A Systems Approach on Solid Waste Management

in Metro Manila, Philippines

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ABSTRACT

The matter of solid waste and its management in Metro Manila had catapulted itself into the limelight in 2000, during which a number of issues plagued the solid waste management (SWM) sector. First came the 'Payatas Tragedy' in July when a huge amount of garbage in Payatas, the largest active open dumpsite in the Philippines, was loosened by heavy rains and caved in on the community of scavengers living around it. Next came the premature closure of the San Mateo Waste Disposal Facility (SMWDF), which took in majority of Metro Manila's solid waste at that time. Come 2001, a garbage crisis ensued, forcing the regional government to declare a 'state of emergency' to obtain assistance from the national government. That same year, the Philippines' first comprehensive SWM law, the Ecological Solid Waste Management Act (RA 9003) which emphasized community based efforts in material recovery and composting, was passed.

Currently, a controlled dump in the outskirts of Metro Manila takes in the bulk of the generated solid waste. There is, however, still an impending garbage crisis looming over Metro Manila, despite the passing of RA 9003. This study examines the SWM sector in Metro Manila as a system and identifies the challenges that hinder implementation of RA 9003. The analysis is done using statistical data from the National Statistics Office of the Philippines (NSO), the National Statistical Coordination Board of the Philippines (NSCB), the Metro Manila Development Authority (MMDA) and other data from relevant bodies with causal loop diagrams, as well as, STELLA models as tools for data synthesis. This thesis also endeavors to examine and discuss the effects of applying user fees, increasing SWM personnel services expenditure, increasing environmental education and opening a sanitary landfill using both system analysis tools mentioned.

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I. Introduction

Solid waste refers to wastes from households, municipal services, construction debris and the agricultural sector. This also includes non-hazardous, non-liquid wastes from institutions and industries. (RA 9003) According to the World Bank (2001), its generation is greatly affected by a country's development. Generally, the more economically prosperous a country is, the more waste is generated per capita. Table 1.1 presents a comparison of municipal waste generation of different cities in the world.

Table 1.1 International Comparison of Municipal Solid Waste Generation by City*

City and Country	Generation (kg/capita/day)
Industrialized Countries:	
New York, USA	1.80
Hamburg, Germany	0.85
Rome, Italy	0.69
Middle-income Countries:	
Cairo, Egypt	0.50
Kano, Nigeria	0.46
Manila, Philippines	0.60
Tunis, Tunisia	0.56
Low-income Countries:	
Calcutta, India	0.51
Karachi, Pakistan	0.50
Jakarta, Indonesia	0.60

*(WB, 2001)

Solid waste management (SWM), on the other hand, pertains to the control of the "*generation, storage, collection, transfer and transport, processing and disposal* (RA 9003)*"* of solid waste in a fashion that is in accordance to societal and economic needs while at the same time compliant to environmental standards and principles.

Solid waste is a telltale sign of how citizens' lifestyles change as a result of economic development. Furthermore, the distribution of waste generation in the different regions of a country is indicative of its degree of urbanization. In cities, where standard of living is higher, there is usually a higher waste output compared to rural areas. This is reflective of the case of the Philippines where its capital and largest urban center, Metro Manila, generates almost a quarter of the country's total waste generation (WB, 2001).

The issue of solid waste in Metro Manila gained international attention in the 1980s through the Smokey Mountain dumpsite, which became representative of poverty in the Philippines (Gonzales, 2002). It used to be the country's largest dump and is also one of the largest slums in the world (Yashwant, 2002). The government was concerned about the negative image that this gave the country that it was eventually closed in 1995.

The matter of solid waste and its management had, once again, catapulted itself into the limelight in 2000, during which a number of issues plagued the solid waste management (SWM) sector. First came the 'Payatas Tragedy' in July when a huge amount of garbage in Payatas, the largest active open dumpsite in the Philippines, was loosened by heavy rains and caved in on the

community of scavengers living around it. Next came the impending premature closure of the San Mateo Waste Disposal Facility (SMWDF), which took in majority of Metro Manila's solid waste at that time, at the end of the year which aroused panic and concerns among the Local Government Units (LGUs) and the Metro Manila Development Authority (MMDA), the bodies responsible for SWM in Metro Manila. They scurried around, desperate for alternative dumpsites and solutions. They also rallied for the repeal of the Clean Air Act (Republic Act 8749), passed the year before, under which incineration of solid wastes was banned.

During this time, the Ecological Solid Waste Management Act (RA 9003), a landmark law which addresses SWM issues was in the final stages of formulation. It was finally approved in January of 2001 after delays due to the political perturbation at that time. The passing into law of RA 9003 was met by much enthusiasm by political leaders and non-governmental organizations (NGOs) alike as it was the first law in the country that addressed SWM in a non-piecemeal manner.

Despite the initial optimism after RA 9003's approval, 2001 turned out to be the year of the Metro Manila garbage crisis. The LGUs and the MMDA provided neither alternative dumpsites nor solutions by the time SMWDF was shut. Garbage dumps were literally growing everywhere in the metropolis – roadsides, waterways, vacant lots, rivers and other public places. The problem got so out of hand that Metro Manila was declared as under a 'state of emergency' to obtain assistance from the national government (The Manila Times, 2002). The crisis also caught the attention of the World Bank, thus its focus on the growing problem of solid waste in the Philippines in the 2001 Philippine Environment Monitor (WB, 2001).

Things had momentarily quieted down with the opening of the Montalban Solid Waste Disposal Facility (MSWDF) in mid 2002. The issue of SWM, however, has not completely faded into the background as earlier events had inspired the activism of several NGOs. Unfortunately, though, it also escalated the growing not-in-my-backyard (NIMBY) problem, making the task of searching for locations for future solid waste disposal facilities for the LGUs and the MMDA a bigger problem. These are just a few of the challenges that face the SWM sector. By looking at it as a system, its relationships and effects with the different elements in the sector can be identified. With this, improvements can be proposed and evaluated.

II. Aims & Objectives

The thesis endeavors to present solid waste management in Metro Manila as a system and recommend solutions using a systems approach. The specific aims are the following:

- To present the current state of SWM in Metro Manila, the challenges it faces and the actors involved.
- To analyze the relationships between significant elements in the Metro Manila SWM system using causal loop analysis.
- To create models to illustrate these relationships.
- To create and model scenarios wherein different solutions in the SWM system are applied.
- To evaluate the effect of these improvements to the SWM system.
- To recommend and discuss applicable solutions to the SWM system.

III. Scope and Limitations

This study looks into the solid waste management situation in Metro Manila, Philippines as a system. It looks specifically, into the wastes generated, its generators and the policies, the authorities and bodies involved in its management. Solid waste, here, refers to municipal solid

waste that is under government responsibility. These are wastes coming from the following sources: households, commercial establishments, some institutions, markets and municipal services. All other wastes from industries, medical facilities and those from institutions/establishments with their own means of waste disposal are excluded from the following analyses. Likewise, hazardous, infectious and other wastes that need special treatment are not considered.

Data synthesis is done using causal loop diagrams and STELLA modeling. The study looks into four different scenarios:

A – Otherwise known as the business-as-usual scenario
B – Characterized by the application of user fees as a solution
C – Characterized by the application of user fees, increased personnel services expenditure and environmental education as solutions
D – Characterized by the application of user fees, increased personnel services expenditure, environmental education and the opening of a sanitary landfill as solutions

The specific limitations, assumptions and bases for the above scenarios are further elaborated and discussed in 5.2.2. The solutions recommended are the application of user fees, increased personnel services expenditure, environmental education and the use of environmental technology. These are analyzed using causal loop diagrams, as well as STELLA models. Taking a community or *barangay*[1] approach and reviewing institutional responsibility in SWM are also discussed. All recommendations are those that are allowed by Philippine environmental laws. For this reason, incineration is not being considered as a solution in this paper.

The SWM system is defined by the elements involved in this analysis and is illustrated by Figures 6.5 and 6.6. The elements of the SWM system are outlined and defined in 5.2.1. Hard factors are quantified using appropriate units. For soft factors, such as NIMBY and environmental responsibility, units were devised by the author as described in 5.2.2. These are not intended to predict specific events in the future but are meant to assist the reader in picturing possible patterns that may be displayed by soft elements.

IV. Background of Metro Manila

4.1 Population

Metro Manila or the National Capital Region (NCR) is the largest metropolitan center in the Philippines and the seat of Philippine government. It is the smallest region in the country in terms of land area but is second largest in terms of population (NSO, 2003). It has a total of 10 295 709 inhabitants (MMDA a, 2003) living within 636 km^2 (ILSR, 2000), bringing population density to 16 188 persons/km^2. It has a whopping 2 132 989 households in 2000, with an average size of 4.63 persons (NSO a, 2003). With a population crossing the 10 million mark, Metro Manila has become one of Asia's five megacities[2] (The Manila Times, 2003). Representing about 13% of the Philippine population in 0.2% of the total land area, Metro Manila is said to be more densely populated than Metro Tokyo and Metro Paris (UNU, 2000). The National Statistics Office of the Philippines (NSO) records an annual growth rate of 1.06% for 1995 to 2000. If the growth rate holds constant, population in the metropolis is expected to double in 65 years. (NSO a, 2003)

[1] The *barangay* is the smallest political unit in the Philippines.
[2] A megacity is defined by United Nations as a city that has more than 10 million inhabitants (UN CSB, 2002).

Metro Manila has 4 districts (as seen in Table 4.1). Each district is composed of LGUs, which refer to the cities and municipalities in the region. There are a total of 17 LGUs and among these, 13 are chartered cities while 4, Navotas, San Juan, Taguig and Pateros (DTI, 2003) are municipalities. Quezon City has the largest share of inhabitants, taking 22.35% of the population. Manila City is a far second with 14.91%. These LGUs are, then, further subdivided into different *barangays* or small communities.

Table 4.1 Metro Manila LGUs and Corresponding Population 2003

District[a]	City/Municipality	Population[b]	% of MM Population
1st	Manila	1 535 517	14.91
2nd	Quezon City	2 301 463	22.35
	Pasig	532 717	5.17
	Marikina	414 462	4.03
	Mandaluyong	287 560	2.79
	San Juan	120 884	1.17
3rd	Kalookan	1 289 050	12.52
	Valenzuela	515 902	5.01
	Malabon	350 229	3.40
	Navotas	239 741	2.33
4th	Taguig	507 298	4.93
	Parañaque	481 596	4.68
	Las Piñas	457 564	4.44
	Makati	453 974	4.41
	Muntinlupa	389 755	3.79
	Pasay	357 858	3.48
	Pateros	60 139	0.58
	Total	**10 295 709**	**≈ 100.00**

a = (NSO, 2003)
b = MMDA Projections 2000-2011 (MMDA a, 2003)

4.2 Economic Development

Metro Manila is the primate region in the country. It is the heart of trade, commerce and industry in the Philippines. It is most favored by industries because it is the most developed in terms of infrastructure. It contributes to 30.59% of the Gross Domestic Product (GDP) in 2002 (NSCB a, 2003). The National Statistical Coordination Board of the Philippines (NSCB) recorded an accelerated growth in Gross Regional Domestic Product (GRDP) from 2001 to 2002 at 4.59%, outpacing its 2000 – 2001 growth (NSCB a, 2003). With 65.2% of the population being economically active, aged between 15 to 64 years old, and a 98% literacy rate, there is a large potential for more growth in this region (NSO, 2003).

NSCB figures indicate Metro Manila as the least poor region in the whole country. It has consistently had the lowest poverty incidence[3] in the country with 4.8%. It also exhibits the best figures in other poverty indicators such as income gap[4], poverty gap[5], severity of poverty[6] and the

[3] Poverty incidence is the proportion of families with per capita income below the poverty threshold as a proportion to the population (NSCB b, 2003).

[4] Income gap refers to the difference of the average income of families living below the poverty line from the poverty threshold in proportion to the number of poor families (NSCB c, 2003).

[5] Poverty gap refers to the difference in the average income of families living below the poverty line from the poverty threshold in proportion to the total number of families (NSCB d, 2003).

[6] Severity of poverty is an indicator that uses the difference in incomes of people living below poverty line to express the depth of poverty. It is sensitive to the income distribution among the poor. (NSCB e, 2003)

GINI coefficient[7], almost always at the top of the lists, despite having the highest poverty threshold[8]. (NSCB g, 2003) It is this image of Metro Manila that attracted multitudes of Filipinos from less affluent regions to migrate into the country's capital. The figures, however, belie the fact that there exists informal settlers or squatters that unofficial sources, such as the Asian Development Bank (ADB) and Greenpeace Southeast Asia (GSEA), say make up a third of the population (The Manila Times, 2003; ILSR, 2000). A large number of these slum dwellers are those who left their home provinces for Metro Manila, enticed by the promise of economic opportunities.

V. Methodology

5.1. Data Collection

Since MMDA ceased operation of its website where most official data are available, data collection presented a problem. There was, therefore, a need to visit the Metro Manila Development Authority Office in Metro Manila, Philippines to obtain hard copies of studies and official files containing useful information and data. Interviews were also conducted by the researcher among personnel in the MMDA's Solid Waste Management Division as well as with the head of Mother Earth Philippines, an NGO that is actively involved in solid waste management developments in Metro Manila.

Extensive research over the internet was done to obtain studies, reports, conference papers, documents and data from relevant bodies. Part of the data used, particularly statistical data, were obtained from the websites of the National Statistics Office (NSO) and NSCB.

5.2. Data Synthesis

5.2.1. Definition of Terms

The collected data is synthesized using a systems analysis approach. A causal loop diagram is used to create a picture of the SWM system in Metro Manila and the important elements in it. This shall be presented later in Chapter 6 (see Figure 6.5). The following is a list of these elements and how these are used in this analysis:

'Waste Generation' is the total amount of waste produced in Metro Manila per unit of time. In the model, it is the product of 'rate of generation' and 'population' and is expressed as ton/year. In the discussion, however, it is expressed as ton/day.

'Rate of Generation' is the amount of waste produced by an individual in Metro Manila per day. It is mostly expressed in this paper as kg/day.

'Population' refers to the population in Metro Manila in a given year. Population projections used in the model were taken from MMDA projections[9].

'Wastes' refers to total waste stock existing in Metro Manila. It increases via 'waste generation' and is depleted through the 'recycling', 'waste collection', 'backyard burning' and 'littering' streams. This is expressed in tons.

'Recycling' is the activity whereby materials are recovered from wastes and are either reused or recycled.

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[7] The GINI coefficient is a measure of inequality in income distribution with a limit of 0 for perfect equality and 1 for perfect inequality (NSCB f, 2003).

[8] Poverty threshold is the minimum income needed by a family to satisfy food and non-food basic needs (NSCB g, 2003).

[9] Referring to projections in MMDA a, 2003.

'Waste Collection' refers to residual waste that is collected for final disposal.

'Littering' refers to wastes that are unmanaged and are dumped around the metropolis, in public places, illegally in vacant lots, in waterways and in bodies of water.

'Backyard burning' refers to wastes that are burned by individual households within their premises as a means of disposal.

'Municipal Services' refer to the wastes yielded from street sweepings and river clean ups that are funded by the city or municipal government.

'Controlled Dumping' is the use of controlled dumps as a means of final disposal for collected wastes. Controlled dumps, as defined by RA 9003, are solid waste disposal facilities, which employ minimum prescribed standards of site operation. Its basic operational controls include waste spread and compaction, stormwater management and the supervision of operations by trained staff (WB, 2001).

'Open Dumping' is the use of open dumps as a means of final disposal for collected wastes. Open dumps are sites where solid wastes are dumped indiscriminately without any form of environmental or health measure taken (RA 9003).

'SWM Costs' is the total annual cost of solid waste management. This includes the cost of landfilling or tipping fee[10], landfill maintenance, aftercare and wastewater treatment, as well as, the individual spent by LGUs for waste collection and transport to the dumps.

'SWM Budget' is the total annual allocation for SWM. This includes the SWM budget for the whole metropolis as well as allocations from the individual LGUs to be spent exclusively in their cities/municipalities.

'Economic Development' refers to economic progress in Metro Manila and is expressed using the GRDP as an indicator.

'NIMBY' stands for the not-in-my-backyard syndrome which is characterized by the aversion and strong opposition displayed by residents to siting of SWM facilities (WB, 2001), often within their jurisdiction.

A causal loop diagram is, likewise, used to analyze where solutions must be applied (see Figure 6.6). Furthermore, the diagram will illustrate how these solutions affect the existing SWM system. As will be seen in the diagram in Chapter 6, new elements have been added into the system. These are:

'User Fees' refers to a policy solution where SWM becomes a public utility, rather than a general service. This imposes a pay-as-you-throw scheme where waste generators pay for SWM services depending on the amount of waste that is collected.

'Environmental Education' stands for any method used to teach the public better SWM practices that can be done in the household or community level. Environmental Education referred to in the analysis are those that are provided for by the government and its measure is dependent on the amount of government allocation.

'Environmental Responsibility' is a value that 'environmental education' hopes to inculcate. This comes from understanding the SWM system, its effect on the general well being of the environment, society and the economy and the role that individuals play in this system.

'Personnel Services' refers to the total expenditure on SWM personnel, including wages, benefits, etc.

'Sanitary Landfilling' is the use of sanitary landfills as a means of final disposal of collected wastes. A sanitary landfill refers to a waste disposal facility that is 'designed, constructed, operated and maintained in a manner that exerts engineering control over significant potential environmental impacts arising from the development and operation of the facility (RA 9003).'

[10] A tipping fee is the amount paid for every unit of trash disposed in a landfill or dump (PCIJ, 2002).

5.2.2 Assumptions

The synthesis of collected data was done through modeling using the STELLA software. For this, there are four scenarios. Scenario A is the business as usual scenario. Scenarios B to D depict different scenarios that show how different types of solutions affect the defined system. All scenarios use the following assumptions:

- 'Solid waste' refers to municipal solid waste unless indicated otherwise.
- Year 2000 as the base year
- Data, as seen in Table 5.2.1, are used as inputs in the STELLA model. GRDP, Generation/Person and Municipal Services are assumed to have a proportional, linear relationship. Data projections for years 2015 and 2020 were worked out by the author using linear regression with data for 2000, 2005 and 2010 as basis.

Table 5.1 NCR GRDP, Waste Generation & Population

Year	NCR GRDP (Php)	Total Gen/Person (kg/day)	NCR Population	Gen/Person (kg/day)	Municipal Services (ton/day)
2000	328 987 000 000 [a]	0.562 [c]	9 861 048 [c]	0.559 [f]	29.37 [g]
2005	440 258 000 000 [a]	0.620 [c]	10 637 915 [c]	0.617 [f]	34.98 [g]
2010	589 165 000 000 [a]	0.685 [c]	11 456 926 [c]	0.681 [f]	41.60 [g]
2015	712 981 330 000 [b]	0.745 [d]	12 247 841 [e]	0.741 [f]	48.10 [g]
2020	843 070 330 000 [b]	0.806 [d]	13 045 780 [e]	0.802 [f]	55.45 [g]

a = GDP projections by NSO and JICA (JICA/MMDA, 1999)
b = worked out by the author from projections in **a**
c = Projected Waste Generation 2000–2011 (MMDA a, 2003)
d = worked out by author from waste generation projections in **c**
e = worked out by author from population projections in **c**
f = difference between total generation/person & municipal services
g = 0.53% of total generation/day (MMDA a & MMDA b, 2003)

- Waste that is neither recycled nor collected or composted are labeled as unmanaged waste. These become improperly disposed waste. 52.8% of which is treated by households through backyard burning (NSO, 2003). The rest, litter, represents garbage that are thrown in public places, waterways, rivers or illegally dumped in vacant lots. Part of it goes back into the system as waste generation through municipal services.
- All recovered recyclables are converted into recycled materials without any cost to the government. This is because material recovery in Metro Manila is done mostly by the 'informal sector' which is composed by scavengers, garbage collectors and individuals who go to households buying recyclables and selling them to junk shops.
- Dumping in open dumps cost Php 300/ton (Gonzales, 2002). Controlled dumps, on the other hand, cost Php600/ton (MMDA 5c, 2002) and double the amount everytime a new landfill of similar type is opened.
- All collected wastes that is not landfilled in either dumps go to improperly disposed garbage.
- SWM expenses include personnel services, landfill aftercare, maintenance and operation costs, wastewater treatment, landfilling costs (tipping fee) and collection and transportation costs. Except for transportation and collection, all costs are deducted from MMDA's SWM budget. Transportation and collection costs are borne by the individual LGUs themselves.
- All initial prices of expenses are worked out from the 2002 SWM budget of MMDA. Maintenance and operation cost Php34.17/m^2 of controlled dump area. Wastewater

treatment costs Php8.68/m^2 while the tipping fee is initially Php600/ton. Landfill aftercare is paid yearly after a controlled dump is closed upto 10 years at the same rate as wastewater treatment. All rates double for each new controlled dump opened. Php2.35 million is spent annually for total personnel services. (MMDA, 2002)

- Collection and transportation costs are priced at Php785.7/ton. This is derived from a weighted average of costs spent by Marikina, Valenzuela and Muntinlupa (WB, 2001).
- Total SWM allocation is composed of the share of SWM from the government plus the individual expenses of LGUs in collection and transportation. The government allocated share for SWM is set as 0.13% of the GRDP, based on the approved 2002 budget (MMDA, 2002). LGU contribution, on the other hand, varies yearly depending on the amount of waste collected.
- Allowable capacities for both open and controlled dumps are calculated based on the total intake of wastes until they are closed. According to MMDA's list of waste disposal sites, all open dumps totaling an area of around 230 000 m^2, shall be closed in 2004. The closure for all controlled dumps, totaling 600 000 m^2, is set at 2006. (MMDA c, 2003) From this data, it was assumed that the allowable capacity for open dumps is 12.20 tons/m^2 while for controlled dumps, 8.16 tons/m^2.
- NIMBY is calculated based on waste per area calculations of the dumps, as well as littering. For waste area calculations, each time the allowable capacity is exceeded, NIMBY points are gained and accumulated. For littering, specified number of points of NIMBY is gained depending on the amount of waste that is littered per year.
- The effect of NIMBY is presented in the model as a factor that multiplies the landfill costs. For every 10 points of NIMBY, the factor increases by an increment of 0.5. This demonstrates how NIMBY contributes to the rising price of solid waste management as fewer towns are willing to host landfills. The rising costs may be due to environmental safety equipment that may be required by the town or incentives for the host town.
- Amount of wastes is always expressed in tons while time is expressed in years.

5.2.2.1 Scenario A – Business as Usual

Scenario A depicts the current solid waste management situation in Metro Manila. Based on findings (see 6.1.4), waste, after it has been generated, is recycled, collected, burned or dumped illegally in streets, public places, vacant lots or waterways. The following are assumptions used for this scenario:

- Material recovery is 10% of waste generated (Sese, 2003). All of which is recycled.
- Collection rates in 2000 to the first half of 2002 is at 70% (WB, 2001). After the opening of MSWDF and the Navotas controlled dump in the second half of 2002, collection increased to about 71.5% of waste generated (MMDA c, 2003).
- Based on MMDA data, 38.15% of collected wastes end up in open dumps while 61.85% go to controlled dumps (MMDA c, 2003). In the model, however, the share of wastes that are supposed to go to the controlled dumps become unmanaged wastes, following the closure of San Mateo landfill at the end of 2000 and the absence of a substitute until the opening of MSWDF and Navotas controlled dumps in 2002 (WB, 2001; MMDA c, 2003).
- All existing controlled dumps are closed by the end of 2006 (MMDA c, 2003). This according to MMDA sectoral plans but may also be taken as an effect of NIMBY.

Even if the government decides to extend the use of these dumps, it is more likely that this decision will be overruled by the host town as what had happened in the case of the San Mateo landfill.

- After operations in existing controlled dumps cease, it is assumed that the government opens a new dump of the same kind and size.
- The open dumps, however, continue to receive the regular amounts of waste past its closure date of 2004 (MMDA c, 2003). This assumption is based on what had happened in the past when Payatas had been ordered closed after it had collapsed but was reopened a few months later due to the garbage crisis (Philippine Star a, 2001). This situation where garbage is dumped in these open dumps even past its capacity is an avenue where NIMBY is gained in the model.
- Total personnel services remains at a constant annual cost of Php2 351 000 (MMDA, 2002).
- Environmental education is not considered in this scenario despite having an allocation in the SWM budget. This will be taken up in Scenario C.

5.2.2.2 Scenario B

Scenario B is the first of three scenarios modeled in this paper that looks into the effects of applied solutions to the system. This scenario examines the outcome of turning solid waste management into a public utility. The system presented in this scenario is able to demonstrate the possible effects of imposing user fees on the SWM budget and to the waste flow. If quantity is measured by weight, it potentially has a significant effect on the amount of waste that households put up for collection. Figure 6.1 shows that a large amount of the waste generated are kitchen wastes. These are heavy as they contain high moisture. On the other hand, these are biodegradable and can be composted. For this reason, composting is added in the waste flow. It is expected that a significant amount of the wastes would be diverted into the composting stream to avoid large waste collection bills. The following are assumptions for this scenario:

- The user fee takes effect in 2004. Php 1276.40 is charged per ton, or Php1.30/kg, of garbage collected. This is worked out by the author based on the total expenditures per unit weight of garbage that is disposed, i.e. landfilling costs, maintenance & operation, wastewater treatment and collection & transport costs. The fees collected are added into the SWM budget.
- Garden & wood wastes plus half of the kitchen waste are composted. This adds up to 29.5% of the total generated wastes (see Figure 6.1). This occurs as an effect of user fee implementation.
- Half of the paper, plastic, metal and glass wastes generated are recovered for recycling after user fee is collected (see Figure 6.1). This increases the material recovery rate to 20.5%.
- After 50% of the waste is diverted to composting and recycling, the difference is collected and deposited into the landfills.
- All compost produced is sold at Php2400/ton based on *Barangay* Sun Valley, Parañaque experience (WB, 2001).
- All recycled goods produced are sold at Php1200/ton based on the experience of the Federation of Multi-purpose Cooperatives[11] (WB, 2001).

[11] See 6.1.2.4

5.2.2.3 Scenario C

There are two solutions added in Scenario C. The first concerns the expenditure for total personnel services. Instead of a fixed constant amount, it has been changed as a percentage of the share of SWM from the GRDP. Economic development, which also triggers a rise in waste generation, will increase the allocation for SWM personnel services expenditure. This may be used to increase the number of SWM employees or to give them better work benefits. Either way, this leads to more productivity, in the model, in terms of municipal services.

The second solution addresses the accumulation of NIMBY as a result littering and the use of the dumps beyond their capacity. Environmental education is introduced in the system as a tool to counter the effects of NIMBY. Environmental education hopefully instills, in the society, better understanding of the solid waste management system and its problems. The model illustrates how the value environmental responsibility is gained from better understanding. With environmental responsibility, waste generation may be curbed.

The assumptions taken for this model are:

- Personnel services take 0.55% of the SWM GRDP share, based on the initial amount allocated in the 2002 SWM budget (MMDA, 2002).
- The change in personnel services allocation manifests itself in the resulting changes in municipal services output. The factor by which personnel services allocation increases results in the same factor by which municipal services output also increases.
- Environmental education takes 1% of the SWM GRDP share, based on the initial amount allocated in the 2002 SWM budget (MMDA, 2002).
- The extent to which environmental education can decrease NIMBY points is proportional to its allocation from the budget. The number of units of environmental education gained is, in turn, inversely proportional to environmental negligence. The more units of environmental education gained per year, the less environmental negligence. Environmental negligence is valued between 1 and 0. With the effects of environmental education, negligence is reduced to a fraction, which is, then, multiplied to the generation per person.

5.2.2.4 Scenario D

Scenario D examines a situation where the government obtains land a 200-hectare piece of land to turn into a sanitary landfill with environmental safety equipment. In this scenario the following are assumed:

- The new sanitary landfill opens right after the controlled dumps reach capacity and are closed.
- The new sanitary landfill size is 200 hectares based on a minimum estimation by JICA of 100 hectares for 10-year landfill lifetime (JICA/MMDA, 1999).
- The open dumps are used until their capacities are reached. Afterwhich, the wastes are diverted into the controlled dumps or sanitary landfill.
- The cost of landfilling in the new landfill is USD25/ton or Php1375/ton[12], the average cost for the use of a sanitary landfill (de Oliveira, 1999).
- No initial cost of investment is considered as this is assumed to be made by a private investor operating under a build-operate-transfer (BOT)[13] scheme.

[12] at Php55 to USD 1

VI. Results and Discussion

6.1. Existing Solid Waste Management Scheme in Metro Manila

6.1.1. Waste Generation

Metro Manila generates a total of 6 140.40 tons of refuse/day (see Table 6.1). Per capita generation may vary depending on income level. In 1997, the Japan International Cooperation Agency (JICA) study team found a ratio of 500:451:344 for high, middle and low income per capita generation, respectively (JICA/MMDA, 1999). Using this information, a weighted average is calculated. For 2003, average per capita generation is 0.597kg/day (MMDA b, 2003). According to official projections made by MMDA and JICA, as GRDP increases, so does per capita generation. Actual data projections are seen in Table 6.1.

Table 6.1 Metro Manila Waste Generation 2003

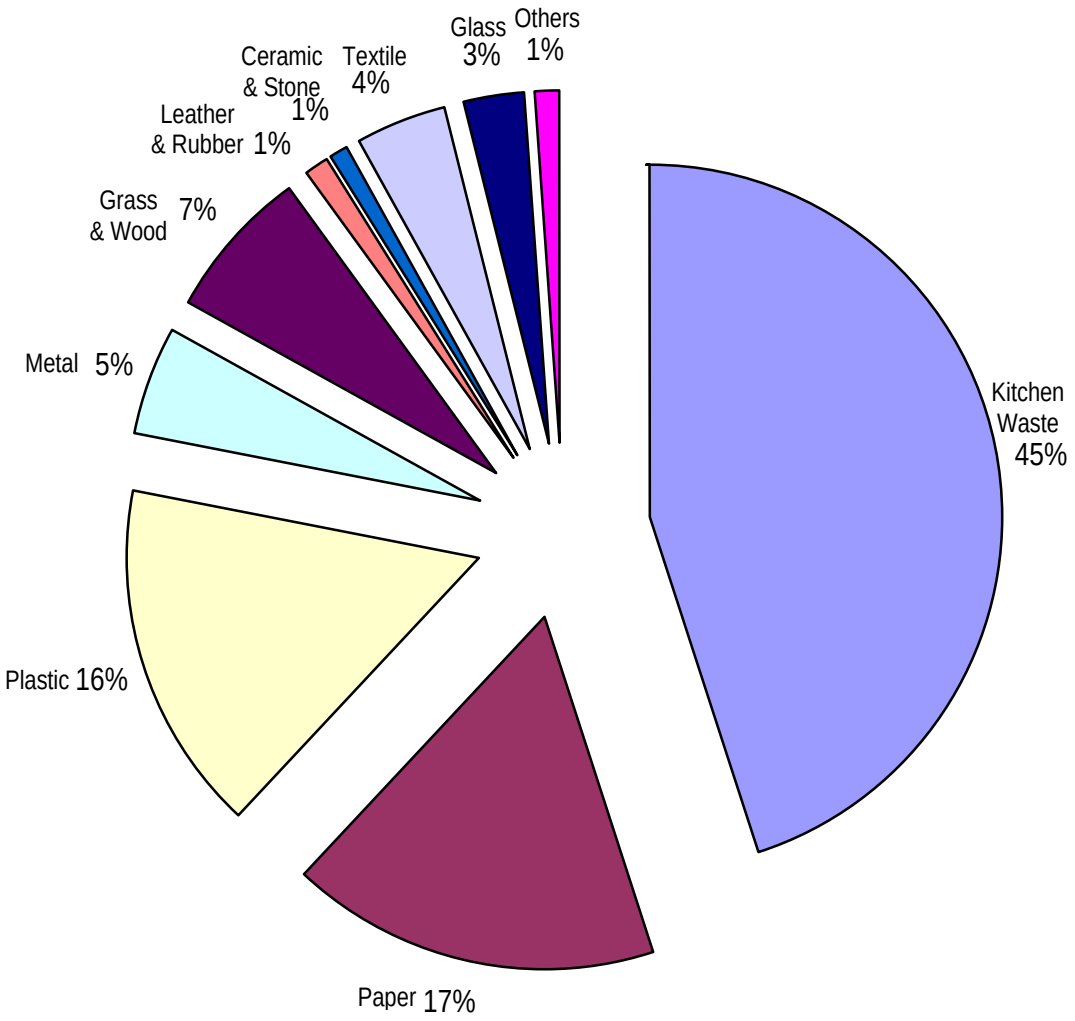
City/Municipality	Waste Generation (tons/day)*
Quezon City	1 372.60
Manila	915.80
Kalookan	768.80
Makati	270.70
Pasig	317.70
Valenzuela	307.70
Las Piñas	272.90
Pasay	213.40
Muntinlupa	232.40
Parañaque	287.20
Taguig	302.60
Marikina	247.20
Malabon	208.90
Mandaluyong	171.50
Navotas	143.00
San Juan	72.10
Pateros	35.90
Total	**6 140.40**

* projected from year 2000 data (MMDA, 2003)

The latest Waste Amount and Composition Survey (WACS) done for Metro Manila by JICA and MMDA was in 1997. It was found that a large amount of the wastes are mostly biodegradable, owing to the large amount of kitchen wastes in the garbage (see Figure 6.1). Moreover, according to the JICA study team, the share of paper and plastics in the waste stream are high compared to other developing countries (JICA/MMDA, 1999). Thus, there is a large potential for waste reduction through composting and recycling.

[13] BOT is a contractual arrangement where the project proponent finances, undertakes the construction of, operates and maintains an infrastructure facility over a fixed term that does not exceed 50 years. Afterwhich, the facility is transferred to the government agency concerned. During the proponent's term, the proponent is allowed to charge fees, at an agreed price, for its use. (RA 7718)

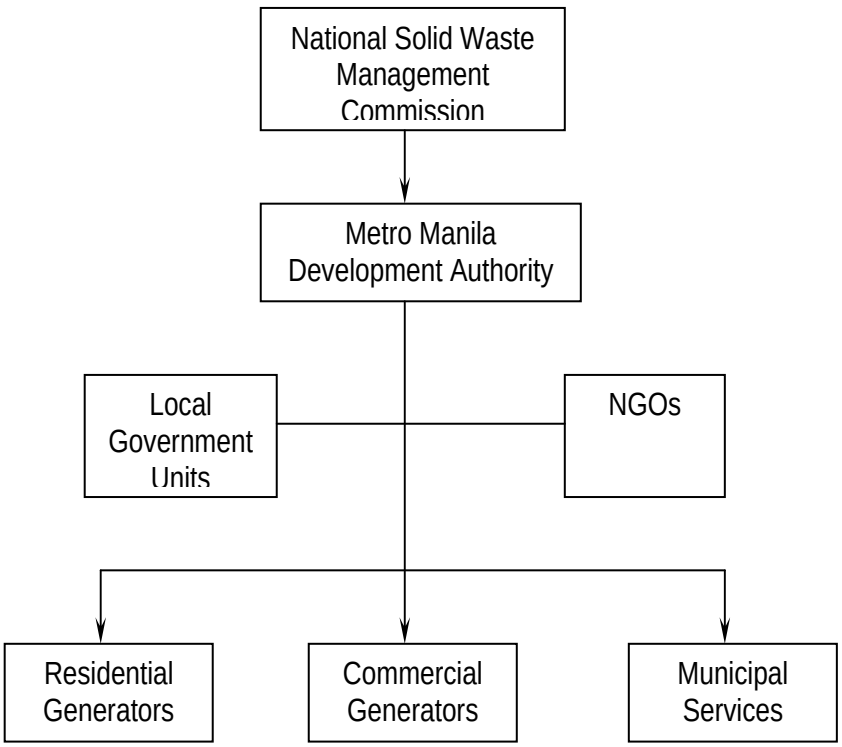
Figure 6.1 Metro Manila Waste Composition (MMDA b, 2003)



6.1.2 Institutions Responsible

With the passing of RA 9003 there came a transformation in the country's SWM. The National Solid Waste Management Commission (NSWMC), a central body for national SWM was created to oversee the implementation of a comprehensive SWM framework (refer to Figure 6.2). Under it are provincial SWM boards to be chaired by their respective governors. The provincial boards will be composed of the city and municipal mayors, as well as, NGOs and representatives of the recycling, and packaging industries. In the case of Metro Manila, the MMDA is mandated to chair its SWM board. (RA 9003) The LGUs work under the MMDA and directly with residential and commercial generators through the delivery of waste collection and municipal services. The NGOs focus on community-based projects such as environmental education.

Figure 6.2 Institutional Set-up of SWM in Metro Manila



6.1.2.1 National Solid Waste Management Commission

The National Solid Waste Management Commission (NSWMC) was created to implement RA 9003. It takes over the responsibilities of the Presidential Task Force on Solid Waste Management, its predecessor, which was abolished in the same act. It is tasked to create a national SWM framework and oversee its implementation in accordance to RA 9003's objectives. The commission is composed of both government and private sector representatives. The secretary of the Department of Environment and Natural Resources (DENR) and a representative of the private sector serve as chair and vice-chair, respectively while the DENR – Environmental Management Bureau (DENR – EMB) provides secretariat support to the commission.

6.1.2.2 Metro Manila Development Authority

The MMDA plays a central role in SWM in Metro Manila. It was created in 1995 with the passing of RA 7924[14]. The act defines Metro Manila as a '*special development and administrative region*' that must be subjected to the direct administration of the office of the President. Thus, the MMDA was created with the task of overseeing metro-wide services within Metro Manila without trespassing on LGU autonomy, which is provided for in RA 7160, the Local Government Code. It is dependent on subsidies and allocations from the national government as well as contributions from LGUs. (Manasan & Mercado, 1999) For a body handling a multitude of responsibilities such as the MMDA, a limited amount of resources can easily be a hindrance in carrying out plans and projects.

[14] RA 7924 is 'An Act Creating the Metropolitan Manila Development Authority, Defining Its Powers and Functions, Providing Funding Therefor and for Other Purposes'

While its involvement in SWM in the past has been limited mostly to final disposal, the implementation of RA 9003 widens its coverage of responsibilities, which includes creating a regional SWM framework in accordance to the national framework. The extent of involvement of the MMDA in its task of making sure that the ESWM is implemented in the region gives it a certain amount of authority over the LGUs that may be contradictory RA7160. This is, perhaps, one reason why the MMDA, seemingly, channels more of its resources to the search for back end solutions such as landfills. The employees at the MMDA Solid Waste Management Office (MMDA-SWMO) insist that MMDA is merely a coordinating body and that it cannot interfere with LGU decisions despite being chair of region's SWM board (from personal interviews). As a body overseeing the most progressive and developed cities in the country, MMDA is too weak for it to carry out the responsibilities that it was tasked to do.

6.1.2.3 Local Government Units

These LGUs or Local Government Units refer to individual cities and municipalities. Under the NCR, there are 17 LGUs – 13 are cities while 4 are municipalities. Their involvement in SWM in their respective jurisdictions involves solid waste collection, street sweeping and river clean ups. The quality of services, however, varies from LGU to LGU, depending on their financial capability to deliver SWM services. There is a large amount of controversy that surrounds the way SWM is handled in LGUs. Majority of the LGUs hire contractors to take care of solid waste collection and transport to the dumps for final disposal. Critics say that SWM is plagued with corruption as many contractors, as well as politicians, see this sector as a lucrative venture (PCIJ, 2001).

With the passing of RA 9003, they are tasked to formulate 10-year SWM plans which would redirect at least a quarter of generated solid wastes towards reuse, recycling and composting through the establishment of community based recovery facilities and buy-back centers (ADB, 2002). Considering the abovementioned corruption in SWM, these vested interests are perhaps some of the reasons why there is a delay in the implementation of ESWM's provisions.

6.1.2.4 Non Governmental Organizations

There is a well-developed sector of non-governmental organizations (NGOs) in the country, championing different causes (Gaite & Eggerth, 2000). The cause of solid waste management is no exception. Especially in Metro Manila, where the problems of SWM were pronounced NGOs have long campaigned for sectoral changes favoring community based solutions. The passage of RA 9003 has long been fought for by an alliance of NGOs which include the Recycling Movement of the Philippines, the Earth Day Network, Mother Earth, *Linis Ganda*[15], Concerned Citizens Against Pollution, and Greenpeace Philippines (Gonzales, 2002). After the signing of RA 9003 into law, these NGOs have not rested their case. They remain vigilant and aware that the law has not been properly implemented. According to Odette Alcantara, founder and head of Mother Earth, they strongly oppose MMDA's plans that focus more on finding the potential landfill sites rather than recycling and waste segregation (Personal Interview).

Aside from lobbying for better legislation and its implementation, these NGOs also conduct community-based recycling and material recovery efforts. Some conduct training and seminars for community leaders and help them set up SWM systems in their areas. An NGO, *Linis Ganda*, organized the Federation of Multi-purpose Cooperatives, an alliance of 572 junk shops that employed over a thousand eco-aides to conduct recycling activities. In 2000, they reportedly

[15] 'Clean is Beautiful' in English

purchased a total of 101 850 tons of waste paper, corrugated boards, cutlets, plastics and metals worth Php 132.5 million and were sold to factories. (WB, 2001)

6.1.3 Solid Waste Management Laws

The Philippines has had a long history of SWM laws, the earliest of which dating back from 1938. These, however, mostly address one aspect of SWM each. Laws such as the Anti-dumping Law of 1938, the Garbage Disposal Law of 1975, the Sanitation Code of 1975 and the Local Government Code of 1991 all specifically address matters of waste collection and disposal. The Marine Pollution Control Decree of 1976 and the Toxic Substances and Hazardous and Nuclear Waste Control Act of 1990, on the other hand, focus on more specific issues. All in all, the past SWM legislations have all taken a piecemeal approach.

It wasn't until a few years ago that SWM policy has taken the limelight. It all started with the passing of RA 8749, the Clean Air Act of 1999 that called for a ban on incineration of all types of solid wastes. Not long after, RA 9003, the Ecological Solid Waste Management Act of 2000, was passed. These two laws are heralded as landmark laws as they have, individually, are hoped to make effective reforms that will protect the environment.

6.1.3.1 RA 8749 The Clean Air Act

RA 8749 provides for a comprehensive air pollution management program (WB, 2001). Article 3 section 20, it defines incineration as *"the burning of municipal, biomedical and hazardous wastes, which process emits poisonous and toxic fumes"*. It bans the use of incinerators and allows up to three years after the act's implementation for existing medical waste incinerators to be phased out. RA8749 encourages the use of *"state-of-the-art, environmentally sound, and safe non-burn technologies"* for the disposal of residual and medical wastes. It includes a statement mandating local government units (cities and municipalities) to encourage recycling and composting but no concrete terms are mentioned. (RA 8749)

This garnered the Philippines accolades as it made the country the first in the world to impose a nationwide ban on incineration. Environmentalist groups, such as Greenpeace, who have been ardently rallying for its approval, called it an environmental milestone (Manila Bulletin, 1999). This, however, did not make much of an impact to municipal SWM systems in Metro Manila, at that time, since landfilling or dumping was the sole form of solid waste disposal technique used. Incineration was a method used, mostly, by hospitals and industries. It did, however, become a big issue among the LGUs and MMDA during the garbage crisis of 2001 since incineration was one less option that they could consider. During this time, there was a clamor by local government executives and legislators for the repeal of the ban on incineration, as it seemed to be the only solution at that time, considering the lack of enough landfill space to accommodate the growing amount of wastes generated by the populace.

For MMDA, the ban presents an additional burden since this would mean establishments that previously used incineration would have to rely on Metro Manila's disposal facilities. This presents an added intake into the dumps, accelerating landfill life.

6.1.3.2 RA 9003 The Ecological Solid Waste Management Act

RA 9003 tackles SWM issues in a non-piecemeal approach. According to the Philippine Legislators Committee on Policy and Development (2002), it is the most comprehensive piece of legislation addressing the country's waste problems that has ever been passed. It called for the

creation of the NSWMC, a central body governing all aspects of SWM which will be comprised by representatives from the government, the private sector and NGOs. The NSWMC is mandated to create a national SWM framework that emphasizes community based approaches in waste reduction. It promotes the idea of waste as a resource and orders the diversion of at least a quarter of the waste generated through recycling, reuse and composting. To support this, the Department of Trade and Industry (DTI) was mandated to create local markets for recyclables and compost through incentives. The participation of the community as well as the private sector is specifically encouraged. (RA 9003)

The act gives specific provisions for existing and future solid waste disposal facilities. Existing open dumps are to be converted to controlled dumps and the opening of new open dumps is prohibited. Controlled dumps are to be converted into sanitary landfills. RA 9003 also includes specific technical requirements for these disposal facilities. (RA 9003)

It came almost two years after the approval of the Clean Air Act and a year after it has been implemented. Considering its capability to reduce residual waste, perhaps, it would have been possible to avoid some of the SWM problems presented by the incineration ban had it come before RA 8749. It does cover almost all aspects of SWM but the challenge is in its implementation since it calls for a major shift in the community's ethics. Moreover, the institutions responsible for bringing about this change, MMDA and LGUs, are the very ones who, not long ago, rallied for the repeal on the incineration ban. It seems that the NGOs have their work cut out for them as they have to work both on the institutional, as well as, community levels.

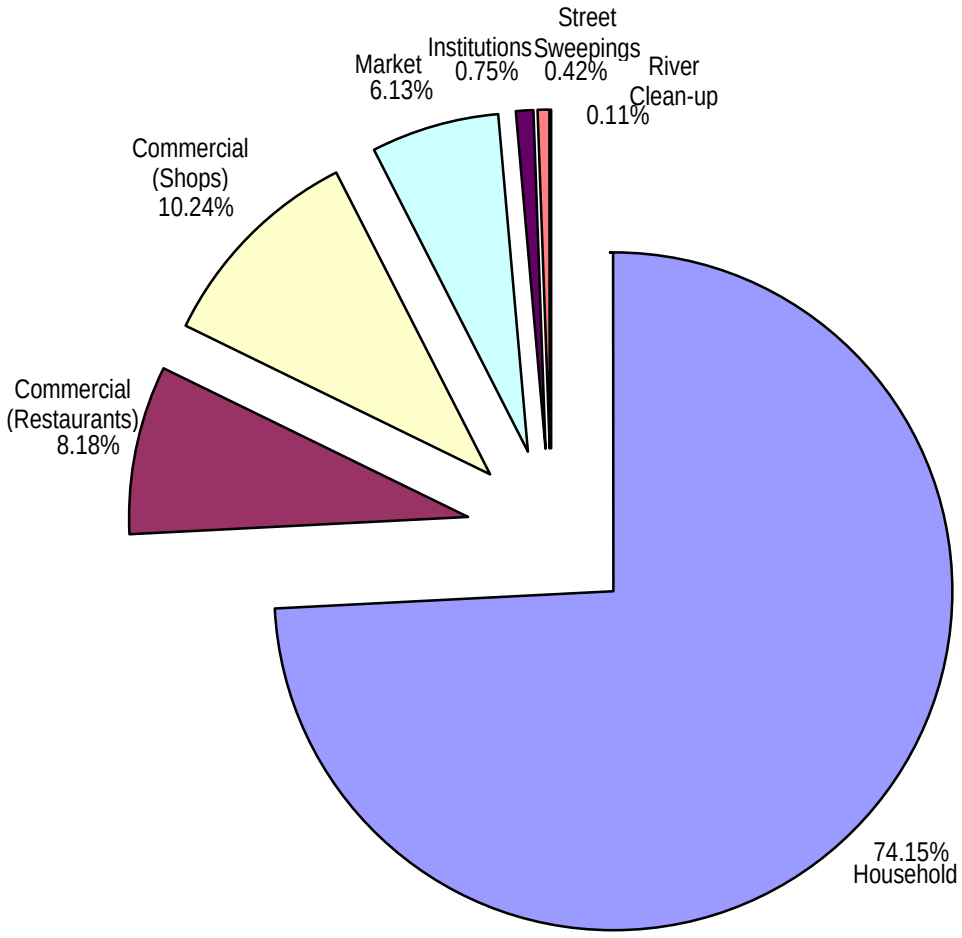
6.1.4 Waste Flow and Facilities

A WACS by JICA and MMDA in 1997 revealed that 74.15% of the total wastes originate from households (see Figure 6.3). This coincides with the waste composition presented in Figure 6.1 where nearly half of the waste stream is kitchen waste. Wastes from institutions make up a small part of the waste stream despite the enormous amount of schools and offices in the metropolis. This might be because a lot of the institutions do not depend on municipal waste collection services for disposal. An example of which is the University of the Philippines who is known to have its own controlled dump (NSWMC a, 2003).

The waste flow in Metro Manila basically follows the set up as seen in Figure 6.4. From the generators, they are burned by the generators themselves, inappropriately dumped and littered, collected or recycled. Backyard burning or small-scale community burning is a traditional waste treatment method and is usually done by households within their premises. This is done by 52.8% of the households (NSO, 2003) and is permitted under the Clean Air Act (RA 8749).

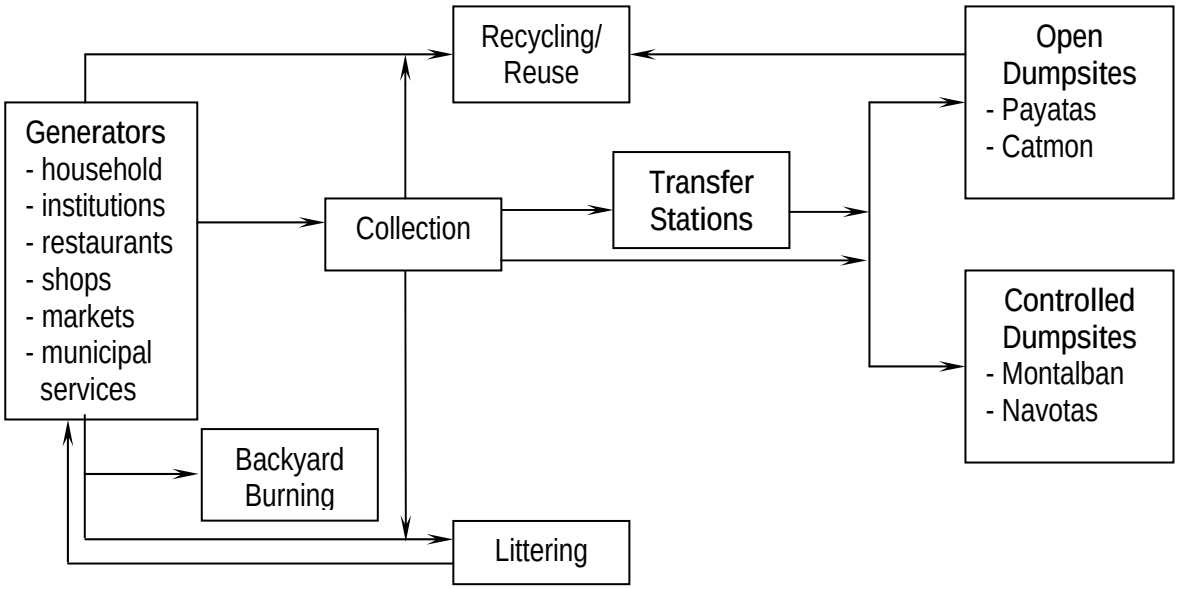
In the diagrams (see Figures 5.1, 5.2 & 6.4), waste from street sweepings and river clean up are collectively known as municipal services. These, basically, reenter into generation, as these are wastes recovered from those that have inappropriately dumped and littered in the streets, waterways, bodies of water and other public places.

Figure 6.3 Sources of Metro Manila Waste (MMDA b, 2003)



Material recovery for recycling is about 10% (Sese, 2003). Most of this is done by the informal sector through scavengers or individual buyers, together with some communities and NGOs. Material recovery occurs in various levels in the waste flow. It could occur right at the source where some generators separate recyclables to sell to individual buyers or scavengers rummage through garbage that has been put out for collection. Recovery also occurs during collection as most of the garbage collectors also scavenge for garbage to add to income or to find something that they may be able to use. Lastly, in the final disposal sites, recovery is practiced by thousands of scavengers who pick through the mounds of garbage for a living. According to a Greenpeace report, there are about 40 000 to 50 000 individuals who work as scavengers in Metro Manila (ILSR, 2000). Most of these people also live or squat in the areas around open dumps, thus exposing them more to the hazards of open dumping. This was seen during the tumbling down of garbage, dubbed as the 'Payatas tragedy', that happened in July 10, 2000 in Payatas dump due to heavy rains and killed at least 234 people who were living around it (Philippine Star a, 2001).

Figure 6.4 Waste Flow in Metro Manila



Percent coverage of waste collection services in individual LGUs differ depending on the financial capability of the city or municipality. On the average, waste collection is at 71.5% of the amount generated (MMDA c, 2003). Not everything, however, is disposed in the dumps all the time. Especially during the garbage crisis, without any dumps available, garbage collection companies have reportedly dumped garbage in vacant lots, roads and bodies of water (Philippine Star b, 2001; Philippine Star c, 2001). On its way to the dumps for final disposal, some of the wastes go through transfer stations before it is transported into the dumps. But because there are only three transfer stations in Metro Manila, most of the wastes collected are transported directly by the contractors to the dumps (NSWMC b, 2003).

Table 6.2 Metro Manila Waste Disposal Facilities*

Waste Disposal Facility	Start of Operation	Type	Size (ha)	Daily Waste Intake (tons/day)
Montalban Solid Waste Disposal Facility - Rodriguez, Rizal	June 2002	Controlled Dumpsite (CD)	14	1321.12
Barangay Tanza, Navotas	October 2002	CD	11	430.00
Lingonan, Valenzuela City	1988	CD	14	270.00
Payatas, Quezon City	1973	Open Dumpsite (OD)	21	1294.00
San Pedro, Laguna		CD	14	467.00
Catmon, Malabon		OD	14	195.00
Pier 18, Tondo, Manila		OD		186.00
Pulang Lupa, Las Piñas		CD	7	228.00
				4391.12

* (MMDA c, 2003)

There is only one manner of final waste disposal practiced in Metro Manila, landfilling. There are two types of landfills being used – open and controlled dumps. Around 38.15% of collected wastes end up in open dumps while the rest go to the controlled dumps.

As seen in Table 6.2, MSWDF and Payatas have the largest intake of wastes. MSWDF is a controlled dump whose opening in June 2002 has been awaited by LGUs as a temporary answer to

the garbage crisis. It is located in Rodriguez, Rizal which is outside Metro Manila and is expected to service the metropolis until 2006 (MMDA c, 2003). Payatas, on the other hand, is the largest active open dumpsite in the country (Gonzales, 2002). It is located inside Quezon City and has been operating since 1973 (MMDA c, 2003). It didn't get much attention until it took over the load of Smokey Mountain after it was closed in 1995 (Gonzales, 2002). It was also ordered to close immediately after the Payatas tragedy but was reopened at the height of the garbage crisis. According to MMDA (MMDA c, 2003), it is set to be closed in 2004, although judging from its past closure, this plan might still come to naught if no adequate alternatives are found.

The Navotas waste disposal facility is a smaller controlled dump with 11 hectares. It services Navotas and Manila City only and is set to operate until 2006. All other controlled dumps such as the ones in Valenzuela, San Pedro, Laguna and Las Piñas are also set to operate until 2006. (MMDA c, 2003) After which, they must have already converted to sanitary landfills as directed by RA 9003. All other open dumps such as Catmon and Pier 18 are set to be closed in 2004 (MMDA c, 2003).

6.1.5 Impacts

With the operation of solid waste disposal facilities that are non compliant to environmental standards, it is expected that a host of problems ensue. The most pressing concern, probably, are the health impacts. Clogged drains result into stagnant water that breed disease spreading mosquitoes. Fecal matter and other organic wastes attract insects and rodents, carrying with them diseases like cholera and dengue fever (UDSU-EAPR, 1999). Since some medical wastes also share the same dumps, the spread of infectious bacteria from sharps (needles, syringes & glassware), blood and body fluids and pathological wastes (tissues and organs) are also dreaded (Emmanuel, 2001).

Leachate from the garbage infiltrates the water table and contaminates groundwater supply, endangering health and aggravating the ever-growing problem of water scarcity. The Carmona landfill, which used to serve the metropolis from 1993 to 1998, was found to be discharging leachate with high levels of chromium and copper, toxic metals, into the Menama River. The San Mateo landfill, with its problems, is within the Marikina Watershed Reservation. (Greenpeace SEA, 2000) The Philippine Environment Monitor 2001 reports that the BOD levels for both Carmona and San Mateo landfills are 3 500 mg/L and 10 000 mg/L, respectively. This is way beyond the standard set by the Environmental Management Bureau (EMB) of 50 mg/L. (WB, 2001) The Payatas dump is probably the worst, with its enormous amount of wastes piling up and rotting since 1973 without any form of environmental measure. It is also at a critical position as it was also found to leach out heavy metals and is located near the La Mesa dam, a primary source of Metro Manila's drinking water (Greenpeace SEA, 2000).

The most vulnerable, perhaps, to the abovementioned impacts are the urban poor, as they cannot afford to take any precautions against these effects. Most of these people are not even able to afford basic medical care. Since they are informal settlers or squatters, they also do not get adequate water service, much less clean water. So with the looming water scarcity, it is an added problem and an added expense as to where they will get potable water for their daily needs. Moreover, their lives are at risk living near enormous mountains of garbage, as was seen during the Payatas tragedy.

Another effect to society is the NIMBY or not-in-my-backyard syndrome. The MMDA does have a track record that would support the growth of such an attitude. Garbage dumps have earned the notoriety of growing into enormous mountains of refuse such as the infamous Smokey Mountain, which gained international attention and became a symbol of poverty in the Philippines.

NIMBY is the very reason why the garbage crisis happened. People from the town hosting both the Carmona and San Mateo landfills found how these, supposedly sanitary, landfills are not working according to design. Rallying and petitioning from the townspeople ensued which forced the premature closure of both the Carmona and San Mateo landfills even before they've reached capacity. It is no wonder why it took the MMDA quite some time to find another waste disposal site, considering their past performance.

For Metro Manila, being the commercial, industrial and financial center of the country, the SWM situation will have a huge effect on future foreign business ventures. Aside from being aesthetically displeasing, the site of garbage dumps spurting around the cities in Metro Manila does not go well with investors as it is a sign that the metropolis still lacks the infrastructure needed to be globally competitive.

On the global level, the EMB has estimated that solid waste brought to the dumps released 203 kilotons of methane, equivalent to an emission of 4,253 kilotons carbon dioxide in 1994 (Merilo, 2001). Moreover, despite the banning of incineration, carbon dioxide emissions will still be a concern, as more and more people will turn to the traditional backyard burning if SWM remains to be inefficient in the future.

6.2 Causal Loop Analysis

Figure 6.5 depicts the current SWM system in Metro Manila. Economic development is a factor to the rise in per capita rate of generation. As incomes increase because of economic development, so does the rate of waste generation. This and a rising population results to a rise in total waste generated. The higher the total waste generation is, the more waste there is to be dealt with.

There is more waste recycled as the total amount of waste increases. Recycling, in turn, helps reduce the stock of waste. Likewise, there will be more waste treated through backyard burning by the residents with the increase in waste. This also decreases the existing waste stock.

Because there is more waste, waste collection increases. An increase in waste collection increases both controlled and open dumping activities. These increase SWM costs, which deplete the SWM budget. The budget is replenished each year and its allocation increases with increasing economic development.

Leftover wastes end up littered in the streets, public places and bodies of water. The more wastes, the more littering. The more this happens, there is more garbage that municipal services deal with. As more waste is recovered by municipal services, rate of waste generation also increases as these go back into the waste stream.

MMDA's track record of open dumping and the visible littering of garbage in Metro Manila are factors that directly affect the growth of NIMBY among Manileños and people from neighboring towns. An increase in NIMBY increases SWM costs.

Out of all the elements in Figure 6.5, economic development, per capita waste generation and population are the strongest factors influencing total waste generation.

Figure 6.5 Causal Loop Diagram of SWM in Metro Manila

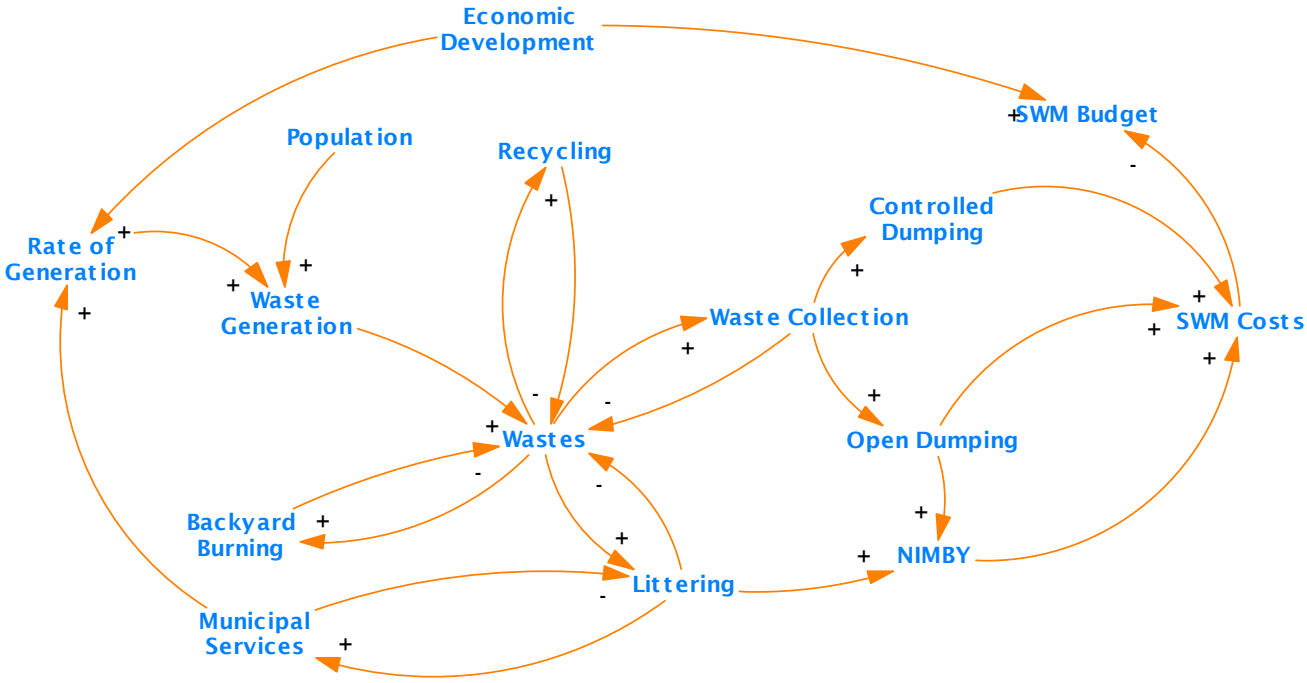


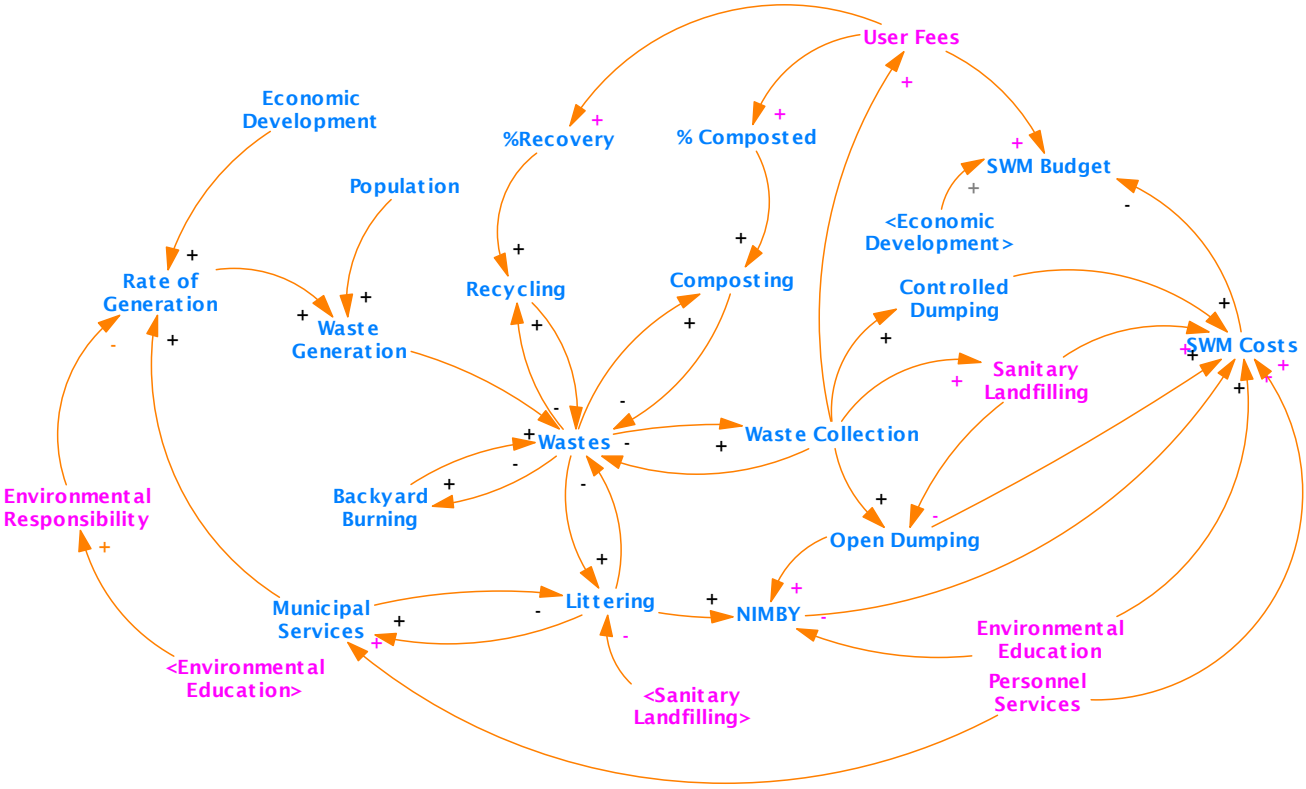
Figure 6.6 illustrates how chosen solutions affect the SWM system. User fees can increase the rates for recovery and composting. This may happen for a number of reasons – households can save on SWM bills by having less garbage collected and the profit from recovered materials and compost can help pay SWM bills. In the previous diagram, composting was not included since at present, there is a negligible amount of wastes that are treated in this manner. Increased user fee collection also increases the SWM budget.

Increased allocation for personnel services expenditure increases SWM costs but it, in turn, increases the yield of municipal services. As more garbage is recovered by municipal services, less is littered around the metropolis. By decreasing littering, it indirectly slows down the growth of NIMBY.

Increasing environmental education is also an added cost to SWM. It, however, directly decreases NIMBY by inculcating environmental understanding and environmental responsibility. Increased environmental responsibility decreases per capita rate of waste generation.

The opening of a sanitary landfill will increase SWM costs as tipping fees would increase in order to maintain equipment needed for environmental compliance. However, since the sanitary landfill is designed to meet the specific demands of the metropolis, there is less open dumping and littering. This will also indirectly slow down the growth of NIMBY.

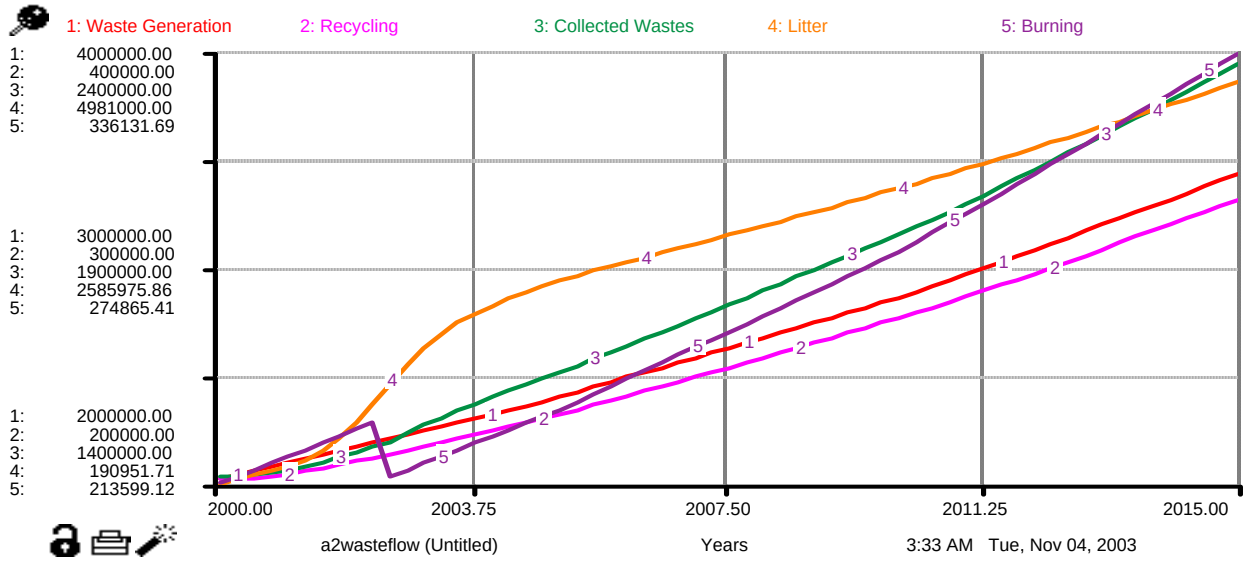
Figure 6.6 Causal Loop Diagram of SWM Solutions for Metro Manila



6.3 Systems Analysis and Modeling of SWM Scenarios

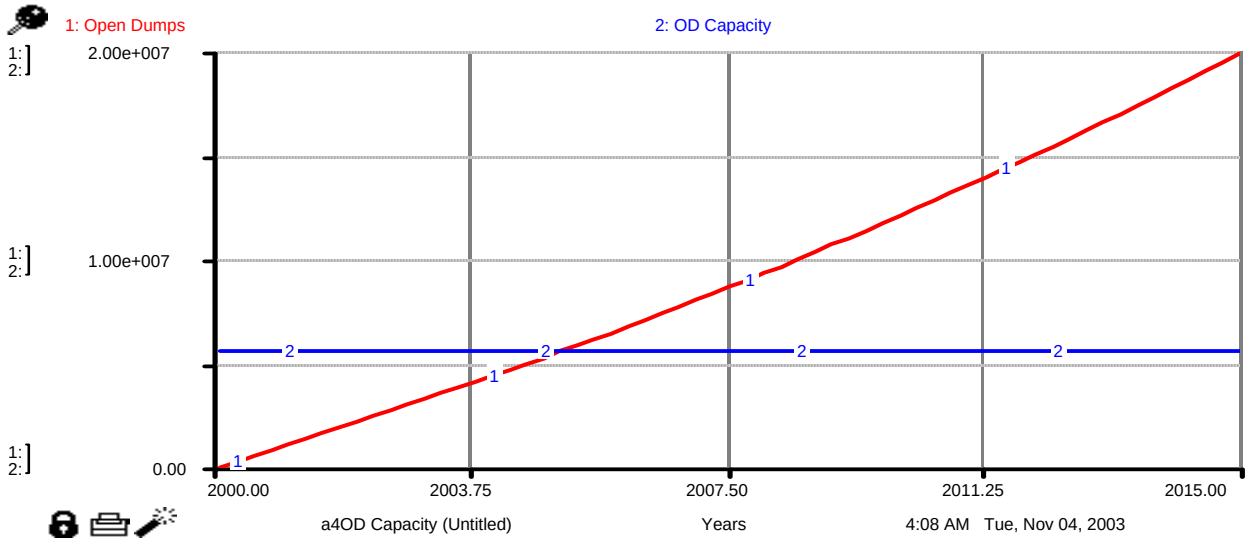
6.3.1 Scenario A – Business as Usual

Under the current SWM situation it is assumed that total waste generation rises with economic development. In Graph 6.1, the steady rise in waste generation influences a similar trend in recycling, collected wastes, littering and burning. The effects of the garbage crisis that occurred after the San Mateo Landfill was closed in December 2000 and before the MSWDF opened is observable in the graph, especially for the amount of litter and wastes burned. Both experience a steep ascent in the time series between 2001 to 2002. Backyard burning experienced a sharp drop once the MSWDF was open. The littering trend was less steep after the opening as well.



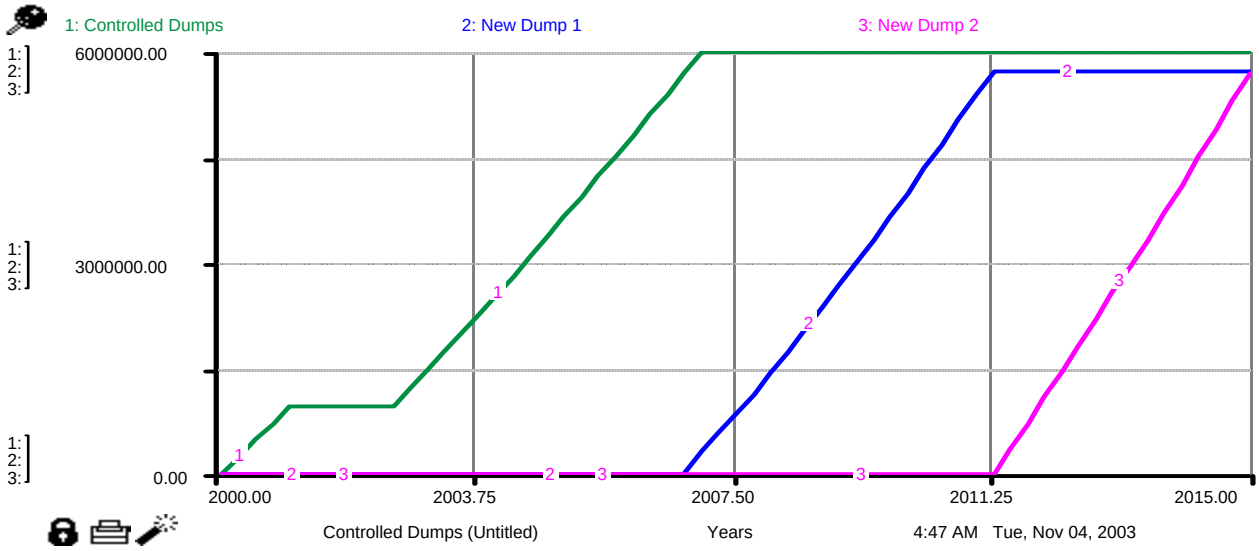
Graph 6.1 Scenario A – Waste Flow

Graph 6.2 shows that at the end of 2004, the open dumps reach capacity and need to be closed. With the present lack of availability of sites for new landfills, these dumps are more likely to be overused past their capacities. This has been known to happen to the old part of the Payatas dump. Dumping was ordered to cease after the huge mountain of garbage collapsed in July of 2000. With the garbage crisis, however, it was ordered open since there were no alternative methods or dumps available where garbage can be disposed.



Graph 6.2 Scenario A – Open Dumps

The assumptions made regarding the controlled dumps are seen in Graph 6.3. It shows how a similar type of landfill with the same capacity as that of the present ones are used once the old controlled dump close. It could be seen in this figure that Metro Manila would exhaust the use of three 60-hectare controlled dumps within 15 years in addition to open dumping, recycling, backyard burning and littering. The brief leveling off of the controlled dumps series at the beginning of the timeline depicts the limited amount of waste that can be disposed in controlled dump facilities in 2001 following the closure of the San Mateo landfill.



Graph 6.3 Scenario A – Controlled Dumps

Graph 6.4 shows how NIMBY affects the waste flow. Again, during the 2001 – 2002 period, there is a sharp increase in the waste streams caused by wastes diverted to unmanaged wastes because of the closure of the San Mateo controlled dump, a major disposal site before MSWDF was opened. This is very obvious to the littering trend while at the same time, there is a dramatic increase in both NIMBY and NIMBY effect. The open dump series appears unaffected as it is assumed that the percentage share of collected wastes that go to the open dumps remain unchanged throughout the garbage crisis.

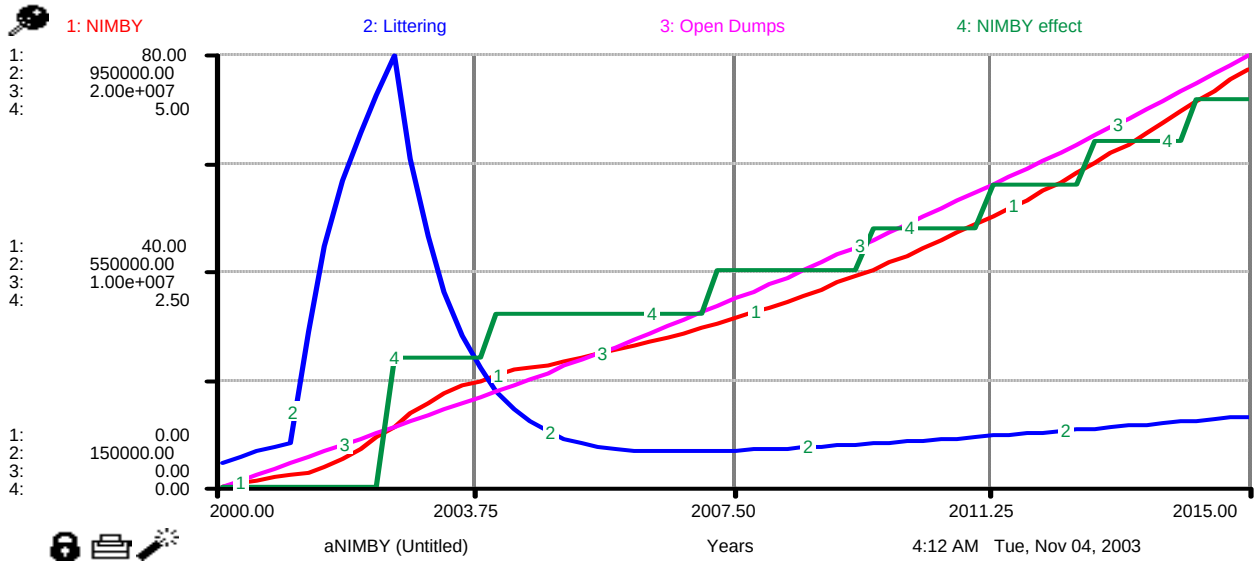
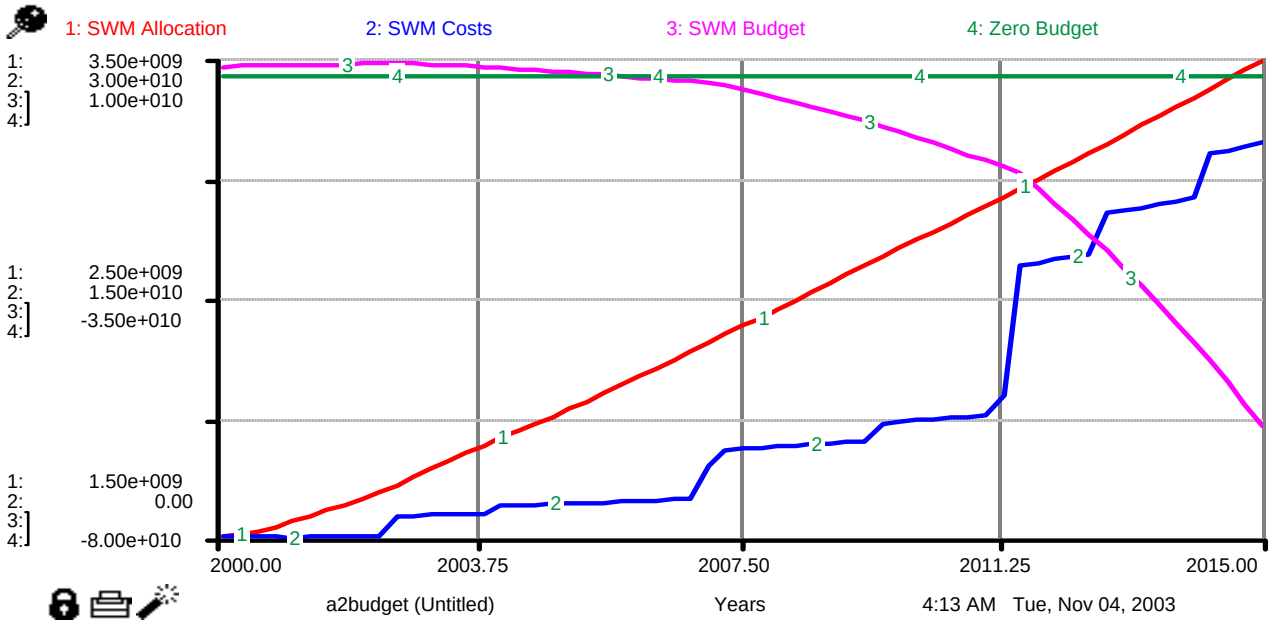


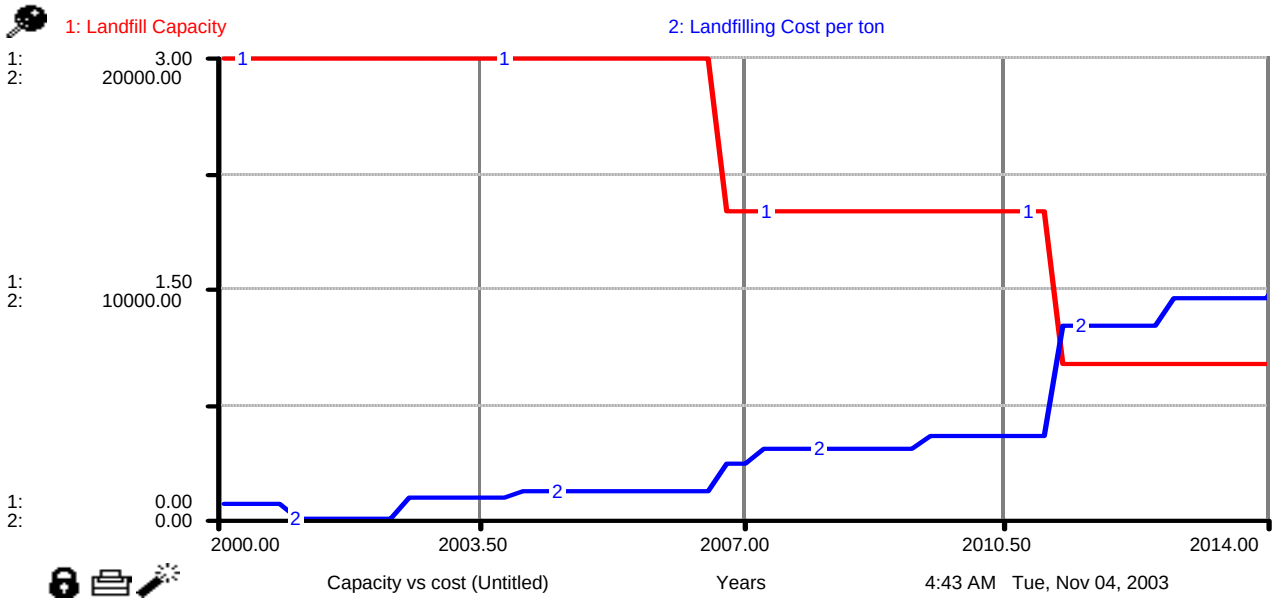
Figure 6.4 Scenario A – NIMBY

A balance of the costs and allocation in the SWM budget is seen in Graph 6.5. Despite the increasing amount of funds that is received by the metropolis for SWM expenditures, the budget is more likely to become inadequate in the future. The rising costs of SWM are due to the increasing waste generation, as well as, the NIMBY effect that has caused the rise in SWM expenditures. The model estimates that at the present share of the SWM in the metropolitan budget, it may face a

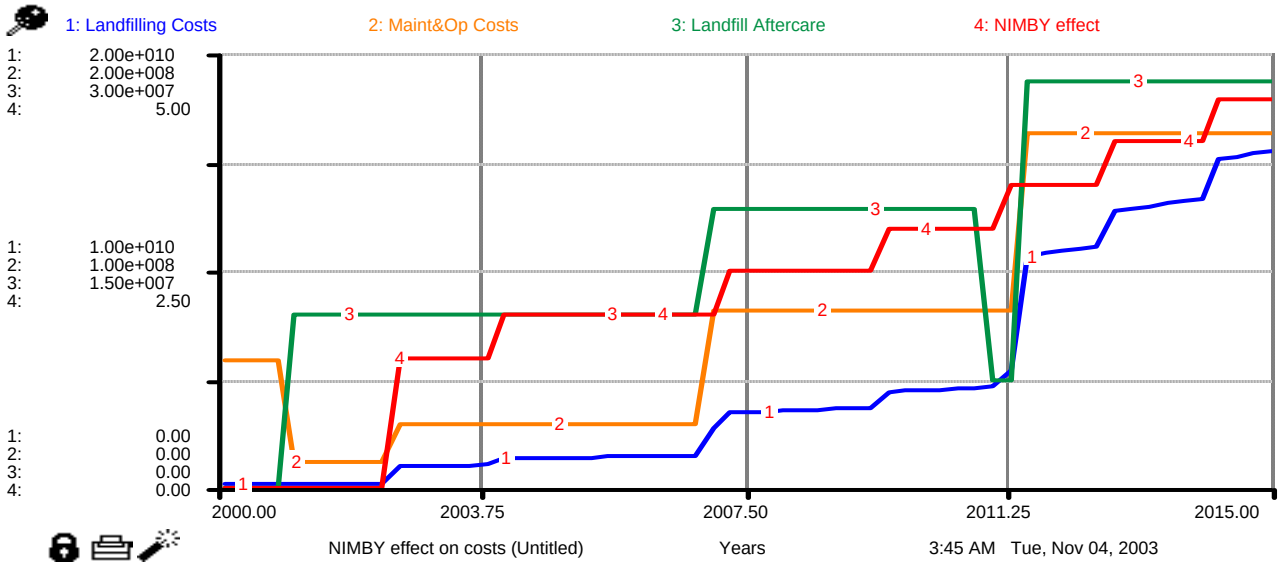
financial difficulty by 2005. Moreover, with decreasing capacity in landfills, landfilling costs per ton of garbage disposed becomes more expensive (see Graph 6.6). The influence of NIMBY on the rising costs of SWM is seen in Graph 6.7. NIMBY effect results indicate that landfilling costs would increase by a factor of 4.5 by 2015.



Graph 6.5 Scenario A – SWM Budget



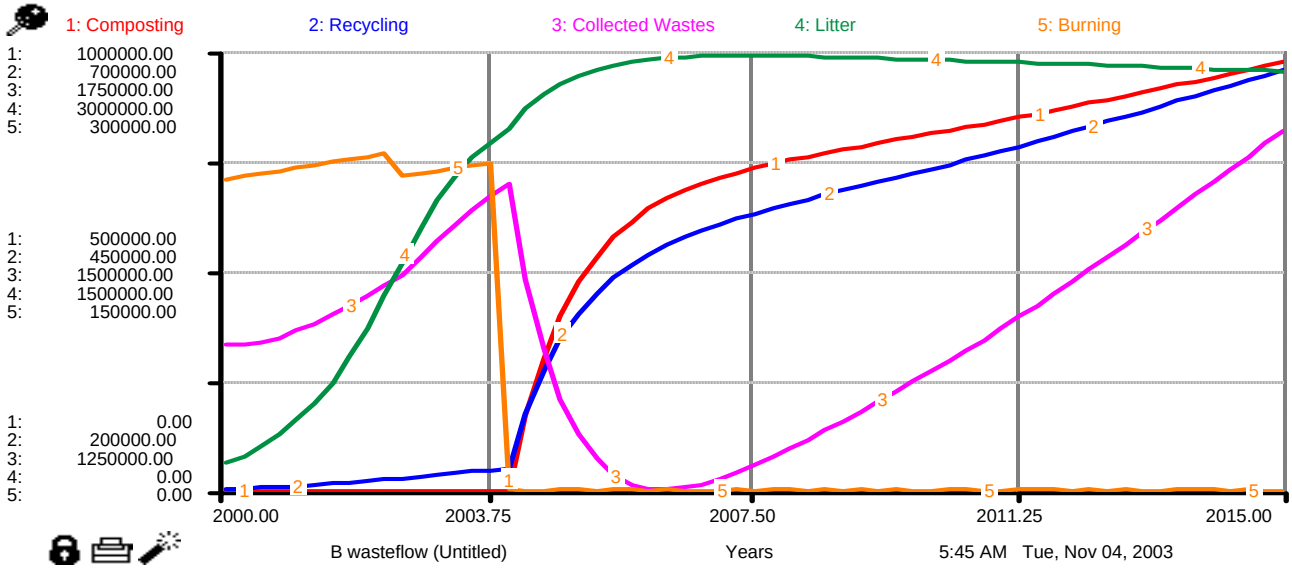
Graph 6.6 Scenario A – Capacity vs Cost



Graph 6.7 Scenario A – Effect of NIMBY on Individual Costs

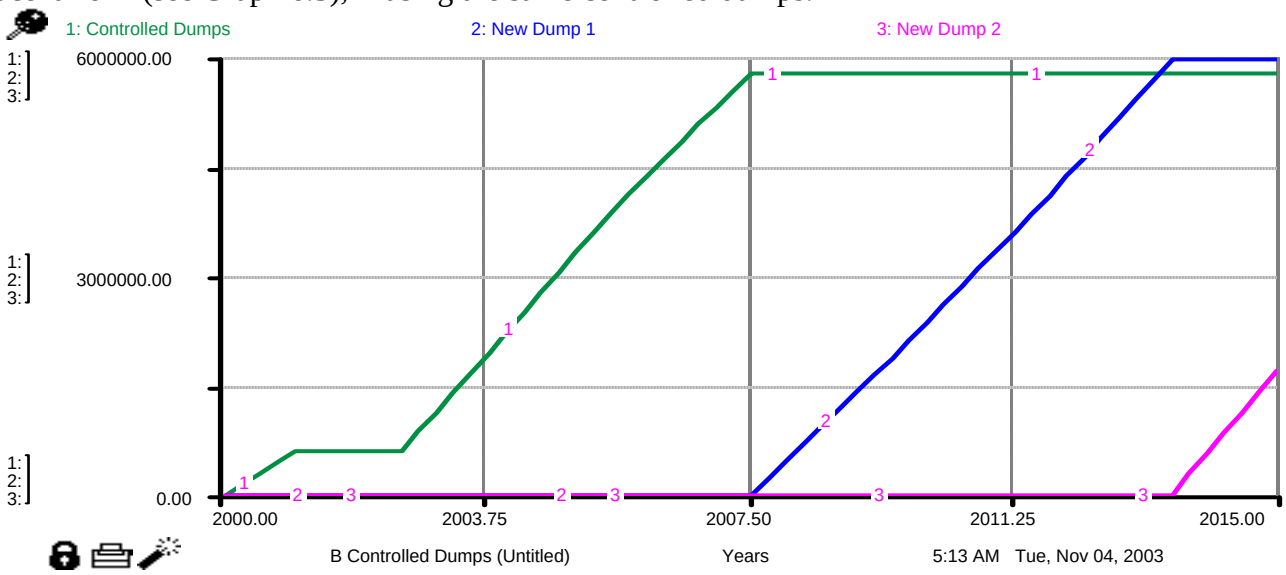
6.3.2 Scenario B

Scenario B examines the effect of user fees and composting to the current SWM system in Metro Manila. Since these improvements are supposed to begin in 2004, the graphs still show the changes in the different streams/trends that are caused by the garbage crisis of 2000. It could be observed in Figure 6.2.8 that there are more obvious changes in the trends after 2004. Littering and composting streams take a large increase as the user fee policy is supposed to encourage these activities to avoid having to pay large SWM bills. The amount of collected wastes drops as 50% of the waste has already been diverted to composting and recycling. This leaves 50% for collection, assuming all residuals are collected, which is less than the amount of Scenario A's 71.5%. It, however, picks up eventually as waste generation increases with increasing development. This does not reduce both litter and backyard burning to a negligible amount, thus the sharp drop in these trends.



Graph 6.8 Scenario B – Waste Flow

With the increase in recycling and the introduction of composting into the system, there is less waste needing final disposal. As seen in Graph 6.9, this results to longer lifetimes, compared to Scenario A (see Graph 6.3), if using the same controlled dumps.



Graph 6.9 Scenario B – Controlled Dumps

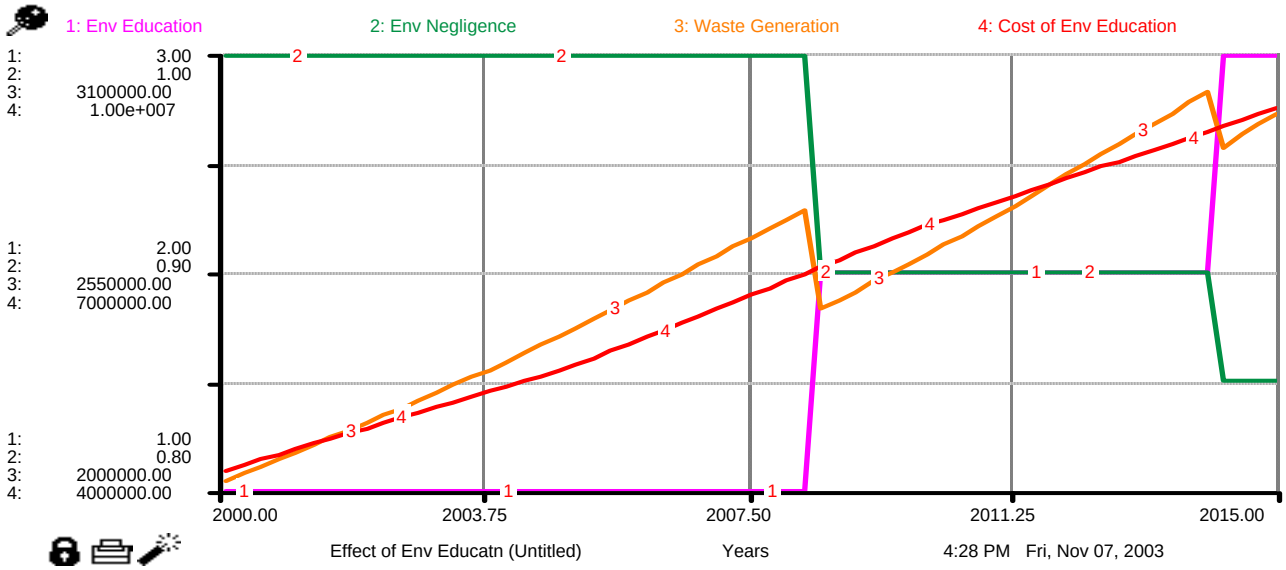
6.3.3 Scenario C

Scenario C examines two solutions added to the scenario B system. The first of which, increasing allocation for personal service expenditures, as seen in Graph 6.10, results to more productivity in terms of municipal services – street sweepings, river clean up and the like. In this graph, the variable 'metro aides' signify the factor to which municipal services increase after a certain amount in the total personnel services budget is reached. Each increase in this factor results to a dramatic rise in municipal services yield.

Graph 6.10 Scenario C – Personnel Services Allocation and Municipal Services

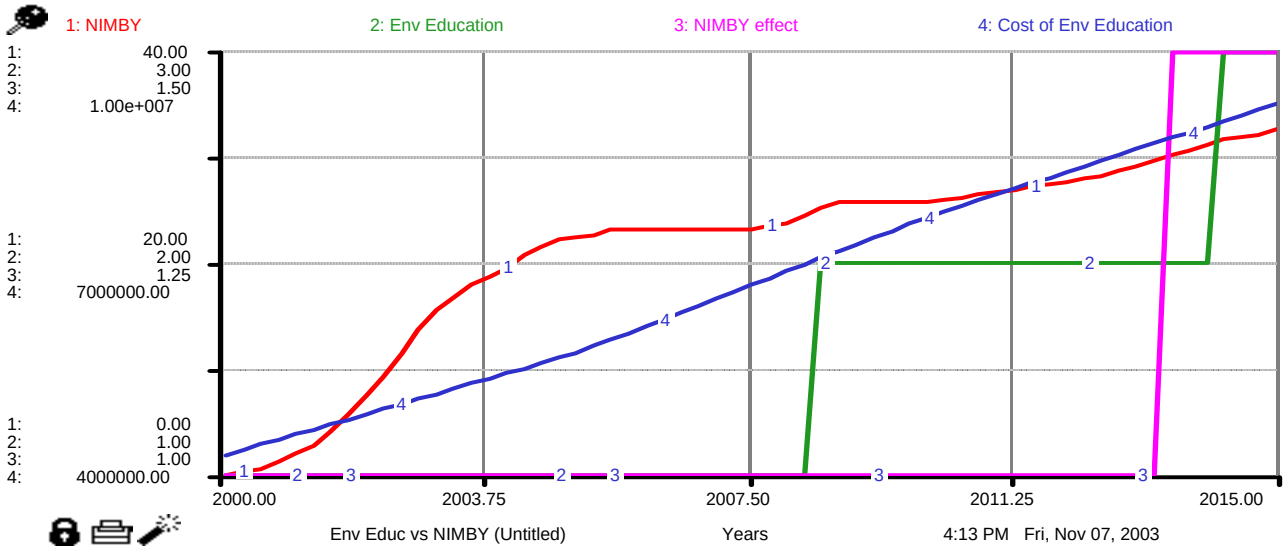
Environmental education, the second solution used in this scenario, is seen to have two effects. Graph 6.11 shows how with increasing allocation for environmental education, there is a decrease in environmental negligence. Environmental education does not only impart data on

environmental degradation but it is also targeted to inculcate deeper understanding of the society's role in solid waste management. Each rise in environmental education units is accompanied by a drop in environmental negligence. With each drop of environmental negligence in the graph, there corresponds a drop in waste generation, although the general trend is still increasing.



Graph 6.11 Scenario C – Effect of Environmental Education on Waste Generation

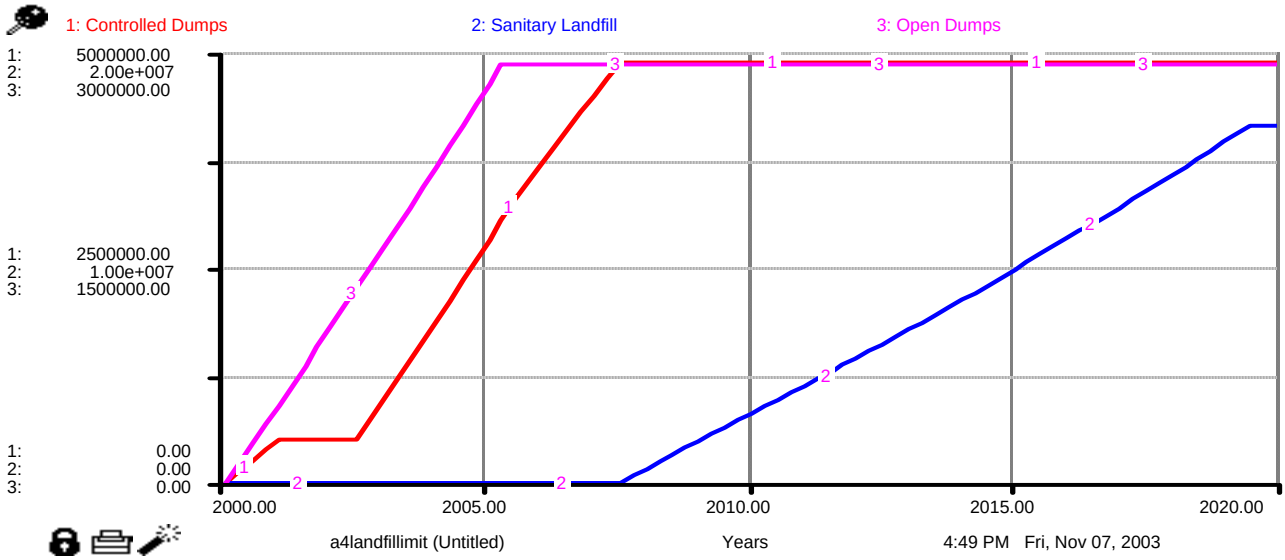
Environmental education is also aimed towards addressing the NIMBY syndrome. The effect of environmental education on NIMBY, as seen in Graph 6.12, does not really look promising as the trends are obviously increasing. However, comparing to the NIMBY trends in Scenario A in Graph 6.4, it could be seen that there is less NIMBY and therefore, less effects. NIMBY effect, in Scenario C, reached a maximum value, which is half of that in Scenario A.



Graph 6.12 – Effect of Environmental Education on NIMBY

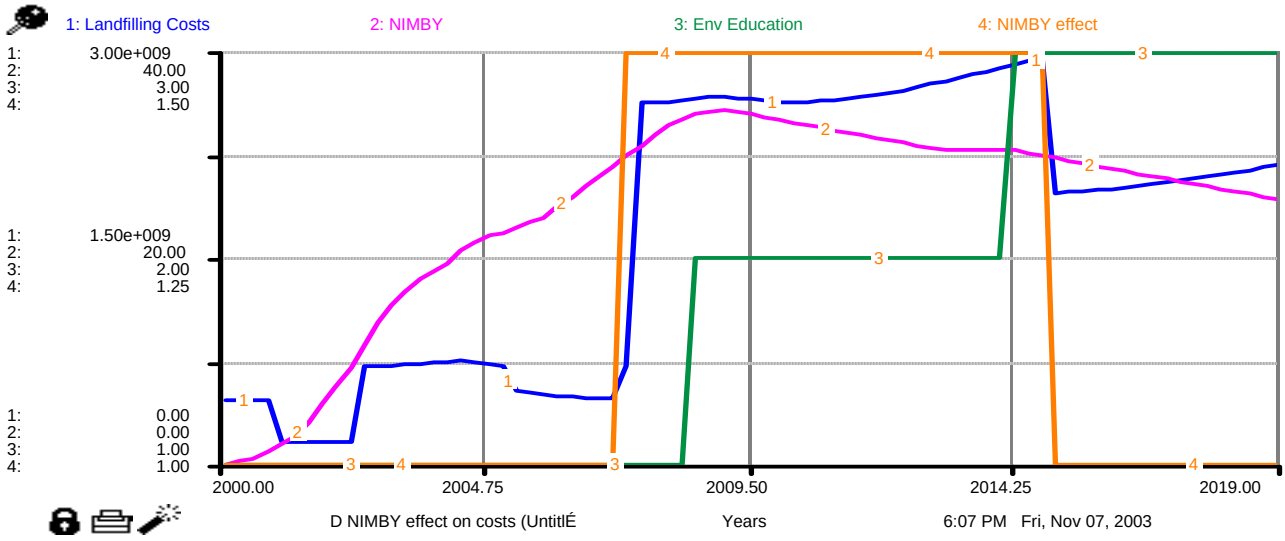
6.3.4 Scenario D

This scenario examines the effect of putting up a sanitary landfill to substitute both the controlled and open dumps. It can be seen in Graph 6.13 that the open dumps reach capacity, and are closed, in the beginning of the year 2005 while the controlled dumps, in the first half of 2007. After these, the sanitary landfill takes over as the sole form of residual solid waste disposal facility. It is observable from the graph that with all the different solutions applied, composting, user fees, increased personnel services allocation and environmental education, the 200-hectare sanitary landfill will last upto 12 years, from 2007 to 2019. This is much shorter than what was initially expected as the assumption was based on JICA's estimation that 100 hectares would accommodate about 10 years' worth of refuse. The time range for the graphs in this scenario has been extended to show the progression of trends during the sanitary landfill's lifetime.

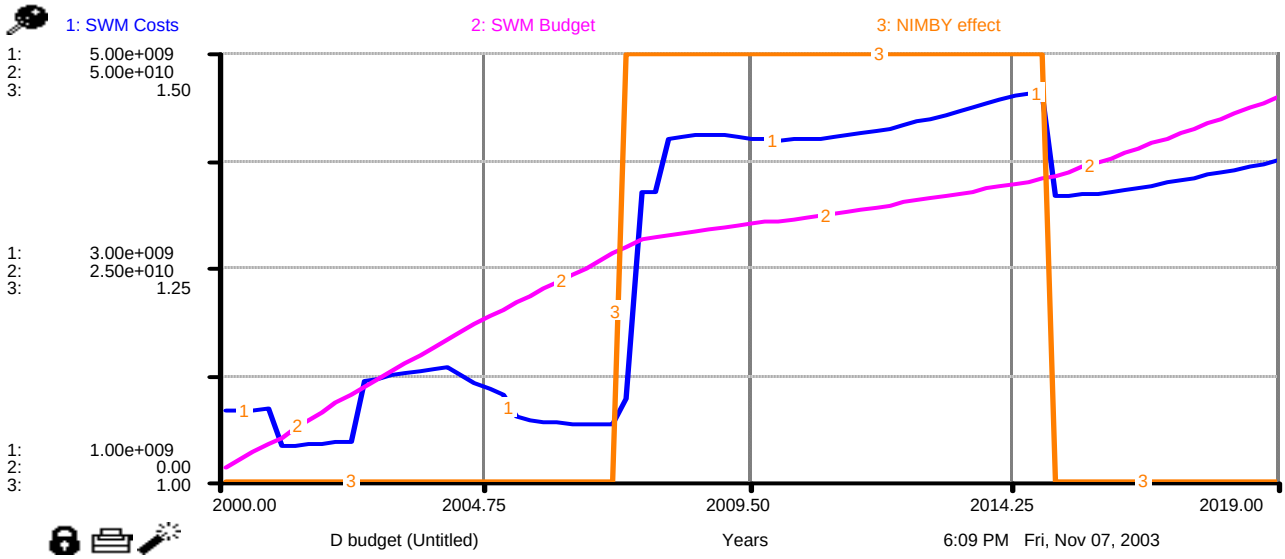


Graph 6.13 Scenario D – Final Disposal Facilities

With the applied solutions in place, it could be seen in Graph 6.14 that the effect of NIMBY reverses itself after 8 years and NIMBY is seen to be in a descending pattern after its peak at around 2008. It could also be observed that landfilling costs drop as the NIMBY effect drops. In Graph 6.15, the SWM budget stays well above the zero line despite having to pay a steeper tipping fee for the sanitary landfill.



Graph 6.14 Scenario D – NIMBY Effect on Costs



Graph 6.15 Scenario D – Budget

VII. Recommendations

7.1 Collection of User Fees

SWM in Metro Manila is treated as a general service in that expenses are taken from taxes paid by the residents. With increasing waste generation and the scarcity of available lands for landfilling, the LGUs & MMDA take on increasing costs. It seems that only the authorities incur the financial effects of the problem. Although increasing expenses for SWM may cut allocations in other sectors, it does not directly affect the generators or households themselves. Because of this, many households are not aware of the extent of the problem, as they do not share the financial burden. The collection of user fees will have two primary effects on the system (see Figure 6.6). It pays for the cost of SWM while at the same time reducing waste output of the generators.

The collection of user fees would change SWM from being a general service to a utility. This directly involves the generators in the financial aspect of the service by contributing to the cost

of SWM. User fees may be collected depending on the amount of waste that is put up by a household for collection. This curbs generation, as households would exert more effort into recycling and composting their wastes to save on household expenses. Considering the composition of wastes in Metro Manila (see Figure 6.1), there is a large potential for composting and recycling, thus a large amount may be diverted from the residual waste stream. Moreover, if amount of waste is measured in weight, composting rates would increase as kitchen wastes are heavy and will most likely be separated by households.

Both JICA and the World Bank have indicated that one of the problems limiting the SWM sector in Metro Manila from delivering better service is the lack of funds that can be allocated for this (JICA/MMDA, 1999; WB, 2001). Different LGUs have varying capabilities and MMDA is dependent on allocations from the former and the national government. The user fees may be collected and used exclusively by the SWM sector, enabling them to expand their coverage and to deliver better services to its constituents.

7.2 Environmental Education

Awareness of the effects of SWM to the general well being of society may affect the system in different ways. With awareness, the general public would know the perils of a failed SWM system and would take measures to protect themselves. Unfortunately, NIMBY resulted from this awareness. With the record of MMDA's past landfills, the strong opposition of townspeople in almost all towns where they plan to build landfills is not astonishing.

Environmental education should be aimed to make people aware but at the same time understand their role in the SWM system. Its goal should be to curb waste generation by promoting the value of environmental responsibility. This, however, is a big challenge as it entails a change in lifestyle. On the other hand, if SWM is added into the curricula in schools, it will inculcate the value of environmental responsibility in the youth. At the same time, if it were practiced in schools, offices and community centers, it could possibly, albeit slowly, be adopted into the community's way of life.

Currently, there are a number of NGOs in Metro Manila, such as Mother Earth, who have established training centers for establishing community-based SWM systems catering to community leaders and common people. It has actively pursued its role as an advocate for the environment by designing its approach in a manner that appeals personally to the community by making use of local culture, values and beliefs as themes for its activities. (Alcantara, 2003)

7.3 Taking the '*barangay* approach' to SWM

The establishment of community-based material recovery and composting facilities, such as that required in RA 9003 entails the participation of all actors involved in the SWM system. This would be next to impossible to do if the actors do not think it is personally worthwhile. Devising programs such as 'cleanest *barangay*' competitions would entice more people to get involved, as the relationships of people within a *barangays* are more intimate and personal. Currently, there are efforts by NGOs such as *Linis Ganda* but since these are mandated by law, these should be enforced by the LGUs themselves.

In well-off *barangays*, there is less personal involvement among community members (Personal Observation). This is an opportunity wherein the informal participants of SWM, the scavengers, can be formally recognized and absorbed into the system. Based on the experience of the *Linis Ganda* community projects, the establishment of material recovery and composting facilities in *barangays* would open up employment opportunities. Their work as eco-aides, or

managers of eco-facilities, facilitates their inclusion into society, not to mention, it enables them to earn a living in better and healthier environments.

7.4 Investing in SWM Personnel

Allocation for SWM personnel services was 0.55% of the GRDP in 2002 (MMDA, 2002). As waste generation increases, so will the workload for SWM workers. As seen from the above analysis, personnel services is a worthwhile investment as it affects the system in numerous ways.

Being a refuse collector or street sweeper is far from glamorous. In fact, these could be counted as the least desirable jobs not just in the Philippines, but also in many countries. Not only do these jobs entail exposure to extremely unpleasant environments but it also makes them, along with the scavengers, vulnerable to the health risks from a failed SWM system more than anybody else in the metropolis. The increase in personnel services allocation can be spent for causes that can improve the welfare of SWM personnel, as well as, the overall performance of the metropolis' SWM services. SWM personnel services provision may be spent on better healthcare as well as increasing the number of employees to meet the increasing workload. Based on the large number of scavengers, there is a big pool of willing and able people to be found. Funds may also be invested in workshops and training seminars for SWM personnel to gain technical expertise. All these not only improve the overall performance of the SWM sector but also develop the potentials of SWM personnel, giving them a platform to improve their status in society.

7.5 Use of Environmental Technology

Existing solid waste disposal facilities in Metro Manila are far from satisfactory, judging from the criticisms from environmental watchdogs such as NGOs and the general reaction of Manileños as well as people from surrounding towns to garbage dumps. There is also an over reliance on landfills as a means of solid waste disposal. With further research, other technologies that are more environmentally reliant and economically viable could be found. Examples of such technology are those that are used in a modern sanitary landfill.

Also, the SWM sector could benefit from the recovery and sale of methane from existing and future dumps and composting facilities. Since 45% of the waste stream is kitchen waste and 7% is garden waste, there is a large potential for this type of technology (MMDA b, 2003). Profits from the sale of methane to the energy sector can be used to augment SWM expenditure.

Funds for research and investment for new and better technologies can always be requested from various aid agencies. In the past, there has been a quite a number of bodies that have offered assistance to address Metro Manila's garbage dilemma. The ADB has been providing technical assistance for the implementation of RA 9003's provisions in Metro Manila (ADB, 2002). The Global Environment Facility (GEF) had also been involved in assisting in the establishment of solid waste projects in 2001 (GAIA, 2001). JICA has also been involved in several projects, involving solid waste, with the MMDA. Furthermore, this is also an avenue where the private sector can increase involvement in the SWM sector.

7.6 Reviewing Institutional Responsibility in SWM

There still remains to be a problem with the lack of a single body fully devoted to SWM issues. The RA 9003 tried to address this issue with the formation of the NSWMC. This however does not really address the problem as the members of the NSWMC are from different branches of the government. The focus, therefore, of these members will not be, solely, on SWM issues but

also concerns that their respective departments face. For example, the DENR-EMB which acts as NSWMC's secretariat is not only responsible for solid waste issues, as demanded by NSWMC. Among its other duties are air and water quality management, chemicals and hazardous waste monitoring and environmental impact assessments (EMB, 2003).

Considering SWM affects different aspects of sustainability, involvement of the different branches of the government, as well as the private sector is not such a bad thing. Only, since there are different concerns for each of these bodies, responsibilities and extent of involvement of these participants must be clearly defined. The relationship between MMDA and the LGUs are quite unclear. RA 9003's provision has made MMDA's additional role dangerous territory that must be tread upon lightly because RA 7160 was not amended to accommodate the former's provisions.

Implementation, or the lack thereof, is, probably, the biggest hindrance to achieving sustainable SWM. It is said that the SWM sector is plagued with anomalies and vested interests. An article from the Philippine Center for Investigative Journalism (PCIJ) describes the different ways and levels wherein corruption exists in the SWM sector (PCIJ, 2001). The obsession on quick fix solutions by the current leading agencies in SWM is rooted from these vested interests. These LGUs, especially, aspire to 'fix' the SWM problem within their political terms, hence, long-term solutions, especially those that call for public participation, are not much considered.

An ADB evaluation of the SWM sector describes it as "*compounded by weak institutional capacity*" hence the crisis (ADB, 2002). The World Bank, in the 2001 Philippine Environment Monitor, thinks that the lack of incentives and financial and technical capacity, as well as, slackness in the enforcement of the law, particularly RA 9003, are challenges that the SWM sector in Metro Manila face (WB, 2001). It is the lack of legitimacy of the authorities in SWM that hinders the effective implementation of the law. This means that before anything else, environmental responsibility must be learned and exhibited by the leaders before this is demanded from the public.

VIII. Conclusion

SWM in Metro Manila is currently undergoing a transformation, mainly due to the implementation of RA 9003. Although implementation has been quite slack, there is a growing awareness among the cities' denizens and the townspeople from surrounding area. This awareness has inspired the growth of an organized group of NGOs devoted to the cause of solid waste management. They act as catalysts to SWM legislation and are currently the main actors responsible for recycling efforts in the region. They have acted as watchdogs that have ardently been fighting for reforms that have been held back by corruption in the SWM sector. Unfortunately, this same awareness had also stimulated the further growth of the society's NIMBY-ism, which had been responsible for the premature closure of the SMWDF and the garbage crisis of 2001.

For years, it seems, the LGUs and MMDA have focused only on the tip of the iceberg that is the SWM system. It was only during the crisis that they have seen the enormity of the problem and the ripples that it had created in the system. Even then, the authorities remain obsessed with quick fixes such as landfills and incinerators.

By looking at SWM as a system, it is obvious that the strongest factors influencing the growth in waste generation are the increasing per capita generation as well as the growth in population. With the rapid growth of the economy, and changing urban lifestyle, the SWM sector will not stand to sustain itself. Solutions must, therefore, be concentrated on these factors rather than devoting most of the SWM budget to back end solutions.

The costs of SWM are escalating considering the resistance to landfills by the general public and the impacts to society, the environment and the economy. The collection of user fees is not a

long term solution to curb waste generation but more of a tool to jumpstart the process while environmental education gradually works on inculcating values that would effect a more permanent change.

Considering the effect of RA 9003 on an enormous amount of people who depend on garbage as a source of livelihood, the building of material recovery and composting facilities in each *barangay* is a venue where these people can be employed and included formally into society. By investing in SWM personnel, these people can benefit from opportunities to gain technical skills and expertise while at the same time improving the quality of SWM services.

The immensity of the SWM system and the responsibilities that it entails is overwhelming. The government, however, cannot bear the brunt of the problems, as society has been a willing and active participant in solid waste generation. Implementation of reforms must, therefore, be a concerted effort of the government, the public and the private sector. This, however, is a daunting task as it entails a change in values and lifestyles of the public. It demands a strong body, unswayed by corruption, to rouse participation and encourage involvement in the implementation of reforms.

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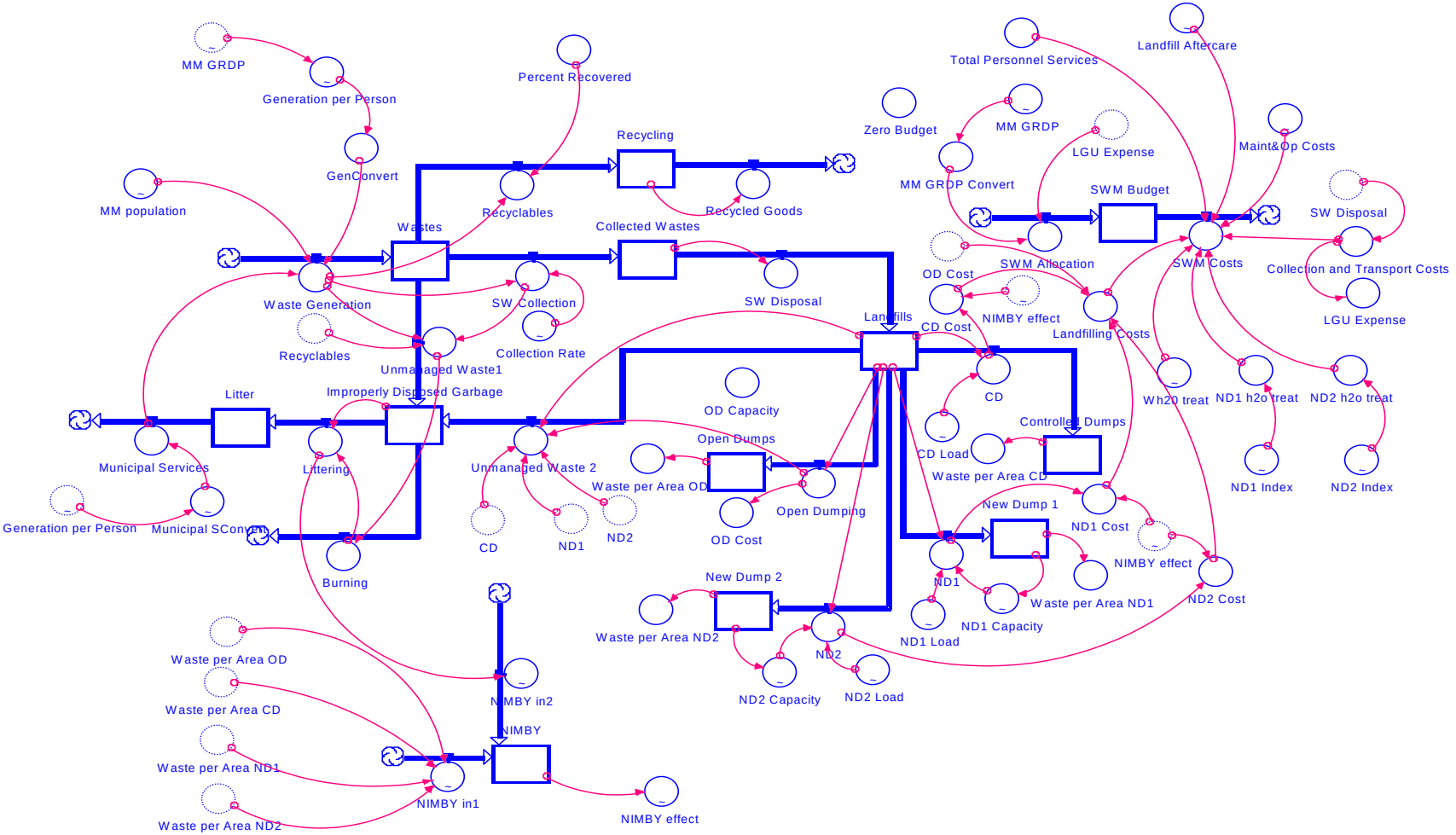
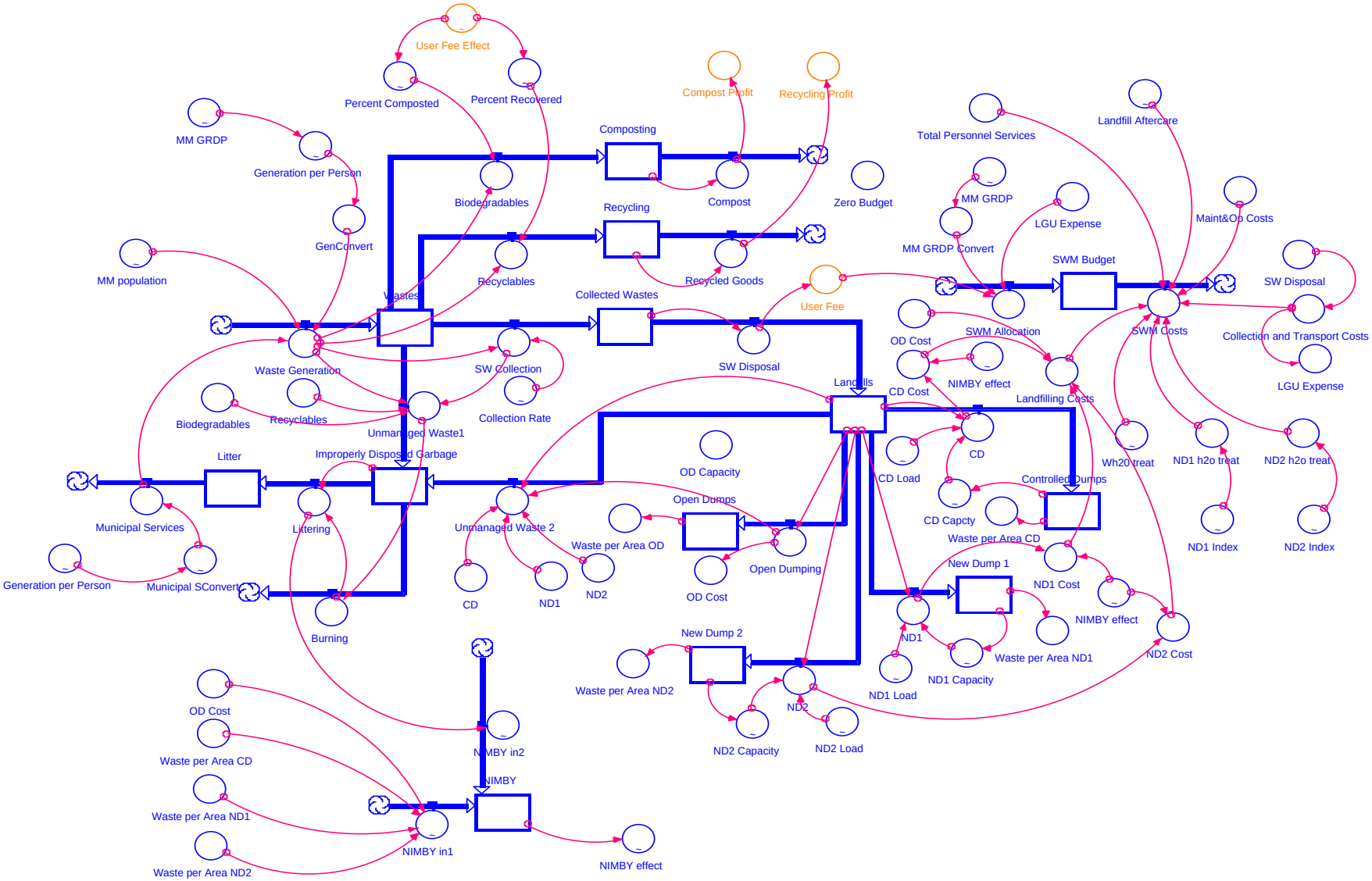
APPENDICES

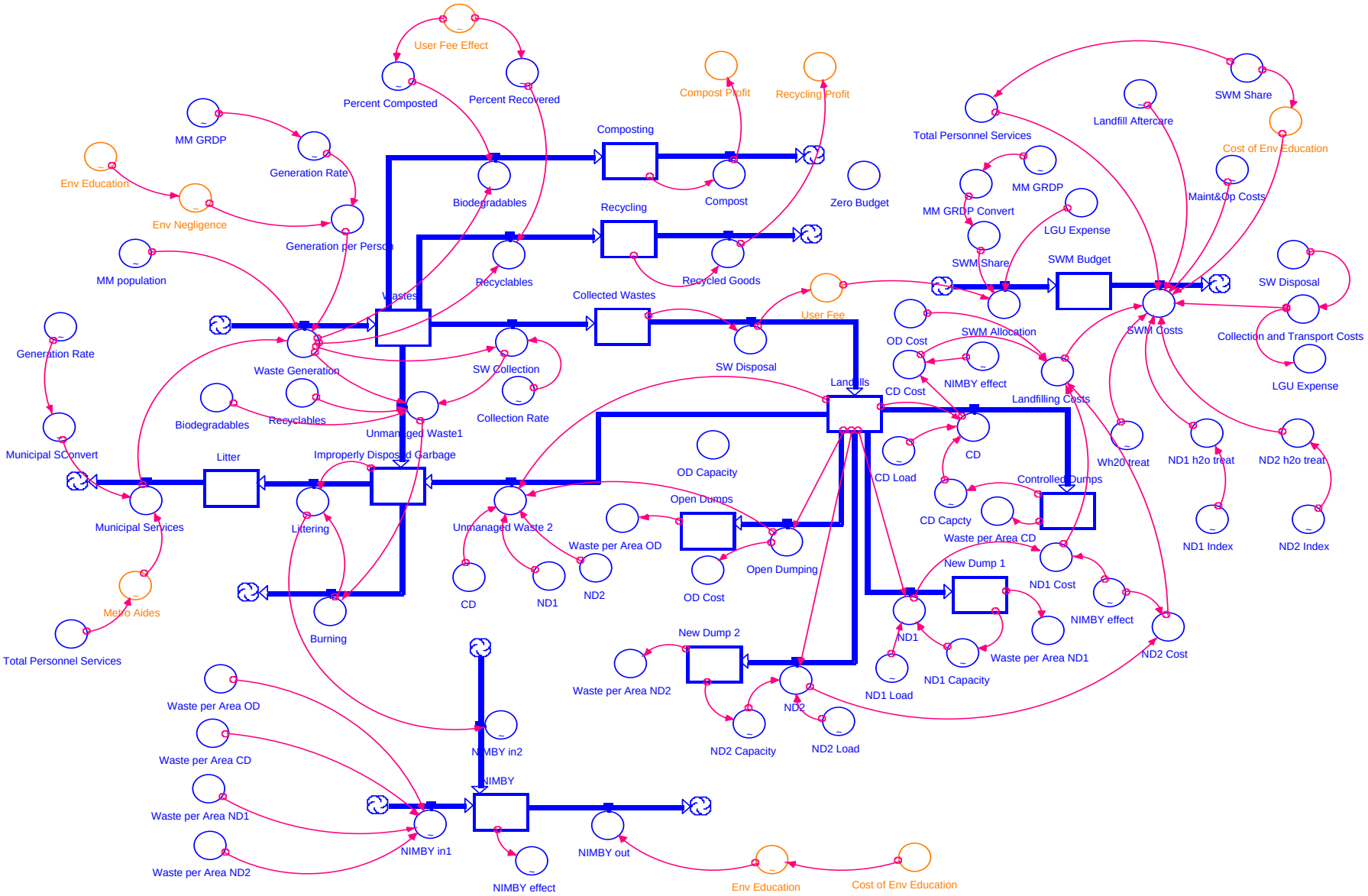
I. STELLA Model – Scenario A



II. STELLA Model – Scenario B



III. STELLA Model – Scenario C



IV. STELLA Model – Scenario D