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Bangkok Medical Waste Privatization

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The opinions expressed in this final report are those of the contractor, Price Waterhouse, Administer of the Energy Project Development Fund, and not the U.S. Agency for International Development.

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Executive Summary

Since 1988, the Bangkok Metropolitan Administration (BMA) has been collecting and disposing of infectious waste separately from the rest of Bangkok's solid waste stream. Even today, however, differentiating between infectious waste and other solid waste is impossible because there is no legal definition of infectious waste. As a result, much of the "questionable" waste is disposed through the regular solid waste stream; it is believed that as much as two-thirds of the potentially contaminated waste currently ends up in the regular solid waste stream.

There have been surveys performed recently which conclude that while the hospitals do recognize the dangers associated with infectious waste, they do not want to be responsible for disposing of it properly; in fact, they would be willing to pay a reasonable fee to have it properly taken care of by someone else. Currently, that someone else is BMA for their own hospitals, as well as for some other health care facilities. BMA, however, is not equipped to handle the vast amount of infectious waste, which is growing every day. While most private hospitals currently are supposed to dispose of their own infectious waste in on-site incinerators, only one hospital is said to actually use a small incinerator on-site; there is no enforcement of violations.

Until a legal definition of infectious waste is developed and implemented, it will be difficult for BMA, hospitals, and clinics to determine how much infectious waste actually exists, and where the waste is generated. In addition, without a legal definition, it will be difficult to attract private companies to bid on an infectious waste collection/disposal contract for Bangkok because users could potentially avoid using the service, claiming their waste to be uncontaminated. Without a legal definition, a private contractor would likely require BMA to guarantee a minimum level of waste quantity and revenues.

With proper incentives, however, a private company could be enticed to enter into a contract to collect and dispose of infectious waste in place of BMA. If the private sector is allowed to operate the service, we believe that the process will be performed more efficiently, with more of the waste being removed, and in a cleaner manner. At the moment, however, the law requires BMA to perform this function, even if the hospitals do not pay the modest fees charged for this service.

In anticipation of a change in the law requiring BMA to perform this service, we have undertaken a study to compare the costs to BMA if they continue to perform the service themselves v.s. the costs required to pay a private company to perform that role. The results herein show that while it is not likely to be cheaper on a per unit basis to pay the contract price for a private company to perform the service, there are other benefits to be garnered, while maintaining current costs. These include:

- More of the infectious waste being collected and disposed
- The private sector will use a cleaner disposal incineration method
- BMA will incur fewer costs
- Future private sector costs may be even lower

The amount which the private company could charge the hospitals, however, would be fixed in the contract. Currently, there is a study which the Ministry of Public Health is reviewing concerning maximum fees per unit which the private sector would be allowed to charge. As a result, BMA would likely move to a regulatory role, thus eliminating the need to use its own funds, equipment, and personnel, while accomplishing infectious waste collection and disposal more efficiently.

In order to solicit the private sector, we recommend that BMA engage in a Request for Proposal (RFP) process. The RFP document should enumerate minimum requirements but should not discuss specific operational details that the private sector should follow. By allowing the private sector maximum latitude in determining operational details, BMA would allow the private sector the opportunity to propose innovative ways of improving the efficiency of the service, thereby reducing costs to a minimum.

We also recommend that BMA choose between two privatization options: a Lease-Develop-Operate option or a full privatization option. While certain efficiencies in operations can be attained through an O&M contract, an O&M contract would not give the private sector maximum incentives to increase efficiency in all parts of the operation (procurement, for example). The two recommended public-private partnership options should allow BMA to attain the best possible service and price.

Even if BMA chooses to provide the service itself, BMA must tackle certain issues, the most important of which are:

- *The definition and sources of medical waste.* These are the first steps required in any of BMA's options. Without defining the market for medical waste, it will be impossible to provide an efficient service, protect the environment, and to test performance.
- *The amount BMA is willing to subsidize the service.* Regardless of whether BMA retains operation of the service or contracts it to a private firm, BMA must decide how much of the cost of collection and disposal it is willing to pay, and how much should be paid by the users of the service.
- *Legal constraints.* BMA must amend certain laws which constrain its ability to provide the service effectively. For example, BMA should be allowed to levy penalties to those who fail to pay the agreed upon fee for either collection or disposal.

- *The billing system.* BMA should, at a minimum, contract with the private sector to set up an automated billing system.

I. Understanding of the Situation

The Bangkok Metropolitan Administration (BMA) is the local government administrative agency in Bangkok operating under Royal Thai Government regulations. BMA consists of the Bangkok City Council and the Governor of Bangkok, elected by the people. According to Article 89 of the BMA Act of 1985, the 27 principal functions of BMA include various city planning, maintenance, and development objectives. Each of these is managed by individual departments and offices within BMA.

The Department of Public Cleansing (DPC) is one department within BMA's structure. Within the DPC, the Solid Waste Collection Sub-Division has responsibility for all solid waste collection throughout Bangkok and the surrounding areas, which has been divided into three geographical sub-sections (1, 2 and 3). The amount of solid waste collected by the Public Cleansing Service Division totals approximately 6,000 tonnes per day over the past 12 months.

Another division within the DPC, the Garbage Disposal Division, has responsibility for solid waste disposal at three major sites within Bangkok: Nong-Khaem, On-Nut, and Ram-in-Tra. Only Nong-Khaem and On-Nut have furnaces for medical waste disposal. On-Nut has received recent additions to its disposal capability, including two, 10-tonne incinerators, set to come on-line before the end of calendar year 1994.

In 1988, BMA laid down a policy to collect infectious and hazardous waste from many hospitals in the Bangkok area separately from municipal solid waste in order to prevent the spreading of disease. Starting in November of that year, BMA began to separately collect this waste from four of the main BMA hospitals. Later, the service was expanded to include government hospitals, private hospitals, health centers and clinics. Currently, BMA collects this waste from 581 sites, including public hospitals, government hospitals, associations and institutes, public health centers, private clinics, and some private hospitals. The waste is collected by BMA employees in special air-conditioned trucks, and then disposed of in the furnace at either the On-Nut or Nong-Khaem sites. When the two new incinerators come on line later this year, all of the waste will go to On-Nut.

Current conditions make it extremely difficult to collect and dispose of all of the infectious waste being produced in and around Bangkok. The main reasons for this are:

- *Lack of definition for medical waste.* The biggest obstacle for infectious waste collection and disposal is that there is still no legal definition of infectious waste. Without a legal definition, there is no way to know how much actually exists, or to easily prevent it from ending up in the regular solid waste stream. This definition must be determined before the infectious waste problem can be successfully tackled.

- *Cost constraints.* Since there is no separate BMA budget for infectious waste collection and disposal, BMA must consistently try to find the funds to provide the service from its solid waste operating budget.
- *The dispersion of health care providers.* It is not known exactly where all of the health care providers are located. This is because it is common practice in Bangkok for doctors to have their own small practices, without formally notifying BMA.

II. Current Collection and Disposal of Medical Waste

The current procedure performed by BMA can be divided into two main sections: collection and disposal of infectious waste.

A. Collection

Currently, hospital and clinic personnel must separate infectious waste from the regular solid waste stream. Although BMA provides special red bags and training, it remains the responsibility of the hospital to put the infectious waste out in BMA containers in the parking lot area. The health care facility is also responsible for denoting a special parking area for the BMA truck to park when collecting the waste. This is where the BMA collection role begins. BMA has divided the city of Bangkok and its environs into three geographical sections. From these three sections, BMA has stated that it collects from 581 facilities as of July 1994. This data needs to be updated; after we analyzed the number of sites visited on a daily basis from August 13 and 14, 1994 records from 13 of the 14 collection trucks, we counted only 119 sites. The total amount of infectious waste reported to be collected per day on average, had the opposite result: while BMA reported approximately 8 tonnes per day, we counted just over 10 tonnes on a daily basis using August 13-14 actual data.

Costs

Currently, BMA provides fourteen specialized trucks designed specifically for the transport of infectious waste. All of the trucks were purchased in 1990 and 1991. We assume that they all have seven-year useable lives despite some claims that seven years may overstate their useful lives. The operating costs for these vehicles and other collection requirements include: salary and welfare, 'sola' truck fuel, brake and machine oil, boot shoes, gloves, and disinfectant solution, which the drivers must use on the trucks after each day of usage. Periodic maintenance for all scenarios are assumed either covered by manufacturer's warranty or are completed by BMA personnel.

According to our analysis, which projects costs if BMA were to collect infectious waste for the next 10 years, the unit cost to collect infectious waste is 0.88 Baht per kg collected.

B. Disposal

BMA currently disposes its infectious waste in either of the old 4.4 tonne furnaces at On-Nut or Nong-Khaem, depending on from which of the three geographical sections of Bangkok that the infectious waste originates. For our analysis, we assume that the new, two 10-tonne incinerators at On-Nut will come on line immediately, and will be used for all future disposal of infectious waste. Since all of the 10 payments have already been made on the new incinerators, we treat the incinerators as a sunk cost which is not included in our analysis.

This is also true of the cost of the sanitary landfill, which already exists outside of Bangkok, and will receive the ash residue from the incinerator. This sanitary landfill is an area which will require future costs from the regular solid waste budget in the future because of the public outcry concerning the current location and performance of the landfill. In addition, we project that at the end of the year 2001, BMA will need another 10-tonne incinerator, the cost of which we also did not include in our analysis.

Costs

It was stated by BMA that 17 people will be trained to operate the new incinerators. While these training costs were also included in the sunk cost of the incinerators, we must include the future salary and wage expense for these people. Other disposal related costs include the operating items for the incinerator; gas, electricity, water, Sodium Hydroxide and scrubber surficant, as well as incinerator spare parts; gas burners, pump and motors, capacity meters, chemical dosing pumps, thermocouples, and spray nozzles.

According to our analysis, which projects costs if BMA were to dispose of infectious waste for the next 10 years, the unit cost to dispose of infectious waste is 13.06 Baht per kg disposed by the new incinerators. As a result, the total cost per kg collected and disposed if BMA were to continue is projected to be 13.94 Baht/kg.

C. Revenues

BMA does charge a fee to remove the infectious waste; it is the same fee structure charged for household waste. BMA has not been allowed to raise this fee for 20 years, although they told us that they have requested an increase various times. Although BMA is required by law to continue to collect even if the hospitals do not pay, we are told that most pay the fee because:

- The fee is low.
- The fee is collected by personnel unassociated with the physical collection. (Household waste disposal payments are made directly to the vehicle drivers, who often pocket the money.)

BMA revenues from these low fees are far below the costs which we calculated. For example, a typical fee would be 4 Baht per month if up to 20 liters per day were collected. Depending on the density of the waste, this comes to approximately .01 Baht per kg of revenue for every 13.94 Baht per kg of expense. The difference is the amount that is coming out of the Department of Public Cleansing's solid waste budget.

III. Collection and Disposal of Medical Waste if Privatized

The actual cost of a private contract to perform collection and disposal of infectious waste can only be estimated, since it will ultimately be determined by the competitive bidding process. We estimated a private bidder's proposed rate based on what it would cost the private company to perform the service plus a profit margin. As a result, we have attempted herein to estimate the contract by determining costs for a private company to perform the service, and then have added a 20% gross profit margin to these costs to come up with an estimate cost to BMA or the hospitals (or a combination) for this contract. The results show that although the private company can perform the service at only slightly lower unit costs (per kg of infectious waste) than can BMA, the private company will have the capability and resources to collect and dispose of more units of waste than BMA, which, in addition to keeping costs down, is also a primary goal of the Department of Public Cleansing.

A. Collection

We have assumed that the infectious waste separation will continue to be done by hospital staff, at no charge to the private contractor. The amount of waste collected, however, should be much higher as explained in the costs section below.

Costs

Based on industry norms, we estimate that the private company would expand the infectious waste trucking fleet faster than would BMA. Also, we estimate that they would only use two people per truck, instead of the three that BMA sometimes uses. We also estimate that the private company would design a more efficient truck routing plan, which maximizes waste collection and kilometers per liter. For these three reasons, the private sector will be able to collect more waste than BMA. The trucks will also have to be replaced every seven years. The operating costs for these vehicles and other collection requirements include: salary and welfare, 'sola' truck fuel, brake and machine oil, boot shoes, gloves, and disinfectant solution, which the drivers must use on the trucks after each day of usage.

According to our analysis, which projects costs if the private company were to collect infectious waste for the next 10 years, the unit cost to collect infectious waste is 0.78 Baht per kg collected. This is 11.4% lower than the cost we estimated for BMA to collect. Once we add the 20% profit, however, the private cost to collect becomes 5.7% higher than BMA's.

B. Disposal

BMA currently disposes of its infectious waste to either of the old 4.4 tonne furnaces at On-Nut or Nong-Khaem depending on from which of the three geographical sections of Bangkok

that the infectious waste originates. For our analysis, we assume that the new, two 10-tonne incinerators at On-Nut will come on line now, and will be used for all future disposal of infectious waste by the private contractor. Since all of the 10 payments have already been made on the new incinerators by BMA, we treat the incinerators as a sunk cost which is not included in our analysis. This is also true of the cost of the sanitary landfill, which already exists outside of Bangkok, and will receive the ash residue from the incinerator. This sanitary landfill is an area which will require future costs, whose source has not yet been determined or included in our analysis. In addition, we project that at the end of the years 1998 and 2002, the private company will need another 10-tonne incinerator, the cost of which we also did not include in our analysis.

Costs

BMA stated that 17 people will be trained to operate the new incinerators. We have assumed that the private company will be able to reduce the number of supervisory personnel at the new incinerators because of their experience in operating similar facilities. The salary and wage expense for these people is included in our analysis. Other disposal related costs include the operating items for the incinerator; gas, electricity, water, Sodium Hydroxide and scrubber surficant, as well as incinerator spare parts; gas burners, pump and motors, capacity meters, chemical dosing pumps, thermocouples, and spray nozzles.

According to our analysis, which projects costs if the private company were to dispose of infectious waste for the next 10 years, the unit cost to dispose infectious waste is 12.73 Baht per kg. This is 2.5% lower than the cost we estimated for BMA to dispose. Once we add the 20% profit however, the private cost to dispose becomes 17% higher than BMA's.

As a result, the total cost per kg collected and disposed by the private company is projected to be 13.51 Baht/kg. This is 3.1% lower than BMA's total unit cost. Once we add in the profit margin, however, the private company's total unit cost becomes 16.3% higher than BMA's.

C. Revenues

The private company would likely price its contract based on the cost to perform the service plus a certain profit margin, as discussed above. BMA must determine how the fees will be paid: it could pay these fees out of the solid waste budget, since there is no separate infectious waste budget it, thus giving the hospitals this service for free. It could let the hospitals pay these fees in full, or in part with BMA paying some or none. It must then be decided as to whether BMA allows the hospitals to pay the contractor directly or through BMA. BMA could also charge the private hospitals more per unit, so as to subsidize the cost for public health care institutions. Regardless of the structure, a revenue source must be found to pay for the service.

IV. BMA's Service Options

In the previous two sections, we have discussed the estimated costs and revenues of the medical waste system if BMA maintains control of the system compared to a privatized system. This section discusses BMA's options for implementing changes in the medical waste field. The three options discussed are:

- BMA continues to perform the service
- BMA issues an Invitation to Bid (IFB) to private firms
- BMA issues a Request for Proposal to private firms

Each of the options are discussed in turn below.

A. BMA Continues to Perform the Service

This option would have BMA continue to perform the service of collecting and disposing of medical waste. BMA would use existing staff with the possible help of outside consultants to improve certain functions such as route planning and marketing. Even if BMA were to choose this approach, several issues would require resolution because of the many problems associated with the current system; this option does not imply maintaining the status quo. These issues are:

- *Setting the definition of medical waste.* Currently, since there is no definition of medical waste, BMA cannot possibly define the scope of the service it is expected to perform. As a first step, BMA must understand what types of waste it is seeking to collect and dispose. The potential for later alterations in the definition should not prevent setting an initial definition as soon as possible.
- *Determining the sources of medical waste.* As mentioned earlier in this report, once the definition of medical waste is determined, BMA must determine all of the sources of such waste. Knowing the sources of waste is vital for efficient operation of the service.
- *Defining the service parameters and costs.* The service parameters include the types of medical waste to be disposed, the interval between pickups, etc. Before developing an efficient operating plan, BMA must define all of the service elements to be provided. Once the above three items are completed, BMA must develop as efficient an operating plan as possible for the service.
- *Identify capital equipment replacement schedules and sources of funds.* Proper long-term financial planning requires planning for replacement of capital equipment. Such planning must include a source of the funds that will be used to pay for the capital replacement.

- *Engage in an operational review of the service.* An operational review should include a review of the general and administrative procedures as well as a review of the procedures used to collect the waste. The object of the review would be to increase the efficiency in the administrative and collection systems.
- *Develop an effective marketing system.* Currently, many potential users of the service do not utilize BMA for disposing of medical waste. This causes three problems:
 - Some of the waste is being disposed of unsafely
 - Potential revenues are not being collected
 - Average cost reductions due to economies of scale are not being attainedIt is therefore imperative that BMA establish a marketing program to market the service and ensure that all potential customers are using the service.
- *Develop a cost recovery system for the service.* The cost recovery system should, at the least, recover all of the costs associated with providing the service, including allocated capital costs.

This option will be very difficult for BMA to implement efficiently. Currently, there are no national systems in place for disposing of medical waste. Therefore, there are no local staff trained in that field. Hiring consultants would help in training local staff, but consultants would not be able to remain with a new program long enough to make it viable and cost effective over the long haul. In addition, BMA staff are inexperienced in many of the issues listed above, such as marketing, pricing, and optimal routing. Therefore, this option is the least likely to produce a successful long-term program.

B. BMA Issues an Invitation for Bid to Private Firms

An Invitation for Bid (IFB) is designed to find a private sector company which will provide the service under strict guidelines set up by BMA. The IFB establishes specific operating and other criteria to which the private bidders must adhere. For example, the IFB may include specifications on the routes, the prices to be charged, the frequency of service, which party will be responsible for capital improvements, etc.

Each of the responses to the IFB are evaluated based on pre-determined criteria. Since all of the bidders will be bidding based on the same basic operating plan, the criteria should stress experience and price considerations. Any of the criteria can be given more weight based on the priorities of BMA. For transparency, it is vital that the criteria and the weights are determined prior to the receipt of the bids, and preferably that they be outlined directly in the IFB.

This method would be effective in bringing a group of experienced contractors to operate the service. After the initial contract period, BMA can elect either to perform the work themselves (based on the system established by the contractor), to continue to contract, or to rebid the work.

There are a number of key issues that need resolution if this option is used, including:

- *Definition of the service.* As with all of the options, BMA must define the service it wants performed, including the definition of medical waste and the frequency and scope of waste collection and disposal.
- *Appropriate legal framework.* Is there an existing legal framework which allows BMA to enter into a contract with the private sector based on an IFB format? Risk mitigation is very important to the private sector when they enter into such agreements; the less risk they perceive in a project, the better the price BMA will receive in response to its solicitation. This is one risk BMA can mitigate, preferably by passing legislation specifically granting BMA the explicit right to enter into such contracts with the private sector.
- *Length of the contract.* The private contractor must be granted sufficient time to amortize his/her capital investment in the project and to earn a reasonable rate of return. Given the nature of the current service, if the private sector were to fund the necessary capital improvements, the private sector would likely require a minimum of five to seven years of operations. The proper length of the contract is dependent, in part, on the type of public-private partnership chosen; these options are discussed later in this chapter.
- *Price regulation.* This will be the most important issue to resolve prior to soliciting the private sector. BMA must decide what price the private sector will be allowed to charge for the service for the entire life of the contract. Choices for regulation include capping prices or limiting the rate of return. In addition, BMA must decide how much, if any, it is willing to subsidize the price faced by the user.
- *Billing and collection responsibility.* This will be another important issue for the private sector. BMA must decide whether it will choose to bill and collect from the service users itself or have the private operator responsible for billing and collections.
- *Contract monitoring.* BMA will be required to monitor compliance with the provisions of the contract. If BMA does not currently have staff designated to monitoring contracts, some staff must be assigned that responsibility.

In addition to the above items, BMA must decide which type of public-private partnership it desires. There are many options from which to choose including:

- *Operations and maintenance contract.* This arrangement would have BMA contract to a private firm to provide the service only. BMA would retain the "license" to provide the service, ownership of the assets, and therefore the responsibility to pay for all capital improvements.
- *Lease-Develop-Operate.* In this arrangement, BMA would lease to the private sector the ability to operate the service and the assets it currently owns, but BMA would maintain ownership of the assets. The private contractor would agree to make all necessary capital improvements during the lease period, in exchange for a fee which would cover costs plus a profit. Leases differ from O&M contracts in that all capital improvements are the responsibility of the private sector. At the end of the lease period, all assets, including any improvements, would be turned over to BMA.
- *Temporary or permanent privatization.* In this arrangement, BMA would sell its assets and the right to provide the service to the private sector. Although in private hands, the service can be regulated, similar to the regulation faced by public utilities.

Because of the increased fiscal responsibility of the latter two options, either the price paid for the service will be higher or the length of the contract will be longer than the O&M contract option. For a similar reason, the temporary privatization option may require a longer contract than the lease-develop-operate option.

Regardless of the options chosen, the key to the success of the IFB option is the amount of detail of the IFB document. The IFB should detail all of the contractor's requirements, including specific details on the constraints that the private sector will be required to work within.

If the IFB document is designed well, the private sector will be competing largely on cost and experience, in addition to the responsiveness to the specifications in the IFB document. In addition, a detailed IFB should significantly reduce the negotiation time between establishing a winner of the bidding process and the final contract, because the IFB should anticipate the potential contract issues and establish the contract provision in its terms of reference. There are a number of drawbacks to using this method. By detailing many of the operational specifications of the project, BMA may prevent the private sector from using innovative cost cutting or revenue enhancing measures. This technique is often best used for operations for which efficiency gains are not a priority. Thus, it may not be best option for this case.

Other drawbacks relate to the monitoring contract performance and payment issues. Without resolution of these issues to the satisfaction of the private sector, the proposed bid prices may be significantly higher than they would otherwise be. In addition, BMA may have to retrain some of its employees on how to implement BMA's new monitoring function.

C. BMA Issues a Request for Proposal to Private Firms

A Request for Proposal (RFP) process is similar to the IFB process listed in Section IV.B above. In both cases, BMA would attempt to solicit private sector involvement in order to operate the collection, disposal, and/or billing of medical waste. In both cases, BMA would evaluate the responses to the solicitation based on criteria determined prior to the process, and preferably written into the solicitation document. BMA would then contract with the winner of the proposal process.

The major difference between the two methods is the specifications detailed in the two documents. While the IFB provides for detailed specifications in order to constrain the bidders, the RFP attempts to allow the bidders latitude in proposing procedures such as frequency of collection, time of collection, type of payment, etc. By allowing the bidders to propose the specifics of the operating procedures, BMA may gain from innovative methods for providing the service efficiently that it may not have previously contemplated.

This method does not necessarily allow the private bidder to propose all aspects of service. For example, BMA should still be prepared to define a minimum standard definition for infectious waste. BMA also may propose a contract length, minimum service collection periods, and environmental regulations on the contractor. In designing the RFP, BMA should remember, however, that the purpose of the RFP is to allow the contractor the ability to provide innovative solutions to problems; the more specifications that are in the document, the fewer efficiency gains the private sector will devise. The specifications set forth in the RFP should be minimum guidelines only. Additional benefits can be attained during the negotiation process prior to contract execution.

Other than the detail in the specifications, the issues that relate to the RFP process are the same as those that relate to the IFB process. For example, BMA must still determine the definition of medical waste, if it has the legal authority to enter into a contract with a private bidder, whether the legal framework is conducive to private involvement, who will have responsibility for billing and collections, and how much to subsidize the service, if at all. These issues must be resolved before the private sector gets involved in the project.

V. Conclusions and Recommendations

Regardless of BMA's choice for providing the service in the future, BMA must tackle certain issues, the most important of which are:

- *The definition of medical waste.* This is the first step required in any of BMA's options. Without defining the market for medical waste, it will be impossible to provide an efficient service, protect the environment, and to test performance. One option is for BMA to request the Ministry of Public Health to specify a uniform, country-wide definition.
- *The sources of medical waste.* Currently, there is no centralized knowledge of the sources of medical waste in Bangkok. While the private sector may be able to increase the exposure of a program after taking over operations, BMA will not be able to properly assess the contractor's performance without a knowledge of the sources of medical waste.
- *The amount BMA is willing to subsidize the service.* Waste collection and disposal rates currently do not cover all operating and capital costs required to maintain the service. Therefore, regardless of whether BMA retains operation of the service or contracts it to a private firm, BMA must decide how much of the cost of collection and disposal it is willing to take, and how much should be paid by the users of the service.

If BMA were to choose one of the latter two options, the private contractor could be paid its contract price completely by hospitals serviced. This structure would eliminate the need for BMA to budget funds for this activity. (An automated fee collection system would allow the contractor to easily bill the hospitals directly.) The downside of this is that some hospitals will likely attempt to pass the extra cost onto patients, which would raise health care costs. Others may refuse to pay the fee. There must be a means for the private contractor or another entity to enforce compliance with the agreed upon fee.

Depending on the competition during the bidding process, it is even possible that BMA could actually receive a portion of the fees charged in the form of a royalty payment from the private contractor as part of a concession agreement for the rights to collect fees for performing this service. The exact structure of this payment would of course be finalized through the RFP process, as described in the next section.

- *Legal constraints.* BMA must amend certain laws which constrain the ability to provide the service effectively. For example, BMA should be allowed to levy penalties to those who fail to pay the agreed upon fee for either collection or disposal. In addition, BMA should allow the private sector to provide the service directly. If BMA chooses not to

allow the private sector to collect for the service, it should contract with the private sector to set up an automated billing system for them.

We believe that BMA's best option is to engage in an RFP process in order to solicit a private sector operator for the service. The private sector will provide the following benefits over the option of having BMA maintain responsibility for providing the service:

- A private contractor will collect more of the waste, thereby reducing the amount of dangerous waste in the regular solid waste stream. In addition, the private sector may dispose of the waste in a cleaner manner. This will improve health risks to collection and disposal workers, the general public, and hospital employees and patients.
- BMA will incur fewer costs. Although the estimated private sector-cost to provide the service was only slightly less (and actually a bit more when the profit margin is included) than the cost faced by BMA, the fee could be paid directly by the hospitals, instead of BMA. In addition, BMA would no longer have to tie up its own resources to perform the service, which would free funds to conduct other important BMA functions.
- BMA can shift all of the revenue risks to the private sector. No longer will BMA need to worry about the revenue and cost risks of conducting this service.
- Future private sector costs may be even lower. Because we included the capital cost for the new incinerators as a sunk cost, any efficiencies brought about by the private sector in replacing those incinerators in the future would reduce costs in the future.

Out of the two solicitation choices, we believe that the RFP process has more benefits in this case compared to the IFB process. Because of a number of factors, such as the lack of definition for medical waste and the lack of knowledge of the potential users, significant changes in the medical waste collection and disposal system will occur in the future. Since change is desirable, it is also desirable to allow the private sector to generate ideas as to the best way to change the system. An IFB may be too restrictive to allow for all of the positive private sector ideas. Thus, BMA should issue an RFP, which should include a list of BMA's minimum requirements for the contractor.

We also recommend that BMA choose between the latter two privatization options: the Lease-Develop-Operate option or the full privatization option. While certain efficiencies in operations can be attained through an O&M contract, an O&M contract would not give the private sector maximum incentives to increase efficiency in all parts of the operation (procurement, for example). The remaining public-private partnership options should allow BMA to attain the best possible service and price.

If BMA should decide not to privatize now or in the future, it should, at a minimum, update its billing system, including its rates, to reflect the actual cost of providing service. By allowing rates to reflect costs, BMA will avoid spending money on a service which can be spent on other solid waste activities.

VI. Appendix

- Table 1 - Collection Analysis: BMA vs private company
- Table 2 - Disposal Analysis: BMA vs private company
- Table 3 - Projection of Private Company Fees
- Table 4 - Projection of BMA's Estimated Costs

Table 1

THAILAND INFECTIOUS WASTE ANALYSIS
Collection of Infectious Waste by BMA

There are currently 14 collection trucks in use
Each truck has either 1, 2 or 3 personnel
Bangkok is divided into 3 geographical sections:
Drivers collect 7 days per week, from approx. 6am-10am.

HISTORICAL DATA FY1994

| | Section I | Section II | Section III | Total/Avg |
|---|-----------|------------|-------------|-----------|
| a) # Trucks | 5 | 5 | 4 | 14 |
| b) # Personnel | 13 | 11 | 8 | 32 |
| c) Avg # Personnel per Truck | 2.6 | 2.2 | 2.0 | 2.29 |
| d) Avg # Sites Visited per Truck per Day | 5.2 | 7.3 | 16.0 | 9.15 |
| e) Avg # km Driven per Truck per Day | 45.8 | 62.8 | 76.0 | 60.31 |
| f) Avg # kg of Infectious Waste Collected per Truck per Day | 734.0 | 1097.5 | 394.8 | 741.46 |
| g) Total # tonnes of Infectious Waste Collected per Day | 3.7 | 5.5 | 1.6 | 10.38 |
| h) Avg # liters gas Consumed per Truck per Day | 8.6 | 17.3 | -na- | 12.44 |
| i) Avg # km driven/liter gas | 5.3 | 3.6 | -na- | 4.85 |

Historical Data Notes:

- * This is based on data from trucks' routes on either August 13 or 14, 1994.
- * Not all of the trucks had data available, so avg in table above includes 5 of the 5 Section I trucks, 4 of the 5 Section II trucks, and 4 of the 4 Section III trucks.
- * # of Sites Visited includes all health care facilities, but not in On-Nat/Hong-Kham.
- * 1,000 kg = 1 tonne

PROJECTIONS if BMA Continues to Collect and Dispose of Infectious Waste

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| a) # Trucks | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| b) # Personnel | 34.5 | 37.0 | 39.5 | 42.0 | 44.5 | 47.0 | 49.5 | 52.0 | 54.5 | 57.0 |
| c) Avg # Personnel per Truck | 2.30 | 2.31 | 2.32 | 2.33 | 2.34 | 2.35 | 2.36 | 2.36 | 2.37 | 2.38 |
| d) Avg # Sites Visited per Truck per Day | 63.31 | 66.31 | 69.31 | 72.31 | 75.31 | 78.31 | 81.31 | 84.31 | 87.31 | 90.31 |
| e) Avg # km Driven per Truck per Day | 761.46 | 781.46 | 801.46 | 821.46 | 841.46 | 861.46 | 881.46 | 901.46 | 921.46 | 941.46 |
| f) Avg # kg of Infectious Waste Collected per Truck per Day | 11.42 | 12.50 | 13.62 | 14.79 | 15.99 | 17.23 | 18.51 | 19.83 | 21.19 | 22.60 |
| g) Total # tonnes of Infectious Waste Collected per Day | 12.55 | 12.64 | 12.73 | 12.81 | 12.88 | 12.95 | 13.02 | 13.08 | 13.14 | 13.19 |
| h) Avg # liters gas Consumed per Truck per Day | 5.05 | 5.25 | 5.45 | 5.65 | 5.85 | 6.05 | 6.25 | 6.45 | 6.65 | 6.85 |

Projected Data Assumptions:

- * Will add 2-3 people per additional truck in the future (avg 2.5).
- * Will add and replace trucks at a rate so as to increase total # trucks in service by avg of 1 per year.
- * Will increase avg km driven per truck at rate of 3km/year.
- * Will increase avg kg waste collected per truck at rate of 20 kg/year.
- * Will get better gas mileage (due to road improvements) at rate of .2 liters/km per year

THAILAND INFECTIOUS WASTE ANALYSIS
Collection of Infectious Waste by Private Company

PROJECTIONS if Private Company were to Collect and Dispose of Infectious Waste

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|--------|--------|--------|--------|--------|--------|----------|----------|----------|----------|
| a) # Trucks | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 |
| b) # Personnel | 36 | 40 | 44 | 48 | 52 | 56 | 60 | 64 | 68 | 72 |
| c) Avg # Personnel per Truck | 2.25 | 2.22 | 2.20 | 2.18 | 2.17 | 2.15 | 2.14 | 2.13 | 2.13 | 2.12 |
| d) Avg # Sites Visited per Truck per Day | 65.31 | 70.31 | 75.31 | 80.31 | 85.31 | 90.31 | 95.31 | 100.31 | 105.31 | 110.31 |
| e) Avg # km Driven per Truck per Day | 781.46 | 821.46 | 861.46 | 901.46 | 941.46 | 981.46 | 1,021.46 | 1,061.46 | 1,101.46 | 1,141.46 |
| f) Avg # kg of Infectious Waste Collected per Truck per Day | 12.50 | 14.79 | 17.23 | 19.83 | 22.60 | 25.52 | 28.60 | 31.84 | 35.25 | 38.81 |
| g) Total # tonnes of Infectious Waste Collected per Day | 12.57 | 12.68 | 12.77 | 12.86 | 12.93 | 13.00 | 13.06 | 13.12 | 13.17 | 13.22 |
| h) Avg # liters gas Consumed per Truck per Day | 5.20 | 5.55 | 5.90 | 6.25 | 6.60 | 6.95 | 7.30 | 7.65 | 8.00 | 8.35 |

Projected Data Assumptions for Private Company Operation: More Efficient

- * Will add only 2 people per additional truck in the future (more efficient)
- * Will add and replace trucks at a rate so as to increase total # trucks in service by avg of 2 per year (have funds to do so, and waste demand exists)
- * Will increase avg km driven per truck at rate of 5km/year (expanded truck routing)
- * Will increase avg kg waste collected per truck at rate of 40 kg/year (more waste identified)
- * Will get better gas mileage (due to road improvements and better routing) at rate of .35 liters/km per year

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Table 2

THAILAND INFECTIOUS WASTE ANALYSIS

Disposal of Infectious Waste by BMA

There are currently 2 furnaces in use, 1 at Or-Nut and 1 at Nong-Khaem
 Very shortly, the 2 new incinerators at Or-Nut will be in use, to replace the two aforementioned furnaces
 These will handle all the infectious waste in the future, and for this analysis:
 The analysis considers only these incinerators, and treats their purchase as a sunk cost

PROJECTIONS if BMA Operates New Incinerators

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| a) # Personnel | 17 | 17 | 17 | 19 | 19 | 21 | 21 | 23 | 23 | 23 |
| Consumables | | | | | | | | | | |
| b) Gas Consumption (liters/day) | 17,132.9 | 18,755.1 | 20,437.3 | 22,179.5 | 23,981.7 | 25,843.8 | 27,766.0 | 29,748.2 | 31,790.4 | 33,892.6 |
| c) Electricity Consumption (units/day) | 1,202.3 | 1,316.1 | 1,434.2 | 1,556.5 | 1,682.9 | 1,813.6 | 1,948.5 | 2,087.6 | 2,230.9 | 2,378.4 |
| d) Water Consumption (m ³ /day) | 45.1 | 49.4 | 53.8 | 58.4 | 63.1 | 68.0 | 73.1 | 78.3 | 83.7 | 89.2 |
| e) Sodium Hydroxide NaOH 50% (liters/day) | 108.2 | 118.5 | 129.1 | 140.1 | 151.5 | 163.2 | 175.4 | 187.9 | 200.8 | 214.1 |
| f) Scrubber Sulfuric (kg/day) | 3.0 | 3.3 | 3.6 | 3.9 | 4.2 | 4.5 | 4.9 | 5.2 | 5.6 | 5.9 |
| Spares per Year | | | | | | | | | | |
| g) Gas Burner (# units) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| h) Pump & Motor (# units) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| i) Capacity Meters (# lots) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| j) Chemical Dosing Pump (# lots) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| k) Thermocouples (# units) | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| l) Spray Nozzles (# units) | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |

Projected Data Assumptions

- * Above analysis is for the two incinerators combined
- * Gas, Electricity, Water, Chemicals and other consumables are assumed to be consumed according to tonnages projected from our infectious waste collection analysis on the previous page
 The base amount of consumption of these items was learned from the Scholler operating cost information sheet based on last year's 7.6 tonnes per day consumed. We assumed that all of these consumables vary directly with tonnes of waste disposed.
- * Incinerators are assumed to burn infectious waste based on 20-hour day, but chemicals are consumed based on 24-hour day

THAILAND INFECTIOUS WASTE ANALYSIS

Disposal of Infectious Waste by Private Company

PROJECTIONS if Private Company Operates New Incinerators

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| a) # Personnel | 7 | 7 | 7 | 9 | 9 | 11 | 11 | 13 | 13 | 13 |
| Consumables | | | | | | | | | | |
| b) Gas Consumption (liters/day) | 18,755.1 | 22,179.5 | 25,843.8 | 29,748.2 | 33,892.6 | 38,277.0 | 42,901.4 | 47,765.8 | 52,870.2 | 58,214.5 |
| c) Electricity Consumption (units/day) | 1,316.1 | 1,556.5 | 1,813.6 | 2,087.6 | 2,378.4 | 2,686.1 | 3,010.6 | 3,352.0 | 3,710.2 | 4,085.2 |
| d) Water Consumption (m ³ /day) | 49.4 | 58.4 | 68.0 | 78.3 | 89.2 | 100.7 | 112.8 | 125.7 | 139.1 | 153.2 |
| e) Sodium Hydroxide NaOH 50% (liters/day) | 118.5 | 140.1 | 163.2 | 187.9 | 214.1 | 241.7 | 271.0 | 301.7 | 333.9 | 367.7 |
| f) Scrubber Sulfuric (kg/day) | 3.3 | 3.9 | 4.5 | 5.2 | 5.9 | 6.7 | 7.5 | 8.4 | 9.3 | 10.2 |
| Spares per Year | | | | | | | | | | |
| g) Gas Burner (# units) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| h) Pump & Motor (# units) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| i) Capacity Meters (# lots) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| j) Chemical Dosing Pump (# lots) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| k) Thermocouples (# units) | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |
| l) Spray Nozzles (# units) | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |

Projected Data Assumptions

- * Above analysis assumes that private company could run incinerator with less personnel, even at higher tonnage per day

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Table 3

THAILAND INFECTIOUS WASTE ANALYSIS
Projection of Private Company Contract Fees to Cover Expenses Plus Profit

All figures in real Thai Baht

| Expenses: | 1993 | 1994 | 1995 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|------------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Collection: | | | | | | | | | | |
| Salary and welfare | 2,160,000 | 2,400,000 | 2,640,000 | 2,880,000 | 3,120,000 | 3,360,000 | 3,600,000 | 3,840,000 | 4,080,000 | 4,320,000 |
| Trucks | 1,070,000 | 1,070,000 | 4,280,000 | 5,825,000 | 1,070,000 | 1,070,000 | 1,070,000 | 2,140,000 | 2,140,000 | 2,140,000 |
| Sole truck fuel | 579,135 | 657,167 | 735,687 | 814,629 | 893,923 | 973,523 | 1,053,379 | 1,133,457 | 1,213,728 | 1,294,168 |
| Machine and break oil | 63,896 | 74,772 | 85,706 | 92,688 | 101,711 | 110,767 | 119,853 | 128,964 | 138,098 | 147,250 |
| Truck disinfectant solution | 9,920 | 0 | 9,920 | 0 | 9,920 | 0 | 9,920 | 0 | 9,920 | 0 |
| Boot shoes | 0 | 0 | 7,500 | 0 | 0 | 7,500 | 0 | 0 | 7,500 | 0 |
| Black gloves | 0 | 47,500 | 0 | 0 | 47,500 | 0 | 0 | 47,500 | 0 | 0 |
| Total Collection Expenses: | 3,884,911 | 4,249,460 | 7,756,813 | 9,672,317 | 5,243,026 | 5,521,790 | 5,823,152 | 7,289,921 | 7,389,246 | 7,901,419 |
| Collection Fee Calculation: | | | | | | | | | | |
| 1994 Present Value of Expense | 3,531,792 | 3,511,934 | 5,827,809 | 6,604,323 | 3,255,523 | 3,116,907 | 3,003,592 | 3,400,802 | 3,218,381 | 3,046,339 |
| 1994 PV Sum of Expenses: | 38,519,603 | | | | | | | | | |
| Projected Tonnages: | 4,501 | 5,323 | 6,203 | 7,140 | 8,134 | 9,186 | 10,296 | 11,464 | 12,689 | 13,971 |
| Projected kg Waste: | 4,501,218 | 5,323,071 | 6,202,523 | 7,139,575 | 8,134,228 | 9,186,480 | 10,296,332 | 11,463,783 | 12,688,837 | 13,971,489 |
| 1994 Present Value of kg: | 4,092,017 | 4,399,232 | 4,660,047 | 4,876,426 | 5,050,715 | 5,185,528 | 5,283,647 | 5,347,940 | 5,381,306 | 5,386,614 |
| 1994 PV Sum of kg: | 49,663,472 | | | | | | | | | |

PV Expenses/PV kg = 0.78 Baht/kg = marginal fee per kg.
 Add 20% profit before tax: 0.93 Baht/kg = marginal fee per kg.

| Disposal: | 1993 | 1994 | 1995 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---------------------------------|-------------------|-------------------|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Salary and welfare | 840,000 | 840,000 | 840,000 | 1,080,000 | 1,080,000 | 1,320,000 | 1,320,000 | 1,560,000 | 1,560,000 | 1,560,000 |
| Gas | 54,014,622 | 63,876,849 | 74,430,277 | 85,674,903 | 97,610,732 | 110,237,760 | 123,553,988 | 137,563,415 | 152,266,043 | 167,657,871 |
| Electricity | 1,042,387 | 1,232,711 | 1,436,374 | 1,653,375 | 1,883,716 | 2,127,395 | 2,384,414 | 2,654,771 | 2,938,467 | 3,233,503 |
| Water | 88,840 | 105,061 | 122,418 | 140,913 | 160,544 | 181,312 | 203,217 | 226,259 | 250,438 | 275,753 |
| NaHO & surfactant | 971,316 | 1,148,643 | 1,338,439 | 1,540,645 | 1,759,281 | 1,982,346 | 2,221,840 | 2,473,764 | 2,738,117 | 3,014,900 |
| Gas Burners | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 |
| Pump & Motors | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 |
| Capacity Meters | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 |
| Chemical Dosing Pumps | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 |
| Thermocouples | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 |
| Spray Nozzles | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 |
| Total Disposal Expenses: | 57,992,464 | 68,238,584 | 79,202,808 | 91,123,138 | 103,723,523 | 116,884,113 | 130,728,759 | 145,515,310 | 160,788,364 | 176,779,327 |

Disposal Fee Calculation:
 1994 Present Value of Expense 52,720,422 56,395,524 59,506,242 62,229,693 64,281,236 65,978,033 67,080,419 67,884,059 68,189,963 68,156,083
 1994 PV Sum of Expenses: 632,431,677

| | | | | | | | | | | |
|---------------------------|------------|-----------|-----------|-----------|-----------|-----------|------------|------------|------------|------------|
| Projected Tonnages: | 4,501 | 5,323 | 6,203 | 7,140 | 8,134 | 9,186 | 10,296 | 11,464 | 12,689 | 13,971 |
| Projected kg Waste: | 4,501,218 | 5,323,071 | 6,202,523 | 7,139,575 | 8,134,228 | 9,186,480 | 10,296,332 | 11,463,783 | 12,688,837 | 13,971,489 |
| 1994 Present Value of kg: | 4,092,017 | 4,399,232 | 4,660,047 | 4,876,426 | 5,050,715 | 5,185,528 | 5,283,647 | 5,347,940 | 5,381,306 | 5,386,614 |
| 1994 PV Sum of kg: | 49,663,472 | | | | | | | | | |

PV Expenses/PV kg = 12.73 Baht/kg = marginal fee per kg.
 Add 20% profit before tax: 15.28 Baht/kg = marginal fee per kg.

Unit cost for private company to dispose & o 13.51 Baht/kg = marginal fee/kg
 including Profit Margin: 16.21 Baht/kg = marginal fee/kg

According to Ben Chang's 1-page summary, "Medical Waste, Baseline Data, WIN-WIN Situation," comparable figures for the above unit fees include Enviro-Tech through Mr. McCoy at 16 Baht/kg.

Operating Costs per Unit:

| | |
|-------------------------------|-------------------|
| Collection: | |
| * Salary, welfare truck div | 5,000 Baht/month |
| * Sole for truck fuel | 8.0 Baht/liter |
| * Machine and break oil | 25.0 Baht/liter |
| * Cost per collection truck | 535,000 Baht |
| * Truck disinfectant soluti | 9,920 Baht/lot |
| * Boot shoes for personnel | 7,500 Baht/lot |
| * Black gloves for person | 47,500 Baht/lot |
| Disposal: | |
| * Salary incinerator operat | 10,000 Baht/month |
| * Gas for incinerator | 8.0 Baht/liter |
| * Electricity for incinerator | 2.2 Baht/m2 |
| * Water for incinerator | 5.0 Baht/m3 |
| * NaHO for incinerator | 20.0 Baht/liter |
| * Scrubber carbo. incinerat | 100.0 Baht/kg |
| * Gas Burners | 330,000 Baht/unit |
| * Pump & Motor | 76,800 Baht/unit |
| * Capacity Meters | 38,500 Baht/lot |
| * Chemical Dosing Pump | 80,000 Baht/lot |
| * Thermocouples | 10,500 Baht/unit |
| * Spray Nozzles | 2,400 Baht/unit |

Notes:

- The above is a present value, long-run marginal cost analysis
- Discount rate = 10%
- 360 day per year operation.
- Only personnel in collection trucks and at incinerator; any planning or other personnel are not included as part of this analysis.
- No interest cost is included because trucks are assumed to be paid for when purchased, and incinerators are already paid off.
- No depreciation expense because trucks are assumed to be purchased in one payment, with O&M costs as separate line items, and new incinerators are already paid for, with spares and O&M as separate line items.
- Trucks must be replaced after 7 years; so must replace the 6 bought in 1990 in 1997, the 9 bought in 1991 in 1998, the 2 bought in 1993 in 2002, the 2 bought in 1994 in 2003, and the 2 bought in 1997 in 2004.
- Private company is projected to need additional 10-tonne incinerator after yrs 1998 and 2001, the cost of which are not included in this analysis, and so some arrangement will need to be made (ie. raise fees in these years, or have BMA buy them).
- Rail Baht means contractor must have provision to raise fees in some relation to an inflation index.
- It is not yet decided as to whether contractor could charge this full amount to hospitals and clinics, or whether BMA would pay a portion to contractor so as to lower burden to all/some hospitals and clinics.

Table 4

THAILAND INFECTIOUS WASTE ANALYSIS
Projection of BMA's Estimated Costs to Continue to Collect and Dispose of Infectious Waste Themselves

All figures in real Thai Baht

| Expenses: | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|-----------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Collection: | | | | | | | | | | |
| Salary and welfare | 2,070,000 | 2,220,000 | 2,370,000 | 2,520,000 | 2,670,000 | 2,820,000 | 2,970,000 | 3,120,000 | 3,270,000 | 3,420,000 |
| Trucks | 535,000 | 535,000 | 3,745,000 | 5,350,000 | 535,000 | 535,000 | 535,000 | 1,070,000 | 1,070,000 | 1,070,000 |
| Sole truck fuel | 541,976 | 582,419 | 623,064 | 663,891 | 704,880 | 746,015 | 787,283 | 828,670 | 870,167 | 911,763 |
| Machine and break oil | 61,666 | 66,267 | 70,892 | 75,537 | 80,201 | 84,881 | 89,577 | 94,284 | 99,007 | 103,740 |
| Truck disinfectant solution | 9,920 | 0 | 9,920 | 0 | 9,920 | 0 | 9,920 | 0 | 9,920 | 0 |
| Boot shoes | 0 | 0 | 7,500 | 0 | 0 | 7,500 | 0 | 0 | 7,500 | 0 |
| Black gloves | 0 | 47,500 | 0 | 0 | 47,500 | 0 | 0 | 47,500 | 0 | 0 |
| Total Collection Expenses: | 3,218,361 | 3,451,186 | 6,826,377 | 8,609,428 | 4,047,501 | 4,193,397 | 4,391,780 | 5,160,456 | 5,326,794 | 5,505,503 |

Collection Expense Calculation:

| | | | | | | | | | | |
|-------------------------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 1994 Present Value of Expense | 2,925,965 | 2,852,220 | 5,128,758 | 5,880,355 | 2,513,180 | 2,367,063 | 2,253,677 | 2,407,391 | 2,258,996 | 2,122,610 |
| 1994 PV Sum of Expenses: | 30,710,215 | | | | | | | | | |

| | | | | | | | | | | |
|---------------------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Projected Tonnages: | 4,112 | 4,501 | 4,905 | 5,323 | 5,756 | 6,203 | 6,664 | 7,140 | 7,630 | 8,134 |
| Projected kg Waste: | 4,111,892 | 4,501,218 | 4,904,945 | 5,323,071 | 5,755,597 | 6,202,523 | 6,663,849 | 7,139,575 | 7,629,702 | 8,134,228 |
| 1994 Present Value of kg: | 3,738,084 | 3,720,015 | 3,685,157 | 3,635,729 | 3,573,773 | 3,501,163 | 3,419,608 | 3,330,665 | 3,235,738 | 3,136,097 |
| 1994 PV Sum of kg: | 34,976,029 | | | | | | | | | |

PV Expenses/PV kg = 0.88 Baht/kg = marginal cost per kg.

Disposal:

| | | | | | | | | | | |
|---------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|
| Salary and welfare | 2,040,000 | 2,040,000 | 2,040,000 | 2,280,000 | 2,280,000 | 2,520,000 | 2,520,000 | 2,760,000 | 2,760,000 | 2,760,000 |
| Gas | 49,342,708 | 54,014,622 | 58,859,335 | 63,876,849 | 69,047,163 | 74,430,277 | 79,966,151 | 85,674,905 | 91,556,418 | 97,610,732 |
| Electricity | 952,228 | 1,042,387 | 1,135,882 | 1,232,711 | 1,332,875 | 1,436,374 | 1,543,207 | 1,653,375 | 1,766,878 | 1,883,716 |
| Water | 81,156 | 88,840 | 96,808 | 105,061 | 113,597 | 122,418 | 131,523 | 140,913 | 150,586 | 160,544 |
| NaHO & surfactant | 887,303 | 971,316 | 1,058,435 | 1,148,663 | 1,241,997 | 1,338,439 | 1,437,989 | 1,540,645 | 1,646,409 | 1,755,281 |
| Gas Burners | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 | 660,000 |
| Pump & Motors | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 | 153,600 |
| Capacity Motors | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 | 38,500 |
| Chemical Dosing Pumps | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 |
| Thermocouples | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 |
| Spray Nozzles | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 | 19,200 |
| Total Disposal Expenses: | 54,338,694 | 59,192,464 | 64,225,761 | 69,678,584 | 75,070,933 | 80,882,801 | 86,634,210 | 92,895,138 | 98,915,292 | 105,205,573 |

Disposal Expense Calculation:

| | | | | | | | | | | |
|-------------------------------|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 1994 Present Value of Expense | 49,378,813 | 48,919,392 | 48,233,765 | 47,591,410 | 66,613,143 | 45,656,237 | 44,457,048 | 43,294,282 | 41,949,867 | 40,561,203 |
| 1994 PV Sum of Expenses: | 455,695,259 | | | | | | | | | |

| | | | | | | | | | | |
|---------------------------|------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Projected Tonnages: | 4,112 | 4,501 | 4,905 | 5,323 | 5,756 | 6,203 | 6,664 | 7,140 | 7,630 | 8,134 |
| Projected kg Waste: | 4,111,892 | 4,501,218 | 4,904,945 | 5,323,071 | 5,755,597 | 6,202,523 | 6,663,849 | 7,139,575 | 7,629,702 | 8,134,228 |
| 1994 Present Value of kg: | 3,738,084 | 3,720,015 | 3,685,157 | 3,635,729 | 3,573,773 | 3,501,163 | 3,419,608 | 3,330,665 | 3,235,738 | 3,136,097 |
| 1994 PV Sum of kg: | 34,976,029 | | | | | | | | | |

PV Expenses/PV kg = 13.06 Baht/kg = marginal cost per kg.

Unit cost for BMA to dispose & collect: 13.94 Baht/kg = marginal fee/kg

Operating Costs per Unit:

Collection:

| | | |
|-----------------------------|---------|------------|
| Salary, welfare truck driv | 5,000 | Baht/month |
| Sole for truck fuel | 8.0 | Baht/liter |
| Machine and break oil | 23.0 | Baht/liter |
| Cost per collection truck | 335,000 | Baht |
| Truck disinfectant solution | 9,920 | Baht/lot |
| Boot shoes for personnel | 7,500 | Baht/lot |
| Black gloves for personnel | 47,500 | Baht/lot |

Disposal:

| | | |
|-----------------------------|---------|------------|
| Salary incinerator operat | 10,000 | Baht/month |
| Gas for incinerator | 8.0 | Baht/liter |
| Electricity for incinerator | 2.2 | Baht/tram |
| Water for incinerator | 5.0 | Baht/m3 |
| NaHO for incinerator | 20.0 | Baht/kg |
| Scrubber stack incinerat | 100.0 | Baht/kg |
| Gas Burners | 330,000 | Baht/tram |
| Pump & Motor | 74,800 | Baht/tram |
| Capacity Motors | 38,500 | Baht/lot |
| Chemical Dosing Pump | 80,000 | Baht/lot |
| Thermocouples | 10,500 | Baht/tram |
| Spray Nozzles | 2,400 | Baht/tram |

Notes:

- The above is a present value, long-run marginal cost analysis
- Discount rate = 10%
- 360 day per year operation.
- Only personnel in collection trucks and at incinerator; any planning or other personnel are not included as part of this analysis.
- No interest cost is included because trucks are assumed to be paid for when purchased, and incinerators are already paid off.
- No depreciation expense because trucks are assumed to be purchased in one payment, with O&M costs as separate line items, and new incinerators are already paid for, with spares and O&M as separate line items.
- Trucks must be replaced after 7 years; so must replace the 6 bought in 1990 in 1997, the 9 bought in 1991 in 1998, the 1 bought in 1995 in 2002, the 1 bought in 1996 in 2003, and the 1 bought in 1997 in 2004.
- BMA is projected to need additional 10-tonne incinerator after yr 2002, the cost of which is not included in this analysis, and so some extra money will need to be budgeted by BMA at that time.
- Real Baht means BMA must have provision to raise fees in some relation to an inflation index, even though they have not been allowed to raise fees for household waste collection (which is the same for infectious waste collection) for the past 28 years.