Outline Strategy for Solid Waste Management, Kolkata Municipal Corporation – Study of Solid Waste Management Disposal and Public Private Partnership Options

Final Report

Prepared for
Kolkata Environmental Improvement Project

Submitted by
SNG Mercantile Pvt. Ltd.

In association with
Gartner Lee Limited

April 2007

Executive Summery

Purpose and Objectives of Study

Based on the findings of the Kolkata Municipal Corporation (KMC) Draft Master Plan on Solid Waste Management (2005), the Kolkata Environmental Improvement Project (KEIP) determined the need for a study to assess both technical and Public Private Partnership (P3) options for processing and disposal of municipal solid waste (MSW) in KMC. Taking into consideration that the Dhapa landfill receives more than one million tonnes of MSW per year and that the landfill is nearing capacity, KEIP sought to develop a cost effective and sustainable strategy for solid waste processing and disposal. KEIP issued a Request for Proposals in early 2006 that resulted in the selection of SNG Mercantile Private Limited, in association with Gartner Lee Limited, to conduct the study. The project was initiated in August 2006.

Key objectives of the study included

1. Identifying the most appropriate final disposal technology;
2. Identifying the most appropriate treatment/processing options for MSW; and
3. Providing an assessment of P3 options.

Work Plan

The Work Plan for this study was organized under the following task heading:

Task1	Project Inception
Task2	Service Area Characterization
Task3	Technology Identification and Assessment
Task4	Preliminary Public-Private Partnership (P3) Assessment
Task5	Interim Workshop to Discuss Technical and P3 Options
Task6	Analysis of System Waste Flows and Cash Flows
Task7	Final Workshop to Discuss Draft Report
Taks8	Preparation of Final Report, Including Implementation Plan

The Project Work Plan endorsed by KEIP was based on the Consultant's Proposal. This work plan was modified at two stages: during the Task 1 Project Inception process and at the closure of the Task 7 Final Workshop. Key additions to the scope of work, agreed upon during Task 1, included adding an interim operating plan for the landfill, an assessment of the proposed landfill design prepared by KEIP, and surveys for landfill mining, waste flow confirmation and landfill rag picker status. Other modifications to the scope of work included scoping the landfill gas utilization study to a theoretical analysis of gas generation and deletion of a requirement to develop a list of potential P3 private sector partners. A more detailed gas generation / utilization project was subsequently amended to Mitsui and Co. Ltd.

As originally planned, this study comprised Phase 1 of a three phase project. Following the Final Workshop (Task 7), where the draft report and recommendations were discussed, KEIP determined that

there was no longer a need for Phase 2 due to the limited potential at present for managing the Dhapa Landfill and compost facility under P3 arrangements. Phase 2 was to involve developing the specifications/contract documents needed for soliciting and evaluating offers from qualified private sector proponents during Phase 3. As Phase 2 was no longer needed, the requirement under the Phase 1 study to develop the Phase 2 consultant's terms of reference was dropped. KEIP requested that the Consultant prepare an implementation strategy instead.

Identification and Assessment of Technologies

Options Identification and Assessment

The study team began the technology identification process by reviewing recommendations in the KMC Draft Master Plan on SWM (2005) and taking into consideration various technology options that could, in its experience, be realistically considered given the volume and characteristics of the waste stream and long term sustainability of options. From this initial overall review, a number of possible options for processing and disposal were identified and discussed with KEIP and KMC officials for the purposes of carrying out a more detailed assessment. The following options were initially identified:

- **Landfill Disposal** - A modified landfill development and closure concept for Dhapa, in which new phases of the landfill would be contiguous with the existing landfill, rather than comprising a physically separate facility.
- **Composting** - Upgrading the existing compost facility at Dhapa in the near term and development of a new full scale facility in the longer term.
- **Waste-to-Energy** - A new facility at Dhapa that would process either the entire municipal solid waste stream or a segregated higher energy value subcomponent.
- **Recycling** - A pilot scale, mixed waste material recycling facility (MRF) at Dhapa.

Options Selection: Outcome of Interim Workshop

The findings of a detailed assessment of these options were documented in a series of task reports and presented at an interim stakeholder workshop held at the KEIP offices on 16 November 2006. At the workshop, it was agreed that the expanded Dhapa Landfill, a pilot composting facility and a pilot MRF would go forward for further analysis in the next step of the study. Waste-to-Energy would not be considered further at present due to the high capital and operating costs and low revenue potential of this type of technology under current local conditions. However, Waste-to-Energy would be referenced as a potential option under the long term strategy. It was further determined that the option for composting would focus on upgrading the existing facility such that it would operate at a pilot scale, allowing time to confirm the technical process and assess the viability of compost markets. The decision to develop a full scale compost facility would be based on the findings from the pilot project.

Options Selection: Outcome of Final Workshop

The expanded Dhapa Landfill, compost facility and pilot MRF facility were discussed in the draft Final Report and presented at the Final Workshop on 17 February 2007. As a result of the discussions held at that meeting, it was determined that the processing and disposal system would consist of the Dhapa Landfill and the compost facility. With respect to recycling, there was little support for the concept of implementing a mixed waste MRF at Dhapa, particularly due to the limited employment potential for

ragpickers. However, there was strong support for implementing a strategy focused on source segregation of recyclables because of the employment potential for ragpickers, among other things.

Waste Flow and Financial Analysis

Waste Flows

An integrated waste management model was developed to analyze alternative waste system configurations and test assumptions regarding waste flows, capital and operating costs, financing (debt and equity), and revenues. The model addresses status quo conditions and provides details on the preferred processing and disposal system at Dhapa. The results of the model provide for an assessment of system capacity and fiscal strengths and weaknesses of each system component under varying circumstances, and lead to preliminary conclusions regarding the viability of P3 options.

To project waste generation, it was assumed based on the KMC Master Plan on SWM (2005), that per capita waste generation in Kolkata would be 0.64 kgs/capita/year in 2007. The waste generation rate was assumed to escalate over time due to increasing economic prosperity such that it would reach 0.72 kgs/person/year in 2030, a 0.5% per year increase. Based on the proposed system configuration and resulting waste flows, it is estimated that the life of the Dhapa Landfill could be extended to 2028. The cumulative volume of waste accommodated in the landfill over the period 2007 to 2028 would be in the order of 19.5 million tonnes. This quantity includes waste disposed plus cover material, at a 6:1 waste to cover ratio. However, the rate at which this capacity is consumed relies heavily on the successful implementation of an aggressive waste diversion program.

For the purposes of this analysis, it was assumed that landfill and vat scavenging, currently estimated to divert 8% of waste from disposal, would be gradually phased out. These activities would be replaced by a source segregation program for recycling as recommended in the KMC Draft Master Plan on SWM (2005). It was assumed that the recycling program would divert 15% of waste from disposal when fully implemented across the city. Composting would divert an additional 15% of waste from disposal, when and if a full scale facility is developed. These estimates are more conservative than those suggested in the KMC Draft Master Plan on SWM (2005) and are based on the study team's experience in other similar jurisdictions.

Financial Analysis

Cash flow modeling took into consideration estimated capital and operating costs of the landfill and composter, and assumed revenue schemes. In the base case, the assumed revenue scheme for the landfill included a service charge of 70 Rs per tonne with an annual escalation rate of 3% and CDM credits valued at 300 Rs per tonne of captured CO^2, with no escalation rate. For the composter, the assumed revenue scheme included a service charge of 70 Rs per tonne with an annual escalation rate of 3% and a compost commodity value of 3,850 Rs per tonne with a 5% annual escalation rate. Based on these assumptions, the results indicated that both facilities have a positive net present value at a 10% discount rate. Three cash flow sensitivity analyses were undertaken for the study to identify areas of risk associated with these fiscal profiles.

Of the two proposed facilities, the landfill presents the strongest business case. A key area of concern however lies with the CDM credits, as they have a very enticing potential but the market is currently unstable. In the absence of CDM credits, KMC will need to apply a service charge in the order of 200 Rs per tonne for the landfill to achieve a positive fiscal profile. Still, by world standards, a tipping fee of

IR 200 is a very modest charge for a modern, well run landfill. If CDM funds are accessed and the tipping fee starts under IR 100 then the business case for the landfill is simply reinforced.

The composter on the other hand presents a more formidable financial challenge. The large initial capital cost outlay requires a strong compensating revenue stream from compost sales. The sensitivity analyses indicated that the feasibility of the facility is quite sensitive to a 10% drop in the assumed commodity price. As such, the marketability of the facility output at the required price thresholds poses a significant concern and business risk. It appears that the compost facility will require a strong subsidy (i.e., KMC funds capital) before the private sector would be willing to take on the risks of operation. While the business case for the facility might be modestly improved by increasing the tipping fee, the dominate revenue generator is compost sales and the viability of the facility is hinged around this aspect.

Recommendations - KMC MSW Processing and Disposal System

The following detailed recommendations are based on the analyses presented in this report and discussions with KEIP, KMC and other project stakeholders during the course of the study. The recommendations are organized thematically under four headings: landfill, compost facility, recycling and waste-to-energy.

a) Dhapa Landfill

Commence Landfill Expansion Immediately

1. The Dhapa Landfill is the essential component of the KMC solid waste processing and disposal system. It is recommended that the design for expansion of the landfill should begin immediately in order to address the impending disposal shortfall in an environmentally sound and cost- effective manner.

Adopt Financing Strategy

2. For the Dhapa Landfill, it is recommended that KMC engages consultants to design and oversee construction of the landfill expansion and contracts the private sector to operate it. This is the most effective approach as it provides KMC with the greatest environmental and technical control over the implementation of new capacity and closure of existing landfill areas, and allows for immediate expansion.
3. Gas flaring should be a part of the landfill operations to enable capture of Clean Development Mechanism (CDM) revenues.
4. It is recommended that KMC establish mechanisms to guarantee revenue to the private sector partner via a tipping fee or other direct payment scheme to ensure payment of operating expenditures.
5. It is recommended that ownership of the landfill should remain with KMC. The exposure risks of not having ultimate control of an essential facility suggests that it is in the best public interest for ownership to stay with KMC. Moreover, on the private sector side, the liabilities posed by the existing site are likely to be a steep deterrent to any private sector interest in ownership and remedy.

Implement the Progressive Landfill Expansion and Closure Design Strategy

6. The currently unused area designated for bone processing and hazardous waste storage should be made available for immediate landfill expansion. The availability of this area needs to be confirmed.
7. The Dhapa Landfill should be designed with a leachate collection and treatment system consisting of

a combination of perimeter drains and underdrains, and a leachate treatment system consisting of anaerobic, aerobic and constructed wetlands.

8. The leachate collection system should be extended to existing landfill areas thus significantly minimizing impacts on adjacent areas.
9. A progressive closure strategy should be designed and implemented, as it will result in immediate stabilization of slopes and minimization of rainwater infiltration.
10. The landfill should be developed by expansion of the existing facility in phases rather than thorough creation of an entirely new separate facility in order to maximize capacity. The disruption of farmland would be minimized or delayed for many years and the expense for new infrastructure would be minimized. A design that incorporates this strategy will need to be prepared.
11. Geotechnical slope stability analyses should be conducted on critical landfill slope areas, and in particular, areas adjacent to villages and water bodies.
12. Additional detailed hydro geological investigations should be conducted to support the detailed design of the landfill expansion.
13. Use of at least a portion of the compost area for landfilling should be further considered by KMC. This designated area has the potential to create a significant amount of additional space, portions of which could be used immediately.
14. Investigations into soil reclamation (landfill mining) have shown that valuable soil can be recovered and used for cover material. It is recommended that material be recovered through screening of materials during slope stabilization activities and that these materials be used as final cover throughout the landfill.
15. It is recommended that a gas collection and flaring system and final cover be designed and applied to closed areas of the landfill.

Implement the Interim Operating Plan

16. It is recommended that KMC immediately implement an Interim Operating Plan for the landfill in order to protect the health and safety of workers and nearby inhabitants, improve efficiency and mitigate environmental impacts.
17. It is recommended that the Interim Operating Plan be developed along the lines proposed in this report, giving consideration to:
    a. Reviewing existing staffing levels and equipment to ensure that actual waste quantities received can be bettered handled;
    b. Transitioning the landfill to the more effective “cell method” of waste placement, and to modern procedures for waste placement, spreading and compaction proposed in this report;
    c. Reviewing health and safety practices and developing a health and safety plan for the site;
    d. Improving the control of vehicle movement on the site;
    e. Phasing out ragpicker access to the site in the longer term;
    f. Placing interim cover over areas of the site that are inactive and this interim cover should be vegetated to promote runoff and evapotranspiration in order to reduce leachate generation;
    g. Installing a gatehouse ahead of the existing weighbridge and the gatehouse attendants should be used to help marshal vehicles.
    h. Preparing a detailed design and analysis of vehicle movements and peak flows, including reviewing the need for further scales, given that KMC already plans to add one more scale;
    i. Improving the interim roads to permit all weather access to the working face and to improve the overall efficiency of operations and minimize disposal times.
18. It is highly recommended that senior landfill staff be given an opportunity to be trained in modern

landfill management practices.

19. It is recommended that the equipment mix proposed in this report be seriously considered. The priority for acquiring equipment should be focussed on obtaining two large bulldozers to allow more efficient spreading and compaction of waste.

b) Compost Facility

Upgrade and Restart Existing Compost Facility Immediately

1. Composting is the second recommended component in the KMC waste processing and disposal system. It is recommended that the Dhapa compost facility be re-activated immediately and operated for an interim period as a 300 tonne-per-day pilot facility utilizing source separated organic wastes from market areas. The purpose of the pilot facility is to produce a quality product that can be used to develop and test markets with a view to determining longer term market size, revenue potential and the financial viability of a large scale operation.
2. To manage the facility, a new operating arrangement should be made with the existing facility operator or with a new operator. This arrangement should ensure that KMC has full access to all data and input into a market development program.
3. As a pilot operation, a number of improvements should be implemented at the existing facility as detailed in this report, including:
   a. Improving the composting pad by creating a better operating surface through use of crushed stone or asphalt;
   b. Upgrading the screening plants to allow for more efficient operation;
   c. Purchasing new loaders and mobile equipment for more efficient turning of windrows and on-site movement of materials; and
   d. Training operating personnel and implementing a preventative maintenance program.

Determine Whether a Large Scale Facility is Feasible

4. Assuming that the equipment is upgraded and well maintained, the pilot facility should be operated for a two to three year period with a decision being taken at the end of this period regarding whether or not to close the existing facility and to construct an entirely new and significantly larger compost plant using more advanced technology.
5. As part of the pilot project, close attention should be paid to generating high quality compost in an efficient, reliable manner. Second and most importantly sound market research needs to be carried out to ascertain the price and volume thresholds for compost.
6. The decision to build a new composter should only proceed after careful deliberation of results from the pilot.
7. If the market thresholds are high, then KMC could proceed to a Build, Own, Operate, Transfer-P3 arrangement but if they are not obtainable it is most likely that KMC will have to assume the capital requirement. Under these circumstances the most plausible P3 arrangement is a Build Transfer Operate configuration.
8. At the other end of the spectrum, if the thresholds are low then a new composter should not be pursued and the land should be used for landfill purposes.
9. Under any form of P3 arrangement, KMC will need to guarantee a steady flow of source separated organics at the volume required (i.e., 315,000 tonnes) per annum and it will also need to provide

revenue guarantees via a tipping fee or other direct payment scheme to make up the balance of funds required after compost sales.

10. Under a Build, Transfer, Operate arrangement KMC will need to guarantee the purchase of the facility once it is built.
11. Whether there are sufficient monies available from operations to both take care of operator needs and also provide KMC with a royalty payment to help offset capital costs needs to be explored once a better understanding of potential market conditions are arrived at.

c) Recycling

Design and Implement Source Segregation Strategy

1. Based on various discussions with KEIP and KMC representatives, and results from the workshops, it is recommended that the concept of building a centralized MRF at Dhapa, although potentially viable, should not be pursued at this time, but may be revisited at a later date.

2. KMC should design and implement a source segregation strategy for collecting and processing recyclables immediately, as diversion of recyclables is critical for prolonging the life of the landfill.
3. It is recommended that the service delivery model for source segregation should be designed to integrate ragpickers currently scavenging at Dhapa Landfill and at the vats. Ragpickers currently provide a valuable service to the city by diverting 8% of waste from disposal, yet they work in unsafe and unhygienic conditions and impede operational efficiency at the landfill. Formalization of these services in a source segregation program will improve working conditions for ragpickers as well as increase the quantity of waste diverted through recycling and improve landfill operations.
4. Consideration should be given to developing a decentralized system of MRFs, in which zone based concessions are distributed to private sector partners (P3) such as Non-Governmental Organization (NGO)-led or private operations that organize and formalize the activities of ragpickers working at Dhapa and at the vats. This type of approach should be tested and developed through a pilot program focused on one neighbourhood or zone in the city using a de centralized MRF. The pilot concession could be assigned to a cooperative of ragpickers, or to a private operator on the condition that ragpickers are engaged.
5. Preliminary research conducted for this study indicates that recyclable materials in the KMC waste stream have a significant economic value due to the strong recycling markets in the region. It is recommended that further research be undertaken to fully assess the economic value of the commodities typically collected by ragpickers at vats and the Dhapa Landfill in order to determine the significance of this potential revenue stream for KMC's recycling strategy.

d) Waste-to-Energy Facility

Reconsider Waste-to-Energy Facility in Future

1. Waste-to-energy should not be implemented as a waste treatment and reduction option by KMC at this time. Technically, municipal solid waste (MSW) in Kolkata could be combusted and varying

levels of waste diversion achieved, depending on the option chosen. However, the analysis undertaken in this study indicated that it is not financially feasible to incinerate MSW generated in Kolkata due to its current low heating value, making it unsuitable for energy recovery. A user fee or other form of financial support in the order of Rs 5,200 per tonne plus profits and contingencies would likely be required.

2. It is recommended that future developments need to be monitored every five years as part of an ongoing solid waste management review strategy, in order to determine if and when a waste-to-energy facility may become feasible for KMC. The following factors, or combination of factors, should be monitored as they could trigger a reversal of economics to make waste-to-energy financially feasible:
   a. A significant increase in electricity costs;
   b. An acute shortage of landfill space, driving up the cost of land filling;
   c. Implementation of a waste management infrastructure that makes a high heating value waste stream available to the developer of a waste-to-energy facility; and
   d. Advances in waste-to-energy technology that make the process more efficient and less costly to build and operate.

Conclusion

The results of this study show that the preferred technical system for waste processing and disposal in KMC consists of the Dhapa Landfill and a compost operation. If the recommendations presented in this study are adopted and implemented, this suite of technologies will provide KMC with a solid platform on which to build a modern, environmentally sound and cost-effective waste management system. Expansion of the Dhapa Landfill, in particular, should be viewed as KMC's highest priority and a matter of considerable urgency.

This urgency arises not only from the fact that the existing landfill at capacity, but also because Dhapa Landfill is located in the highly sensitive East Kolkata Wetlands, an internationally recognized ecological and economic resource. The progressive landfill expansion and closure strategy presented in this study was designed to significantly enhance the level of environmental protection afforded to the EKW, as well as to protect the health and safety of workers and nearby inhabitants, and reduce greenhouse gas emissions.

It must also be reiterated that KMC needs to move quickly to adopt and implement a source segregation-based collection program for recyclable and compostable materials, and improve its secondary collection and transportation operation. These are fundamental components of the system that will have a direct effect on the lifespan of the landfill and the feasibility of the compost facility. They will also have a direct effect on the cleanliness of the city - a significant public health concern, as well as a matter of civic pride. A well thought out source segregation program has the potential to formalize and indeed expand the role ragpickers now play in managing the City's waste, but would do so in a much more effective manner.

Transitioning to a modern waste management system involves institutional and cultural adjustments as well as technical modifications. In this regard, KMC's solid waste staff would greatly benefit from access to educational courses and conferences to enhance the knowledge and skills they will need to manage and operate these modern facilities. More broadly, an ongoing public education program is needed to build the level of knowledge and participation in the system required of waste generators.

Finally, transitioning to a modern waste management system will require leadership, which in turn will enhance the city's status and image among Class 1 Indian cities. Leadership can be demonstrated in actions taken to protect the EKW from leachate contamination, improve the air and water quality around Dhapa, improve the working conditions and economic prospects of ragpickers, develop markets for compost, and implement source segregation programs throughout the city. These are just a few of the leadership opportunities that arise for KMC should it move ahead with a strategy to modernize the waste management system as recommended.