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"The Economics of Water and Waste: A Case Study of Jakarta, Indonesia"

By

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Supplementary Paper No. 1

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Foreword

This "Supplementary Paper" is made available by the Environmental and Natural Resources Policy and Training (EPAT) Project funded by the United States Agency for International Development (USAID). EPAT is part of USAID's effort to provide environmental policy information to policymakers and practitioners in developing countries. The objective is to encourage the adoption of economic policies for promoting sustainable use of natural resources and enhancing environmental quality.

"Supplementary Papers" are intended to augment the EPAT publication series. They typically focus on technical aspects or contain extensive details on a topic of interest to a particular segment of the EPAT audience. They may also assist development professionals, civil servants, project officers, and researchers who are directly involved in the implementation of development activities.

This "Supplementary Paper" presents an in-depth analysis of how three basic urban environmental services - drinking water, wastewater treatment, and solid waste collection and disposal - are handled in Jakarta, Indonesia. Observations are made on how costs of these services are managed. The study concludes with several lessons learned, particularly the possibility of using different solutions that match different kinds of environmental services to different income groups. Development professionals and researchers will find useful background information on these topics which could assist their efforts in providing urban environmental services.

USAID supports the nominal costs of duplication and mailing in response to requests from interested EPAT readers. The total amount is estimated to be $500. The availability of the paper is being announced to more than 2,000 professionals in developing countries. We will assess its effectiveness by soliciting the views of recipients. An evaluation sheet is enclosed with each mailing of EPAT documents for that purpose.

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The Economics of Water and Waste:

A Case Study of Jakarta, Indonesia

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Note on Currency Units

Throughout this paper, all Indonesian Rupiah (Rp) figures have been converted into 199. US Dollar figures by use of the average Indonesian Consumer Price Index for the year of the figure and for 1993, and then converted into US Dollars ($) by application of the 1993 exchange rate between the Rupiah and the Dollar. (Whenever the exact year of a Rupiah figure is not given, it is assumed to be the year before the date of publication of the source document.) The Indonesian Consumer Price Index (CPI) for the relevant years:

Year	CPI
1980	62.9
1981	70.6
1982	77.3
1983	86.4
1984	95.5
1985 (base)	100.0
1986	105.9
1987	115.6
1988	124.9
1989	133.0
1990	142.9
1991	156.1
1992	167.8
1993	184.0

Source: IMF, 1994 (and various earlier issues), and unpublished BPS material (for the last two months of 1993). The average exchange rate for 1993 was Rp2,087.1 = $1 (Source: IMF, 1994).

Note on Quotations

Since many of the quotations are from rough draft material, I have taken the liberty of correcting obvious misprints and grammatical inconsistencies. I apologize if I have ever damaged the style or altered the meaning.

The Economics of Water and Waste:

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The Economics of Water and Waste: A Case Study of Jakarta, Indonesia

Richard C. Porter

1. INTRODUCTION

1.1 Purpose, Scope, and Overview

This monograph has two different objectives, and it seeks to reach two different audiences.

Its objectives are both descriptive and prescriptive. The ways in which Jakarta provides, and fails to provide, drinking water and disposal services for its human and solid waste products are fascinating; and one of the objectives of the following is simply to describe the economic processes behind this provision. Since the provision of these essential urban environmental services so often fails to reach the poor, or fails to reach the poor in reasonable amounts and at reasonable prices, I have made no effort to resist discussing ways in which the efforts could be improved.

I hope the audience for this monograph will consist of both economists and non-economists. Beyond assuming that all readers have mastered the introductory course in microeconomics, I have tried to write so that the arguments can be followed by everyone. Where I have been tempted to become more technical, I have driven the temptation into an appendix, some seven of which have gathered at the end -- it is up to the individual reader to decide which of (or if) these appendices are appropriate reading.

The monograph is concerned with the three basic urban environmental services -- drinking water provision, wastewater treatment, and solid waste collection and

disposal. After some general introductory observations about Jakarta's urban environment and its poor residents (in this, Section 1), I discuss each of these services separately in the next three sections (Sections 2, 3, and 4). The focus in each section is on what is provided, how it is provided, to whom it is provided, and at what price(s) it is provided. Some general observations about "covering costs" are gathered in Section 5. And some "lessons" are preached in the final Section 6.

1.2 The Environment of Jakarta

Jakarta is two cities, the beautiful and the ugly. Drive along its major "protocol" avenues and, despite the air pollution and traffic congestion, admire the broad medians, manicured landscaping, meticulous upkeep, tall buildings, sweeping parks, and impressive sculptures. Turn onto any side street or alley and see small, densely packed bungalows, tiny houses, and hovels, intermingled with small commercial and industrial establishments, with no running water, with open toilets, polluted ditches and drains, and littered with garbage and other solid waste.

To some extent, this description applies to most of the capital cities of the developing world. But the extremes are more extreme in Jakarta than elsewhere. For example, for two often measured indicators of the urban environment, access to drinking water and to sanitation facilities, the cities of Indonesia generate "the lowest degree of coverage" (Struyk et al., 1990, p. 19).1 Indonesia spends less than one half of one percent of its GDP on its urban infrastructure, by far the lowest percentage in Asia.

Even aggregate data show the differences (Table 1.2.1). Among comparable Asian countries, Indonesia lies almost exactly between Sri Lanka and the Philippines in GNP per

1 The United Nations Center for Human Settlements (Habitat) is being quoted.

capita. But it does much worse on most basic indicators of health and welfare, especially in urban areas. It even produces lower values of most such welfare measures than the weighted average of eight other comparable Asian countries.2

In a comparison of Bangkok, Jakarta, Manila, and Seoul, Brennan and Richardson (1989, Table 3) find Jakarta to have "very severe deficits" in all four of the categories, housing, water, sewerage, and environment; none of the other three cities has more than a "serious" deficit in more than two categories.

Explanations of Indonesia's poor urban welfare performance are not easily located in cross-country data comparisons. Indonesia's cities, and Jakarta in particular, are not larger than the urban areas and capital cities of other comparable Asian countries; nor has the population of its cities, and Jakarta in particular, grown more rapidly in recent decades (Table 1.2.2). Indeed, Jakarta's population growth rate has declined dramatically over the past thirty years (Table 1.2.3), so that one should expect that the pressures on urban infrastructure would be more heavily felt in the cities of Indonesia other than Jakarta.3

Cross-country comparisons of central government expenditure offer only a few aaa more hints about Jakarta's lack of an urban environmental infrastructure (Table 1.2.4).4 The central government of Indonesia spends a much smaller percentage of its budget on urban welfare and

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2 That weighted average is heavily influenced (67% of the sample) by India, whose health and welfare performance has been dismal -- though it must be remembered that India's GNP per capita is barely half Indonesia's).

3 Among these are the cities surrounding Jakarta itself. The four cities, Jakarta, Bogor, Tangerang, and Bekasi, comprise the larger Jakarta region called Jabotabek. The Botabek part of this region has grown at 4-5% per annum throughout the past two decades. See Hugo et al., 1987, pp. 311ff.

4 Data on local government expenditure are few, but municipal taxes play a much smaller role in urban expenditure in Asia than in Western Europe and North America.

amenities than do comparable countries, despite Indonesia's lower spending on defense.

The history of Jakarta begins to make the situation clearer. Even more than other European colonizers, the Dutch ran Indonesia as a business. What little expenditure was devoted to urban amenities in Batavia (the Dutch colonial name for Jakarta) was directed toward the places where the Europeans lived and worked:5

> ... every budget was weighted in favor of European interests in the city. Most of the biggest items, such as road-building and maintenance, street-lighting, drinking-water provision, and payment of municipal personnel were items of expenditure largely on behalf of Europeans, since they were the ones who lived along and used roads most; street-lighting and drinking-water were largely restricted to their areas .... (Abeyasekere, 1987, p. 119)

Not until 1929 did the Dutch initiate a *kampung* (urban area, strictly translated as "village") improvement program, but it was "virtually abandoned" during the Depression of the 1930s (Abeyasekere, 1984, p. 7). Then the 1940s were lost to the Japanese occupation and the prolonged independence struggle.

With Independence, President Sukarno's vision of Indonesia began to shape contemporary Jakarta. The major avenues, divided by landscaped medians and surrounded by parks and sculptures appeared in the 1950s. Every new nation must make trade-offs between investments in a sense of nation-hood and investments in material welfare, and Sukarno frankly defended his choice:

> Man does not live by bread alone. Although Jakarta's alleys are muddy and we lack roads, I have erected a brick-and-glass apartment building, a clover-leaf bridge, and our superhighway I

---

5 This phenomenon is, of course, not as stark in Jakarta as in the cities of South Africa, whose structure I have analyzed under the title, "the apartheid city" (Porter, 1993a).

> consider money for material symbols well spent. I must make Indonesians proud of themselves. They have cringed too long. (Sukarno, 1966, p. 293)

But Jakarta doubled in size (Table 1.2.3) during Sukarno's 15 years, and little happened to the urban infrastructure beyond the main streets. Moreover, a major priority of the New Order, for its first 15 years, was to prevent the growth of the large cities, and attention to the urban infrastructure was to a great extent postponed for fear that better urban conditions, especially for the poor parts of the cities, would simply accelerate the rural-urban migration.6 There were efforts -- the Kampung Improvement Program (KIP) began in Jakarta in 1969 -- but the emphasis was on roads and paths, not on basic sanitation and clean water (Abeyasekere, 1984, p. 15 and 1987, pp. 223ff; Noormohamed, 1980).

Thus, by 1980, Jakarta had grown nearly fourfold, from a city of 1.8 million in 1950 to a city of 6.5 million. From the viewpoint of its drinking water, sewage treatment, and solid waste disposal, however, it had simply become a huge village, where inhabitants are left largely on their own with regards to water and waste. Listen to one contemporary account of the late 1970s:

> The growing numbers of people exerted an enormous pressure on the land. They produced an ever-increasing amount of refuse though there was no proper system of rubbish collection. It accumulated in the pathways and progressively choked the Cideng River. It was left to rot in the heat and humidity. The disposal of human waste created even bigger problems. The community built toilets out over the Cideng River. They were at least tolerably efficient when the river flowed but they were a disaster in the dry season or when the river was in flood. The river had long been too polluted to drink. Two wells were dug but their water became too contaminated for consumption. It could still be used for washing though one had to queue for quite some time to

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6 In 1970, the City was declared "closed" to migrants, an edict that is nominally still in effect (UN, 1989, p. 17).

> obtain a supply. Drinking water became a precious and expensive commodity. It was distributed by traders who carted it in metal containers suspended from a pole slung over their shoulders. In 1978 the poorest families in Kebun Kacang [a *kampung* in Central Jakarta] spent up to 5% of their incomes to buy a meagre eight liters of water per person per day, a minuscule amount especially for the tropics. (Jellinek, 1985, pp. 38-43)

Ironically, beside this public squalor, there was growing private opulence, and not just for the few. The material wealth of Jakarta, and Indonesia, was growing at a miraculous pace. Jakarta's poorest *kampungs* were sprouting corrugated iron roofs and second floors to dwellings, electricity, glassed windows, radios, and motorcycles; the children were becoming well fed, clothed, and schooled.

At last, in the 1980s, the government's interest in the urban infrastructure began to grow "markedly" (Kingsley, 1993, p. 1), but the problem has become so immense that it has hardly been dented by the efforts of the last 15 years (Table 1.2.5). Partly, catching up is a costly business, "since it is then necessary to disrupt already built-up areas to improve roads, lay water mains, and construct drainage systems" (World Bank, 1993c, p. 109). Partly, Jakarta's growth has involved both sprawl, which expands the problems, and density, which makes land-intensive solutions more difficult.7 And partly, Jakarta continued to grow in the 1980s, albeit at a much slower rate (Table 1.2.3), making it necessary to catch up to a moving target.

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7 The ever-greater sprawl and density and the belatedness of the inevitable "vertical densification" would be the subjects of another study. The World Bank blames both too many government "policies and regulations ... and attempts to control land prices" (World Bank, 1993b, Volume 1, p. 19) and too few government policies to prevent private sector land development from "occurring in an uncoordinated fashion" (World Bank, 1993c, p. 109).

Table 1.2.1

Asia Comparison: Output, Health, and Urban Welfare Indices

Country	GNP per Capita	Human Development Index	Infant Mortality Rate	Urban Population with Adequate Water	Urban Population with Adequate Sanitation
Indonesia	$610	0.515	74	65%	40%
Bangladesh	220	0.189	105	39%	40%
India	330	0.309	90	79	38
S. Korea	6,330	0.872	16	91	99
Malaysia	2,520	0.790	15	96	94
Pakistan	400	0.311	103	84	56
Philippines	730	0.603	41	93	79
Sri Lanka	500	0.663	18	80	68
Thailand	1,570	0.715	27	67	84
Median	$615	0.633	34	82%	74%
Average	$635	0.362	83	77%	47%

Notes:

1. GNP per Capita in 1991.
2. Human Development Index (which ranges from 0, lowest, to 1, highest) for 1990. This index combines indicators of purchasing power, education, and health.
3. Infant Mortality Rate is in deaths per 1,000 live births in 1991.
4. Percent of Urban Population with Adequate Water and Sanitation in 1988-1990 (Bangladesh and Thailand Water figures from earlier years).
5. Median and Average (weighted by 1991 population) are of the countries other than Indonesia.

Source: World Bank, 1993d, Tables 1 and 28; UNDP, 1993, Tables 1 and 10 (and an earlier issue of the same publication).

Table 1.2.2

Asia Comparison: Urbanization Rates and Levels

Country	Urban Population Percent	Urban Population Growth	Capital City Population Percent	Capital City Population Growth
Indonesia	31%	5.0%	5%	3.7%
Bangladesh	16%	6.5%	6%	8.8%
India	27	3.8	1	1.2
S. Korea	73	4.4	26	4.6
Malaysia	44	4.9	10	5.0
Pakistan	32	4.4	7	4.8
Philippines	43	3.7	14	4.4
Sri Lanka	22	1.5	4	0.7
Thailand	23	5.0	13	3.9
Median	30%	4.4%	8%	4.5%
Average	29%	4.1%	4%	2.6%

Notes:

1. Urban Population (1991) and Capital City Population (1990) are in percentage of total population.
2. Urban Population growth rate is per annum for 1970-1991; Capital City Population growth rate is per annum for 1960-1990.
3. For Pakistan, Karachi rather than capital city.
4. Median and Average (weighted by 1991 populations) are of the countries other than Indonesia.

Source: World Bank, 1993d, Tables 1 and 31 (and an earlier issue of the same publication); UNDP, 1993, Table 23.

Table 1.2.3

Rank, Size, and Growth Rate of Jakarta, 1950-1990

Year	City Rank	Population	Growth Rate
1950	33	1.8	nc
1960	25	2.8	4.5%
1970	22	4.5	4.9
1980	21	6.5	3.7
1990	15	8.3	2.5

Notes:

1. City Rank is the global population rank.
2. Population is in millions.
3. Growth Rate is decennial, in percent per annum.
4. nc means not calculated.

Source: Sivaramakrishnan and Green, 1986, pp. 16-18; BPS, 1993, p. 41.

Table 1.2.4

Asia Comparison: Central Government Expenditures, 1990s

Country	General Service	Defense	Health, Educ.	Welfare, Amenities	Other
Indonesia	36%	8%	11%	2%	43%
Bangladesh	31%	10%	16%	10%	33%
India	6	17	4	7	66
S. Korea	11	22	17	13	37
Malaysia	15	12	25	10	38
Pakistan	7	29	3	9	52
Philippines	11	11	20	4	54
Sri Lanka	11	9	13	18	49
Thailand	11	17	28	6	38
Median	11%	14%	16%	10%	44%
Average	9%	17%	8%	8%	59%

Notes:

1. All figures are as percentages of total central government expenditure.
2. "Welfare, Amenities" includes social security, welfare, housing, and community amenities.
3. "Other" is calculated as a residual.
4. Data of most recent year available (1990s except for Bangladesh, 1985, and Pakistan, 1986).
5. Median and Average (weighted by 1991 populations) are of the countries other than Indonesia.

Source: IMF, 1992, pp. 44f (and an earlier issue of the same publication); World Bank, 1993d, Table 1.

Table 1.2.5

Estimates of Indonesia's Urban Public Shortcomings

Population Group	Year 1980	1990	2000
Total Population	148	179	206
Urban --			
Population	33 (22%)	49 (27%)	76 (37%)
In Poverty	9 (27%)	12 (24%)	18 (24%)
Inadequate Water	18 (55%)	27 (55%)	42 (55%)
Inadequate Sanitation	24 (73%)	34 (69%)	54 (71%)

Notes:

1. Population figures are in millions.
2. Percentages in parentheses in the Urban Population row are of Total Population.
3. Percentages in parentheses in the final three rows are of Urban Population.

Source: UNDP estimates, as reported in Van Der Hoff and Steinberg, 1992, p. 41. Total Population for 1980 and 1990 from BPS Census figures; for year 2000 an estimate of World Bank, 1993d, p. 288.

1.3 The Urban Environment and the Urban Poor

It has long been understood by development economists that most of the truly poor in developing countries live in rural areas, not cities. The World Bank stresses this continually in its Indonesian reports. For example:

> ... the average urban dweller is unambiguously better off than the average rural dweller in terms of income levels and other social indicators. (World Bank, 1990a, p. 110)

And a later report notes that the mean urban expenditure per capita was $27, the mean rural expenditure per capita was $15, and prices in urban areas "were no more than 20 percent higher than in rural areas" (World Bank, 1993b, Volume 1, p. 13).

Nevertheless, the numbers and the percentage of the poor who live in cities are large and growing. The sheer size of the urban population has grown (Tables 1.2.2 and 1.2.3). The fraction of the population that is urbanized has grown rapidly, and the fraction of the urban population that is impoverished has hardly fallen at all (Table 1.2.5). This is, of course, the expected result of general equilibrium forces -- as unskilled labor moves to the cities, relative wage rates of the unskilled rise in the countryside and fall in the urban areas. Dillinger (1993) reminds us, "as countries have urbanized, poverty has urbanized as well" (p. 3).

Cities grow because they are productive, and the incomes of their residents grow because of this growing productivity. But this very process of growth in city size and congestion also reduces the real incomes of city workers by raising the prices they pay and worsening the environmental conditions in which they live. Those workers whose incomes do not reflect the productivity growth become worse off rather than better off. There is no inconsistency between the facts of a higher <u>average</u> real income in

developing country cities and of an increased number and percent of the city's workers falling into, or remaining in, poverty.

A look at the measurement and meaning of poverty in Indonesia is instructive. Early estimates of poverty differentials between city and country in Indonesia were based entirely on rice consumption -- the "very poor" were defined as those whose incomes permitted consumption of less than 240 kg of rice per capita per annum -- even though cereal consumption usually comprised only 10-20% of an Indonesian household budget. Since rice prices differ only slightly between city and country, the poverty line, so measured, is similar in the two areas, and the measured percentage of the poor who live in cities is small (Booth, 1993, p. 73).

Once one expands the cost-of-living beyond rice, and begins to include such items as housing, the gap between the urban and rural poverty lines grows. The absolute numbers in poverty, by this definition, have declined in the rural areas since 1970 but have risen in the urban areas. By 1993, more than one third of the poor lived in cities ("Indonesian Poverty", 1994). The percentage grows each year as more non-food items, with their ever higher relative prices in cities, are incorporated into the price comparisons.8

By 1993, Indonesians are reckoned impoverished if their incomes are below $9 per capita per month in rural areas or below $19 per capita per month in Jakarta (where the poverty line is the highest of the cities). The World Bank thought that incomes almost twice as high in cities proved the relative absence of poverty there; it turns out that incomes more than twice as high are needed just to stay at the poverty line in Jakarta!

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8 "The new [1993] survey includes 52 food items and 46 non-food items that include housing, clothing, power, water, education ..." ("Indonesian Poverty", 1994).

This difference in the poverty line may seem incredibly large, so an illustration may be useful. Consider a poor person in Jakarta who consumes only one fourth as much water as the average person in the City and who works sufficiently long hours that this water must be purchased from a street vendor. The cost will be some $2-5 per month in Jakarta, while a poor person in a rural area probably gets comparable water for free.9 Water alone may account for as much as half the gap between the poverty line for Jakarta and that for rural areas.

To summarize this digression into poverty measurement, there are many poor in Jakarta, and they are particularly poor because of the high cost of environmental amenities -- those that can be bought are very expensive in Jakarta, and those that are just unavailable, like clean air everywhere and waste disposal in some places, are in effect prohibitively costly. The argument I am making, however, is not that the government should provide these environmental services because they are expensive. Rather, they are expensive because the government does not provide them, and it is costly for people to find or provide substitutes for them. Expensive substitutes are available, but only the rich can readily afford them. Urban environmental services stereotypically involve public goods, natural monopolies, or externalities, and in the provision of these the private market is well known to fail in the sense that it provides too little and at too high a cost and price.

This inadequacy of public provision of environmental services and the high cost of private substitutes may go unnoticed because they do not show up in any of the usual

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9 We will return to, and document, these numbers in Section 2.3. This poor person could reduce the water cost by buying directly at a standpipe, but since most poor people do not, it must be that the opportunity cost of the time spent walking to, waiting at, and carrying from the standpipe exceeds the markup of the vendor. Water in the rural areas of developing countries is, of course, not free -- while it rarely costs money, it usually costs time.

economic statistics. As it becomes less pleasant and more costly for the poor to live in Jakarta, the wages that must be paid there rise, reducing Jakarta's output and the rate of return to private capital in unknown and unmeasured ways. Unknown amounts of resources are wasted on expensive, inefficient private substitutes for the absent or inadequate public environmental services. And opportunities to increase welfare are lost because, even where willingness-to-pay is high, it is often unmeasured and hence unnoticed.10

Where public goods and externalities are involved, economic theory is clear on the optimal pricing -- prices should be set at marginal social cost. For goods with large minimum efficient scale, marginal private cost will be below average private cost; and for goods that generate positive externalities, marginal social cost will be below marginal private cost. On both accounts, optimal pricing will produce total revenue that is less than total cost. If the service is considered a "merit good", or a "basic need", then an even lower price may be appropriate.11 In theory, the deficit is to be covered from a general fund collected by means of non-distorting taxation.

In Jakarta, as elsewhere in the real world, deficits are not so readily covered. Taxation for the general fund is politically constrained and economically distorting. The concern for optimal pricing and allocation must be tempered by a concern for covering costs. As we examine the specifics of Jakarta's provision of drinking water, waste water treatment, and solid waste disposal (in the next three

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10 I have found more hints than careful studies of this willingness-to-pay in Indonesian cities. For a fuller discussion of willingness-to-pay concepts and studies elsewhere that attempt to measure willingness-to-pay for urban environmental services, see Coolidge et al., 1993 (and for a brief summary of that paper, see Porter, 1993b).

11 A "merit good" is one that the government feels should be available to all people, in at least some minimal quantity, regardless of their ability to pay for it.

sections), we must share this concern for both efficient pricing and revenue generation.

Economic theory helps us with this twofold concern. Finding the optimal prices given the need for a certain revenue collection is the province of "the second-best". It involves a groping search for, and a slow adjustment to, the ultimately optimal techniques, discriminatory pricing, and the offering of different kinds of service to customers of different income levels.12

We will find in the next three sections that actual policy in Jakarta does not always follow the prescripts of "second-best" theory. Too often, the goal is high-quality provision for all, but the provision starts in the well-to-do areas and is priced below average cost. The result is that budgets run out before the poor are reached: "... the reluctance to charge for many types of urban infrastructure limits the availability of resources ..." (Patten et al., 1993, p. 12). Furthermore, subsidies end up in the pockets of the rich, not the poor:

> Subsidies ... are particularly ineffective means of pursuing poverty reduction goals (because they inadvertently subsidize non-poor consumers) and are inefficient (because they reward over-consumption). As governments rarely provide full compensation to the providers for the full costs of these subsidies, their costs take the form of deferred maintenance and reluctance to extend service into low-income areas. (Dillinger, 1993, p. 22)

The basic purpose of this monograph is to urge that there are budgetarily feasible ways of providing better urban services to the poor in Jakarta than they now receive.

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12 See Fischer and Porter, 1993, for a theoretical treatment of these issues as they apply to urban environmental services in developing countries.

2. DRINKING WATER

SUMMARY

The problem with drinking water in Jakarta is not scarcity but inefficient allocation and inequitable pricing. Relatively few households receive drinking water piped into their residences, and these few are relatively rich households and their water is subsidized. The poor, unless they have access to cheap shallow wells, must rely on the relatively expensive water from standpipes, usually delivered by vendors.

Shallow wells are a cheap source of water for rich and poor alike, but such water is increasingly becoming polluted in Jakarta. This means that the demand for piped water will increase rapidly. Household connections are desirable for all, but budgetary problems will prevent such an outcome for many years.

In the meanwhile, for efficient and equitable allocation within budget constraints, the water agency (PAM Jaya) should: 1) ease the initial hookup-cost burden by offering loans at modest interest rates; 2) establish a minimum price for piped water that covers at least the marginal delivery cost; and 3) escalate the water price for households that are heavy users (i.e. "lifeline" pricing).

For households that continue to rely on standpipes and vendors for their water, the price should be brought down by expansion of the number of public standpipes. Lest such standpipes become a burden on PAM Jaya, they should be owned and operated by private entrepreneurs, with the growing numbers of standpipes preventing monopoly practices.

For large commercial and industrial businesses, their reliance on deep well water should be restrained, in two ways: 1) the fee for deep well water should be greatly increased, so as to increase its total cost to or above the charge for piped water; and 2) the charge for PAM Jaya piped water should be reduced to, or near, its marginal delivery cost.

Finally, PAM Jaya should concern itself much more with the delivery of adequate quantities of

drinking water in the short run, with attacks on quality problems being postponed. Part of this concern with providing adequate water quantity, within budget constraints, must involve a reduction in the amount of water for which PAM Jaya fails to collect any fee at all.

2.1 Introduction

There is no shortage of water in Jakarta. A dozen rivers and several canals wind their way northward through the City, and groundwater is accessible within a few meters of the surface in most of the City. And more is available outside the City -- only a few percent of Java's water resources are currently used for municipal purposes.1 The problem is that most of this water is not drinkable, at least not without lengthy boiling. Indeed, most of it is too polluted to be used even for washing or for laundry.

The pollution of the rivers, canals, and shallow aquifers is a recent phenomenon, brought on by the rapid growth in the numbers and density of the population. And it has seemingly caught Jakarta unawares, as the City has moved in a few decades from one where each household could readily find its own drinking water to one where drinking water is a scarce, and often very expensive, commodity. In parts of Jakarta, "inadequate access to reliable and low-cost sources of clean water has led consumption to fall to health-threatening levels" (Crane, 1993, p. 1).

The blessing of copious water long made it possible, even reasonable, to postpone public involvement in the water

1 Java gets plenty of rainfall; the problems are that it is very seasonal and that its rivers are steep and short. So most of the water runs unused to the sea. But reservoirs, now few, could be constructed; and the agricultural value of the water for irrigation is less than $0.05 per cubic meter, so much more water could be made available for Jakarta at very low opportunity cost (World Bank, 1993c, pp. 52f).

system. The Dutch installed few water systems, and there was little development after Independence until the 1970s. The capacity of municipal water treatment facilities more than tripled during that decade, but even today fewer than one fourth of Jakarta's population receive water that is piped into their residences.

Those that receive piped water receive it from Perusahan Air Minum Jaya, PAM Jaya for short, the parastatal agency for drinking water supply in Jakarta. PAM Jaya obtains its raw water primarily from the West Banjir Canal (5,600 liters per second (lps)), the Sunter River (4,000 lps), and the West Tarum Canal (2,000 lps), but these are supplemented by water from various other rivers and canals (635 lps), spring water from Bogor (300 lps), and several deep wells (120 lps).2 The water, especially the surface water, is heavily treated, but it arrives at the intake of the treatment plants so polluted that "it is difficult" to attain minimum World Health Organization (WHO) drinking water standards (Hadiwinoto and Clarke, 1990, p. 9).

PAM Jaya makes its treated water available basically through either piped house connections or public standpipes. But only about 11% of Jakartans get all their water from piped in-house connections (Table 2.1.1).

More than half of Jakarta's households draw their water supply entirely or principally from shallow wells. The remaining fourth, with neither house connections nor shallow wells, rely upon the public wells and standpipes or have their water delivered to their residences by water vendors, who have purchased their water supplies at public wells and standpipes.3

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2 Another 3,000 lps will become available at the end of 1994 ("Piped Water", 1994).

3 Some 10% of Jakarta households also use spring water (Cestti, 1993, p. 12), of which over 600 million liters a year are sold in Indonesia (mostly by a single firm, Aqua). It is sold both in small bottles, like soda, for occasional use and in large bottles for regular home use.

There is a definite relationship between income level and water source and water consumption (Tables 2.1.2 and 2.1.3).4 High-income and middle-income families, with house connections and wells, spend 4-5% of their incomes on water; low-income families, relying almost entirely on standpipes and vendors, spend 10% of their incomes on water (IWACO, 1992, p. 24; Cestti, 1993, p. 14).5

The reason the poor spend so much higher a percentage of their incomes on water is only partly the result of income inelasticity of water demand and the low incomes of the poor. The poor also pay a higher price. Water from vendors costs much more than water from PAM Jaya connections or water from wells (even those with electric pumps). Where aquifers are depleted, rivers are polluted, and households are far from the nearest well or standpipe, vendor water may cost as much as $5 per cubic meter.6 This is 10-25 times the marginal cost of PAM Jaya water through a house connection.

The huge price differentials between different water sources and the large percentage of their incomes that the poor must spend on this essential product make water a sensible target of public policy. Once the rivers and canals have become polluted beyond use, water can no longer be provided for oneself in an urban environment at a reasonable price. Water has essential elements of a natural monopoly. Moreover, water generates significant positive health externalities -- adequate quantities of drinking and

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4 Tables 2.1.2 and 2.1.3 present similar information in interestingly different ways. Apparent contradictions are resolvable by careful attention to the definitions of the variables, but the underlying data do come from different samples at different times and may indeed be contradictory in places.

5 Paradoxically, "a criterion used for determining the number of town inhabitants who are potential customers of a water supply scheme has been the assumption that a household is able to spend 4% of its income on piped water" (PT Indah, 1988, Section 6, p. 22).

6 One cubic meter equals one kiloliter.

bathing water of adequate quality not only reduce one's own skin and intestinal infections but also prevent the transfer of such infections to others.

Table 2.1.1

Distribution of Jakarta Households, by Water Source

Main Water Source	Population	.Water Sources (%). Piped	Well	Vendor
Piped Connection				
Only	11%	100	--	--
Principally	8	53	43	4
Shallow Well				
Only	37	--	100	--
Principally	20	26	65	9
Standpipe/Vendor				
Only	11	--	--	100
Principally	13	15	18	67

Source: World Bank, as reported in Cestti, 1993, p. 13.

Table 2.1.2

Principal Water Source by Income Category in Jakarta

Water Source	Income Class Low	Middle	High
Piped Connection	14%	36%	56%
Shallow Well	40	42	38
Standpipe/Vendor	47	22	6
Average Consumption	100	117	250

Notes:
1. Percentages may not add to 100% due to rounding.
2. Average Consumption is in liters per capita per day (assuming six persons per household for each income group).
3. The precise income ranges are not defined.

Source: IWACO, 1992, p. 20.

Table 2.1.3

Domestic Water Use in Jakarta, 1989

Income Class	Water Source Piped	Well	Other	Average
High	212	178	--	192
Middle	143	123	103	129
Low	112	108	96	105
Average	153	127	97	131

Notes:
1. Water Use is in liters per capita per day.
2. Other is largely from vendors.
3. The precise income ranges are not defined.

Source: Bansgrove, 1991, p. 70.

2.2 Groundwater and Wells

Not only does Jakarta have an abundance of surface water, but there is also groundwater of naturally high quality under it in shallow and deep aquifers. Both types of aquifers have been used and abused.

The shallow aquifer is tapped by wells of less than 15 meters in depth. There are no data on the numbers of shallow wells or their output of water, but since the wells are usually not shared among households and since over half of Jakarta relies at least partially on well water, there must be close to a million such wells and their total water output must be several hundred million cubic meters per year.7 There are no policy restraints on the digging or operation of shallow wells, and there are no charges on the water from them (beyond the private cost of pumping and treating the water). The shallow aquifer is running dry in only a few parts of Jakarta, but the water is rapidly becoming saline and contaminated by leachate from inadequately handled human and solid waste.8

For those households with groundwater of adequate quantity and quality -- about 40% of Jakarta, and a fair cross-section of rich and poor (Table 2.1.3) -- shallow wells provide a cheap water source. The only cost is basically the digging, plus maintenance and electricity.9 The average cost of well water has been estimated to run $0.20-0.35 per cubic meter (IWACO, 1992, p. 23), about the

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7 The World Bank estimated 120 million cubic meters per year for 1986 (World Bank, 1990b, p. 142) and "200 plus" million cubic meters in 1993 (World Bank, 1993c, p. 54). While wells are not usually shared, some people with wells sell water to their neighbors, and, in some poor sections of the City, public wells with free water are maintained by the community.

8 Especially in North Jakarta. Elsewhere in Jakarta, the groundwater "is relatively good" ("Piped Water", 1994).

9 70% of the shallow wells use electric pumps (IWACO, 1992, p. 22).

marginal cost of PAM Jaya piped water for those who buy relatively little water.10

Is the increasing pollution of the shallow aquifer a justification for restrictive water policy concerning these wells? Obviously, the pollution of the aquifer is an external cost of inappropriate disposal of sewage and solid waste and hence is a justification for stricter wastewater and solid waste policy.11 It is not, however, a justification for stricter shallow well policy for two reasons.

One, theory. The very existence of the pollution of the well water should be sufficient incentive for rational users to properly reduce their consumption of it. The pollution is not intangible, and users are well aware of it. As IWACO (1992, p. 80) points out, it is rarely appropriate to tax the victim of pollution, and the well-user is a victim and not a generator of externality -- only in certain parts of Jakarta, and only at certain times of year, does water taken from one shallow well reduce the water availability (or raise the water cost) at another shallow well (World Bank, 1993b, Volume 2, p. 9).

And two, practicality. It is difficult to think of ways to tax or restrict the use of shallow wells. They are not even enumerated, much less metered. Since such wells are about equally used (in proportion to the population) by rich and poor, there is no income-distribution reason to levy taxes here. Enumeration and fees would create more bureaucracy than revenue; harsh fines would be impractical, and small fines would be ineffective (Shugart, 1991b).

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10 It might seem that treatment costs should be added to the costs of well water in order to make a valid comparison to piped water, but that is probably not appropriate since both water sources are polluted and need boiling or other treatment before use.

11 To a great extent, the pollution of the wells is not even an externality. Two thirds of the shallow wells in Jakarta are within ten meters of the family's own latrine or septic tank (IWACO, 1992, p. 77).

Most of Jakarta's well water comes from shallow wells, but there are also several thousand deep wells, pumping possibly another one hundred to three hundred million cubic meters per year from an aquifer at about 200 meters (Figure 2.2.1).12 In principle, permits are needed to sink deep wells, and the City charges fees for the water that is extracted.13 There is widespread agreement that the deep aquifer is being greatly overextracted, causing its salinization and land subsidence.14

Withdrawal from an aquifer at a rate above the recharge rate results ultimately in its depletion. In the interim, each marginal withdrawal imposes four kinds of external costs upon society: 1) water extracted for one use (or user) is not available for another use (or user) and hence incurs an opportunity cost of the value in the next best use; 2) as the aquifer is depleted, each extraction further lowers the declining level of the groundwater table and thereby increases the pumping costs of all other users; 3) the decline in the groundwater table causes land subsidence and thereby increases flooding and risks serious damage to buildings and roads; and 4) the decline in the groundwater table causes salinity of the groundwater, which reduces its

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12 As of June 1992, PAM Jaya had registered 2,691 deep wells, with a 1 cubic meter per second (m3/s) rate of extraction. The source of Figure 2.2.1 (and of the other two figures in this section) is City, various issues.

13 Groundwater extraction charges have existed in Jakarta since 1975, and deep well production has been metered since 1983, although enforcement has been "very poor" (IWACO, 1992, p. 82) and permits are "not too difficult" ("High-Rise", 1994). Water can be drawn directly from a river or canal without permit.

14 Land subsidence in turn threatens the stability of structures and increases the risk of flooding. A 1992 hydrologic study estimated deep well extraction at 3 m3/s, "suggesting that not all deep wells are registered by PAM Jaya" (IWACO, 1992, p. 73). Cestti (1993, p. 5) estimates that current groundwater extraction is about twice the sustainable rate -- 7.0 m3/s versus 3.6 m3/s. And JMDPR (1993) estimates deep groundwater extraction at 9 m3/s, while the recharge rate is only 3 m3/s (and recharge times are long, perhaps as much as 100 years).

quality to other users and damages pumps. The correct policy response to the depletion of the aquifer is a tax on users to reflect the external costs they impose on other users. Consideration only of externality (1) of the four listed above justifies a tax on groundwater that would possibly lift its total cost above the cost of surface water.15

In fact, current groundwater charges are much below surface water charges for large commercial and industrial users. Groundwater costs only about half as much as piped water (Table 2.2.1).16 PAM Jaya sets high piped-water prices for commerce and industry in an effort to cross-subsidize residential users -- the price of PAM Jaya piped water to large industrial users is five times the price charged the smallest residential users and 1.5 times the price charged the largest residential users (Cestti, 1993, p. 11; IWACO, 1992, p. 8). Of course, with low groundwater prices, this drives many such establishments to deep wells and ends up contributing little to the cross-subsidization. We return to this in Section 2.5.

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15 The economics of the aquifer is developed more fully in Appendix I.

16 For firms that use, for example, 10,000 cubic meters per month of water, the average price of piped water is about $1.00/m3, and the average price of deep well groundwater is $0.45-0.60/m3 (Cestti, 1993, p. 11). (The price range indicates that the price differs for establishments inside and outside PAM Jaya's service area.) To compare <u>costs</u> of the two sources, one must add to the groundwater price the cost of drilling the deep well and pumping out the water, but one must add to the piped water price the cost of the greater treatment that it requires and any cost imposed by its interruptible service. The Jakarta City Council authorized increased groundwater prices to large industrial users in April 1994, by "100 percent to 500 percent", but the new price schedule was not then announced ("Revised Bill", 1994).

Figure 2.2.1
Registered Deep Wells

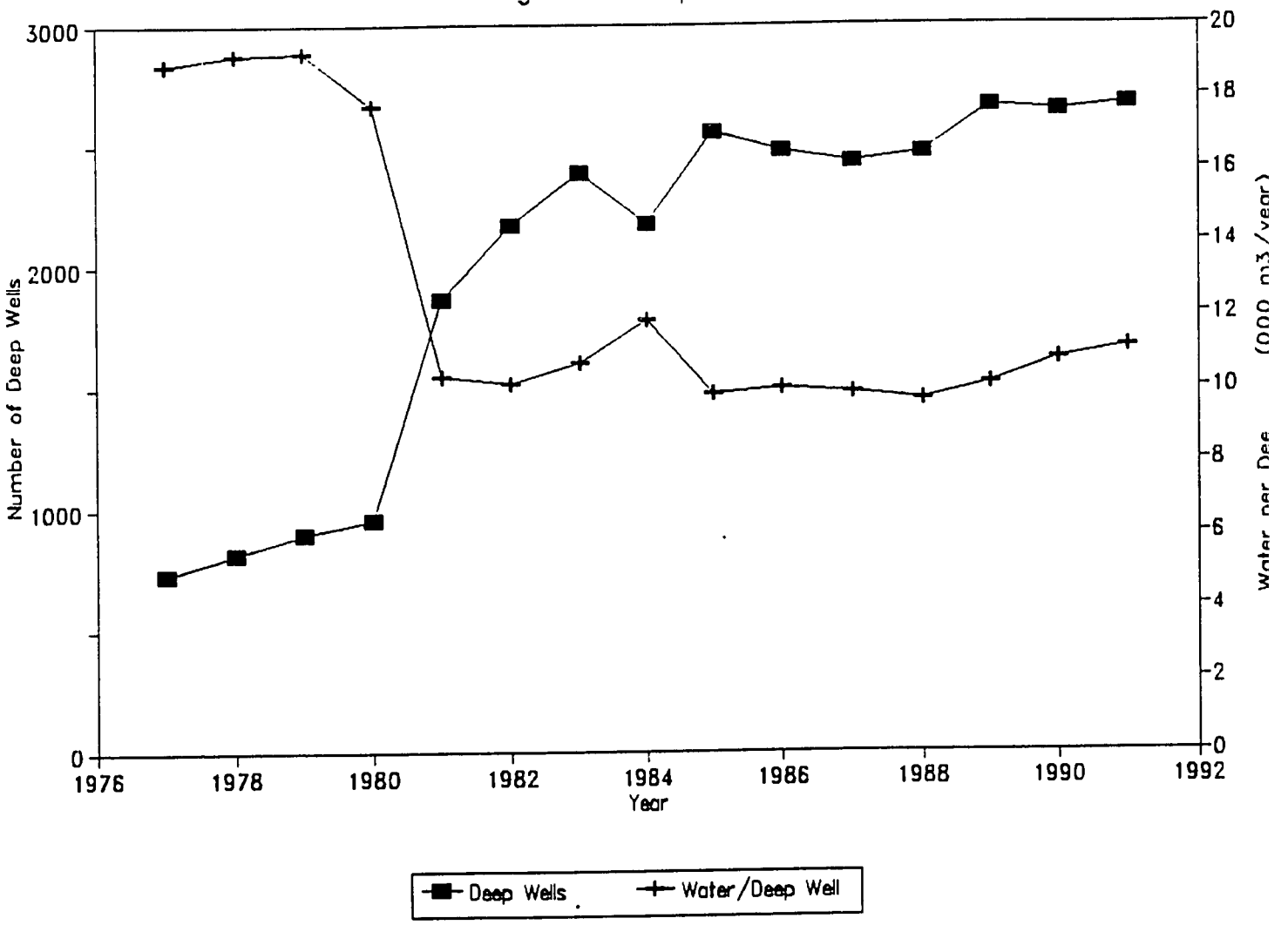

Table 2.2.1

Average Cost of Water to Industrial Users, 1992

Source	Average Cost
River Water	0.06
Groundwater	0.67
Piped Water	1.31
Tanker or Bottled Water	39.30

Notes:
1. Average Cost is in $ per cubic meter.
2. Cestti (1993, p. 27) estimates the average cost of river water to industrial users is higher ($0.11-0.26), but still much below that of other sources.

Source: World Bank, as reported by IWACO, 1992, p. 83.

2.3 Standpipes and Vendors

As the river and canal waters have become non-potable, and especially in those parts of Jakarta where the well water has also become polluted or run dry or become brackish, the poor have had to find their water at public standpipes or to purchase it from vendors who deliver water from such standpipes.17 Reliance on water vendors is not unusual in cities like Jakarta -- "water vendors serve 20 to 30 percent of the urban population of the Third World" (Cairncross, 1990, p. 114).

This water delivery system has two problems. One, distributing water by cart (or by truck) is inefficient compared with pipes, and therefore the vendor system is at best a stopgap measure. And two, this inefficiency shows up in the prices of water and means that those without house connections, usually the poorer households, end up paying much higher prices for their water and, as a result, consuming much less water.

The number of public water standpipes in Jakarta actually declined in the mid-1980s, and by the end of 1987 there were barely 1,000 spread throughout the City (see Figure 2.3.1).18 This is relatively few by Indonesian city standards -- Surabaya, for example, with barely one fourth

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17 In South and East Jakarta, almost all households still use wells (Section 2.2); in West and North Jakarta, where the quantity and quality of well-water has drastically declined, 79% of households use vendors, while only 12% have PAM Jaya house connections (Shugart, 1991c, p. 3).

18 For the recent trends in numbers of hydrants and consumption per hydrant, see Figure 2.3.1. There are two kinds of standpipes, the *hidran umum* (public standpipe) and the *hidran contoh* (sample or pilot standpipe). Private operators apply to PAM Jaya for licenses to construct, own, and operate a *hidran umum*; Bappenas finances the construction of a *hidran contoh*, PAM Jaya retains ownership, and it is operated under the guidance of the local community. The economic difference is small since the capital costs of hydrants and their reservoirs amount to only about $300, which means no more than a few dollars a month (Shugart, 1991c, p. 5).

the population, has twice as many public water taps (Lovei and Whittington, 1991, p. 14).19 The water at these standpipes was heavily subsidized, and hence PAM Jaya was "reluctant" to encourage public standpipes because they were considered "problematic" and "less profitable" (IWACO and WASECO, 1990, p. 35):

> ... neither the local water enterprises were motivated to provide standpipes nor were the poor generally benefiting from those that were available. The local water enterprises were required to meet financial performance objectives .... This was in direct conflict with their social objectives of providing subsidized water to the poor .... For most enterprises substantial profits were being made from house connection fees and residential tariffs but none from constructing public standpipes which also generally require more maintenance attention. (World Bank, 1990a, p. 115)20

Public hydrant owners still do receive water from PAM Jaya at a heavily subsidized rate, currently $0.07/m3; they in turn sell it, nominally at a fixed price, currently $0.24/m3. In fact, in the late 1980s, the hydrant selling prices were often at least twice the officially fixed prices.21 There are a number of minor reasons why large markups often appeared at the standpipes: the pressure in

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19 For completeness, it should be mentioned that, in addition to hydrants, PAM Jaya also provides a few *terminal air* (water tanks where the water is delivered by truck rather than pipe) and a few *stasiun air* (outlets where PAM Jaya sells water to private tanker trucks).

20 An earlier World Bank report had spoken even more strongly: "... the PDAMs ... find excuses for not constructing standpipes" (World Bank, 1984, p. 50). It was also suggested that the number of standpipes may have been artificially restricted so "various officials" could collect "unofficial fees" from monopolistic SP operators (Shugart, 1991c, p. 8).

21 Studies varied on how much higher. In 1990, 34.3% of the hydrant operators charged more than the maximum price (IWACO, 1992, p. 10). Lovei and Whittington (1991) found standpipe prices of $0.37-0.68/m3, Yayasan Dian (1990) $0.20-0.91/m3, and Crane (1993) an average of $1.18/m3.

the public mains was low, hydrant reservoir capacity was limited, hydrants were broken, hydrants could operate only a few hours a day, lines were long, hydrant operators colluded (Chifos, 1991, p. 42; Shugart, 1991c, pp. 14f; World Bank, 1984, p. 48; World Bank, 1990a, p. 115n). But the principal reason was a lack of standpipes -- each one had a great degree of local monopoly power. The resulting monopoly profits surfaced in the large "unofficial" payments that hydrant operators had to pay for their licenses -- the payment for entry was variously observed to be $225, $850, and $1,850 (IWACO, 1992, p. 11n; Shugart, 1991c, p. 5).

In an effort to bring hydrant prices down, the number of standpipes was dramatically increased after 1988, nearly doubling by 1992 (IWACO, 1992, p. 11 and Figure 2.3.1). In a country where civil servants survive, and sometimes thrive, on unofficial income, this policy change was impressive and praiseworthy. It was achieved by several means. Bappenas expanded its financing for the *hidran contoh* program; new tertiary mains were laid to open up new areas to standpipes; PAM Jaya's *hidran umum* licensing was eased; several hundred new *terminal air* were opened; and households that were connected to PAM Jaya water were permitted to resell water to neighbors and vendors, greatly increasing the number of potential sellers (PAM Jaya Director General Announcement 030/INSTR/PAM/IV/1990, 2 April 1990).22

The effect on standpipe profit was dramatic; on this all studies of standpipes are agreed. The percentage of the hydrant selling price that was available for operator profit or for unofficial license payment fell from 34% to 14% in a few years (Table 2.3.1). Standpipe prices fell, in nominal as well as real terms (World Bank, 1990a, p. 116; IWACO, 1992, p. 10); Shugart, 1991c, p. 19).

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22 Crane (1993, p. 9) estimates that about 12% of the households with piped water connections resell to neighbors.

Note that the increased number of standpipes and their reduced ability to extract monopoly profit result in three kinds of welfare gain for water consumers. One, there is a real gain, as the average distance between households and standpipes is reduced, resulting in reduced transport cost for the household (or its vendor). Two, there is a transfer from hydrant operator to consumer, as the former monopoly profits become lower standpipe prices. And three, there is another real gain, as the reduced price of water induces customers to increase their consumption (and consumer surplus).23

The clear increase in consumer welfare from the increase in the number of standpipes has led some observers to call for further increases: "Five to ten thousand public taps could be constructed in Jakarta for the price of one of the city's underutilized water treatment plants" (Lovei and Whittington, 1991, p. 14). But others have called for caution in further expansion: "Public tap programs should be limited to where they are the only alternative" (World Bank, 1993a, p. 4). Many have called for free entry into the standpipe industry. Others have warned against that: "Given the oligopolistic and spatial nature of the market, there is no reason to think that *free entry* will necessarily lead to the number of standpipes that is either the social optimum ... or that will result in the lowest final cost to the consumer" (Shugart, 1991c, p. 43; his italics). Clearly, a discussion of the concepts behind the optimal number of standpipes is necessary.

Within a few decades -- how many depends upon how fast Indonesia eradicates serious poverty in its cities -- most Jakartans will have piped water connections into their houses (or apartments). So public standpipes will basically become relics within the lifetime of most Indonesians. It is tempting to follow the World Bank's advice (of the

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23 Crane (1993, pp. 12ff) attempts to quantify these gains.

previous paragraph) and not invest in capital which will soon become obsolete. But that temptation should be resisted. Once the mains are installed, as they must be for any piped water delivery system, standpipes are cheap, privately and socially.24 If water is to be provided cheaply to the poor, the alternative to more standpipes is the heavy subsidization of house connections. This is probably one of those situations where the "stopgap" measure is called for.25

Given that standpipes should be encouraged, the question then arises, how many is the optimal number? The answer is empirical in the end, but again some conceptual clarification is helpful. Shugart (1991c) is quite right that the innately spatial nature of the standpipe industry makes it questionable whether the free market would lead to an optimal solution. Indeed, in theory, it does not. Ironically, the inevitability of locational monopoly power means that free entry leads to too many, not too few, sellers. Each standpipe operator, viewing his regional monopoly power, charges too high a price and thereby attracts too many entrants into the industry.26 This, however, is an unnecessary worry in practice since there is hardly now free entry, and there are almost certainly too few standpipes at this time.

There is finally the question, how much and what kind of subsidy is appropriate for standpipes? This question we postpone to Section 2.5.

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24 The construction cost of a system of standpipes is barely half that of a system of house connections. The reason is not primarily the saving in pipe costs but rather that standpipe users "consume much less water than households with private connections, so that they put less demand on the water abstraction, treatment, pumping, and storage capacity of the system" (Cairncross, 1990, p. 121).
25 See Appendix IV (Part B) for a fuller discussion of the choice between stopgap and permanent solutions.
26 This is developed more fully in Appendix II.

Some people buy their water directly at the standpipe, but it is testimony to the high opportunity cost of time of even Jakarta's poor that most prefer to buy it delivered by a vendor.27 There are no accurate counts of vendors, but Crane (1993, p. 6) estimates that there are around 8,000. Vendors deliver water in jerrycans on long, narrow, single-axled handcarts. Their prices escalate rapidly with distance, with the result, noted earlier, that customers a few kilometers from the nearest standpipe may end up paying as much as 50 times the original PAM Jaya price for their water.28

Lovei and Whittington (1991) argue that vendors earn monopoly rents in their vending territories. Their data show that nearly half of the average price that customers pay vendors cannot be attributed to the vendor's costs (Table 2.3.2). The implicit wage is "2.5-3 times the average wage for men who have not completed primary school" (Lovei and Whittington, 1991, p. 11). How do vendors acquire and maintain their monopoly territory? It requires them "to maintain good relations with community leaders to be allowed to operate in a neighborhood and to obtain assistance in discouraging households from obtaining water directly from public taps or other water sources" (Lovei and Whittington, 1991, p. 12).

Shugart (1989b and 1991a), on the other hand, argues that water vendors

> operate in a relatively competitive market with reasonably free entry. The seemingly high markup

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27 4% of Jakarta's households buy their water primarily at a public standpipe, while 22% buy it primarily from a water vendor (Stockholm Environmental Institute survey, as reported in World Bank, 1993b, Volume 2, p. 6).

28 Lovei and Whittington, 1991, found vendor prices ranging over $1.50-5.20 per m3, while the PAM Jaya price to the standpipe was $0.09 per m3 (p. 7). In the illustrative calculation of Section 1.2, the poor person was assumed to use one fourth of the average water of Jakartans (i.e. one fourth of 131 liters per capita per day -- Table 2.1.3) and pay $1.50-5.20 per m3.

> over the cost of water at the standpipe is due to actual costs that the vendors incur, by far the most important being the implicit cost of the vendors' own labor. (Shugart, 1991a, p. 3)

He finds the implicit wage to be $2.50-6.00/day and claims that this rate is not unusually high for unskilled labor in Jakarta once the difficulty of the job is considered (Shugart, 1991c, p. 23).

Armchair evaluation is not the proper methodological approach to resolving this conflict of research findings. But it is tempting. I find Shugart's conclusions more plausible. That the surplus measured by Lovei and Whittington did not decline while the numbers of standpipes were expanding rapidly suggests that it is something other than surplus. That the price rises with distance from the standpipe in just the way implied by time and wages is inconsistent with monopoly power, which ought to diminish as the vendor gets further from his own standpipe and nearer to other vendors' standpipes. That, despite close and regular ties between vendors and their customers, there is a vendor fringe of *orang liar* (wild people) always looking for new customers makes it unlikely that monopoly power could be long exercised.

On the other hand, Shugart's implicit wage rate <u>is</u> high, and Jakarta's *kampungs* do treat outsiders with much more suspicion than elsewhere, in either developed or developing world cities. Localized vendor cartels could well exist in Jakarta despite the appearance of free entry.29 A greater frequency of standpipes should reduce any power that vendors can exercise since the shorter

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29 There is, moreover, evidence of monopoly power in one study's observation of price discrimination between rich and poor by vendors (IWACO, 1992, p. 11). But the direction of the price differential is the reverse of that which one would expect -- because the rich have more water options than the poor, the rich presumably have a more price-elastic demand -- and the price difference could simply reflect a quality differential.

distances reduce the costs of direct household collection of water.

Whether or not there are monopoly rents involved, there is no question that water purchased from standpipes and delivered by vendors is expensive. Handcarts are no substitute for pipes in the efficient transport of water. Families that use vendors pay many times more per liter of water than do families with house connections. The question keeps asking itself, why doesn't everyone get a house connection? The answer is many-fold and will be explored in the next section.

Figure 2.3.1
PAM Jaya Hydrants

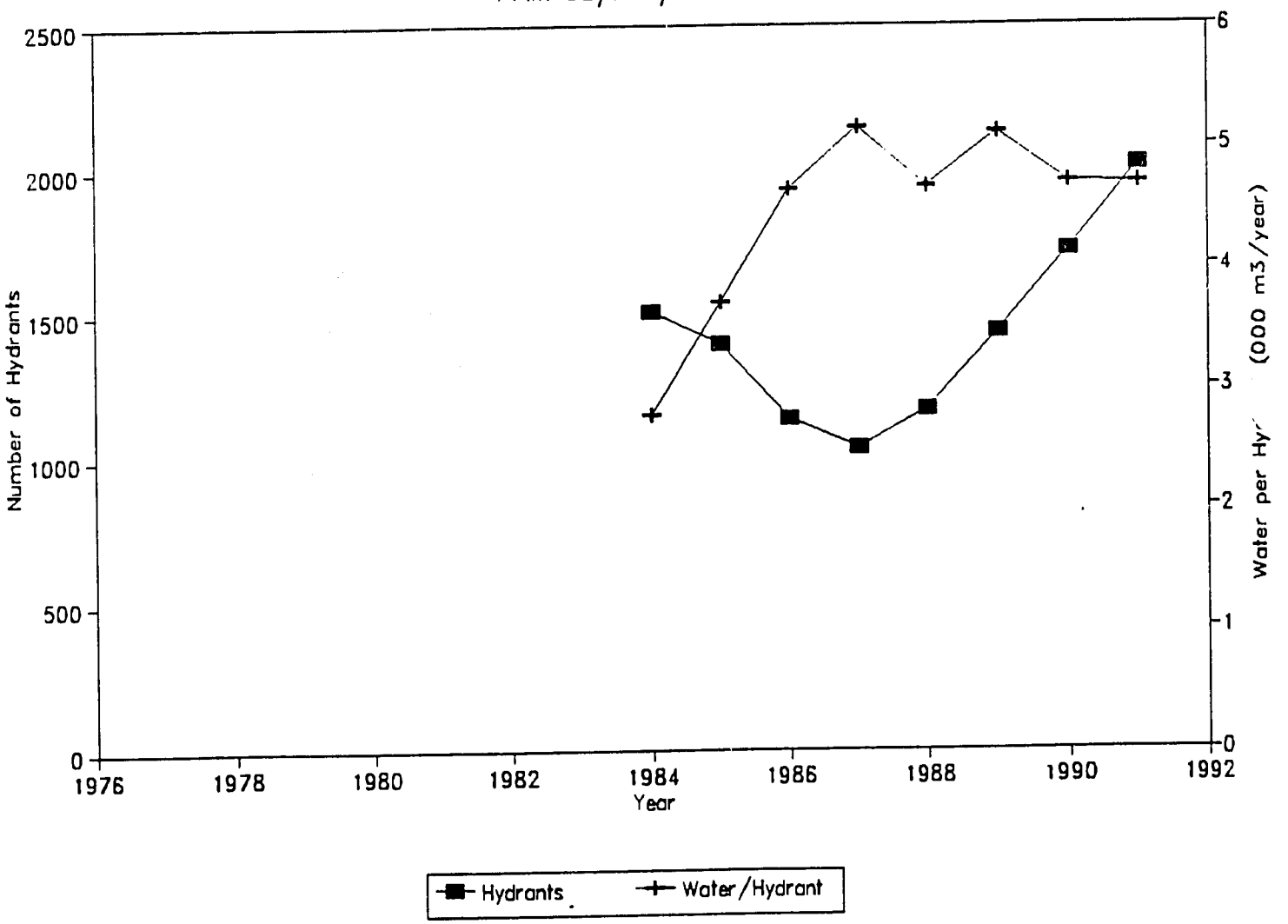

Table 2.3.1

Allocation of Price Paid by Vendors to Hydrant Operators

	Year	
	1988	1992
Average Price	0.35	0.33
Payment to PAM Jaya	30%	40%
Implicit Value of Operator's Labor	32	42
Other Operating Cost	4	4
Surplus Available	34%	14%

Note: Average Price is in $ per cubic meter.

Source: Lovei and Whittington, 1991, as adjusted and presented by IWACO, 1992, p. 11.

Table 2.3.2

Allocation of Price Paid by Households to Vendors

	Year	
	1988	1992
Average Price	2.65	2.46
Payment to Hydrant Operator	13%	13%
Implicit Value of Vendor's Labor	31	32
Implicit Value of Equipment Rental	7	7
Surplus Available	49%	47%

Notes:
1. Average Price is in $ per cubic meter (and exclude bottled water sales).
2. Totals do not add due to rounding.

Source: Lovei and Whittington, 1991, as adjusted and presented by IWACO, 1992, p. 10.

2.4 Piped Water and Individual Connections

Nearly one fourth of Jakarta's residents are now connected to the PAM Jaya water supply through connections into their houses (see Figure 2.4.1).30 Once connected, a household gets its water for a monthly fee of $0.77 plus a charge per cubic meter that begins as low as $0.17 and rises to a peak rate of $0.55 (see Table 2.4.1). While it is not as cheap as well water (provided one has access to good well water that does not require much pumping or treatment), PAM Jaya water piped through a house connection is much, much cheaper than water purchased through vendors.31

Still unanswered is the question, why have not more households chosen to connect to piped water? Of course, many do not have the option of connection, living in areas of Jakarta that are not yet reached by PAM Jaya's system or lacking sufficient security of tenure for a hookup. And others, of course, do have access to cheap and good shallow wells. But many who could connect continue to purchase water from vendors. Why?

The usual answer is the connection, or hookup, fee. As recently as 1989, the official connection fee was $113, no small sum for a poor household. In June 1989, the official fee was reduced to $57, and payments were allowed to be made

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30 Recent data on connections are not yet released, and then one must make a guess as to the number of people served per connection. The Ministry of Public Works claims that "now 35 percent of Jakarta's ... population get piped water" ("Water Shortage", 1994), but that figure undoubtedly includes an estimate of the number who get it from standpipes and vendors. My guess in the text, "nearly one fourth", simply updates a 1991 guess of one fifth (Crane, 1993, p. 5). These few piped water connections go primarily to rich households; according to the World Bank, in 1992, fewer than 10% of households with monthly expenditure below $50 had piped water connections, compared to 90% of those with monthly expenditure above $370 (World Bank, 1993e, pp. 129f).

31 Recall, vendor water is some 10-25 times the average price of PAM Jaya water through house connection (Shugart, 1991c, p. 1).

in three installments.[32] The reaction was immediate: the number of household connections rose from around 135,000 to some 250,000 within the next three years (IWACO, 1992, p. 5).

Connection fees, however, cannot tell the whole story, given the great price differences between vendor and piped water. Studies have shown that a typical household can recapture through water savings the entire connection fee within a few months of the connection. There is also a cultural lag, as poor urban residents have not yet adapted to the concept of the monthly bill, which requires sophisticated budgeting as compared to a simple day-to-day cash-flow balancing. For many people, PAM Jaya water is perceived as inferior to vendor water, and supply interruptions and pressure reductions reduce the value of the connection. This is especially true for those households too poor to have space and utensils to maintain reservoirs and pumps (World Bank, 1993c, p. 113). And finally, the newly connected household acquires a new element of risk to an already uncertain existence: PAM Jaya metering and billing procedures periodically add an inexplicable fillip of tens or hundreds of thousands of Rupiah to a previously stable bill (with the threat of cutoff if not paid). Despite all these caveats, hookups by poor households should be encouraged by the provision of moderate-interest loans to cover the initial charges.

Once connected, a household faces a variable-rate water tariff (see Table 2.4.1). In principle, the charge is supposed to begin at the average total cost of providing piped water and then rise, in step-wise fashion, to a maximum for households of three times this average total

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32 Banks offer twelve-month finance of household water connections (Crane, 1993, p. 18). But "the credit plans are little used" (Crane, 1993, p. 19), possibly because the poor have little experience with formal-sector credit and possibly because "unofficial" fees are heavy.

cost.33 In fact, studies show that no consumer pays the average total cost of the water; the future average total cost, or the "long-run marginal cost", of PAM Jaya water, piped to a private connection, is believed to be around $0.63 per m3, and the highest current consumer marginal rate is $0.55 per m3 (Cestti, 1993, p. 9; on the meaning and measurement of "future average total cost" and "long-run marginal cost", see Appendix VI). While big users do pay a marginal water tariff of some three times that of the smallest users, that tariff is still below cost -- and the multiple of the highest tariff to the lowest has fallen from eight to three over the last decade. Since household water connections are predominantly owned by the well-to-do, this means, in the end, that general taxation or foregone public expenditure elsewhere is being used to subsidize the better-off.34

Why are household water prices so low? The answer lies in some mix of several reasons:

1. PAM Jaya does not know the exact cost of its water. Over the years, most of its capital expenditure has been arranged by the central government and financed by grant or soft loan -- even today little is financed by the local water agency itself (Villinski, 1991, p. 7). Much of the investment probably has been

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33 Indonesia's Third Five-Year Plan, Repelita III, spelled out central government guidelines for the calculation of the structure and level of water prices, and these encouraged inclusion of depreciation and interest (or at least of that interest payable on loans). These pricing guidelines were made operational in 1984 (Joint Decree of Minister of Home Affairs and Minister of Public Works, No. 5 of 1984 (28/KPTS/1984), 23 January, "Basic Guidelines for Tariff Structure for Water Supply Enterprise/PDAM and Interim Water Supply/BPAM").

34 This is not just a Jakarta phenomenon. Lovei (1988) reports that "a recent examination of 163 water enterprises has revealed that, in 1987, 116 (71% of the sample) did not recover the full cost of production from their customers and 30 (18%) had revenue even less than direct operational expenditures" (pp. 1f).

inappropriate or has involved excessively high-priced foreign equipment. Foreign aid is the source of much of Indonesia's water investment -- Jakarta's newest water treatment plant is 70% financed by Japan ("Piped Water", 1994). Such aid is too often perceived as costless by the recipient country, even though it still involves procurement that is tied by country as well as function, which can mean excessively high costs (Hutcheson and Porter, 1972). As a result, today, PAM Jaya does not know and probably does not want to know its per-unit capital costs (in either interest or depreciation).35

2. PAM Jaya wants to increase the number of house connections and uses low prices as a marketing strategy (Van Der Hoff and Steinberg, 1992, p. 22). Indonesian water planning has always been to increase capacity first and then let connections catch up. There is nothing necessarily wrong with this approach, but it does put continual pressure on the local water authorities to locate, and even to subsidize, potential new connections.36

3. All Indonesian city water authorities must get local government approval in order to increase their rates. Not only does this delay tariff adjustments but local officials may succumb to the comforts of inertia, especially when they "know" the central government "will bail them out" (Villinski, 1991, p. 10).

Household water charges <u>do</u> change -- the basic household water tariffs were tripled by PAM Jaya in 1988 (Table 2.4.1), but not often, not enough to raise the real

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35 Again, see Appendix VI.

36 Lovei and Whittington (1991) suggest that water utilities may be pursuing objectives other than the delivery of water and that the low water prices permit the extraction of a "full" connection fee that exceeds the official charge (pp. 18-20).

cost of water, and not enough to cover water costs. Other revenue sources do not cover these losses. As we noted in Section 2.2, large commercial and industrial users of PAM Jaya piped water do pay high prices for their water, roughly twice as much as the largest household purchasers per cubic meter. The result, however, is that small commercial establishments disguise their water needs as residential, and large industrial establishments rely primarily on other sources of water, particularly deep wells.

We turn now to the question, what is the optimal structure of water prices?

Table 2.4.1

Rate Schedule for Household Water Connections

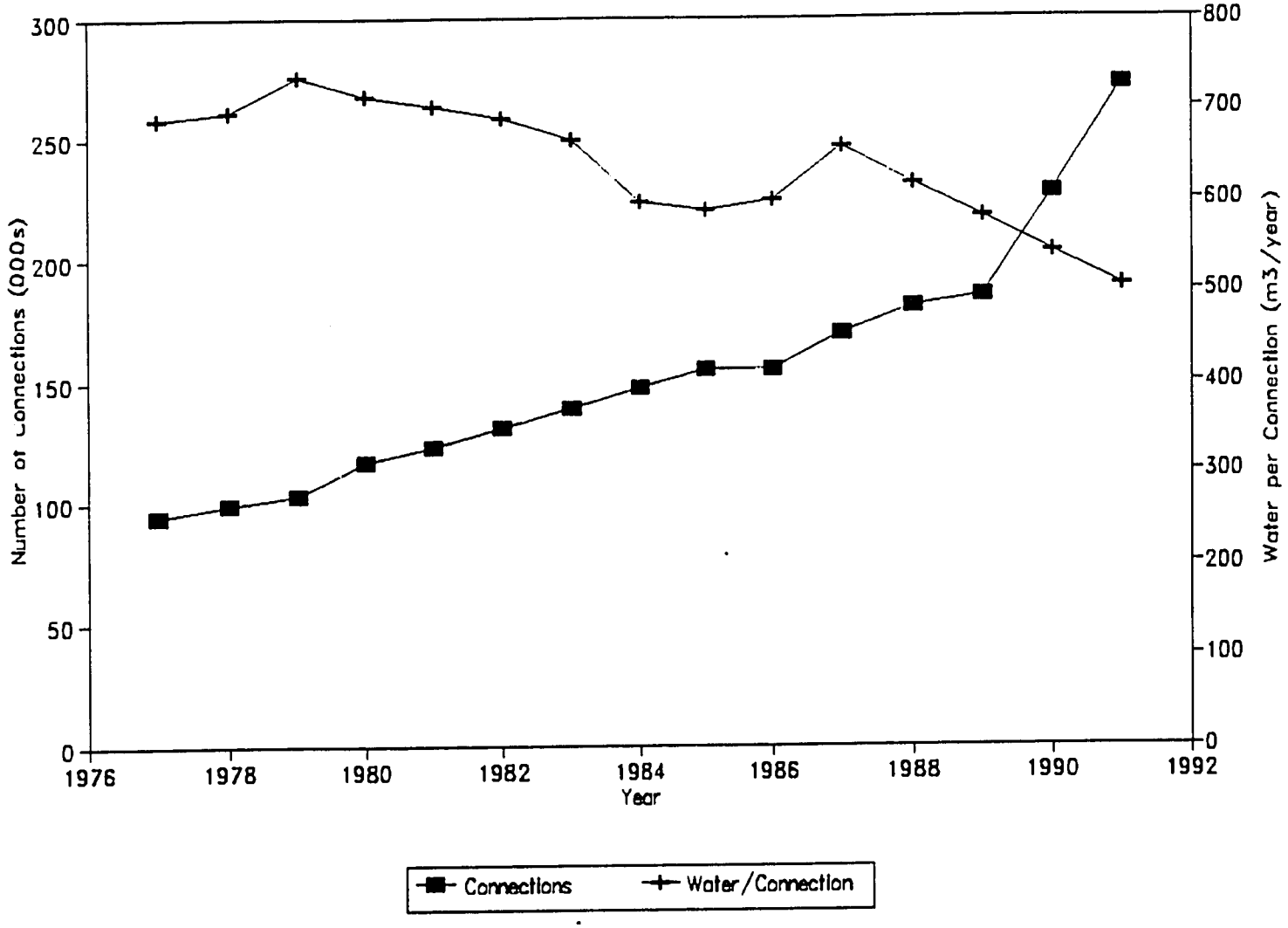
	May 1983	Apr 1988	Nov 1991	Mar 1994
Monthly Charge	$0.61	$0.85	$0.90	$0.77
Consumption Rate				
0-15	$0.04	$0.13	$0.20	$0.17
16-30	0.08	0.25	0.37	0.31
31-50	0.31	0.39	0.48	0.41
>50	0.31	0.64	0.65	0.55

Notes:

1. Monthly Charge is in $ per month, assumes 0.5 inch pipe, and includes both meter rent and administrative fees.
2. Water Rate Schedule is in $ per cubic meter. Consumption Rate is in m3 per month.
3. The nominal Rupiah prices have not changed since November 1991.

Source: IWACO, 1992, p. 8.

Figure 2.4.1
PAM Jaya Household Connections



2.5 Water Prices and Water Costs

The people of Jakarta get their water in many ways, in widely varying amounts, and at widely varying prices. Thus, PAM Jaya's pricing problems are conceptually complex and its pricing decisions have interdependent impacts on how Jakartans get their water and how much water they get. Since water is an important ingredient in the budgets of many Jakartans, PAM Jaya's prices also directly affect their overall standard of living.

Basically, PAM Jaya sets four prices (or structures of prices): 1) the price of deep well water; 2) the price of public standpipe water; 3) the price of household connection water; and 4) the price of commercial/industrial connection water. Currently, only the second of these above prices is fixed independently of quantity; the other three all involve price structures in which the marginal price rises with the quantity consumed.

Before looking more closely at these prices, and their impacts on incentives, allocations, and welfare, we should examine more broadly what it is that PAM Jaya is -- or should be -- trying to achieve. The goals are threefold:

1. Efficiency. The pricing rules for first-best (i.e. unconstrained) allocations are well-known: everyone should pay the marginal cost of each purchase. This is complicated by several factors. Marginal cost is not always clear conceptually, and it is difficult to measure empirically.[37] Moreover, the relevant

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37 Water treatment facilities are lumpy investments, while water demand expands steadily. When there is excess capacity, the marginal cost is low. It is simply the treatment and distribution cost. But as capacity becomes strained, the marginal cost rises -- as increasingly scarce water must be rationed. In the process, overhead costs begin to become covered by marginal-cost pricing (until it becomes optimal to undertake another lump investment in treatment facilities -- see Appendix IV). Note the seeming paradox: when a new treatment facility is added, price comes down; but that is the very moment when overhead cost goes up! (This is discussed more fully in Appendix VI.)

marginal cost is social, not private, so that any positive externalities of water consumption through public health effects or any negative externalities through wastewater disposal, river or canal pollution, and aquifer depletion or contamination should be incorporated.38

2. Equity. Water is widely held by public authorities as a "basic need" (or "merit good"), which means that some minimal consumption level should be reached by all families regardless of their ability to pay. Moreover, water comprises a significant part of the expenditure of the urban poor, and altering its price may be one of the few feasible ways for the government to influence the welfare of the very poor. This may imply pricing below marginal cost for the poor, and it may imply pricing above marginal cost for the rich.39

3. Covering Costs. Public water companies everywhere are increasingly being asked to "cover costs". It is not clear that they should be so asked, at least in a first-best world; there are important externalities in water consumption, and there are important elements of natural monopoly in piped water delivery. However, where low-distorting taxation alternatives are absent and the government's general fund is under stress, pricing water so that total revenues reach some specified fraction (perhaps one) of total costs may be appropriate. In practice, this means that prices must be above marginal costs -- in order to contribute to the overhead capital costs --

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38 We return to this connection between water consumption and wastewater generation in Section 5.2.

39 It also has implications for the pricing of industrial and commercial water. Since input prices are generally passed on into output prices, equity considerations may mean prices below marginal cost for firms that produce income-inelastically demanded consumer products.

for at least some (perhaps all) of the water customers; and it also means that, if prices below marginal cost are contemplated for the poor, prices must be raised elsewhere to compensate for the losses.

With these three criteria in mind, let us look at the actual PAM Jaya pricing decisions. These will be explored, in turn: 1) for large commercial and industrial users; 2) for public standpipes; and 3) for household connections.

First, large commercial and industrial users. Though the demand for industrial water is quite price elastic -- 1.6, according to the World Bank (IWACO, 1992, p. 101) -- small, and even moderate, changes in PAM Jaya's piped water price will not greatly affect industrial demand for piped water as long as the cost of groundwater is low. Efficiency here requires both that the price of piped water be reduced and that the price of groundwater be much raised -- a start is apparently being made (as of April 1994 ("Revised Bill", 1994)). If, as consensus opinion suggests, the deep aquifer is currently being inefficiently depleted, the correct structure of prices requires 1) piped water be priced at (or somewhat above, to contribute to overheads) its marginal delivery cost, and 2) deep well groundwater be priced so as to keep its cost somewhat above the price of piped water.40

These price adjustments will, for most industrial users, raise their water costs. Some worry that this will drive up prices of water-intensive products and that some water-intensive firms will leave the Jakarta area for other

40 See Appendix I for the theoretical reasoning that urges groundwater prices above surface water prices. Actual groundwater prices increase with the amount pumped (Cestti, 1993, p. 11; "Revised Bill", 1994), but neither efficiency nor equity readily justifies such differential prices by the size of the industrial and commercial customers. The justification of such price differentials requires the assumption of either a differential marginal cost of pumping (since the goal is to equalize the overall price paid for groundwater) or of monopoly power (since the incidence of higher input prices is then partly on profit).

parts of Indonesia where water is cheaper (IWACO, 1992, p. 83). Neither is an undesirable result. Even if some of these water-intensive products are income-inelastically demanded, there are better ways to offset the income-distribution effects than keeping industrial water cheap. And in the long run, Indonesia should seek to locate its water-intensive industries in areas where water is cheap.

Second, public standpipes. People who use standpipe water are indeed the poorer people of Jakarta, but the price they end up paying is much more a function of the vendor labor costs (and possibly monopoly rents) than it is of the standpipe water price itself. PAM Jaya's price of standpipe water could be raised to or above its marginal cost with little impact on the poor if the price increase were accompanied by an aggressive effort to expand the number of standpipes. Such an effort would reduce the average distance that vendors need to carry the water. Pipes, it must be remembered, are a more efficient means of moving water than handcarts.

Income distribution considerations may, nevertheless, urge that PAM Jaya keep the price of standpipe water near or below marginal cost. Indeed, though the proof is long, it can be shown that overall consumer welfare may well be maximized, given a revenue collection constraint on the water utility, by offering consumers a choice between low-priced standpipe water and high-priced household-connection water.41 The poor will self-select the cheaper standpipes, and generate welfare, while the rich will self-select the more expensive but more convenient household connections, and generate revenue.

Whatever the price of standpipe water, two things are clear: 1) the numbers of standpipes should be increased so that households that use standpipes are, on average, much closer to them; and 2) standpipes should not be operated at

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41 The proof is found in Fischer and Porter, 1993.

a loss, lest this deter the expansion of their numbers -- private ownership and operation can prevent standpipes from becoming a drain on PAM Jaya's budgetary resources.

And third, household connections. Most of PAM Jaya's sales are through this outlet, and its effort to cover more than just marginal costs must focus on a structure of prices that yields an average price above marginal cost.42 The "lifeline" structure that it has adopted is precisely the correct way to do this. It produces equity in the sense that the smaller, lower-income consumers pay less (at the margin and on average) than the larger, higher-income consumers. But it is also efficient, in a second-best sense, in that it generates a given surplus above marginal costs at the lowest cost in terms of foregone consumer surplus.43

While PAM Jaya's "lifeline" structure of prices for household connections is correct in principle, it can nevertheless be improved in detail. The lowest-priced segment of the schedule applies to quantities up to 15 m3/month, and this first notch could well be reduced -- Cestti (1993, p. 25) suggests to 10 m3/month. The highest-priced segment should perhaps be more than three times the price of the lowest-priced segment. If there appears to be an incentive for the wealthy to return to shallow wells in response to higher marginal prices, this may be no cause for worry as long as the shallow aquifer is not thereby endangered; if it becomes endangered, then this may put a

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42 As PAM Jaya fully realizes ("Water Shortage", 1994).
43 See Appendix III for a full derivation of this statement. Note that the "lifeline" pricing argument does not justify rising rates to business firms since we have no policy interest in their "consumer surplus". Indeed, if large business water-users have more price-elastic demand, because they can more readily switch to deep well water, then "second-best" revenue concerns urge lower rates to them.

limit on the extent to which the rich can be induced to pay the system's overhead costs.44

A little noted byproduct of the steeply rising "lifeline" price structure is that the rich, with high price elasticity for water, will reduce their consumption and thereby reduce the rate at which PAM Jaya needs to expand its water treatment capacity. Cestti performs the illustrative calculations:

> ... a 10 percent increase in water price will result in a 7 percent decrease in water demand. Thus, water savings that can result from a price increase of 50% are of the order of 14.2 million cubic meters per year, which represent about 25% of the domestic consumption. The conserved water volume then could be used to serve about 260,000 people waiting for a connection, about 8% of the current population without piped supply, at an average consumption rate of 150 lcd [liters/capita/day]. Thus, a considerable extension of coverage, from 19% to 27%, may be obtained without additional investments in storage, transmission, and treatment facilities. (Cestti, 1993, p. 25)

Raising prices to cover costs is one way of reducing the costs that have to be covered. There are two other ways that PAM Jaya can reduce costs.

One, pay less attention to the quality of the piped water -- not because it is already so high, but rather because it is so low. The intake water is currently so polluted that a great deal of expense is needed to raise it to potable standards. Then, leakages in the distribution network make the water essentially unsafe again. Almost all

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44 As PAM Jaya makes piped water ever more expensive to the big users, they are given incentive to switch (or return) to shallow wells. The costs of such wells consist almost entirely in the drilling and the pump purchase, so the average cost declines with increased consumption and the marginal cost is essentially zero throughout. PAM Jaya has apparently already considered the possibility of different price schedules in different parts of Jakarta, based on property assessments and the availability of groundwater alternatives ("Water Company", 1993).

households feel the need to boil piped water that will be used for drinking or cooking.45 Indeed, it is said that the lead in the pipes gets into the water, so that it is not even safe to drink piped water after boiling it. Some day, Jakarta will have to target this low water quality for action, but in the interim quantity may mean more than quality, especially if small and meaningless improvements in quality are very expensive to achieve. Disease caused by lack of water quality gets more publicity than disease caused by lack of water quantity, but the latter may well be more important. Getting ample and uninterrupted water to poor people at a low price may be the single most important means of improving their health.

And two, reduce the unaccounted-for water (UFW). Estimates of water that is produced (in the sense that it goes through a treatment plant) but for which no revenue is collected run as high as 60%, most of it lost in billing and collection inefficiencies (Table 2.5.1). This is extremely high UFW by comparison with other big cities, in either the industrialized or the developing world.46 To the extent that these losses are technological, reducing UFW is like finding free new treated water. To the extent that these losses are administrative, reducing UFW increases revenue without increasing treatment and distribution costs, and hence reduces PAM Jaya's deficit.47

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45 For Jakarta alone, the cost of boiling water has been estimated at more than 1% of the City's GDP (JICA, 1985, Volume II, p. 4-20).

46 It is also high compared to other cities in Indonesia. A recent study of 14 local water authorities (including Surabaya and Bandung but excluding PAM Jaya) found UFW (over 1985-1990) to range from 23% to 51%, with the (weighted by operating income) average being 39% (Municipal, 1992, Volume III, p. 11).

47 The composition of PAM Jaya's revenues and costs, and the extent of its deficit, cannot be discussed here because PAM Jaya does not make available to the public its income statements (or balance sheets).

Table 2.5.1

Unaccounted-For Water (UFW) in PAM Jaya, June 1992

Category	Percentage Lost	Percentage Remaining
Total Water Produced		100.0%
Production Losses	5.9%	94.1
Billing Losses	39.0	55.1
Collection Losses	17.1	38.0

Source: IWACO, 1992, p. 79.

3. WASTEWATER

SUMMARY

Despite its size, Jakarta has almost no sewer system. Wastewater receives little treatment, being disposed of either directly into the canals and rivers or into septic tanks that are too densely clustered or too poorly maintained to prevent groundwater contamination. The resulting pollution is felt most seriously in the poor areas, where congestion elevates both the number of polluters and the number of sufferers from that pollution.

In the long run, the solution to wastewater disposal in a city of Jakarta's size and density is sewers. But sewers are expensive. In a budget-constrained city, alternatives to sewers must be sought for most residents for many decades to come. Only in the most congested areas, where private toilets are demanded and in-situ treatment of sewage is not feasible, are sewers needed immediately. Elsewhere, the near-term solution must involve: 1) improved septic tanks; and 2) public toilets.

Where in-situ treatment through septic tanks is feasible, Jakarta must encourage its residents to construct and maintain septic tanks. Subsidies are inevitable.

Where in-situ treatment is not feasible and the residents are too poor to afford private toilets and sewage systems, public toilets with off-site sewage treatment are the solution. These must also be subsidized since it is impossible to force poor residents to use them, but private ownership and operation may succeed in keeping use high and the needed subsidies small.

Finally, flood control projects have high returns, especially in congested areas.

3.1 Introduction

One of the first impressions of many visitors to Jakarta is that it does not look like a huge city. There is little skyline. The City is composed of millions of low-lying residences, shops, and small industries, crowded together, stretching off to the west, south, and east seemingly forever. It looks like a sprawling, compacted village.

In ways not so easily seen, Jakarta is indeed a sprawling, compacted village. Its wastewater treatment, or rather the absence of wastewater treatment, is more appropriate for a small village than for the world's fifteenth largest city. As Marcussen characterizes the situation:

> ... the problems of the City's sanitation have never been solved and affect Jakarta seriously today; the City's growth pattern has not been disciplined by modern infra-structure systems.
>
> Jakarta has no underground sewer system at all, and it would indeed be expensive to build under the topographical conditions. It means that even formal business and residential areas are serviced with septic tanks or collection tanks. Millions of people use latrines with direct outlets to swamps or canals, if they do not go directly to the canals .... The severe problems inherent in this situation are aggravated by the inadequacy of the drainage system, which is unable to prevent seasonal flooding .... (Marcussen, 1990, pp. 89f)

It is not quite true to say that there is no underground sewer system. There are old Dutch-built sewerage networks, and there are new World-Bank-financed pilot sewerage projects. But only some one percent of Jakarta's residents are served by operating sewer systems. A few large hotels, large apartment complexes, and large businesses operate sophisticated systems for treating both

their sullage and sewage. [Sullage, or "gray water", is the wastewater of kitchens, showers, and laundries; sewage, or "black water", consists of human waste.] For the rest of Jakarta, something short, usually far short, of modern urban treatment of wastewater occurs.

The result of this inadequate treatment is noted by all the senses. While industrial water pollution is growing with Indonesia' rapid industrialization, residential waste contributes three fourths of the pollution problems of Jakarta's rivers and canals (Bansgrove, 1991, p. 102; see also Table 3.1.1).1 The river and canal pollution in turn contributes to the pollution of the shallow groundwater, from which much of Jakarta's drinking water is, or was, drawn, and of the ocean and beaches along the north side of Jakarta.

The major portion of this pollution is due, not to septage, but to sullage (Hadiwinoto and Clarke, 1990, p. 10; Kingsley and Ferguson, 1992). Even in those households that treat, or attempt to treat, their septage, there is direct discharge of sullage into open drains, and these drains flow directly to the rivers and canals (or flooded areas). This means that, even when a household treats its black water with 100% efficiency, the overall treatment efficiency of its wastewater (both gray and black water) is only 38%.2

The treatment of septage in Jakarta varies across households. The constant across households is that, whatever the treatment, it is on-site and private.

A large and growing fraction of Jakarta's households have private toilets -- 54% in 1980, 72% in 1992 (World Bank, 1993b, Volume 2, p. 45). But for one third of these

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1 Kingsley and Ferguson, 1992, put the figure for the household contribution to river BOD (Biochemical Oxygen Demand) at 75-85%.

2 For the typical Jakarta household, BOD per person per day is 17.4 of gray water and 10.5 of black water, so treatment efficiency, with complete removal of black water BOD, would be 10.5/(10.5+17.4) = 38% (JICA, 1991, p. F-8).

private toilets, there is no waste treatment: they directly "drain to open watercourses" (PT Indah, 1989, p. 7).

Most of Jakarta's private toilets drain to septic tanks or leaching pits.[3] Unfortunately, "many of the septic tank systems are defective" (PT Indah, 1989, p. 7). Some septic tanks leach and contaminate groundwater; others are not emptied regularly; for others, the sludge that is pumped out is discharged directly without treatment into ditches, canals, and rivers; for still others, the septic tanks are drained correctly, but the sludge is improperly disposed of. Moreover, even those private septic tanks that are privately well cared for are often collectively ineffective: they are too numerous; they are too densely packed together; their drainage fields are too small; and their leachate pollutes piped water, water drawn from shallow wells, and water in canals and rivers.

For those without private toilets, there are public toilets or *helikopter* toilets (i.e. latrines that overhang the canals). The difference is not always as great as it might appear, for many of the public toilets are not well maintained and simply overflow into nearby pools or canals.

Two things are clear from this brief review. One, public efforts in wastewater disposal are "practically lacking" (World Bank, 1993a, p. 4). The main problem with sewage in Jakarta is "that so little is being spent on it" (Kingsley, 1993, p. 13). In fact, sanitation concerns currently consume only 3% of urban public expenditure in Indonesia, and nearly three fourths of its urban inhabitants "were without adequate sanitation facilities" (Van Der Hoff and Steinberg, 1992, p. 22). And two, the private efforts

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3 Technically, septic tanks are for treatment and disposal of both toilet waste and gray water; leaching pits are for toilet waste only. However, since domestic gray water in Jakarta is almost always directly discharged into surface ditches and drains, there is no functional difference between septic tanks and leaching pits (JICA, 1991, p. F-7), and we will ignore the technical difference here.

at treatment of wastewater are inadequate, especially for a large, growing, and densely populated city.

Perhaps not so obvious, but just as clear upon reflection, the quality of the sanitation facilities is closely related to income. Private toilets and septic tanks are expensive; public toilets are few and not well maintained. But beyond this, the poor live in the more densely populated areas, and it is there that the wastewater pollution is most serious.4

Ironically, while the need for wastewater treatment is greatest in densely populated and poor areas, it is precisely in these areas that there is the least wastewater treatment. Partly, of course, this result stems from the fact that the poor, being poor, cannot afford to spend as much as the rich on anything, including their wastewater treatment.5 But it also arises in the very nature of the wastewater externality. The more densely packed the community, the more nearly the wastewater environment becomes a public good (or "bad") about which each individual can do little. So, where wastewater treatment is most

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4 JICA (1991) found a high correlation (R2=0.76) between river water quality (BOD in milligrams per liter) and population density (persons per hectare) -- BOD = 7.285 + 0.237 PopDens -- across the *kelurahans* of Jakarta (JICA, 1991, pp. 9-49 and H-10); for practical purposes, this implies an elasticity of BOD with respect to population density of almost unity. 36 of Jakarta's 256 *kelurahan* had more than 500 persons per hectare, 21 more than 400, and 23 more than 300 (JICA, 1991, p.2-1), and in these *kelurahans* are found a large percentage of Jakarta's poor.

5 This observation is not based on much empirical evidence. Unlike drinking water, for which many studies of willingness-to-pay (WTP) have been undertaken, in Indonesia and elsewhere, there are few studies of demand and WTP for improved sanitation. Sewage treatment is much more difficult than drinking water to study because, while one can get estimates of WTP for water by looking at the prices of alternative, inferior sources (e.g. vendors in Jakarta), the poor just do not purchase sanitation when it is not offered cheaply. What WTP studies there are suggest, not surprisingly, that people are willing to pay for sewer connections but not for sewage treatment.

needed, there is the least incentive for private individuals, rich or poor, to undertake it.

Table 3.1.1

Water Pollution Loads in Jakarta, 1989

Source	BOD/day Tons	BOD/day Percent
Domestic Sullage	152	39%
Industrial Discharges	49	13
Commercial Discharges	40	10
Septage Discharges	93	24
Solid Wastes	59	13
Total	393	100%

Notes:
1. BOD = Biochemical Oxygen Demand, a common measure of pollution.
2. Totals may not add due to rounding.
3. Government discharges included in Commercial Discharges figure.

Source: World Bank, 1993b, Volume 2, p. 46.

3.2 Sewers

In the long run, everyone agrees, the solution to Jakarta's wastewater problem is sewers, for both sullage and septage, throughout the City, with appropriate sewage treatment facilities. There is no place, in the long run, for on-site treatment -- not to mention non-treatment -- of human waste. In the long run, sewers are not only more efficient but cheaper.

Unfortunately, this only sustainable long-run solution is very expensive.6 Its costs are up-front, it is very capital-intensive, it involves the construction of underground tunnels, and it requires laying hundreds of miles of pipes under dense housing and congested streets in a flat city with high water tables.7 The master plan for such a system, developed by the Japan International Cooperation Agency (JICA, 1991), involves spending some $1 billion over the next 10-15 years, and this sum covers only the capital costs, still leaves many areas with on-site treatment, and delegates some expenditures to the private sector (World Bank, 1993b, Volume 2, p. 49; JICA, 1991, Section 9, passim). No wonder the World Bank calls Jakarta's sewers "a long-term challenge ... [that] will not be resolved any time soon" (World Bank, 1993c, p. 112).

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6 It may be true that "800,000 households have installed septic tanks [in Jakarta], at a cost equal to three times the amount that would have been required to provide connections to piped sewerage systems" (Dillinger, 1993, p. 3), but the important point is that the septic tanks are already installed, while the sewer system is not.

7 To get an idea of the costs involved, look at the World-Bank-financed Jakarta Sewerage and Sanitation Project (JSSP), pilot sewer project under construction and partly operational. It serves an area of the city with 500,000 residents, but its capacity is 170,000, and there are only 3,700 direct house connections. The capital cost: $25 million, or $150 per person served, and 40% of the people served will receive public toilets with on-site sanitation facilities (JICA, 1991, pp. 7-7 and F-27).

In the face of this high cost, the current plan is to phase in the sewer system, attacking first the areas of greatest need. Jakarta is divided into three areas, by population density (JICA, 1991, Section S):

> For Area A, with population density of less than 100 persons per hectare (comprising an expected 12% of the City's population in 2010 AD), only simple on-site treatment systems (basically properly operated septic tanks) will be introduced. There will be sanitary disposal of toilet waste, but river discharge of gray water.
>
> For Area B, with population density of 100-300 persons per hectare (comprising 39% of the City in 2010 AD), both toilet waste and gray water will be treated, "typically [with] septic tank ... as it is found to be more economical than sewerage" (JICA, 1991, p. S-19).
>
> For Area C, with population density greater than 300 persons per hectare (comprising 50% of the City in 2010 AD), sewerage will be installed because it is "more economical than on-site [treatment] systems" (JICA, 1991, p. S-20).

It is this Area C part of the plan that will cost $1 billion (JICA, 1991, p. S-24). All the septic tanks and sludge treatment, except for public washing and toilet facilities, are left "for the private sector", at a cost of almost another $1 billion (JICA, 1991, p. S-22).

The immense (and up-front) costs of sewer systems has led the World Bank to conclude that

> Water-borne sewerage collection systems are unlikely to be economically justifiable for any but the most wealthy residential areas for the foreseeable future. (World Bank, 1993c, p. 114)

This is a serious confusion between economic justification and the ability to cover costs. It is not at all clear that

any sewer system, even for the rich, will be able to cover its costs unless everyone is forced to attach onto it. (Whether a sewer system ought to try to cover its costs is a subject which we leave for Section 5.) But the ability to cover costs should play a minor role, if any role at all, in the analysis of economic justification. Sewers should go, in a world free of budget constraints, where the social benefits of sewers exceed their social costs by more than the social benefits exceed the social costs of alternative means of treating sewage. Budget constraints alter this economic analysis, but they do not obviate it.

Nevertheless, the World Bank is quite correct in concluding that, in practice and in the near future, conventional sewerage systems can "cover only a small percentage of the population, are prohibitively expensive, and hardly ever are capable of addressing the sanitation needs of the poor" (World Bank, 1990a, p. 118). This means that alternatives must be considered, probably for a lengthy "interim".

One of the alternatives is non-conventional sewerage -- after all, the important thing is to get the sewage off-site, not the means of doing it. Pilot projects in Jakarta are examining: 1) small-bore sewers to remove septic tank effluents where leaching systems are ineffective; 2) shallow sewers for high-density *kampungs* where on-site treatment systems are not feasible; and 3) small anaerobic treatment plants on the outskirts of *kampungs* (PT Indah, 1989, p. 12). While there is not yet a consensus body of evidence on these "alternative" sewer system costs, they may well cost only 40-60% as much as the conventional sewer (in equivalent annual cost per capita).8 But that is still expensive, especially to the poor. Given Jakarta's budget constraints, alternatives to sewers must be considered for a long time.

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8 On the proper measurement of equivalent annual cost, see Appendix VI.

3.3 Alternatives to Sewers

There are literally hundreds of means -- some thoroughly proven, some promising but quite untested -- for disposing of human waste in a sanitary way. This is not the place to review them. Rather, let us focus on the three basic problems: 1) that some people with septic tanks do not operate them properly; 2) that some people do not use septic tanks at all in areas where on-site treatment is feasible; and 3) that many people live in areas where the terrain or congestion requires off-site sewage treatment. There are cheap and proven techniques for handling each of these problems. In succeeding paragraphs, we will look at each of these problems, the solutions, and the political, financial, and psychological impediments to implementing them.

The first problem is that, for many households that have septic tanks, the tanks are not well tended. Septic tanks need desludging about once every two years; the sludge must be removed carefully and then treated. Too often, this does not happen. How often is not easily estimated, since the number of septic tanks in Jakarta is quite unknown. But the City desludges an average (1985-1990) of only 25,000 household septic tanks per annum, surely a small fraction of the total.9 The City owns two septic tank sludge treatment plants, and it would not be very expensive to build more plants and treat more sludge.

But the City "has no effective regulation system for on-site human waste disposal systems ... [and] there is no basis for establishing large-scale and systematic septic-tank emptying operations" (World Bank, 1993b, Volume 2, p. 48). When there is no way to regulate or tax anti-social behavior, one must look -- reluctantly, in a tightly budgeted world -- for ways to subsidize the cessation of

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9 There are also five private desludging companies, but they only do about 2% of the total desludging (JICA, 1991, p. F-53).

such behavior. Since much of the benefit of a functioning septic tank accrues to the owner, the extent by which desludging would have to be subsidized is probably not large. Furthermore, the price could well differ by area of the City, with the largest subsidies being offered in the poorest and most congested areas, where proper desludging is most beneficial, and with little or no subsidy being offered in areas where households are richer and the problems less serious. Such a price differential would serve the interests of both equity and efficiency.

The second problem is that many households for whom on-site, septic-tank treatment of human waste is feasible and desirable do not have septic tanks. This is the most difficult of the three problems. Septic tanks, even leaching pits, are not cheap; the construction cost is $80-350, which is very high for low-income families. Annualizing the figure and allowing for a long life still leaves a fairly high cost; even when subsidized loans were given households to construct their own leaching pits, the rate of construction was slow (JICA, 1991, p. F-27).

It is small consolation that leaching pits "cost about one-tenth that of sewerage systems" (World Bank, 1990a, p. 118) if it is impossible to induce the poor to construct them. Subsidies here are expensive in terms of budget. Perhaps the best hope is to induce people in such areas to use public toilets.

The third problem is that many people live in areas where the terrain or congestion requires off-site sewage treatment (or that they cannot afford proper on-site treatment of a private toilet). The solution is straightforward, in principle: public communal toilets and washing blocks (with appropriate waste treatment).

Communal toilets and washing blocks are not a new idea in Jakarta. A long-established ingredient in the Kampung Improvement Program (KIP) is the construction of MCK (i.e. *mandi-cuci-kakus*, bathing-washing-toilet) facilities.

Usually, MCKs discharge sullage directly to surface drains and toilet wastes to septic tanks or leaching pits. The KIP takes a multifarious approach to poor residential areas, seeking to provide for each targeted area a mix of investments and services to improve the standard of living of the residents. In varying proportions, it has provided roads, paved paths, drainage ditches, water standpipes, schools, clinics, and public toilet and washing facilities. Until now, however, MCKs have played a minor role in most such activities (Marcussen, 1990, p. 102; World Bank, 1990a, p. 118). Various explanations have been offered for this lack of emphasis:

1. MCKs are expensive, not so much in their construction as in the need to acquire scarce and high-priced land for their drainage (World Bank, 1990a, p. 118; Silver, 1990, p. 2-5).

2. MCKs have been poorly planned, sited, and constructed "with the result that the facilities are often not wanted and so not used" (PT Indah, 1989, p. 7).

3. It is hard to sustain the operations of MCKs. They endemically suffer from lack of maintenance. In principle, public toilets "are maintained by the community concerned" (JICA, 1991, p. F-29), but in fact, they serve so many people that free-rider problems invade.

4. Public maintenance is also inadequate. The Dinas Kebersihan (DK) operates a septic pumpout service, but it is very inefficient, and much of the sludge is simply dumped without treatment. Many of the MCKs are never desludged.

5. Being built in *kampungs* prone to flooding, many MCKs themselves flood, or their treatment tanks overflow (Marcussen, 1990, p. 132).

As a result, "the MCK program in Indonesia does not enjoy a good reputation" (Silver, 1990, p. 2-1). The communal facilities have failed in three senses. One, many end up as inefficient treatments of human waste. Two, many others that are potentially efficient are not much used. And three, still others, potentially efficient with modest use, have become so successful that they literally overflow their design capacity, perpetuating the very problem they were intended to solve.

The magnitude of the failure of MCKs and the multitude of problems that have led to this failure indicate that there is no easy solution. And yet, in the interim that may last many years, while *kampungs* are poor and crowded and sewer systems not yet constructed, there is no other way to provide proper treatment of human waste at an affordable (private and social) cost.

Perhaps lessons can be learned from Jakarta's standpipes -- turning carefully designed MCKs over to private entrepreneurs, who will maintain the facilities or forgo profit and who will craft pricing structures that result in both use and profit.10 Privatization is not costless to the municipality -- it requires heavy subsidization, both in construction and in desludging -- but it may be the cheapest interim partial solution to Jakarta's problem of human waste treatment in poor and densely populated areas.11

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10 An alternative, suggested by PT Indah (1989, p. 13) is to install community toilets "for small groups of families who should be given full responsibility for maintenance". But this loses sight of the principal purpose of the MCK, to reduce the number of toilet facilities in crowded areas so as to use less land and to achieve economies of scale in the treatment of human waste.

11 An emphasis in this sentence must, unfortunately, be put on the word, "partial". A full solution (at feasible expenditure) must await sewers. Silver's tone is pessimistic, but his reservations must be noted:

> In areas where an off-site solution is appropriate but its implementation is not likely to occur for

3.4 Drinking Water and Wastewater

The connection between drinking water and wastewater is not always sufficiently stressed. It is too easy to get caught up in the obvious social costs of inadequate treatment of wastewater. There are aesthetic costs: every visible drop of water in the City murks and stinks, even in the potentially beautiful rivers and canals. And there are health costs: those who use the City's waterways or shallow wells are at continual serious risk of digestive and skin diseases. Beyond these actual costs, there are opportunity costs: Jakarta's potentially copious beneficial use of its river water, canal water, and groundwater has been essentially nullified.12

Drinking water and wastewater are simply two ways of looking at the same thing. From a materials-balance viewpoint, one is input into the City's water consumption process, and the other is output. Increased supplies of drinking water increase the quantity of wastewater needing treatment. Less obvious, but just as important, is the reverse connection. Absence of wastewater treatment contaminates existing potential drinking water supplies and

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> many years, the promotion of on-site solutions in the interim carries unknown health implications. It seems logical that use of toilets which discharge septic tank wastes to the drain would be somewhat safer than direct defecation in the drain, as there will be less chance for direct contact with excreta. Likewise, it seems logical that if it were possible to upgrade an area in which 60% of the existing on-site systems overflowed to the drain, so that only 20% overflow, this would also bring a benefit, since the probability of the community's contact with pathogens from sick people having effective on-site disposal is smaller. However, these inferences are unproven. (Silver, 1990, p. 1-11)

12 For a more detailed listing of the potential benefits that could be derived from cleaner rivers and canals, see Appendix VII.

increases the need for new drinking water supplies. The greatest cost of inadequate wastewater treatment may be this, that it generates more water needs and, ultimately, even more inadequate wastewater treatment.

The interdependence of drinking water provision and the need for wastewater treatment has two important practical implications. One, it means that the planning of new investments in the two areas must be simultaneous and interrelated if it is to be efficient. And two, it means that the pricing of drinking water must reflect the impact that water supplies place on wastewater treatment resources. We discuss the first of these here, and we return to the second aspect in Section 5.2.

The need for simultaneous and interdependent planning of drinking water provision and wastewater disposal and treatment has not been recognized by the urban planners of Indonesia or Jakarta. There are probably many reasons for this omission, but three should be noted:

1. Throughout the developing world, and indeed earlier in this century in the now industrialized world, public improvements in urban sanitation have lagged behind improvements in water supply services. Water is more obviously necessary for life than sanitation. Improvements in the quantity and quality of drinking water have more immediate, visible, and measurable impacts on public health than do improvements in sanitation. And, last but never least, it is much easier to charge fees for water than for waste disposal.

2. In Indonesia, the government has long maintained as a "basic premise ... that sanitation is an individual responsibility" (World Bank, 1993b, Volume 2, p. 48). There was little attention paid to sanitation in the Five-Year Plans (Repelitas) until the early 1980s, and even over the last decade the provision of ample and clean drinking water in cities

has taken clear precedence over programs to dispose of the resultant wastewater (World Bank, 1993a, p. 14).

3. The timing of urban infrastructure investments in Indonesia has been driven by the availability of foreign loans (and grants). Since foreign-aid agencies have preferred water investments, that is where (and when) the investments have gone.[13]

The interdependence of water and sewage and the optimal timing of these investments have been largely ignored during Jakarta's growth. These issues, however, are not easy ones to handle correctly, either conceptually or empirically.[14] I cannot here begin to explore all of this complexity, but I do want to give a flavor of the difficulties by looking hypothetically at just one piece of the problem -- the optimal time to install a sewer.

First, consider the choice between installing the sewer now (i.e. in year t=0) and waiting until next year (t=1) to install it.[15] For the decision to install now to be optimal, two social benefit-cost tests must be passed: 1) future social benefits of the sewer, discounted to t=0, must exceed its current and future social costs, also discounted to t=0; and 2) the social costs of postponing the installation until t=1 must exceed the social benefits of postponement. The first test is widely known and generally

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13 It is interesting to speculate why aid agencies show this preference. It may be simply that water is "cleaner" in the input than in the output stage of the flow through the city. It may be that sewers are too big for most aid budgets, and micro-sanitation projects are too small and complex.

14 See Porter, 1977 and 1983, for discussions of aspects of these problems.

15 We will ignore, just to make this abstract discussion simpler, the fact that the sewer could not be installed in just one year. We will also assume, for simplicity of the argument, that the benefits begin to appear in the year after the sewer is installed.

accepted.16 The second requires explanation. There is benefit to postponing the sewer (from t=0 to t=1), namely the interest cost for one year on the capital that would have been expended at t=0.17 The costs of postponement are twofold: 1) the social benefits (net of recurrent costs) that would have occurred in t=1 are lost (forever) if the project is not undertaken in t=0; and 2) the increased real capital cost of installing the sewer rises, since we can expect that cost to rise over time.18 If the benefit of postponement exceeds the sum of the two costs of postponement, then the sewer should be put off, even if it passes its benefit-cost test for installation in t=0.19

Second, consider a slightly different situation. Suppose the benefits of increased sanitation are so great

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16 Curiously, in the only such benefit-cost test that I have seen of the Jakarta sewer, the present value of the measured benefits exceeds the present value of the measured costs only if a real discount rate less than 4% per annum is used (JICA, 1991, pp. 11-1ff). That is a much lower discount rate than is typically applied in Indonesian evaluations of public investments. But that benefit-cost analysis: 1) stops with a horizon of 50 years, when the benefits of a sewer system will continue much longer than that; and 2) counts as benefits only the averted medical costs due to the reduction in disease when there are manifold benefits beyond disease (see Appendix VII) and medical expenditures misrepresent, and generally undervalue, the benefits of avoided disease (Courant and Porter, 1981).

17 To be precise, it is not the interest per se that is saved. That does not matter in a social benefit-cost test. But the interest is a proxy for the productive benefits foregone elsewhere if capital is put into a sewer rather than its best alternative use.

18 It is the ever greater size and density of the city that raises the system costs.

19 The formula underlying the words of the text is developed in Appendix IV, Part A. Applying this formula to the data of the benefit-cost test in JICA (1991, pp. 11-1ff), we find that, if the sewer passes its benefit-cost test for t=0, it should be postponed at least one year, unless the capital cost of the sewer is rising at a rate higher than the discount rate. This surprising result follows from the fact that, in the JICA data, the benefit of the sewer in its early years is exceeded by its recurrent costs in those years.

that something should be done immediately, but there is a choice to be made between a full sewer system now (t=0) and a stopgap measure for a few years, followed by a full sewer system (in t=T). The stopgap measure is cheap, but it becomes totally wasted when the sewer is installed, and the real cost of the sewer is growing over time. For the decision to install the sewer now to be optimal, the social costs of postponing the installation until t=T must exceed the social benefits of postponement. The cost of postponement is clearly the cost of the stopgap measure; but, if the real capital cost of the sewer is rising at a rate less than the real discount rate, then postponement yields a benefit by reducing the present value of the sewer costs.20

The purpose of this brief flight into abstract theory is to hint at the complexity of the correct timing of these decisions, even when the interaction with water is ignored and a very simple sewer investment is postulated. In reality, of course, it would be very difficult to conduct such analyses with any empirical precision; but even a rough benefit-cost analysis insures consistency in the data and can help to prevent gross error.

3.5 Flooding and Drainage

For the most part, our concern with wastewater in Jakarta is with its contamination and the aesthetic and health consequences. Here, briefly, we look at the problems arising from its sheer volume. Of course, it is not the volume of wastewater by itself that poses problems, but rather its variability and misdirection -- in short, periodic flooding of large parts of the City.

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20 The formula behind these words is developed in Appendix IV, Part B.

Jakarta is a flat city, with many north-south rivers running through it. The area receives more than 200 cm per year of rainfall, almost all of it in heavy downpours during the half-year between November and April (BPS, 1992, pp. 20f). Not surprisingly, parts of it flood. About one fifth of Jakarta's land area is "prone to flooding" (Hadiwinoto and Clarke, 1990, p. 2); and 6% is "habitual inundation area", which means that it floods more than twice a year on average to a depth of 25 cm (JICA, 1991, p. 3-3).

While the root causes of the flooding are natural, urbanization and growth have exacerbated the extent of the flooding and the economic damage owing to them. With urbanization has come increased water piped into Jakarta, land subsidence, runoff from protected residential areas, and clogging of both natural and constructed drains with human and solid waste. Jakarta's flood damages are estimated to be $26 million per year, mostly due to damage to private property, but also in profit losses for business, higher operating costs (including time) for vehicles, and damage to the public infrastructure (JICA, 1991, p. B-66).21

Efforts to control Jakarta's floods have long been made. The West Banjir (i.e. flood) Canal was completed in 1920, and the City is now honeycombed with public drainage canals. Private efforts are also made, although these resemble musical chairs, since the prevention of flooding in one area often simply increases the volume of runoff into other areas. Indeed, every construction of a flood-proof building simultaneously increases the rate of flow of water into the reduced remaining area.

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21 This estimate of flood damages, barely $3 per Jakartan per year on average, is very low, but this should not surprise since neither health nor aesthetic costs were assessed. The infrastructure damage is principally to roads: "Regardless of how soundly constructed a road is, if it is inundated all the time, it will be destroyed" (Mariyanto, Director General of Bina Marga (Highways), as quoted in "Road Repair", 1994).

Since the propensity to flood reduces the value of land, the poor tend to live where the floods are worse. And, to complete the vicious circle, the floods are worse where the poor tend to live since their dense populations mean more waste to clog whatever drains there are and their large numbers reduce the incentive, through free-ridership, of affected householders to keep community drains clean. Accordingly, almost any expenditure on drainage and flood control will end up benefiting the poor. Even where such expenditure benefits business, it will mean greater convenience and lower prices for the poor residents in the area. Even without consideration of the equity aspects, drainage projects tend to show high internal rates of return.22

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22 One analysis of several such projects found rates of return around 20% (JICA, 1991, pp. 11-1ff). But these analyses excluded the cost of acquiring land (or more accurately, excluded the economic value foregone by using the land for flood control). Land costs were excluded on the grounds that the land values would be appreciated by the flood control, but, since reduced flood damages were already counted as a benefit, this amounted to double-counting them. The corrected rate of return was nearer 10%, but this seriously underestimated the true rate of return since many of the benefits of flood control were not measured.

4. SOLID WASTE

SUMMARY

Jakarta generates a surprisingly large amount of solid waste, given its modest standard of living and extensive recycling. Its solid waste, moreover, is wetter and denser than its richer counterparts, making it both more urgent and more difficult to dispose of.

For much of the City, solid waste collection begins with handcarts, paid for by fees, whereby the waste is transported to central depots. The fact that fees suffice at this stage indicates the willingness to pay of even the poor to get the waste away from their residences. Meanwhile, much of the waste is being picked over by thousands of scavengers -- an unsubsidized activity that produces recycling as well as reduced pressure on the collection and landfilling processes. At this first stage, the solid waste collection process works amazingly well.

The solid waste disposal process works less efficiently at the next stage. Transport from the local depots to the landfill is partial, at best. Since it is difficult to collect fees for this stage of the disposal process, the City is inevitably budget-constrained here. But it is further hampered by: 1) the distance to Jakarta's only active landfill; 2) the increasing capital-intensity of the vehicle fleet involved; and 3) the City's excessive concern for landfill quality and main-street cleanliness.

4.1 Introduction

For those only familiar with systems of solid waste collection and disposal in contemporary industrialized societies, Jakarta's handling of the problem will come as a great surprise. In the industrialized world, solid waste disappears as if by magic, with households involved only to the extent that they collect their own trash and see it

(perhaps) to the curbside on a regular basis. From there, it is whisked away by highly capital-intensive trucks -- perhaps through transfer stations, perhaps through recycling centers, perhaps for some distance -- to an expensive, environmentally safeguarded, sanitary landfill. All this occurs at no observable cost to the households, with the cost of the entire operation being borne by the general fund budget of the relevant local jurisdiction.

In Jakarta, households are much more involved -- both physically and financially -- with the collection and disposal of their solid waste. Less than ten percent of Jakarta's solid waste is actually picked up from households on a door-to-door basis (JICA, 1987, p. S1-55). Even in the poorest residential areas, people pay directly for the collection of their solid waste -- even if it is irregularly or incompletely collected. Much of the solid waste is recycled, not at a capital-intensive Materials Recovery Facility (MRF), but by labor-intensive, street-scavengers. And finally, something like 25% of Jakarta's unrecycled solid waste is not collected at all, and perhaps another 15%, which is initially "collected", does not find its way to the City's landfill.1

Perhaps also a surprise to those unfamiliar with developing country cities is the quantity and composition of Jakarta's solid waste. We do not know, of course, exactly how much solid waste is generated in Jakarta, because so

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1 Estimates of the efficiency of Jakarta's solid waste collection range widely. Watt et al. (1991, p. 8) says 75% is collected and 60% reaches the landfill; Manschot (1991, p. 37) says 80% is successfully "managed"; JICA says that 60% is collected and 73% of what is collected is disposed of at the landfill (JICA, 1987, p. 33; Bansgrove, 1991, p. 83); the World Bank refers to an estimate (of 1986) that 40% of Jakarta's solid waste ends up in "informal sites" (World Bank, 1993b, Volume 2, p. 55; this estimate also appears in Hadiwinoto and Clarke, 1990, p. 2); the Jakarta Solid Waste Department (*Dinas Kebersihan* or DK) itself claims that the City "carries" about 80% of the solid waste generated (IWACO, 1992, p. 80).

much is either recycled, privately handled and not reported, not collected, not carried to the landfill, or not carefully measured when it is disposed of there. But most estimates agree that the City of Jakarta produces some 5,000-6,600 tons/day of municipal solid waste (CPIS, 1992, p. 2 for the lower figure, World Bank, 1993b, Volume 2, p. 54 for the higher).

Considering how poor Indonesia is relative to the countries of Western Europe and North America, its cities produce a lot of solid waste. The United States, for example, is a very high producer of solid waste. But it generates only about three times as much solid waste per capita as Indonesia while generating some 35 times as much GNP per capita. The production (or perhaps better termed "consumption") of solid waste turns out to be income-inelastic -- cross-country comparisons show the income elasticity to be only about 0.3.

The low income elasticity of solid waste production offers good news and bad news. The good news is that Jakarta does not have to anticipate a rate of growth of its solid waste problem as fast as the rate of growth of its total income.2 The bad news is that solid waste currently poses a relatively more serious resource and budget problem for Jakarta than it does for the large cities of, for example, the United States. If all of each country's solid waste were collected and disposed of, the resources needed to achieve it would amount to about 1.3% of Indonesia's GNP

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2 For example, to take rough but useful numbers, if Indonesia' real income grows at 5% per annum, its population grows at 2%, and hence its real income per capita grows at 3%, its flow of solid waste would grow at 2.9% per annum. (The formula is readily derived: 0.3 times the growth rate of income plus 0.7 times the growth rate of population; for any numbers, the growth rate of solid waste is less than the growth rate of income as long as 1) the income elasticity of solid waste generation is less than unity, and 2) the rate of growth of per capita income is positive.)

but only about 0.3% of the USA's.3 What this means in more practical budget terms is that solid waste consumes some 20-50% of a typical developing country city's total budget, and most only collect a part of the waste flow and spend little on the environmental safeguarding of the dumps to which it goes (Cointreau-Levine, 1991, p. 14).

The composition of Jakarta's solid waste is also very different from that of a city of the industrialized world. It is wetter and denser -- organic waste makes up about 75% of Jakarta's household waste (Figure 4.1.1).4 This dominance of organic waste in the solid waste stream disappears as development proceeds, falling, for example, to only 25% in the United States. Richer people have much more to throw away than the inedible remnants of their meals.

There are four important economic implications to this high proportion of organic material in the solid waste stream in developing country cities. One, the solid waste stinks and rots more quickly, especially if the climate is wet and hot as Jakarta is much of the year, making it more important for aesthetic and health reasons to dispose of it promptly and completely. Two, because of its high moisture content, it does not burn well, making incinerators much less tempting as a means of reducing the costs of disposing of the waste (Cointreau-Levine, 1991, p. 16; World Bank, 1993b, Volume 2, p. 60).5 Three, it yields relatively little recyclable material, which means that recycling

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3 Indonesia's lower labor costs are offset by its higher capital costs and the extreme density of its cities -- greater density reduces solid waste costs up to a point, but that point is passed when streets become too narrow for solid waste collection vehicles.

4 The source of Figure 4.1.1 is City, various years.

5 Surabaya's incinerator has experienced "substantial problems in start-up ... because the municipal solid waste in Surabaya has a low calorific value ... and waste oils from tankers in the port must be added to sustain combustion" (Cointreau-Levine, 1991, p. 30). (Incidentally, such oils are categorized as hazardous waste in the United States.)

offers much less potential as a means of reducing the amount of waste to be disposed of; Jakarta's highly organic waste is ideal for composting, but there are still very few well-functioning composting operations to evidence that composting can be a cost-effective means of solid waste treatment.[6] And four, organic waste is already dense waste, and it cannot be much further compacted by compactor trucks -- in the United States, solid waste weighs about 100-150 kilograms per cubic meter (kg/m3), while in Indonesia, it weighs from 200 to 500 kg/m3 (Manschot, 1991, p. 14).[7]

Having seen what it is that needs to be disposed of, we turn to the process by which Jakarta's solid waste is -- and is not -- collected.

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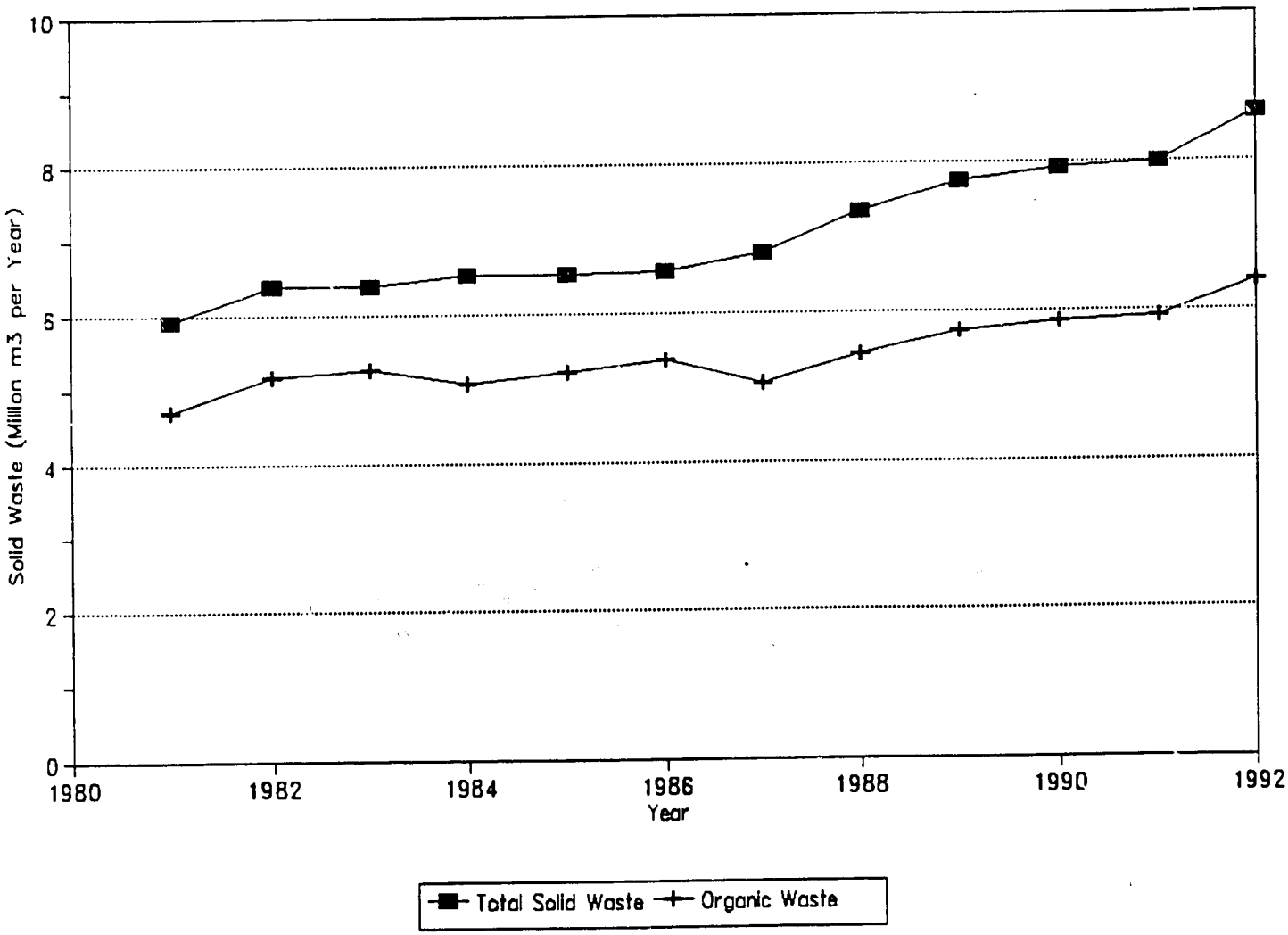
6 In Jakarta, several of the hotels sell their restaurant waste, carefully segregated from the other waste, to farmers -- but this is uniquely pure and rich compost material.

7 The wider range for Jakarta is due to the difference between the rainy and dry seasons, exacerbated by the open outdoor storage of such a large percentage of the waste.

Figure 4.1.1
Total and Organic Solid Waste



4.2 Initial Solid Waste Collection

About half of Jakarta's solid waste is produced by households -- see Table 4.2.1 -- with the rest being generated by commercial and industrial establishments and markets.[8] Most of this solid waste is "collected", as opposed to being "self-treated" or disposed of "informally", which means burned, littered, or thrown into a waterway.[9] The varied processes by which this collection occurs is the subject of this section.

The collection process for residential areas in Jakarta is very decentralized and very different in different areas. For well over half the households, the initial waste collection is organized and executed by the lowest level of government organization, the Rukun Warga (RW) or the Rukun Tetangga (RT), loosely structured communities of up to a few thousand people.[10] The community itself decides on -- and pays for -- the kind of collection service it wishes. For less than one tenth, this means door-to-door, curbside pickup. For another one tenth, it means *jali-jali* (block) collection: the collection vehicle moves down the street on

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8 Table 4.2.1 is nearly a decade out of date, so all its totals are undoubtedly low for today, but this is the most detailed study available for the source and disposition of Jakarta's solid waste, and its relative magnitudes have probably not changed much.

9 About two thirds of what is "collected" does not reach the landfill but becomes in turn, despite its initial pickup, informal disposition -- to this latter problem we return in Section 4.4.

10 Jakarta is successively divided into sub-government organizations. These are:

Name of Entity	Number in Jakarta	Average Population
Wilayah	5	1,450,000
Kecamatan	30	240,000
Kelurahan	260	30,000
Rukun Warga (RW)	2,201	3,000
Rukun Tetangga (RT)	28,001	250

pre-arranged days, stopping every 200 meters or so, and playing music to alert the residents to the need to bring their solid waste to the vehicle. These services are relatively expensive, require streets wide enough for sizeable vehicles, and are chosen only by well-to-do areas.

For the majority, either their average income or the width of their streets, or both, preclude such convenient and costly collection. For these households, the initial collection is made either by foot or by handcart to an open depot space or to some sort of community container. Not only may the feet or the handcart be the only feasible system of waste collection in densely packed, street-less *kampungs*, but they offer the additional advantage of frequency. Since the average poor kampung residence is tiny, frequent removal reduces the need to allocate scarce household space to waste storage.

The handcarts, and the handcart operators, are a fascinating part of the waste disposal process. Several thousand of them ply the narrower ways of Jakarta, making collections once or twice a week from the roughly one hundred households that each handcart services and delivering that waste to a temporary solid waste storage place -- *Lokasi Pembuangan Sementara* (LPS) -- where it awaits City collection. Handcart operators are at the bottom of the skill ladder, receiving only some $25 per month. They move the solid waste to Jakarta's several thousand LPSs at a cost of about $0.85 per ton.11

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11 A little handcart economics. Operators receive about $25 per month and operate a cart with about 350 kg capacity. They work roughly 300 days per year and make some four or five round trips per working day. This makes the labor cost, at the handcart collection stage, about $0.63 per ton. The cart costs $300, lasts about four years, and has a 10% residual value; thus, depreciation is about $0.15 per ton. Finally, the interest charge on the handcart capital, at 10% per annum, is $0.07 per ton. The total cost of the handcart collection comes to $0.85 per ton. This figure will be used Section 4.4. (Data source: JICA, 1987, Annex S; to the JICA

The diversity among RT/RWs lies in the mix of vehicle and handcart employed and in the sophistication of the LPS to which the waste is delivered. At one extreme, the LPS may be nearly a modern transfer station, with municipal attendants and metal dumpsters equipped for mechanical transfer. At the other extreme, the LPS may be simply a large metal container, a large concrete bin, or a large open space.

The cost of this first stage of solid waste disposal is borne entirely at the local level, and the sophistication and completeness of the collection depends simply and essentially on what the residents are willing to pay for. Depending upon their income and wealth, and upon the quality of service chosen, households pay anything from a few Rupiah to $3 per month to the neighborhood leader. About half of these solid waste fees are then used to provide the collection service, with the rest being used for other neighborhood security services and community events (Watt et al., 1991, p. 8; Chifos, 1991, p. 56; JICA, 1987, pp. S3-36 and S4-68).

The disadvantage of this system is that, in neighborhoods that are composed almost entirely of poor residents, very little waste fee revenue can be collected, and the level of service is particularly bad. Not only is this inequitable, but it exacerbates the health problems that are most worrisome in just these highly congested areas. Moreover, the situation becomes unstable -- as the quality of the solid waste collection deteriorates, households begin to refuse payment for it, and the concomitant revenue losses mean further deterioration of service.12

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cost estimates have been added the interest charge -- for an explanation of the need for its inclusion, see Appendix VI.)

12 One survey of very poor *kampungs* found that the average household payment was $0.75 per month, low partly because one third of the households were so unhappy with the service

On the other hand, Jakarta's policy of making the first stage of solid waste collection a neighborhood responsibility makes very good economic sense, for two reasons. One, while there are externalities attached to solid waste creation and disposition at all stages, it is most nearly a private good when it is closest to the household that created it. Households benefit greatly from having their own waste removed from their immediate vicinity, they are willing to pay for this removal, and the service is readily terminated if they do not pay. Only as the solid waste accumulates, far from its creators, does it take on critical aspects of a public good (or more properly a public "bad") and require public solution at a higher government level. And two, most Jakarta neighborhoods are quite heterogeneous in terms of the income levels of their residents. The rich benefit more, in money terms, from a clean neighborhood than do the poor; and no one is better situated to find the proper level and progressivity of solid waste fees than the local community and its leader.13 It is difficult to think of a feasible fiscal mechanism for Jakarta that would more optimally organize the first stage of solid waste collection for most the population.

The rest of the collection system is more familiar and can be described briefly. Many households have their solid waste picked up by door-to-door service, provided either 1) by the neighborhood, which transports it to a LPS, 2) directly by the City Cleaning Department (*Dinas Kebersihan*, DK), or 3) by a private waste collector under contract to

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that they refused to pay anything at all (Chifos, 1991, p. 37 and Tables H42 and H43).

13 There may also be a progressivity in the kind of service provided, where the neighborhood exhibits a wide variance of incomes, with the higher fees paid by the rich earning them better service while they cross-subsidize the service received by the poor.

the DK.[14] If picked up by the DK or a private contractor, the waste may initially be hauled to an LPS, to the City's one (privately owned and operated) formal transfer station, or directly to the City's landfill. Big commercial and industrial establishments are responsible for disposing of their own waste; some use, and pay for, DK service, but most employ private organizations.[15] A variety of other public agencies complete the responsibilities for initial collection -- P.D. Pasar Jaya collects waste from Jakarta's markets; the Public Works Department also cleans streets, canals, and rivers; and the Parks Department cleans the City's parks and gardens.

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14 Jakarta put solid waste collection out to private contract in 27 of its 261 *kelurahans* in the late 1980s (Manschot, 1991, p. 4).

15 Private collectors cost more but give more dependable service (JICA, 1987, p. S6-35).

Table 4.2.1

Source and Disposition of Jakarta's Solid Waste, 1986

Source	Disposition "Collected"	"Informal"	"Self-Treated"	Total
Households	1,690	490	300	2,480
Markets	300	220	--	520
Commercial	810	160	180	1,150
Industrial	450	130	200	780
Collections	-1,170	1,170	--	--
Informal	180	-180	--	--
Total	2,260	1,990	680	4,930

Notes:

1. All figures in tons per day.
2. All solid waste sources and dispositions exclude recycled materials.
3. -- means assumed zero.
4. Percent of not-self-treated solid waste "Collected" = 81% (i.e. [2,260 + 1,170]/[2,260 + 1,990]).
5. Percent of not-self-treated solid waste disposed of at the landfill = 53% (i.e. 2,260/[2,260 + 1,990]).

Source: Surveys conducted by JICA Study Team, August-September 1986, as reported in JICA, 1987, pp. 32f.

4.3 Recycling

Jakarta has an extensive recycling system. No sooner has solid waste left the household than it begins to be pored through by scavengers, lonely individuals with bags or carts, seeking a living through collection of discarded items that have value in recycling or reuse. Scavengers (*Pengumpul Barang Bekas*, gatherer or collector of used goods) operate outside residences, at LPSs, outside commercial establishments, and at the landfill. There are some 10,000-40,000 scavengers in Jakarta (BPS, 1980 Census; CPIS, 1988, p. V-4; JICA, 1987, p. S1-115; Manschot, 1991, p. 42; IWACO, 1992, p. 99). The range of estimates is large, partly because of the informal nature of the occupation, but largely because, until recently, scavengers were considered urban undesirables, grouped with prostitutes and beggars, and continually subject to police harassment, and liable to compulsory job retraining, exile from the City, or transmigration (CPIS, 1988, p. V-1). It was not until 1987 that they were freed from official impediments to their work.16

Scavengers tend to be young, male, uneducated, recently migrated into Jakarta, and formerly unemployed or day laborers in their villages (JICA, 1987, pp. S1-112 and S4-30).17 They collect not only the items that are now beginning to become recycled in the already industrialized economies -- paper products, plastics, glass, and metals -- but also discarded household durable goods (for repair and resale), wood (from old packing boxes and pallets), bone, sawdust, and garbage (for fertilizer), usable bottles and

16 For decades, scavengers were defined as *gelandangan* (undesirables) "because of the improper nature of their job" (CPIS, 1988, p. III-3); in October 1987, President Soeharto declared them to be *laskar mandiri* (translated as "a self-reliant army" by Sicular, 1992, p. 181).

17 All the JICA information on scavengers comes from a large survey undertaken by BPP Teknologi in 1983 (Studi Aktivitas Pemungutan dan Pemanfaatan Barang Bekas).

boxes (for resale as containers), and cigarette butts (for reprocessing into new, albeit inferior, cigarettes).18

Each scavenger deals with a single buyer, called a *penadah* (or *bandar* or *lapak*; the *lapak* is also the staging area). *Penadahs* not only provide a certain market and a stable price for their scavengers but also provide a variety of services -- financial assistance in emergencies, rent-free capital (basically a cart, possibly scales), free housing, interest-free loans, holiday bonuses, etc. (CPIS, 1988, pp. V-4f). The ongoing relationship between scavenger and *penadah* also reduces the need for constant monitoring.

Despite this paternalistic, monopsonistic relationship, scavengers earn fairly good incomes for their skill levels, some $25-125 per month, which is well above the minimum wage rate.19 Again, the wide range of the income estimates is partly due to the informality and past persecution of the profession, but it is also due to the fact that the different kinds of scavengers and their different collection sources and techniques mean that scavengers differ greatly in the effort they must make and the risk they must take; it is no surprise that their rewards differ greatly as well.20

In the absence of good empirical information, it becomes an interesting exercise in second-best logic to discuss the question, are there too many or too few

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18 A sign of the rising standard of living in Indonesia is the decline of the cigarette-butt scavenger -- as incomes rise, smokers are demanding virgin tobacco in their cigarettes.

19 The lower monthly income estimate is from JICA's survey (JICA, 1987, p. S1-112); the higher is from a recent survey by Boomgard (personal communication). The CPIS survey (CPIS, 1988, p. V-5) found $75.

20 Scavengers who deal with heavier items, greater distances, or longer hours make larger incomes. According to CPIS, scavengers who work at the landfill make the largest incomes -- they "must retrieve the items quickly before they [the scavengers or the items?] are bulldozed underground" (CPIS, 1988, p. V-11) -- although Boomgard's recent interviews suggest this wage differential may no longer exist.

scavengers from the viewpoint of economic efficiency? The City is "a kind of urban commons" (Sicular, 1992, p. 27) and as such is over-grazed by the scavengers (because they equate their opportunity-cost wage rate to the average revenue product, rather than to the marginal revenue product). But scavengers sell to monopsonistic *penadahs* (buyers), and monopsonists earn their excess profit by offering too low a price, which in turn means that there will be too few scavengers. In Appendix V, it is shown that these two forces exactly offset each other -- in theory. Reality, however, is not so neat in either respect: 1) the monopsony power is never complete, as new *penadahs* can and do appear and as scavengers can and (occasionally) do change *penadahs*; and 2) the recyclables "commons" is subject to some formal and informal reservation of territory by the individual scavengers. Further, we must recognize that the private benefit to the scavenger of his scavenging consists only of its recycling value, while the social benefit also includes the saved costs of transporting the material to the landfill and interring it there.

When the theory leaves us uncertain and the data are few, diverse, and imperfect, it would be dangerous to formulate policy intended to encourage or discourage scavenging. The bottom line consists of two observations. One, scavenging removes some 7-20% of Jakarta's solid waste from the disposal stream and puts it back into the privately profitable productive process.21 And two, the developing world is littered with the bones of promising informal-sector activities that became the target of well-meaning government policy. Until a much later date, when formal recycling becomes appropriate -- indeed necessary, if the advanced countries provide a clue, as informal recycling

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21 In this percentage, too, there is a range of opinion. Sicular (1992, p. 4) suggests 7-15%; the CPIS studies suggest 20% (CPIS, 1988, p. V-4; and CPIS, 1992, p. 2); and JICA suggests 7% (JICA, 1987, p. S1-115).

gradually becomes unprofitable and disappears -- it may be wise policy to leave the scavengers alone.

Of course, the recycling process does not end with the scavenger. After the scavenger sells the daily collection of waste to the *penadah*, the recyclables are sorted, cleaned, and compressed at the *penadah's lapak*. (There are some 3,000 *lapaks* operating in Jakarta (CPIS, 1988, p. 2).) It is then sold to a *bandar* who basically supplies capital and transport on a larger scale than the *penadah* can muster. The *bandar* sells to a supplier, who in turn sells to a factory that recycles the materials (CPIS, 1988, p. V-4). At each stage, there are fewer agents, larger quantities, more working and fixed capital, and greater specialization.

Currently, there are a dozen factories in the Jakarta area recycling some 200,000 tons of waste paper per year; another half dozen factories processing some 500,000 tons of scrap iron per year; and various processors of non-iron metals, plastics, glass, rubber, and textiles (CPIS, 1988, pp. V-3f). Not all their inputs come from Jakarta, which adds a final layer of complexity to the recycling story. Some of the recyclable solid waste is imported ("Scavengers Call", 1993; and "Imports of", 1994). Apparently, some imports of solid waste materials are banned, but others enter with a modest 10% duty.

Again, in the absence of good empirical information, it becomes an exercise in second-best logic to discuss the question, should the import of solid waste for recycling be banned? To the extent that solid waste is being dumped in Indonesia under the pretext of its being recycled when it is in fact not, then a heavy duty, if not a ban, is appropriate, for such solid waste either becomes costly litter or requires costly disposal. If the Indonesian government cannot monitor whether imported solid waste is going to be recycled or dumped, then an appropriate cautious policy might still be a ban. But for solid waste imports that are definitely going to be recycled, the appropriate

tariff policy is not clear, from the viewpoint of economic efficiency. Imports of recyclables push down the prices of recyclables in Indonesia and hence reduce the number of scavengers. It comes back to the question we asked earlier, are there too many or too few scavengers? And that question, as we saw earlier, is not easily answered.22

4.4 Transportation to the Landfill

Moving the solid waste from the small local transfer station (the LPS) to the landfill is basically the job of the DK.

In principle, much if not all of this cost is covered by the solid waste fees paid at the local level, but very little -- around 1% of these fees -- reaches the municipal agency, so this stage of the waste disposal is in fact paid for from the City's general fund.23 Where the waste fee (*retribusi sampah*) and the waste are collected by the neighborhood, fees are low and "little reaches city coffers" (Watt et al., 1991, p. 8). And where the fees and the waste are collected by the DK itself, its door-to-door collection technique suffers serious shortcomings -- the collectors are few and part-time, they lack incentives, the moneys pass through the hands of at least six agencies, and DK does not

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22 One final interesting footnote to this question. For producers of solid waste in industrialized countries, this solid waste is an unfortunate byproduct of their activities. Waste is, for them, essentially an "output" that they must sell at a negative price (i.e. the cost of environmentally safe disposal). If industrialized-country waste is physically imported into Indonesia, it earns foreign exchange for Indonesia, so it is really an Indonesian export (i.e. Indonesia is selling landfill space to foreigners). The appropriate question is, should this export be taxed or subsidized? But ... enough.

23 Waste fee receipts rarely cover as much as 10% of the DK routine budget (Cervero, 1991, p. 1). The World Bank says they cover "about 3%" of the City's solid waste expenditure (World Bank, 1993b, Volume 2, p. 55).

automatically retain the revenues (JICA, 1987, p. 55 and Section S6, passim; and Cervero, 1991, p. 1).[24]

How much of the solid waste expenditure ought to be covered by fees is a question to which we return in Section 5. The point here is that the DK is not well-funded. This evidences itself in the high fraction of "collected" solid waste that never, or slowly and irregularly, leaves the LPS -- about one third (1,170 of the 3,430 tons collected each day; see Table 4.2.1).[25] There are too few trucks for the job, the trucks are old, the trucks are poorly maintained, and the trucks make too few trips per day to the landfill.[26]

A comparison with other Asian cities illustrates the underfunding of Jakarta's solid waste collection system (Table 4.4.1). Jakarta employs fewer workers per resident and gets a smaller percent of those workers into the field. As a recent World Bank report put the situation,

> The increase in the amount of waste resulting both from population growth and from the extension of services to areas previously unserved has not been matched by appropriate increases in personnel and vehicles or the productivity of the system. (World Bank, 1993b, Volume 2, p. 54).

It is obvious, and easy to say, that Jakarta spends too little on the process of disposing of the solid waste that it generates and even initially collects. A more difficult, but equally important, question is, could it spend its existing resources more effectively? There are at least

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24 Bogor collects almost as much *retribusi sampah* as Jakarta while handling 4% of the solid waste tonnage (Cervero, 1991, p. 1).

25 What is not collected tends to get burned.

26 Only 70% of the collection vehicles are in operation on any given day. The vehicles make about 60% of the "standard number of trips" each day. And 73% of the vehicles are more than five years old (JICA, 1987, pp. 40ff and later unpublished JICA material). Most of these problems are of course not unique to Jakarta (see Cointreau-Levine, 1991).

four areas in which greater waste-disposal productivity might be achieved:

1. The capital-intensity of the transport operation. Solid waste collection and transportation can be a very unskilled-labor-intensive operation, and countries where such labor is still relatively inexpensive should take advantage of this opportunity to keep costs down. Capital-intensification is inevitable, indeed desirable, as development proceeds, but premature capital-intensification should be avoided. In Jakarta, there has recently been a dramatic movement toward such capital-intensification (Table 4.4.2). Between 1986 and 1990, while the total number of collection vehicles remained essentially unchanged, the number of open-body trucks declined by 40%.27

Open-body trucks are unsightly and certainly far from "state-of-the-art". The collection workers at the transfer locations simply "scoop refuse into baskets, then lift them onto open, fixed-body trucks" (Sicular, 1992, p. 115). But each of the other, more mechanical vehicles offers its own disadvantages: 1) greater initial expense; 2) greater repair and maintenance demands; and 3) shorter expected life. In return for these disadvantages, tippers and arm-roll trucks do little except save time and labor, no great advantage until labor costs become high; and compactor trucks offer little, if any, advantage when the waste is as dense and organic as is Jakarta's.28 A study by the Department of Public Works showed that the open-body truck was the cheapest to operate in average annual vehicle cost (Table 4.4.2, final column). Compactors were some three times as costly, arm-rolls were 60% more costly, and tippers were somewhat more costly -- although tippers require extensive

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27 It is impossible to track the precise trend of the composition of the vehicles because the data are not released in the same form from year to year.

28 Indeed, the breakeven point in payload advantage for the compactor is about 200 kg/m3 (Manschot, 1991, p. 29), which is below the average for Jakarta.

container investment that was not included in the calculation.29 The transition noted in Table 4.4.2 raised the (weighted, real) average cost per vehicle by 11% without increasing the number of vehicles.

It is certainly true, as one World Bank report notices, that Jakarta's solid waste service is "generally inefficient: obsolete, often open dump vehicles, low productivity methods, unsanitary conditions for garbage collectors" (World Bank, 1993a, p. 17). But it does not necessarily follow from that statement that state-of-the-art transport equipment should be immediately introduced.

2. The relative resource allocation to street sweeping and waste transport. Jakarta's "protocol" avenues are beautifully landscaped and cleaned, while its lesser streets and alleys suffer badly from waste that is not collected or collected but not removed. This outcome is not surprising: street sweepers outnumber the drivers and crews of the DK's solid waste collection vehicles.30

Every city must make some critical tradeoffs between public appearance and public health, and it is presumptuous for outsiders to criticize the choice; but the extent to which Jakarta has moved into diminishing returns in the cleaning of its major arteries is surprising -- the avenues would be almost as beautiful if they were manicured every other day, rather than every day as they are now, and that would cut the costs of such street sweeping nearly in half.31

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29 In this study, the interest charge was also not incorporated in any of the cost estimates, and its inclusion would generate even greater cost advantage for open-body trucks (see Appendix VI).

30 Street sweepers, 2,611, and drivers and crews, 2,151 in 1986 (JICA, 1987, p. S1-92); the number of street sweepers rose by 9% per annum over 1986-1994, to 5,063 ("Trash to", 1994).

31 Some major arteries in tourist areas now get swept twice a day (Boomgard, personal communication).

The current focus on the sweeping of major streets may derive less from a careful economic analysis of the tradeoffs involved than from the competition of Indonesian cities for the *Adipura* Award, given annually by the President on Environment Day to the cleanest cities. Refocusing the criteria for the Award away from the "visible" activities and areas of cities might lead to a refocusing of solid waste priorities.[32]

3. The distance (and time) to the landfill. Between 1983 and 1992, seven open dumps that served as final resting places for Jakarta's solid waste were closed as they reached capacity. One new landfill, at Banatar Gebang in Bekasi, was opened in 1989, but it is 40 km from the City. With only one disposal site at so great a distance, the haulage costs of Jakarta's solid waste have risen greatly.

According to a JICA study, the addition of a second landfill in the Tangerang area would lower haulage costs by 12%, and with the addition of two further sites haulage costs would be reduced another 8% (JICA, 1987, p. 115). Indeed, if landfill sites could be located at the periphery of the City, haulage cost decreases of the order of 50% would be possible (JICA, 1987, p. 115). If these estimates, admittedly nearly a decade out of date, are realistic, there are tremendous solid waste cost savings available to Jakarta in return for new landfills. Land around Jakarta is not cheap, and the high prices are presumably not artificial but reflect the opportunity cost of that land in other uses. Furthermore, given the terrain around the City, acceptable landfill sites may not be easy to locate. But the potential for solid waste transport savings is so big that a careful search is called for.

4. The environmental quality of the landfill. The Bekasi disposal site is much more a sanitary landfill than

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32 This *Adipura* emphasis on the visible leads to other inefficiencies, like forbidding squatter housing anywhere that can be seen from major streets.

Jakarta s open dumps were in the past. This improved quality has come about largely for technical and political reasons. Whether it is good economics is less clear.

Typically, landfill requirements are much less strict in developing country cities -- so that the relative disposal costs of solid waste are usually no higher than they are in industrialized countries, about 0.1% of GDP.33 This is undoubtedly due partly, in some cases at least, to shortsighted reactions to budget constraints; but it may also stem from the fact that getting the waste out of the city, even when imperfectly interred, is so socially beneficial that the quality of the landfill is of distinctly second order of concern. Any leaching, aroma, litter, etc. at the landfill will cause so much less damage to society than leaving the waste in congested areas; in budget-constrained developing country cities, improving collection at the expense of landfill quality makes sense, at least for the near future.

The World Bank notices that, in Indonesia,

> ... disposal of collected garbage is usually done at uncontrolled dump sites, without compaction, no leachate prevention measures, no control of methane gas emissions: not a much better environmental impact than from uncollected garbage, only it is at a removed location. (World Bank, 1993a, p. 17)

But this observation misses the main point -- getting the garbage to a "removed location" is the principal business at hand. Resources saved at the landfill end of the disposal process can be used to improve the removal process, and Jakarta must choose the optimal point on this tradeoff.

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33 See Bitar and Porter, 1991.

Table 4.4.1

Asia Comparison: Public-Sector Employment in Solid Waste

City	Employees per 1,000 Population	Ratio of Field Workers to Total Employment
Jakarta	0.87	70.5%
Bangkok	1.55	92.9%
Manila	2.12	74.9
Seoul	0.91	99.0
Shanghai	2.50	na

Notes:
1. Field Workers include drivers, crews, and street sweepers.
2. Jakarta data for 1985; others for 1981 or 1983.
3. na = not available.

Source: JICA, 1987, p. S1-90.

Table 4.4.2

Composition and Cost of Jakarta's Solid Waste Vehicle Fleet

Truck Type	Numbers of Vehicles 1986	Numbers of Vehicles 1990	1990 Cost per Year
Open-Body	223	129	$ 7,220
Compactor	219	277	21,280
Tipper	213	215	8,760
Tipper, with Cranes	11	13	nr
Arm-Roll	68	102	11,410
Total	734	736	

Note: nr means not reported.

Source: JICA, 1987, for 1986 data; DK (as reported by Manschot, 1991) for 1990 data.

5. ON COVERING COSTS

SUMMARY

Of the three municipal environmental services discussed in this monograph, the provision of drinking water differs importantly from the treatment of wastewater and disposal of solid waste in that water is essential for life. Thus, fees are feasible, possibly even fees that cover costs in their entirety. But even here, high fees are not necessarily desirable, from either an efficiency or an equity viewpoint. Indonesians are not so heavily taxed, relative to their South Asian neighbors, that reliance on tax finance is impossible.

With wastewater and solid waste, especially once the waste is removed from the immediate vicinity of a residence, it is difficult to collect fees. If high fees are imposed, there will be little demand for the service, and the negative externalities accompanying improper disposal and treatment of waste will abound. In order to get a high degree of treatment of wastewater and disposal of solid waste, these services must be subsidized from general municipal funds.

Drinking water projects are not better than sanitation projects or solid waste projects simply because they can generate revenues.

5.1 Introduction

Throughout the world, there is a move to expand the application of user fees in order to make the beneficiaries of public services pay for them and to help public services cover their own costs. Indonesia is no exception to this trend -- local governments are being urged to achieve full cost recovery through direct user charges for the municipal services they provide (Cointreau-Levine, 1991, p. 10). In this section, we will look briefly at two aspects of this

issue: 1) should, in principle, Jakarta attempt to cover costs in its provision of drinking water supplies, wastewater treatment, and solid waste disposal? and 2) can a pricing structure be envisaged that would, in fact, permit Jakarta to cover these costs?

The "should" and "in principle" side is quickly reviewed. Jakarta is no different from other cities in this respect, and the theory of user fees, budget constraints, and public provision of urban services is well known. Theory tells us that an urban environmental service is just like any other private good -- best left to the marketplace, which will adjust to produce the optimal amount at the optimal price -- if four conditions on the urban service are met: 1) if its marginal cost is not below average total cost; 2) if there is no element of a "public good" in its provision; 3) if its provision generates no external benefits; and 4) if the product in question is not a "merit good". Urban environmental services generally involve several, if not all four, of these causes of "market failure".1

Once any of these four conditions for market failure arise, the general pricing rule -- price should equal marginal social cost -- means that losses will be experienced. These deficits are correctly covered, in theory, by allocations from a government general fund that is raised by taxation that does not distort the optimal workings of the economy's private markets. But all taxation does in fact distort private incentives to some extent. The question then becomes, is it better to cover costs through non-optimally above-marginal-cost prices or through distorting taxation? Theory offers us little help on this question, since it comes down to an empirical estimate or,

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1 On these pricing issues, with respect to urban environmental services in developing countries, see Coolidge et al., 1993.

more accurately, an empirical judgment on the question, where are the distortions greatest?

This is not the place to review Indonesia's or Jakarta's tax and revenue systems. These were the subject of extensive reform efforts in the early 1980s as the "soft years" of large oil revenues came to an end.2 But Indonesia is still not a heavily taxed economy, especially with respect to personal taxation, and it may not be either very difficult or very distortionary to increase the extent to which urban services are priced around marginal cost and their deficits covered from general-fund allocations.3

Suppose, however, that greater cost coverage is the appropriate path. The question then arises, can greater cost coverage be achieved? In this respect, there is a great difference between the three basic urban environmental services that we have been considering (at length) in Section 2 (drinking water supply), Section 3 (wastewater treatment), and Section 4 (solid waste disposal).

Drinking water is, in the most basic biological sense, absolutely essential for survival. There is no limit to what one will pay for water, except that provided by one's income and wealth. This we have seen in Section 2 -- in Jakarta, some of the poorest people pay vendors up to 10% of their incomes just to acquire minimal quantities of drinking water. Moreover, when PAM Jaya raises the prices it charges for its water, through connections, standpipes, and deep

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2 There are many reviews of these efforts. See, for example, Gillis, 1985; and on Jakarta's (and other regional) finance, see Kelly et al., 1993.

3 Over half of Indonesia's government revenue came from oil revenue and taxes on corporate income and capital gains; no other of the six comparable Asian countries (of Tables 1.1.1, 1.1.2, and 1.1.4) earned more than one fourth of their revenues in this fashion (the needed data are not available to include Bangladesh and Pakistan). Another way of looking at the personal tax effort is through the non-oil, non-corporate revenues as a percent of GNP. In Indonesia, this percent is 8%; for the six comparable countries, the percent ranged from 11% to 20% (IMF, 1992; World Bank, 1993d).

wells, there are few substitutes to which people can turn. Shallow wells and bottled water are available to some households, and higher PAM Jaya prices encourage such substitutions, but for most Jakartans these alternative sources are either already exploited or quite limited.

On the other hand, waste disposal -- both wastewater and solid waste -- is not essential and substitutes are available. While all households want to move their wastes from the immediate vicinity of their residences, there are many public places where such waste can be discarded. Such public disposal may generate high social cost, but it does rid the household of the nuisance at very low private cost. This availability of means of private disposal at very low private cost places a limit on the price that can be charged for participation in a process that produces disposal at low social cost.

The question for drinking water, therefore, is not whether PAM Jaya can cover its costs -- it can. The questions are whether Jakarta <u>should</u> cover costs (and which costs) and, if so, what structure of prices should it choose of the many that will achieve this. In Indonesia, the decision has been made that PAM Jaya should cover (at least a large portion of) its costs and that a pricing structure should be adopted that discourages overextraction of the deep aquifer and encourages provision of minimal quantities of drinking water to every resident at an affordable price. These answers are eminently defensible, and the details of the appropriate pricing structure (discussed in Section 2) do not need reiteration here.

Efforts to cover costs in wastewater treatment and in solid waste disposal are less tractable. They are discussed briefly in the next two sections.

5.2 Covering Wastewater Treatment Costs

Especially with sewerage systems, it is not hard to think of ways to cover costs. After all, such systems are just like water systems in reverse, and the obvious parallels in connection fees, monthly charges, and metered usage costs suggest themselves. In a sense, sewage is even easier than water since meters on sewage may be made unnecessary by the close relationship of wastewater output to drinking water input, and PAM Jaya already meters its water deliveries.

Unfortunately, there is one big difference between water and sewage -- households have cheap alternatives to sewer hookups. This poses an irreconcilable dilemma for sewerage pricing where hookups are optional: if the price is high enough to cover costs, few households will want the service; and if the price is low enough to encourage widespread adoption, the sewer will not only fail to cover cost but it will also be providing a subsidy to relatively well-off households (who will be the typical demanders of the service).

Even in the earliest stages of sewering Jakarta, the City is falling on both horns of this dilemma. Costs are not being covered:

> ... the degree of cost recovery for sewerage is low. In the case of Jakarta, sewerage tariffs barely cover the O&M [operation and maintenance] cost that is around 1-2 percent of total capital costs. Even for future projects, only 10 percent ... of the capital costs are proposed to be recovered through user charges in addition to full O&M and replacement costs recovery. (World Bank, 1993b, Volume 2, pp. 49f)

The hookup charge for Jakarta's sewer currently consists of adding a charge of about $0.50 per month to the water bill each month for the next 30 years, and the demand for connections is greater than can be met. How much subsidy is

involved depends upon one's estimate of the rate of inflation over the next three decades and one's choice of the real discount rate, but at least half the cost will not be recovered.[4] And this subsidy is being given primarily to the well-off.

The dilemma of sewer pricing is, in fact, even more profound than this. Most of the benefit, to the City, of having people hooked up to sewers is external -- in the reduction of the pollution of rivers, canals, and groundwater. This benefit does not accrue to the individual household when it becomes connected to a sewer. The proper pricing of wastewater disposal, from this social viewpoint, would require that those who are connected to sewers pay <u>less</u> than those who are not connected, for their connection means that they are generating fewer negative externalities. This, however, is in direct conflict with the other goals of pricing -- to achieve equity and to cover costs.

There is no easy way out of these dilemmas. Both efficiency and equity urge that new, and especially high-rise, buildings be compelled to adopt proper wastewater treatment standards and be charged if the City provides them. But sewerage investments ought not be selected just because the mix of buildings existing or anticipated there is most likely to provide revenue or easy compliance. It is the externality, not the willingness to pay (or the willingness to accept compulsion), that should drive the location and timing of sewers.

While sewers attract the most attention because of their high cost, it must be remembered that, for the

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4 With both the monthly inflation rate and the monthly real discount rate assumed to be 1%, for example, the present value of the connection charges reaches only 10-20% of the connection cost; with these two rates both assumed to be 1/2% per month, the present value reaches 25-40% of the connection cost. Sewer connections certainly raise property values, sometimes greatly; were property assessments and the concomitant property taxation to react to the installation of sewers, it would reduce the size of this subsidy.

foreseeable future, sewers are only a tiny part of the Jakarta wastewater solution. The major role will continue to be played by proper siting, maintenance, and cleaning of septic tanks and of public toilets. Since advances here will require voluntary compliance, covering cost is completely out of the question. Some charges are possible since there exists

> ... a willingness of households to pay for the more immediate benefits of removing human and solid waste from their own property and often a strong spirit of cooperation on the part of local community groups to improve environmental conditions within their own neighborhood. (World Bank, 1993c, p. 114)

Nevertheless, optimal wastewater treatment in Jakarta will necessarily involve deficits, not just in the short run but for many decades to come.

When covering cost is an important goal and sufficient direct charges are impossible or undesirable, it is tempting to look for surrogate charges. There is no shortage of candidates in Jakarta. Add-ons to existing taxes or prices or the introduction of an "environmental tax" are often suggested. All but one of the candidates really represent nothing more than a new tax, unrelated to wastewater generation. The exception is a wastewater charge added onto water bills, since water consumption is clearly, in a materials-balance sense, closely related to wastewater generation. In a very real sense, the consumption of drinking water generates an externality, placing an explicit burden on wastewater treatment facilities and placing an implicit burden on the community through pollution and flooding. Not only is a water add-on a pragmatic substitute for sewerage charges, it is a theoretically appropriate part of the water price.

The problem, of course, lies in the heavy reliance in Jakarta on shallow wells. Any wastewater charge on piped water not only would be horizontally inequitable in that it

would fall differentially on otherwise identical households depending on whether they had access to well water or not but also would be inefficient in that it would distort households with piped water toward the use of other water sources.

In short, except for sewage system connections, it is impossible to levy a true wastewater-treatment fee in Jakarta; and it would be undesirable to attempt to levy such a fee. Sewage, once it has left the immediate area of its generation, is so fraught with externalities that it cannot be treated as a private good. In a budget-constrained world, general tax revenues must be found to cover the inevitable and desirable deficits of public toilets and septic tank maintenance.

5.3 Covering Solid Waste Disposal Costs

Jakarta already makes the beneficiaries of its solid waste disposal system "pay" for it, to a great extent. Households themselves bear the entire burden of the first stage of collection, from the early consolidation and storage of their waste to the curb, truck, or handcart. Most households then pay fees to cover the cost of the next stage, which takes the solid waste to a temporary storage location. Commerce and industry pay fees that cover the entire disposal cost of the waste they generate, either through their own efforts or the fees they pay private or public agents.5 So the question of "covering costs" really is a question of the costs for residential waste of its transport to the landfill and its disposal there.

Jakarta currently makes little effort to collect fees to cover this final stage of the disposal process -- unless

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5 We are ignoring here the social costs to the environment of any legal or illegal dumping of solid waste that businesses may do.

one counts the few Rupiah that trickle up into the general fund from the waste fees collected at the *kelurahan* level. Other cities in Indonesia do much more on this front. Surabaya collects waste fees through the water bills; Bandung collects these fees through the electricity bills; Medan gathers to the city level a much larger part than Jakarta of the fees paid at the *kelurahan* level.

Often unnoticed in the rush to cover the costs of solid waste disposal is that none of these "fees" is really a price for solid waste disposal. A price is what one pays to utilize a good or service. Indonesia's solid waste "fees" are related neither to the average amount nor to the marginal amount of the service utilized. They encourage neither source reduction nor alternative means of disposal (i.e. recycling, incinerating, or composting).

The application of proper fees for solid waste -- that is, fees based on the average or marginal amounts of solid waste generated for collection and disposal -- is beyond the ability of all but the richest cities of the world. Such fees have three prerequisites: 1) people must be rich enough to be able and willing to pay for their own solid waste removal; 2) residences must be sufficiently large in area and sufficiently spread out that there are no problems of externalities from neighbors' trash; and 3) "midnight", or illegal, dumping of trash to avoid fee payments is not a problem. None of these preconditions are yet present in Jakarta. In the mostly densely populated and poor residential neighborhoods of Jakarta, the proper disposal of one's own solid waste yields little personal benefit when one is surrounded by an ambience of trash beyond one's control and when alternative, free if technically illegal, means of trash disposal are readily available.

To encourage the Dinas Kebersihan (DK) to provide solid waste services only where the residents can, will, and do pay fees that cover the entire cost of the disposal would focus its waste collection efforts only in the wealthiest of

neighborhoods. The effect would be like "privatizing" the entire solid waste system without regulatory oversight.6 It would forget that the reason we involve the public sector in solid waste management is the existence of externalities, which are not incorporated in private-profit decisions. And it is precisely in the poorest and most congested neighborhoods that the social, external costs of uncollected waste are highest!

If direct pricing of solid waste disposal is undesirable from a social viewpoint, is there nevertheless a role for surrogate, or indirect, pricing in a second-best, budget-constrained municipal environment? A solid waste fee could be, as in Surabaya, included in the water bills. Revenue can thereby be generated, but not without the serious side-problems mentioned in the previous section. A water surcharge for solid waste, moreover, completely lacks the justification of technical linkage that makes a water surcharge for wastewater at least theoretically appropriate. Tying the solid waste fee to electric bills overcomes some of the disadvantages of a water surcharge -- electricity consumption is more income-elastic; there are no ready substitutes, and disconnection is less of a health issue. But most of these advantages would equally accrue to a solid waste "fee" that was levied as a gasoline-tax surcharge or as a special property tax.

In short, it is impossible to levy a true solid waste disposal fee in Jakarta (beyond perhaps a few very well-off neighborhoods). Furthermore, it would be undesirable to attempt to levy such fees. Solid waste disposal, once it has left the immediate area of its generation, is so fraught with externalities that it cannot be treated as a private good. In a budget-constrained world, taxes must be raised

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6 It is no accident that (according to the Forum on River Water Pollution) "... solid waste collection by private enterprises is only carried out in high-income areas" (IWACO, 1992, p. 99).

to cover solid waste costs, but there is no reason for selecting a tax just because it can be perceived as being very loosely connected to the solid waste process.

5.4 Some Overall Comments on Covering Costs

Projects that cannot generate fees to cover a significant portion of their costs are not necessarily undesirable projects. Projects that can generate fees to cover a significant portion of their costs are not necessarily better than projects that cannot generate such fees. Indeed, in an economy where taxation can be raised without allocative distortion, the ability of a project to generate revenues is completely irrelevant to its social desirability. These basic truths of economic efficiency are often lost on a budget-constrained world.

On the other hand, most cities in developing countries cannot raise taxation without serious allocative distortions elsewhere, and hence the ability to raise revenues is not in fact an irrelevant aspect of projects. Ideally, in the evaluation of projects that make demands on scarce municipal budget funds, shadow prices should be applied to those budget funds. This will reduce the viability of projects that make serious demands on such funds, but it will not automatically reject them. We must remember that the reason why urban governments undertake the provision of environmental services is that, by the nature of the activity, it cannot cover its costs.

6. LESSONS FOR AND FROM JAKARTA

SUMMARY

Historically, Jakarta has not provided much to its residents in the way of environmental services. The provision of first-class services to all its residents is now budgetarily infeasible, for the foreseeable future. As a result, the limited public services have largely gone to the rich, while the poor have been forced to the private sector for expensive service (i.e. water) or have been forced to do without service (i.e. waste treatment and disposal).

The solution involves "second-class" services, whereby the poor receive something less than the best but at prices they can afford (and at costs that budgets can support).

6.1 Lessons

Such basic environmental services as drinking water and waste disposal are poorly provided to the residents of Jakarta, but especially poorly to the poor. It is tempting to be cynical and to suggest that this once again shows the poor to rarely rate high in the priorities of governments. But Indonesia has undertaken many pro-poor policies in other areas -- that and sensible macroeconomic policy have been mainsprings of its rapid growth over the past quarter century. Something more than cynicism is needed for an explanation.

Historically, the general backwardness of urban environmental services in Jakarta seems ironically to derive from its natural abundance of water, both for drinking and for waste disposal. Only recently, as its rivers and groundwater have become polluted, has it become clearly necessary to undertake the investments needed by a large,

crowded, and modern city to provide drinking water and waste disposal services. And the investments needed to provide first-class service to all its residents are now huge, far beyond the politically feasible -- and even beyond the economically sensible -- short-run budgetary reallocations.

The result has been an effort to begin to provide first-best service to as many as possible, within existing budgets. Since this has in turn meant efforts to cover costs, it has resulted in services being provided largely to those who can and will pay a price for them. Thus, for example, one finds most of the piped water flowing at modest prices into rich residences, while the poor are forced to buy expensive water, hand-carried from distant standpipes. The irony, of course, is that where water delivery is not well provided, because the poor cannot afford first-class service, there the poor must display a high willingness to pay simply to acquire second-class water service.

This is the dilemma of urban environmental services in Jakarta, and in many other cities of developing countries. Equity, health externality, and economies-of-scope-and-scale arguments all urge the provision of modern, first-class service to all; but the constraints of budget and willingness to pay urge this provision, in the short run, only to the rich.

The dilemma is exacerbated by a belief that the best temporal route to provision of first-class service to all is through the provision of first-class service to a few, with marginal expansions of the system gradually over time increasing the coverage, until eventually all are served. This single-minded emphasis on first-class service means that the poor too often end up with not even second-class service.

The principal lesson learned from a study of Jakarta's urban environmental services is that more attention needs to be given to the provision of less-than-first-class, but affordable, services to the poor. In each of the three

services we have examined, the welfare of the poor could be greatly improved at low cost by provision of improved, but still not the ultimately desirable first-class, service. For drinking water, more and better operated standpipes; for human wastes, more and better operated community washing-bathing-toilet (MCK) facilities; and for solid waste disposal, improved collection from the central depots in poor areas. None of those three kinds of improvements represents a movement to the first-class service that Jakarta will ultimately want to provide for all its residents, but each would mean a dramatic improvement in the welfare of the urban poor during what may prove a very long interim until the thoroughly modern city emerges.

A partial solution to the dilemma then rests in the provision of different kinds of environmental services to different income groups. First-class services can be provided to those who are willing to pay a high price for them, and second-class services are provided at low cost and low price to the poor. The alternative, in reality, is to leave the poor with third-class service, no service at all, or expensive service supplied by the private sector.

If there is to be increased emphasis on the provision of second-class service, budgetary reality makes it critical that attention be paid to cost. Four lessons for cost economy also emerge from Jakarta:

1. Labor-intensive provision is, and will for many decades, be cheaper than a premature movement to "modern" capital-intensive provision. Standpipes and community toilets, for example, are inherently labor-intensive, and solid waste transport by open trucks, for another example, is much more labor-intensive than by compactor trucks. These methods will ultimately become obsolete, but they can keep costs down in the near future.

2. The private sector can play a role in the delivery of environmental services -- not so much in

the currently much discussed privatization of large capital-intensive water and sewage treatment plants, but at the consumer end of the delivery process, in the operation of standpipes and community toilets, in solid waste recycling, and perhaps even in waste collection and transport.

3. The involvement at the local level of the people to be served can insure that the services provided are those that are demanded. Moreover, if there is cost-sharing at the local level, there will be incentive there to find low-cost delivery methods.

4. While much of the human and solid waste disposal process will require subsidies, since in poor areas there is always the plausible private alternative of spending nothing, it is important to structure the subsidies to provide incentives for good services and low costs.

In short, it is expensive, unreasonable, or impossible for the urban poor to provide themselves through private-sector activities with drinking water and with waste disposal. Public provision is essential. But first-class provision is usually inappropriate -- if the cost is not covered, the municipal budgets cannot provide enough, and if their costs are covered, the poor cannot afford such service. Emphasis on first-class service inevitably shortchanges the poor. *Le mieux est l'ennemi du bien* (the best is the enemy of the good).

Appendix I

The Opportunity Cost of an Aquifer

Aquifers may be used forever if the withdrawals are modest, so that the aquifer naturally recharges each year. Or they may be drawn down over a finite number of years and exhausted. In this appendix, we explore some of the economic theory behind the decision by society whether or not to deplete the aquifer.

Consider an aquifer with an initial volume of water, A_0, and an annual recharge of a. The size of the aquifer in year t (A_t) is then

[I-1] $$A_t = A_0 + (a - x)*t \quad ,$$

where x is the annual rate of extraction from the aquifer. If x = a, there is a perpetual aquifer, with the annual recharge exactly replacing the annual extraction; if x > a, the aquifer will be depleted, and it will become economically empty in year T, where

[I-2] $$T = A_0/(x - a) \quad .$$ [1]

If the water from the aquifer is cheaper to "produce" than surface water, then it is tempting to those who see only private cost to deplete the aquifer. Let us assume that the price (or cost) of surface water (P_{sw}) is greater than that of groundwater (P_{gw}), i.e.

[I-3] $$P_{sw} > P_{gw} \quad .$$

The question of opportunity cost of groundwater is whether groundwater is <u>socially</u> more expensive than surface water.

Two possible extreme strategies suggest themselves for the handling of an aquifer:

1. Perpetuate the aquifer. Draw each year only the amount of the recharge (a) from the aquifer, producing anything more that is needed from surface water.

2. Deplete the aquifer. Draw all that is needed from the aquifer each year until it is depleted, and then switch to producing everything needed from surface water.

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1 Note that once the aquifer is emptied, it collapses economically. Not even the annual recharge (a) is available for use thereafter.

In-between strategies also are possible, but for this short appendix, we will examine only these two.[2]

Let n be the annual water need (with $n > a$) and i be the relevant discount rate. Then we can find the present value of the total cost (PVTC) of each of these strategies:

$$[I\text{-}4] \qquad PVTC_{perp} = \frac{-a*(P_{sw}-P_{gw}) + n*P_{sw}}{i} \quad \text{and}$$

$$[I\text{-}5] \qquad PVTC_{depl} = \frac{-n*(P_{sw}-P_{gw})*(1-e^{-iT}) + n*P_{sw}}{i} \quad ,$$

where, recall, T is the date at which the aquifer is depleted (and is given by equation [I-2] with n substituted for x).

The strategy with the lower value of PVTC is not obvious. Examination of equations [I-4] and [I-5] indicates that $PVTC_{perp} \gtrless PVTC_{depl}$ as

$$[I\text{-}6] \qquad 1 - (a/n) \gtrless e^{-iT} \quad .$$

Condition [I-6] appears impenetrable, but rearranging terms and dividing by i we get condition [I-6] in a friendlier garb:

$$[I\text{-}6'] \qquad n*(1 - e^{-i*T})/i \gtrless a/i \quad .$$

The left-hand side of conditon [I-6'] is the present value of the total amount of water that would be taken out of the aquifer before it were exhausted if the depletion strategy were adopted; and the right-hand side of [I-6'] is the present value of all the water that would be taken out of the aquifer (forever) if the perpetual strategy were adopted. <u>The lower (PV) cost strategy is the one that takes the greater (PV) amount of water out of the aquifer</u>. Note that it is not indisputable which strategy is preferred (from the PVTC viewpoint): for example, a large aquifer size (A_0) or a high discount rate (i) would make it more likely that the depletion strategy should be accepted.

We now ask what is the cost in terms of increased PVTC of removing one extra cubic meter of water from the system? This is the true marginal social cost, or opportunity cost,

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2 Readers who know natural-resource theory know that society should always begin by extracting from the least-cost resource source (here P_{gw}). This means that the aquifer should always be <u>somewhat</u> depleted in the early stages. This appendix, being a brief exposition of these ideas, does not explore this "somewhat" strategy.

of water. The answer depends upon which of the two regimes we are operating in, the perpetual regime or the depletion regime.

In the perpetual aquifer regime, an extra cubic meter of water now means simply that an extra cubic meter of surface water must be produced -- at cost P_{sw}. The aquifer is already being utilized at its maximum sustainable rate, and any extra water demand must be taken from surface water. The opportunity cost of water is P_{sw}, the cost of producing another unit of surface water. Any user of water should be made to recognize that this is the opportunity cost of water -- and the easiest way to make someone recognize a cost is to make that user pay the cost. In the perpetual aquifer regime, the price of water must be P_{sw} -- regardless of the source of the water being used. This urges a tax on groundwater to the amount of the difference in their costs, that is, a tax of $(P_{sw}-P_{gw})$.

In the depleted aquifer regime, an extra cubic meter of water now means that the aquifer will reach its depletion date (T) slightly sooner. Alternatively, one can view one cubic meter of water taken today as the equivalent of a reduction in the initial aquifer size by one cubic meter, from A_0 to (A_0-1). This has two social costs: 1) it incurs a cost of P_{gw} now to remove the extra cubic meter itself; and 2) it raises the cost of water from P_{gw} to P_{sw} at an earlier date (i.e. it reduces the date of groundwater depletion, T). Appropriate derivatives of equations [I-2] and [-5] show this social (PV) cost to be

$$[I\text{-}7] \qquad \frac{(P_{sw} - P_{gw})*n*e^{-i*T}}{(n - a)} + P_{gw} \quad .$$

This is greater or smaller than P_{sw} according to the sign of condition [I-6] (or [I-6']). If the depleted aquifer strategy is the correct one, the social cost of groundwater today is less than P_{sw}; if the perpetual aquifer strategy is the correct one, then the social cost of groundwater today is greater than P_{sw}. The proper tax on groundwater is one that raises its cost from the private level, P_{gw}, to the correct social cost, given by [I-7].

<u>If the aquifer is currently being depleted, and it ought not to be, then the correct groundwater tax is greater than $(P_{sw}-P_{gw})$. Such a tax would raise the cost of groundwater above that of surface water -- and, not incidentally, put a halt to the excessive use of the aquifer.</u>

Appendix II

The Optimal Spacing of Standpipes

As long as the poor in cities are served water from standpipes, there will be the important policy question of how many standpipes should there be. More standpipes make the poor better off by reducing the average distance they have to walk for water (or pay vendors to carry their water). But standpipes must be supervised, and supervision uses resources. In this appendix, we explore two aspects of the economic theory of standpipe frequency: 1) what standpipe spacing emerges with free entry of standpipe operators into the standpipe market? and 2) is this free-market spacing socially optimal?

Consider a long and very thin city with standpipes located throughout it at equal distances from each other. Households are uniformly distributed (with one household per unit of distance) throughout the city. Each household buys exactly one unit of water each day from one of the standpipes and then carries it back to the residence at a time-and-effort cost of t per unit of distance.

Each household is on a line between two standpipes. Consider a household at point x, with the two nearest standpipes at point 0 and point D. These standpipes charge P_0 and P_D, respectively, at the standpipe. The household will buy at standpipe 0 or standpipe D according as

[II-1] $$P_0 + t*x \;><\; P_D + t*(D-x) \quad ,$$

or, rearranging terms, as

[II-2] $$x \;><\; \left[\frac{P_D - P_0 + t*D}{2*t} \right] .$$

Now consider the standpipe at point 0. In the absence of collusion, the operator of this standpipe considers P_D and D as exogenous. The operator chooses P_0 so as to maximize profit. Assume for simplicity that the P_D and D to the left of the standpipe at 0 and to the right of the standpipe at 0 are identical. Then its profit is

[II-3] $$\text{Profit} = 2*P_0*\left[\frac{P_D - P_0 + t*D}{2*t} \right] - F \quad ,$$

where F is the fixed cost per day of operating the standpipe, and we ignore -- again for simplicity -- any variable costs to the standpipe operator. The operator maximizes profit with respect to P_0, which means setting

[II-4] $$P_0 = (P_D + t*D)/2 \quad .$$

Since all standpipe operators are identical, in equilibrium they will choose identical prices, so that $P_0 = P_D = P$, and the standpipe price will be, for all standpipes,

[II-5] $$P = t*D \quad .$$

Profit for each operator will then be

[II-6] $$\text{Profit} = t*D^2 - F \quad .$$

But with free entry, new operators will enter and squeeze the market of each existing standpipe -- until the profit is gone. At this point, the distance between standpipes will be

[II-7] $$D = [F/t]^{1/2} \quad ,$$

and the price at each standpipe will be

[II-8] $$P = [F*t]^{1/2} \quad .$$

And finally, the cost per unit of water of those households who are most distant from the nearest standpipe will be

[II-9] $$P + t*D/2 = 1.5*[F*t]^{1/2} \quad ,$$

exactly 50% higher than the cost to those who live closest to the nearest standpipe.

Let us look next at the average social cost of water delivery in this city. This social cost consists of two parts, the transport cost of the individual households from the standpipes to their residences, and the overhead costs of operating the standpipes.[1] The water carrying costs range linearly from nothing (for those next to the standpipes) to $0.5*[F*t]^{1/2}$ (for those furthest from the standpipes); the average, per unit of water, is $0.25*[F*t]^{1/2}$. The overhead cost, per unit of water, is F divided by D, or $[F*t]^{1/2}$. Thus, the average social cost

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1 Remember, we are ignoring all variable costs of water delivery (except for household time and effort). Adding a water charge to the standpipe operator would change nothing essential as long as we continue to assume that each household has a fixed demand for water regardless of its cost.

(ASC) per unit of water delivered, under a system of free entry and competition, is

[II-10] $$ASC = 1.25*[F*t]^{1/2} \quad .$$

Not surprisingly, this ASC is higher the higher is either F or t.

Consider now a standpipe system that is operated, not for profit, but in order to minimize the average social cost (ASC) of delivering water. Standpipes are set D units apart and charge identical -- perhaps zero -- prices. The water transport costs of households range from zero, for those next to the standpipe, up to t*D/2, for those furthest away; the average transport cost for all households' water is t*D/4. For the overhead cost, the F is spread across D units of water sales, for an average overhead cost per unit of water of F/D. Thus,

[II-11] $$ASC = t*D/4 + F/D \quad .$$

minimizing this ASC with respect to the distance between standpipes yields

[II-12] $$D = 2*[F/t]^{1/2} \quad ,$$

The socially optimal distance be een standpipes, given by equation [II-12], is exactly twice the distance between standpipes that the competitive market will produce, given by equation [II-7].

<u>A free-entry market in standpipes will generate twice as many standpipes as is socially optimal</u>.

The reason for this excessive entry when there is free entry is that each standpipe operator has a monopoly in its immediate vicinity, and operates in a triopolistic market overall (since it need not worry about any standpipe further than its two nearest competitors). The incentive to exploit this monopolistic situation produces overly high prices and profit, which in turn induces excessive entry. Ironically, consumers end up paying more, on average, for their water with free entry because there are too many monopolists, not too few, and the overhead costs are too thinly spread.

All this is included in the hope that the reader will be interested. But for practical purposes, we must remember that there is <u>not</u> in fact free entry into the standpipe business in Jakarta, and there are almost certainly too few standpipes at present. All this theory suggests is that a change to <u>perfectly</u> free entry could result <u>ultimately</u> in too many standpipes.

Appendix III

"Lifeline" Pricing for Equity, Efficiency, and Revenue

The idea of "lifeline" pricing is to provide a modest quantity of a basic public service at a low price, so that even the poor can afford a minimal purchase, with a higher, marginal-cost price being charged if a household wants larger quantities of the service. This is often defended on grounds of equity (or "merit goods"), in which case it conflicts with efficient pricing -- which requires that all users pay the same price, namely, a price equal to the marginal cost of providing the service.1

The difference between "lifeline" pricing and efficient pricing is clear -- they offer a very different pricing structure to the different income groups in the society. But they do share one attribute: neither price structure generates enough total revenue to cover total cost if the service is a natural monopoly (i.e. is produced under conditions of low marginal cost, high fixed cost, and hence declining average total cost). "Lifeline" pricing will produce a larger deficit than uniform marginal-cost pricing, but the fact remains that both produce deficits.

In the world of "second-best", however, where the public entity providing the service is required to meet revenue constraints -- and perhaps even cover its total costs -- "lifeline" pricing may become efficient, in the sense that it maximizes total consumer welfare given the necessity of generating a certain amount of revenue. It may be appropriate to charge everyone a slightly above marginal-cost price for the first few units of the service and then charge a much higher price for units beyond that basic amount. This means, in practice, that the marginal and average cost of the service is higher for heavy demanders (i.e. the rich).

In this appendix, we show how second-best lifeline pricing works in a very simple theoretical model. There are just two homogeneous groups, the rich (r) and the poor (p). There are N_r rich households and N_p poor (with $N_r < N_p$). Each group demands the service in question. Their demand

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1 If the marginal cost declines with the volume demanded, then efficient pricing may even require lower prices to the rich, who demand larger quantities. Such declining prices are rare in developing country cities. If there are hookup costs involved, which of course are independent of the amount demanded per time period, then the average cost of the service will be lower for the rich than the poor even if the marginal costs are the same.

curves are linear; at a zero price, each household, rich or poor, would demand B units of the service; but at any above-zero price, the rich demand more than the poor. This demand curve:

$$[\text{III-1}] \qquad Q_i = \begin{cases} 0 & \text{if } P > A_i \ , \\ B*(A_i - P)/A_i & \text{if } A_i > P > 0 \ , \text{ and} \\ B & \text{if } P = 0 \ , \end{cases}$$

where the subscript i refers to the income group (i = r or p), and $A_r > A_p$.[2]

The public agency is planning to provide this service at a price of P_1 for the first Q^* units, and a price of P_2 for all units demanded beyond Q^*. Notice that the same Q^* units are provided at P_1 for all groups, so that the agency does not need to identify who is rich and who is poor. And notice also that we are not now specifying that $P_1 < P_2$; the purpose of this appendix is to <u>prove</u> that total consumer welfare is maximized under a revenue constraint by setting $P_1 < P_2$.

At the price P_1 (assumed to be between 0 and A_p), each poor household will demand

$$[\text{III-2}] \qquad Q_p = B*(A_p - P_1)/A_p$$

units of the service per time period. Let the agency set Q^* equal to this amount, i.e.

$$[\text{III-3}] \qquad Q^* = B*(A_p - P_1)/A_p \ .$$ [3]

Beyond Q^*, where the rich wish to purchase, the price is P_2; so the demand of each rich household is

$$[\text{III-3}] \qquad Q_r = B*(A_r - P_2)/A_r \ .$$

2 A_i is the price-axis intercept of the demand curve -- that is, the willingness-to-pay by the ith income group for the first unit of water.

3 Notice that we are assuming that the poor will not buy more than Q^* at the price P_2. If they can, and do, then the second-best pricing scheme is the familiar "two-part tariff", where P_1 is set as high as necessary to capture any revenue requirements from the consumer surplus on the early consumption units and P_2 is set equal to marginal cost (here assumed zero) in order to avoid distorting the consumer's marginal consumption decision.

The total revenue of the agency (TR) is

[III-4] $$TR = N_p*P_1*Q_p + N_r*P_1*Q_p + N_r*P_2*(Q_r - Q_p)$$

And the total consumer surplus (CS) generated by the provision of this service is

[III-5] $$CS = N_p*(A_p - P_1)*Q_p/2 + N_r*(A_r-P_2)*Q_r/2 + N_r*(P_2 - P_1)*Q_p \quad ,$$

where the final term of equation [III-5] reflects the fact that the rich do not pay P_2, but rather P_1, for the first Q_p units they buy.4

In this second-best world, the agency must select P_1 and P_2. It wishes to maximize the total consumer surplus (CS), subject to the constraint that it must earn a certain total revenue (TR^*). To make the algebra simpler, without losing the point, let us assume that there are no marginal costs to providing the service, and hence that the agency needs to generate this TR^* for the purpose of covering some or all of its exogenous fixed costs.

The calculus is tedious, and its verification is left to the masochistic reader. The major point that emerges is that, as the agency feels the pressure to generate revenue, the optimal values of P_1 and P_2 both rise, with P_2 rising at a rising rate relative to P_1. <u>The greater the pressure for revenue, the higher is the optimal P_2 relative to the optimal "lifeline" price, P_1</u>. The poor receive a lower price than the rich (at the margin) not because of merit-good, externality, or income-distribution considerations but because that is the efficient way to generate total consumer surplus under a revenue constraint.

This optimal path of prices is illustrated in Figure III.1 for the following values of the parameters: $A_p = 0.25$; $A_r = 1.25$; $B = 1$; $N_p = 4$; and $N_r = 1$. Total revenue (TR) per household is maximized at $P_1 = 0.17$ and $P_2 = 0.42$, so the X-axis is not pictured beyond that point.

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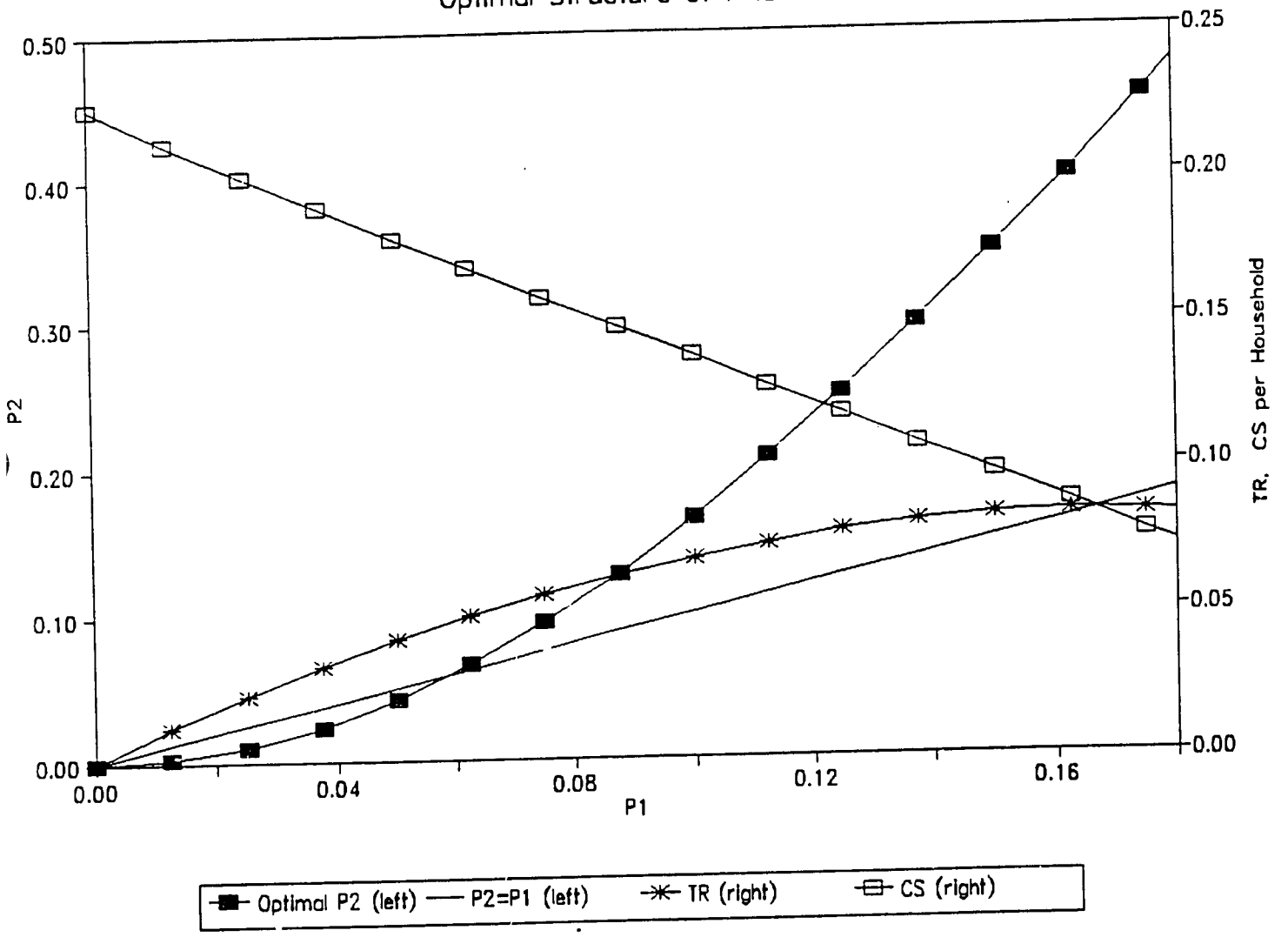
4 At this point, we do not know whether $P_1 >< P_2$, so this final term may reflect either a tax or a subsidy to the rich for their first Q_p units.

Figure III.1
Optimal Structure of Prices



Appendix IV

The Optimal Timing of Large Infrastructure Investments

Water or sewage treatment plants or the large-scale introduction of piped water or sewerage into new areas of a city are big investments. Postponing such infrastructure investments saves a lot of costs but also forgoes a lot of benefits. Optimal timing is an important policy issue.

Here we explore the economic theory behind two aspects of this optimal timing issue: 1) should a large investment be undertaken now, or should it be postponed until later? and 2) if something must be done now, should it be a high-cost permanent investment or a low-cost temporary investment (that permits the postponement of the permanent solution)?

A. Now versus Later

Many urban infrastructure investments are intrinsically indivisible, and large. The need is not now urgent (though the need is growing over time), and the expense is great, which suggests postponement.[1] But the expense may become larger (in real terms) if the investment is postponed, which urges that the investment be undertaken now.[2] The criteria for this choice are examined in this section.

The net benefit of an infrastructure investment is B_0 now (i.e. in this year, t = 0) and is growing exponentially at rate b:

[IV-1] $$B_t = B_0 * e^{b*t} \quad .$$

The cost of the investment is C_0 now and will grow exponentially at a rate c if the investment is postponed:

[IV-2] $$C_t = C_0 * e^{c*t} \quad .$$

The investment cost need be undertaken only once, and once undertaken it will yield the flow of benefits in every year (starting the year after the investment is undertaken)

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1 The need is growing because the city is becoming larger and more densely populated at the core.

2 The expense may become larger for any of a number of reasons, but the principal cause is the increasing population density of the city core. More people and more traffic are disrupted when the city undertakes construction activity on, under, and around the streets.

forever after.[3] The present value (PV) of the investment, if made at time T, is therefore

$$[IV\text{-}3] \qquad PV_T = -C_0 * e^{(c-i)*T} + \left[\frac{B_0 * e^{(b-i)*T}}{(i-b)} \right] ,$$

where i is the relevant discount rate, and b is assumed to be less than i.

Is this PV_T maximized by choosing T = 0? There are two ways in which T = 0 could be optimal.

1. If the cost of the investment is growing more rapidly than the benefit (i.e. c > b), then it is either optimal to make the investment now or not at all. It is optimal to make the investment now if

$$[IV\text{-}4] \qquad B_0/C_0 > (i-b) \quad .$$

2. Even if c < b, investment at T = 0 may be optimal. Investment at T = 0 is optimal if:

$$[IV\text{-}5] \qquad B_0/C_0 > (i-c) \quad .$$

Thus, making the investment immediately is optimal if the ratio of the initial benefit to the initial cost (B_0/C_0) is greater than (i-x), where x is the smaller of b and c.

Alternatively, we could examine the conditions under which postponement is optimal. Clearly, b > c is one of the conditions, for otherwise the correct decision is a now-or-never decision. The other condition is:

$$[IV\text{-}6] \qquad B_0/C_0 < (i-c) \quad ,$$

where condition [IV-6] is the exact reverse of condition [IV-5].

It is easy to put these two conditions for optimal postponement into economic words. One, the benefit of the investment must be growing more rapidly than the cost (i.e. b > c). And two, the benefit of the postponement must be larger than the cost of the postponement. To see these benefits and costs of postponement, rewrite [IV-6] as:

$$[IV\text{-}7] \qquad i*C_0 > B_0 + c*C_0 \quad .$$

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3 The assumption that the benefits begin to flow in the year after the investment is made is arbitrary but simplifies the algebra. Longer gestation periods change nothing essential.

The benefit of postponement is the saved interest cost on the investment ($i*C_0$), and the two costs of postponement are the lost benefits for that year (B_0) and the growth in the real costs of the investment during the postponement ($c*C_0$). Inequality [IV-7] is the one discussed in Section 3.4 of the text.

B. Temporary versus Permanent

For other urban infrastructure investments, there is urgency in the sense that something must be done now. But there is a choice between a expensive investment that provides a full and permanent solution and a relatively inexpensive partial or temporary solution. Even though the latter will have to be replaced by the permanent-solution investment later -- and that investment will have become more expensive in the meantime -- it may be optimal to adopt the temporary expedient now. The criteria for this choice are examined in this section.

In this section, we ignore benefits, since it is assumed that they will be realized in any case. The policy question is whether to install the full, complete, permanent investment now or to temporize for some T years with a temporary but -- for now -- cheaper solution. The cost of the permanent solution, as in the previous section, is:

[IV-8] $$C_t = C_0*e^{c*t} \quad ,$$

where again $c > 0$ to indicate that the real cost of this investment is growing over time. And the cost of the stopgap investment, to be made at $t=0$ (if at all) is S_0.

The condition for preferring a stopgap solution now is:

[IV-9] $$S_0 + C_0*e^{(c-i)*T} < C_0 \quad ,$$

where T is the date of the later switch over to the permanent solution. Condition [IV-9] will be met if T is large enough (assuming $c < i$), since, by definition of stopgap, $S_0 < C_0$. Stopgap measures are always preferred if the date at which one plans to switch to the permanent solution is sufficiently far in the future.4 Inequality [IV-9] is the one discussed in Section 3.4 of the text.

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4 It is left to the interested reader to add two elements of reality to equation [IV-9], where the stopgap measure offers fewer benefits than the permanent solution and where the stopgap measure requires higher operating costs than the permanent solution. Both elements are relevant to the discussion of standpipes versus house connections in the text.

Appendix V

Monopsony Middlemen and the Recycling Commons

When scavengers seek recyclables in what is essentially an urban commons, there will be too many scavengers from the viewpoint of social efficiency (i.e. the "tragedy of the commons"). When there are middlemen with monopsony power buying the recyclables from scavengers, there will be too few scavengers from the viewpoint of social efficiency. The question addressed here is whether there are too many or too few scavengers when both of these characteristics are present -- that is, when the recyclables are in a commons and the scavengers must deal with monopsony middlemen.

The answer is that these two opposing distortions in the recyclables market exactly cancel each other out, and the number of scavengers is optimal from the viewpoint of social efficiency.

Consider a simple production function for recyclables, where the total volume of recyclables collected (Q) is a Cobb-Douglas function of the total number of scavenger laborers (L):

[V-1] $$Q = a*L^b \quad ,$$

where a and b are positive parameters (and $b < 1$). Scavengers have an opportunity cost, assumed for simplicity to be identical for all scavengers; it is the wage could earn in their best alternative occupation; call it W, the (exogenous) wage for low-skill, hard-work jobs.

Scavengers will enter the recycling commons as long as their average earnings exceed this wage. Their average earnings are

[V-2] $$P_b*Q/L \quad ,$$

where P_b is the price at which the scavengers' middleman buys recyclables from scavengers. Manipulating equations [V-1] and [V-2], we derive the number of scavengers in the commons:

[V-3] $$L = (a*P_b/W)^{1/(1-b)} \quad .$$

In general, this is not the socially optimal number of scavengers. The value of recyclables to society is P_s (exogenous), the price at which middlemen sell their recyclables (and not the price at which they buy them). So, from a social viewpoint, the optimal number of scavengers is the number that maximizes social profit, $(P_s*Q - W*L)$, the

excess of the value of recyclables over the opportunity cost of collecting them. Social profit is maximized at

[V-4] $$L = (a*b*P_s/W)^{1/(1-b)} \quad .$$

Comparing equation [V-3], the actual number of scavengers, with equation [V-4], the socially optimal number of scavengers, indicates that the actual number will equal the optimal number only if

[V-5] $$P_b = b*P_s \quad .$$

Note that, if scavengers face competitive middlemen, who buy at their selling price ($P_b = P_s$) -- we are assuming away any middleman costs -- or if the scavengers can sell directly at P_s, there will be too many scavengers.

Let us look now at the pricing choice of the monopsonistic middleman. This middleman seeks to maximize profit with respect to the choice of buying price. If P_b is set at zero, there will be no scavengers and hence no recyclables for the middleman; if P_b is set at P_s, there will be lots of scavengers and lots of recyclables, but there will be no profit per unit of the middleman's recyclables. The middleman must choose the value of P_b (with $0 < P_b < P_s$) that maximizes

[V-6] $$(P_s - P_b)*Q \quad ,$$

subject to equation [V-3], which tells how scavenger labor reacts to the middleman price. Tedious algebra shows that the maximization of [V-6], subject to [V-3], yields

[V-7] $$P_b = b*P_s \quad .$$

Note that [V-7] is the same as [V-5]. <u>The profit-maximizing monopsonistic middleman sets exactly that buying price (P_b) that results in the socially optimal number of scavengers</u>.

Appendix VI

The Concept of "Long-Run Marginal Cost"

At several places in the text, big, indivisible, durable investments are discussed, and it is useful to try to attribute the costs of these investments to their users. The concept, "long-run marginal cost", has come into being as a way of making this attribution. This appendix looks more closely at this concept and the sense it which the resulting attribution is useful.

The term, "long-run marginal cost", is in quotation marks because there is of course no such concept. In the long run, there are no fixed factors and all factors are adjusted to their optimal levels. So, if there are no economies or diseconomies to scale, any addition to output requires an expansion of all factors in equal proportion, and the long-run marginal cost is simply the average total cost of the future output. The concept of "long-run marginal cost" arises only because some factors cannot be expanded in small, proportional increments but must be expanded in large, lumpy increments that need to be made only once every several years.

Technically, then, an addition of one unit to output might have a huge marginal cost -- if it required a big investment that lasted a long time simply to make it feasible. The concept of "long-run marginal cost" has been developed in order to attribute to any increment in output in any particular year only the average cost over time when a big, indivisible, durable investment must be undertaken in order to produce it.

Consider, for example, an investment that is made now ($t = 0$), that costs C (in real terms), that needs to be made only once every T years, and that in itself (for simplicity we ignore other factors of production) produces Q units of output each year during its life ($t = 1, 2, \ldots, T$). The present value of the cost of such an investment (PV_1), made now ($t = 0$) and repeated every T^{th} year thereafter to infinity is

[VI-1] $$PV_1 = C*\{1 + (1+i)^{-T} + (1+i)^{-2*T} + \ldots\} \quad ,$$

where i is the relevant (real) discount rate. Summing this series, we can write the PV more succinctly:

[VI-2] $$PV_1 = C*(1+i)^{T}/\{(1+i)^{T} - 1\} \quad .$$

The present value of the total cost of the output that is produced by this investment (PV2) is

[VI-3] $$PV_2 = x*Q*\{(1+i)^{-1} + (1+i)^{-2} + (1+i)^{-3} + \ldots\}$$

where x is the average cost of each unit of output, so that the product, x*Q, is the total cost of output in each year (and the output is assumed to begin to flow in the year after the initial investment of C is first undertaken). This series [VI-3] may also be summed:

[VI-4] $$PV_2 = x*Q/i \quad .$$

PV1 and PV2 are simply two ways of expressing the present value of the total cost of the investment. They should be identical. Indeed, the fact that they are identical is what lets us calculate the value of x. Setting PV_1 in equation [VI-2] equal to PV_2 in equation [VI-4] permits us to derive the average cost of each unit of output, x:

[VI-5] $$x = i*(C/Q)*(1+i)^T/\{(1+i)^T - 1\} \quad .$$

Unfortunately, equation [VI-5], while accurate, is unwieldy and offers no easy insight into the value of x. Much insight can be gained by writing out the following series:

[VI-6] $$(1+i)^T = 1 + T*i + T*(T-1)*i^2/2 + \ldots \quad ,$$

and approximating it by ignoring all but the first two terms:

[VI-7] $$(1+i)^T = 1 + T*i \quad .$$

Putting this approximation [VI-7] into equation [VI-5] yields

[VI-8] $$x = (C/Q)*\{i + (1/T)\} \quad .$$

Written in the form of equation [VI-8], the average cost, or "long-run marginal cost", x, has a nice interpretation. <u>It consists of two parts, the interest cost on the investment per unit of output, (i*C)/Q, plus the depreciation of the investment per unit of output, C/(Q*T).</u>

Both of these two components of cost are included in the calculations of the text whenever the total cost of an indivisible, durable investment is converted into cost per unit of output.1

A final reminder is perhaps appropriate concerning the concept, "long-run marginal cost". The concept plays no

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1 Repair rates are readily added to the formula, and they are included in the formula in the text.

role at all in the well-known efficie y adage that "price should equal marginal cost". The marginal cost referred to there is short-run marginal cost. When there is excess capacity, short-run marginal cost consists only of variable costs and does not include depreciation or interest charges; when capacity is strained, the short-run marginal cost rises too reflect the scarcity of this capacity, and it may well rise above, even well above, the expected future long-run average total cost of new capacity. Only if practicality demands a stable price does the long-run marginal cost become a sensible choice.2

The real operational use of the concept of long-run marginal cost, or expected future average total cost, is this: as long as short-run marginal cost is below long-run marginal cost, capacity is adequate; only when short-run marginal cost is above long-run marginal cost, is capacity expansion called for. In short, the concept of long-run marginal cost should be applied to capacity expansion decisions, but not to pricing decisions.

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2 For more on this, see Bahl and Linn, 1992, pp. 299ff.

Appendix VII

Elements of a Benefit-Cost Analysis of Cleaning One River

A. General

Economics focuses on benefits and costs of change. Moreover, economics attempts to quantify these benefits and costs in monetary terms. Many of these benefits and costs are not economic, and many are not quantifiable; if the non-economic or non-quantifiable benefits and costs predominate, then any formal economic Benefit-Cost (B/C) analysis is of marginal value. Listed below are the costs and benefits that may be important, that are economic, and that lend themselves to quantitative estimation.

B. Costs

The principal source of the river's pollution is household activity, and cleaning the river requires changing the relevant household activities. This involves costs of three kinds -- with the order not intended to be a guess at the order of quantitative importance:

1. The resource costs of providing alternative means of disposing of sewage and solid waste.

2. The education, monitoring, and enforcement costs of changing people's behavior, so that they use the new disposal alternatives to the river.

3. The costs in time and inconvenience to the people who must switch to these new disposal means. (If the new disposal means are superior to the river, then this item becomes a benefit, rather than a cost.)

There are also industrial sources of pollution of Jakarta's rivers -- although these do not yet dominate the household sources -- and the costs of reducing these industrial sources must also be counted.

Finally, there are once-and-for-all costs of cleaning up the river at the start -- reducing the flow of new waste provides little benefit -- and would be difficult to achieve in any case -- if the stock of old waste lingers.

C. Benefits

Cleaning up a typical Jakarta river, to the extent imaginable at this time, would not make it into drinkable water. But many other benefits would, or might, emerge. A tentative list follows -- with the order again not intended to be an estimate of the quantitative importance of each:

1. Increased quality of the river water. This means reduced treatment costs. Many people and businesses use the rivers of Jakarta for drinking water, but they must now treat the water extensively -- long boiling at least. A cleaner river might reduce these treatment costs -- less boiling, etc.

2. Increased quantity of water used by riverside residents, for drinking, washing, or bathing. Conceptually, there is little difficulty in distinguishing between the quality and quantity aspects, but estimating willingness-to-pay for a greater quantity may be difficult -- a possible shortcut is the cost of acquiring such additional water by other means (e.g. vendor prices or the cost of digging shallow wells).

3. Reduced water-borne diseases affecting riverside residents and workers. Medical costs avoided may be sizeable, and they only begin to measure these benefits.

4. Increased fishing. If edible fish return to the river, they provide protein or profit for those who catch them.

5. Improved flood control. If the river is not clogged with waste, it might offer greater flood-control value or reduced flood-control expenditures elsewhere.

6. Increased irrigation-water possibilities. Cleaner water might prove of value to riverside agriculture.

7. Increased recreational use of the river (e.g. swimming, rafting). This is not easily measurable, but it is not irrelevant, especially for the poor of the riversides for whom few low-cost recreational activities exist.

8. Aesthetic improvement for those who come into any kind of contact with the river.

REFERENCES

Abeyasekere, S. 1984. "Overview of the History of Jakarta, 1930s to 1970s", Lecture in the AIA-CSEAS Winter Lecture Series, Monash University.

Abeyasekere, S. 1987. Jakarta: A History, Oxford University Press.

Bahl, R. W., and J. F. Linn. 1992. Urban Public Finance in Developing Countries, Oxford University Press.

Bansgrove, A. J. 1991. Sources of Water Pollution in the Ciliwung River, Jakarta: An Application of the Rapid Assessment Approach, M. A. Thesis, Geography, University of Waterloo (Canada).

Biro Pusat Statistik (BPS). 1993. Statistik Indonesia, 1992, Jakarta (also various earlier years and unpublished recent material).

Bitar, D., and R. C. Porter. 1991. "What Does a Landfill Cost? A Case Study of Ann Arbor, Michigan", IPPS Discussion Paper No. 335, November.

Booth, A. 1993. "Counting the Poor in Indonesia", Bulletin of Indonesian Economic Studies, April.

BPP Teknologi. 1983. "Studi Aktivitas Pemungutan dan Pemanfaatan Barang Bekas" (Survey of Activities of Scavengers), unpublished, Jakarta, July.

Brennan, E. M., and H. W. Richardson. 1989. "Asian Mega-City Characteristics, Problems, and Policies", International Regional Science Review.

Cairncross, S. 1990. "Water Supply and the Urban Poor", Chapter 5 of S. Cairncross, J. E. Hardoy, and D. Satterthwaite (editors), The Poor Die Young: Housing and Health in Third World Cities, Earthscan Publications.

Center for Policy and Implementation Studies (CPIS). 1988. Becak Drivers and Scavengers in Jakarta Informal Sector, Jakarta, January.

Center for Policy and Implementation Studies (CPIS). 1992. Enterprises for the Recycling and Composting of Municipal Solid Waste in Jakarta, Indonesia, Jakarta, September.

Cervero, R. 1991. "Improving Revenue Performance for Solid Waste Management", Harvard Institute for International Development, Jakarta, July.

Cestti, R. 1993. "Policies for Water Demand Management and Pollution Control in the Industrial and Household Sectors in the Jabotabek Region", Indonesia, draft, World Bank paper, March.

Chifos, C. 1991. Urban Environmental Management as a Component of an Integrated Urban Development Strategy: A Case Study of Jakarta, Volume III, Research Triangle Institute, Report for USAID, Jakarta, December.

City of Jakarta. various years. Jakarta in Figures, Jakarta.

Cointreau-Levine, S. J. 1991. "A Framework for Private-Sector Participation in Municipal Solid Waste Services in Indonesia", Report to the World Bank, Bridgewater (CT), November.

Coolidge, J. G., Z. Zhong, and R. C. Porter. 1993. "Urban Environmental Services in the Third World", EPAT/MUCIA Working Paper No. 9, November.

Courant, P., and R. C. Porter. 1981. "Averting Expenditures and the Cost of Pollution", Journal of Environmental Economics and Management, December.

Crane, R. 1993. "Water Markets, Market Reform, and the Urban Poor: Results from Jakarta, Indonesia", Department of Urban and Regional Planning, University of California at Irvine, August.

Dillinger, W. 1993. "Decentralization and Its Implications for Urban Service Delivery", Urban Development Division, World Bank, Draft, December.

Fischer, C., and R. C. Porter. 1993. "Different Environmental Services for Different Income Groups in LDC Cities: Second-Best Efficiency Arguments", Department of Economics Discussion Paper, The University of Michigan, November.

Gillis, M. 1985. "Micro- and Macro-Economics of Tax Reform: Indonesia", Journal of Development Economics, December .

Hadiwinoto, S., and G. Clarke. 1990. "The Environmental Profile of Jakarta", Metropolitan Environmental Improvement Program.

"High-Rise Building Owners Say Ground Water Use Necessary". 1994. Jakarta Post, 5 April.

Hutcheson, T., and R. C. Porter. 1972. "The Cost of Tying Aid: A Method and Some Colombian Estimates", Princeton Studies in International Finance No. 30, March.

Hugo, G. J., et al. 1987. The Demographic Dimension in Indonesian Development, Oxford University Press.

"Imports of Waste Hurt Scavengers' Income". 1994. Jakarta Post, 28 February.

"Indonesian Poverty on the Decline, Ginandjar Says". 1994. Jakarta Post, 25 March.

International Monetary Fund (IMF). 1992. Government Finance Statistics Yearbook, 1992, Washington.

International Monetary Fund (IMF). 1994. International Financial Statistics, Washington, February.

IWACO and WASECO. 1990. Water Supply Sector Study, Volume I: The Water Supply Sector in West Java, Draft, Jakarta, February.

IWACO. 1992. Regulatory and Price Policies for Water Conservation and Recycling in DKI Jakarta, Rotterdam, October.

"Jakarta Rivers Not Properly Cleaned". 1994. Jakarta Post, 7 April.

Japan International Cooperation Agency (JICA). 1985. Jakarta Water Supply Development Project, Final Report, March.

Japan International Cooperation Agency (JICA). 1987. Study on Solid Waste Management System Improvement Project in the City of Jakarta in Indonesia, November.

Japan International Cooperation Agency (JICA). 1991. The Study on Urban Drainage and Wastewater Disposal Project in the City of Jakarta, Master Plan Study, March.

Jellinek, L. 1985. "Underview: Memories of Kebun Kacang, 1930s to 1980s", Lecture in AIA-CSEAS Winter Lecture Series for 1984, Monash University.

JMDPR (Jabotabek Metropolitan Development Plan Review). 1993. Socio-Economic Implications, Jakarta, June.

Kelly, R., J. Bastin, and K. Suryowibowo. 1993. "Regional Government Finance in Indonesia: An Examination of Ongoing Reforms", Development Discussion Paper No. 461, Tax Research Series No. 16, Harvard Institute for International Development, July.

Kingsley, G. T. 1993. "Urban Infrastructure and Poverty Alleviation in Indonesia", The Urban Institute, Washington, October.

Kingsley, G. T., and B. Ferguson. 1992. "Urban Environmental Quality Management in Asia", The Urban Institute, Report prepared for the World Bank, Washington.

Lovei, L. 1988 . "Cost Recovery in the Municipal Water Supply Sector", Note Prepared for the Government of Indonesia by the World Bank for REPELITA V, Jakarta, September.

Lovei, L., and D. Whittington. 1991. "Rent Seeking in Water Supply", Infrastructure and Urban Development Department, World Bank, Report INU 85, Washington, September.

Manschot, C. A. 1991. "Urban Solid Waste Management Systems for the City of Jakarta, Indonesia", Student Paper No. 9, York University.

Marcussen, L. 1990. Third World Housing in Social and Spatial Development: The Case of Jakarta. Avebury, Gower Publishing Group.

Municipal Finance Project. 1992. Financial Performance of Local Water Authorities (PDAMs), December.

Noormohamed, S. 1980. "Housing the Poor in Jakarta", in R. G. Garnaut and P. T. McCawley (editors), Indonesia: Dualism, Growth, and Poverty, Research School of Pacific Studies, Australian National University.

Patten, D., B. Lewis, P. Smoke, and M. J. Breinholt. 1993. "Urban Development and Poverty Alleviation", Harvard Institute for International Development, Jakarta, August.

"Piped Water for 108,000 Families in North Jakarta". 1994. Jakarta Post, 24 March.

Porter, R. C. 1977. "On the Optimal Size of Underpriced Facilities", American Economic Review, September.

Porter, R. C. 1983. "The Optimal Timing of an Exhaustible, Reversible Wilderness Development Project", Land Economics, August.

Porter, R. C. 1993a. "Toward an Economic Theory of the Apartheid City", in L. Stetting, K. E. Svendsen, and E. Yndgaard (editors), Global Change and Transformation, Economic Essays in Honor of Karsten Laursen, Munksgaard International Publishers.

Porter, R. C. 1993b. "Providing Urban Environmental Services in Developing Countries", EPAT/MUCIA Policy Brief No. 4, November.

PT Indah Karya. 1988. Support Study for Master Planning for Water Supply Subsector Policy, draft, Jakarta, September.

PT Indah Karya. 1989. Preparation of National Strategic Plan for the Human Waste and Waste Water Disposal Sub-Sector for Urban Areas, Final Report (Summary), Jakarta, January.

"Revised Bill on Exploitation of Groundwater Passed into Law". 1994. Jakarta Post, 13 April.

"Road Repair Impossible until Sunter River Dredged". 1994. Jakarta Post, 28 February.

"Scavengers Call for Total Ban on Imported Waste Material". 1993. Jakarta Post, 14 January.

Shugart, C. 1989a. "RDA Appraisal of Water Projects: Results of Work in Surabaya", draft, Jakarta, February.

Shugart, C. 1989b. "Water Carrier Prices along Jalan Gresik in Surabaya", Jakarta, February.

Shugart, C. 1991a. "Standpipe-Vendor Memo", Harvard Institute for International Development, Jakarta, October.

Shugart, C. 1991b. "Groundwater Abstraction Study: My Comments", Harvard Institute for International Development, Jakarta, October.

Shugart, C. 1991c. "An Exploratory Study of the Water Standpipe-Vendor System in Jakarta", Harvard Institute for International Development, Cambridge, December.

Sicular, D. T. 1992. Scavengers, Recyclers, and Solutions for Solid Waste Management in Indonesia, Center for Southeast Asia Studies, Monograph No. 32, University of California at Berkeley.

Silver, L. E. 1990. "Review of Urban Sanitation Experience", Project INS/88/005 for the UN/World Bank Water and Sanitation Program, November.

Sivaramakrishnan, K. C., and L. Green. 1986. Metropolitan Management: The Asian Experience, Economic Development Institute, World Bank, Oxford University Press.

Soejarni, M. 1984. Present Waste Management in Cities in Indonesia, Center for Research on Human Resources and the Environment, University of Indonesia.

Struyk, R. J., M. L. Hoffman, and H. M. Katsura. 1990. The Market for Shelter in Indonesian Cities. Hasfarm Dian Konsultan and The Urban Institute Press.

Sukarno. 1966. Sukarno: An Autobiography, as Told to Cindy Adams, Gunung Agung.

"Trash to Mount by 20 Percent". 1994. Jakarta Post, 12 March.

United Nations. 1989. Population Growth and Policies in Mega-Cities: Jakarta, Department of International Economic and Social Affairs, Population Policy Paper No. 18, ST/ESA/SER.R/86.

United Nations Development Program (UNDP). 1993. Human Development Report, 1993, Oxford University Press.

Van Der Hoff, R., and F. Steinberg (editors). 1992. Innovative Approaches to Urban Management: The Integrated Urban Infrastructure Development Program in Indonesia. Avebury, Ashgate Publishing Limited.

Villinski, M. T. 1991. "Loan Financing of Indonesian Water Supply: Implications for Tariff Levels and Consumption", Harvard Institute for International Development, Jakarta, April.

"Water Company to Impose Different Tariffs". 1993. Jakarta Post, 7 May.

"Water Shortage Looming in Jakarta: Ministry". 1994. Jakarta Post, 24 March.

Watt, S., et al. 1991. "Private Sector Participation in Selected Urban Services", Prepared for USAID by WASH, Task No. 186, Washington, May.

World Bank. 1984. Indonesia: Urban Services Sector Report, Report No. 4800-IND, Washington, June.

World Bank. 1990a. Indonesia: Poverty Assessment and Strategy Report, Report No. 8034-IND, Washington, May.

World Bank. 1990b. Staff Appraisal Report: Second Jabotek Urban Development Project, Report No. 8339-IND, Washington, May.

World Bank. 1993a. Indonesia: Urban Public Service Provision, Discussion Paper, Washington, April.

World Bank. 1993b. Indonesia: Urban Public Infrastructure Services, Report No. 12154-IND, Washington, June.

World Bank. 1993c. Indonesia Environment and Development: Challenges for the Future, Report No. 12083-IND, Washington, August.