,604	186,642	215,857	242,761	275,040	306,009	-
Total Maintenance Costs	-	11,800	10,800	10,821	10,842	10,955	11,079	11,217	11,368	11,536	-
Total Replacement Investments	-	-	-	-	-	-	-	-	-	-	-
change in A/P	-	(7,055)	(1,099)	(1,426)	(78,918)	(11,519)	(12,947)	(14,252)	(16,765)	(17,333)	151,210
change in CB	-	5,644	879	1,141	63,135	9,215	10,358	11,402	13,412	13,866	(120,968)
Total Outflows	**-**	**2,146,709**	**3,344,600**	**3,093,958**	**859,290**	**1,857,699**	**1,678,337**	**1,306,609**	**1,478,879**	**1,644,553**	**30,242**
Net Cash Flow	**-**	**(1,088,459)**	**(1,655,804)**	**(1,487,341)**	**822,147**	**689,598**	**972,363**	**1,393,662**	**1,258,619**	**1,122,782**	**477,264**
***Net Present Value (NPV)* @ 10.0%**	**3,127,013**										

TABLE 10: NATIONAL ECONOMIC PARAMETERS

TABLE 10.1: Economic Cost of Capital (EOCK)

Economic Cost of Capital	12.17%

TABLE 10.2: Economic Cost of Foreign Exchange

Foreign Exchange Premium	12.06%

TABLE 11: CONVERSION FACTORS

Connections

MATERIALS

	Weight	Conversion Factor	For Financial Analysis: Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
Cement	25%	0.873	2.50%	6.25%	0.75%
Steel	10%	0.798	1.60%	2.50%	0.30%
Wood	5%	0.873	0.50%	1.25%	0.15%
Bricks	50%	0.952	0.00%	12.50%	0.00%
Sand	10%	0.945	0.00%	2.50%	0.00%
	100%		4.60%	25.00%	1.20%

Conversion Factor
0.912

EQUIPMENT

	Weight	Conversion Factor	For Financial Analysis: Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
600mm Pipes	20%	0.820	2.00%	5.00%	0.60%
PVC Pipes	20%	0.941	2.00%	5.00%	0.60%
50mm PVC Pipes	30%	0.820	3.00%	7.50%	0.90%
Motor Pumps	15%	0.767	2.70%	3.75%	0.45%
Pump Controller	10%	0.767	1.80%	2.50%	0.30%
Transformer	5%	0.771	0.90%	1.25%	0.25%
	100%		12.40%	25.00%	3.10%

Conversion Factor
0.828

Collectors & Interceptors

MATERIALS

	Weight	Conversion Factor	Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
			For Financial Analysis		
Cement	30%	0.873	3.00%	7.50%	0.90%
Steel	10%	0.798	1.60%	2.50%	0.30%
Wood	5%	0.873	0.50%	1.25%	0.15%
Bricks	50%	0.952	0.00%	12.50%	0.00%
Sand	5%	0.945	0.00%	1.25%	0.00%
	100%		5.10%	25.00%	1.35%

Conversion Factor
0.908

EQUIPMENT

	Weight	Conversion Factor	Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
			For Financial Analysis		
600mm Pipes	4%	0.820	0.40%	1.00%	0.12%
PVC Pipes	3%	0.941	0.30%	0.75%	0.09%
50mm PVC Pipes	3%	0.820	0.30%	0.75%	0.09%
Motor Pumps	30%	0.767	5.40%	7.50%	0.90%
Pump Controller	30%	0.767	5.40%	7.50%	0.90%
Transformer	30%	0.771	5.40%	7.50%	1.50%
	100%		17.20%	25.00%	3.60%

Conversion Factor
0.777

Pumping Stations & Raw Sewage Pressure Pipes

MATERIALS

	Weight	Conversion Factor	Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
			For Financial Analysis		
Cement	25%	0.873	2.50%	6.25%	0.75%
Steel	15%	0.798	2.40%	3.75%	0.45%
Wood	5%	0.873	0.50%	1.25%	0.15%
Bricks	40%	0.952	0.00%	10.00%	0.00%
Sand	15%	0.945	0.00%	3.75%	0.00%
	100%		5.40%	25.00%	1.35%

Conversion Factor
0.904

EQUIPMENT

	Weight	Conversion Factor	For Financial Analysis Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
600mm Pipes	4%	0.820	0.40%	1.00%	0.12%
PVC Pipes	3%	0.941	0.30%	0.75%	0.09%
50mm PVC Pipes	3%	0.820	0.30%	0.75%	0.09%
Motor Pumps	50%	0.767	9.00%	12.50%	1.50%
Pump Controller	20%	0.767	3.60%	5.00%	0.60%
Transformer	20%	0.771	3.60%	5.00%	1.00%
	100%		17.20%	25.00%	3.40%

Conversion Factor
0.777

Treatment and Outfall Pipes

MATERIALS

	Weight	Conversion Factor	For Financial Analysis Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
Cement	30%	0.873	3.00%	7.50%	0.90%
Steel	10%	0.798	1.60%	2.50%	0.30%
Wood	5%	0.873	0.50%	1.25%	0.15%
Bricks	40%	0.952	0.00%	10.00%	0.00%
Sand	15%	0.945	0.00%	3.75%	0.00%
	100%		5.10%	25.00%	1.35%

Conversion Factor
0.908

EQUIPMENT

	Weight	Conversion Factor	For Financial Analysis Weighted Tariff	Weighted Sales Tax	Weighted Port Handling
600mm Pipes	20%	0.820	2.00%	5.00%	0.60%
PVC Pipes	10%	0.941	1.00%	2.50%	0.30%
50mm PVC Pipes	45%	0.820	4.50%	11.25%	1.35%
Motor Pumps	15%	0.767	2.70%	3.75%	0.45%
Pump Controller	5%	0.767	0.90%	1.25%	0.15%
Transformer	5%	0.771	0.90%	1.25%	0.25%
	100%		12.00%	25.00%	3.10%

Conversion Factor
0.819

Accounts Payable

Total Cost of Labor Required by Project	-	35,309.46	36,015.65	36,735.96	95,933.84	110,460.40	136,012.98	155,705.61	195,158.00	234,387.42	-
Total Cost of Tertiary Labor Required by Project	-	18,007.83	16,927.36	16,898.54	41,251.55	41,974.95	51,684.93	59,168.13	74,160.04	89,067.22	-
Total Cost of Chemicals	-	-	-	-	-	-	-	-	-	-	-
Total Energy Costs	-	4,038.31	8,132.71	13,483.35	565,441.83	659,052.10	750,811.48	840,607.80	926,506.02	1,007,019.83	-
Total Other Service Costs	-	13,191.79	14,047.41	15,437.11	161,604.26	186,642.11	215,857.16	242,760.75	275,039.53	306,009.13	-

	Weight	CF	Wight * CF
Total Cost of Labor Required by Project	12.73%	**0.462**	0.059
Total Cost of Tertiary Labor Required by Project	4.91%	**0.462**	0.023
Total Cost of Chemicals	0.00%	**0.825**	0.000
Total Energy Costs	63.66%	**1.051**	0.669
Total Other Service Costs	18.70%	**0.700**	0.131
Conversion Factor	**0.881**		

TABLE 11.1: SUMMARY TABLE OF CONVERSION FACTORS

Revenue from SEWAGE COLLECTION	1.000
CEMENT	0.873
STEEL	0.798
WOOD	0.873
BRICKS	0.952
SAND	0.945
600mm PIPES	0.820
PVC PIPES	0.941
50mm PVC PIPES	0.820
MOTOR PUMPS	0.767
PUMP CONTROLLER	0.767
TRANSFORMER	0.771
LABOR	0.462
TERTIARY LABOR	0.462
CHEMICALS	0.825
ELECTRICITY	1.051
OTHER SERVICES	0.700
MAINTENANCE COSTS	1.000
REPLACEMENT INVESTMENTS	1.000
INVESTMENT COMPONENTS	
Connections	
Materials	0.912
Equipment	0.828
Collectors & Interceptors	
Materials	0.908
Equipment	0.777
Pumping Stations & Raw Sewage Pressure Pipes	
Materials	0.904
Equipment	0.777
Treatment and Outfall Pipes	
Materials	0.908
Equipment	0.819
Land	1.000
Accounts Receivable	1.000
Change in Accounts Payable	0.881
Change in Cash Balances	1.000

TABLE 12: ECONOMIC VALUE OF SEWERAGE COLLECTION IN GUARAPARI

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2027**
Sewage Collection Benefits	-	21,536	43,370	65,354	3,008,843	3,508,049	3,997,384	4,476,251	4,934,330	5,363,694	-
Environmental Recuperation Benefits					4,395,640	4,554,347	4,634,955	4,634,955	4,634,955	4,634,955	-
Total Economic Benefits	***-***	***21,536***	***43,370***	***65,354***	***7,404,484***	***8,062,396***	***8,632,339***	***9,111,206***	***9,569,284***	***9,998,649***	***-***

TABLE 13: NET ECONOMIC BENEFIT STATEMENT

Year	CF	1996	1997	1998	1999	2000	...2005	...2010	...2015	...2020	...2025	...2027
ECONOMIC BENEFIT FLOWS												
Sewage Collection Benefits		-	21,536	43,370	65,354	3,008,843	3,508,049	3,997,384	4,476,251	4,934,330	5,363,694	-
Environmental Recuperation Benefits		-	-	-	-	4,395,640	4,554,347	4,634,955	4,634,955	4,634,955	4,634,955	-
Salvage Value of Land	1.000	-	-	-	-	-	-	-	-	-	-	150,000
Total Inflows		**-**	**21,536**	**43,370**	**65,354**	**7,404,484**	**8,062,396**	**8,632,339**	**9,111,206**	**9,569,284**	**9,998,649**	**150,000**
ECONOMIC COSTS												
Investment Costs												
Labor												
Non-Qualified Labor	0.462	-	150,004	263,084	250,161	-	-	-	-	-	-	-
Qualified Labor	0.462	-	38,770	67,848	64,617	-	-	-	-	-	-	-
Connections												
Materials	0.912	-	96,443	163,019	149,027	-	-	-	-	-	-	-
Equipment	0.828	-	11,653	19,390	17,428	-	-	-	-	-	-	-
Collectors & Interceptors												
Materials	0.908	-	457,821	773,791	707,314	-	-	-	-	-	-	-
Equipment	0.777	-	53,454	88,924	79,902	-	-	-	-	-	-	-
Pumping Stations & Raw Sewage Pressure Pipes												
Materials	0.904	-	217,646	367,774	336,103	-	-	-	-	-	-	-
Equipment	0.777	-	25,258	42,019	37,756	-	-	-	-	-	-	-
Treatment and Outfall Pipes												
Materials	0.908	-	433,399	732,514	669,583	-	-	-	-	-	-	-
Equipment	0.819	-	51,734	86,086	77,375	-	-	-	-	-	-	-
Cost of Land	1.000	-	150,000	-	-	-	-	-	-	-	-	-
Operational Costs												
Total Cost of Labor Required by Project	0.462	-	16,297	16,623	16,956	44,278	50,983	62,777	71,866	90,075	108,182	-
Total Cost of Tertiary Labor Required by Project	0.462	-	8,312	7,813	7,800	19,040	19,374	23,855	27,309	34,229	41,109	-
Total Cost of Chemicals	0.825	-	-	-	-	-	-	-	-	-	-	-
Total Energy Costs	1.051	-	4,244	8,548	14,171	594,287	692,673	789,113	883,491	973,771	1,058,392	-
Total Other Service Costs	0.700	-	9,231	9,830	10,802	113,082	130,602	151,045	169,870	192,457	214,128	-
Total Maintenance Costs	1.000	-	11,800	10,800	10,821	10,842	10,955	11,079	11,217	11,368	11,536	-
Total Replacement Investments	1.000	-	-	-	-	-	-	-	-	-	-	-
change in A/P	0.881	-	(6,218)	(969)	(1,257)	(69,554)	(10,152)	(11,411)	(12,561)	(14,776)	(15,276)	133,269
change in CB	1.000	-	5,644	879	1,141	63,135	9,215	10,358	11,402	13,412	13,866	(120,968)
Total Outflows		**-**	**1,735,493**	**2,657,973**	**2,449,698**	**775,109**	**903,650**	**1,036,817**	**1,162,594**	**1,300,537**	**1,431,937**	**12,301**
Net Cash Flow		***-***	***(1,713,958)***	***(2,614,603)***	***(2,384,344)***	***6,629,374***	***7,158,746***	***7,595,522***	***7,948,612***	***8,268,748***	***8,566,712***	***137,699***

Net Present Value (NPV) @ 12.17% 35,103,958

TABLE 14: DISTRIBUTIVE ANALYSIS

	PV Financial @ Economic . Rate of 12.17%	PV Economic @ Economic . Rate of 12.17%	PV of Externalities	GOVERNMENT	CONSUMERS	LABOR	SOCIETY*
ECONOMIC BENEFIT FLOW							
Revenue Collected from Sewage Collection	14,247,989		(14,247,989)		(14,247,989)		
Sewage Collection Benefits		20,601,940	20,601,940		20,601,940		
Environmental Recuperation Benefits		25,220,902	25,220,902				25,220,902
Salvage Value of Land	4,260	4,260	-				
Total Benefits	**14,252,249**	**45,827,102**	**31,574,853**				
ECONOMIC COST FLOW							
Investment Costs							
Labor							
Non-Qualified Labor	1,126,709	520,034	(606,675)	138,019		468,657	
Qualified Labor	290,893	134,262	(156,631)	70,484		86,147	
Connections							
Materials	352,164	321,112	(31,052)	31,052			
Equipment	46,047	38,145	(7,903)	7,903			
Collectors & Interceptors							
Materials	1,678,227	1,524,191	(154,035)	154,035			
Equipment	225,093	174,931	(50,162)	50,162			
Pumping Stations & Raw Sewage Pressure Pipes							
Materials	801,545	724,422	(77,123)	77,123			
Equipment	106,415	82,659	(23,755)	23,755			
Treatment and Outfall Pipes							
Materials	1,589,899	1,442,885	(147,014)	147,014			
Equipment	206,798	169,352	(37,446)	37,446			
Cost of Land	133,721	133,721	-	-			
Operational Costs							
Total Cost of Labor Required by Project	776,935	358,596	(418,340)	98,896		319,444	
Total Cost of Tertiary Labor Required by Project	311,672	143,853	(167,819)	39,673		128,147	
Total Cost of Chemicals	-	-	-				
Total Energy Costs	3,870,940	4,068,412	197,472	(197,472)			
Total Other Service Costs	1,140,696	798,195	(342,501)	342,501			
Total Maintenance Costs	87,972	87,972	-	-			
Total Replacement Investments	9,811	9,811	-	-			
change in A/P	(115,644)	(101,922)	13,721	(13,721)			
change in CB	92,515	92,515	-	-			
Total Costs	**12,732,407**	**10,723,143**	**(2,009,264)**				
NET BENEFITS	***1,519,842***	***35,103,958***	***33,584,117***	***1,006,869***	***6,353,951***	***1,002,395***	***25,220,902***

*Society includes Consumers