



Innovative solid waste management in China

Ms Jane Olley and Dr Rada Olbina, UK

THIS PAPER DISCUSSES work carried out by the authors on the *Solid Waste Management Component* of the *Chongqing Urban Environment Project (CUEP)*. The paper looks at the existing municipal solid waste (MSW) collection system in the city and discusses the process by which an improvement strategy for MSW collection was selected and developed. The paper also highlights the benefits of the innovative project approach used by the combined international and local project team in undertaking the study.

The paper is split into 6 sections. *Section 2* discusses the study's aims and objectives. *Section 3* describes the innovative project approach used and its effect on the study's organisation and management. *Section 4* details the current collection system and *Section 5* highlights its main constraints and features. In *Section 6* the proposed solution is outlined. Finally *Section 7* draws some overall conclusions about the study.

Purpose of project

Chongqing Greater Municipality (CGM) is the largest municipal district in history, covering 82,000km² with a population of over 30 million. It is made up of 11 administrative districts, 2 cities and 8 counties. The *Solid Waste Management Component* of the CUEP concentrated on improving municipal solid waste management (MSWM) in Chongqing, the largest city in the CGM with 9 districts and about 3 million inhabitants. The River Yangtze passes through the city and its importance as a port is expected to increase with the development of the Three Gorges Project. The aim of the project was to review and suggest measures to upgrade MSWM in Chongqing. The study was carried out in three phases. A review of existing MSWM was followed by further development of the existing waste management strategy and a five year Action Plan and Investment Programme. In the final phase a feasibility study was carried out for key investment items including the construction and operation of one of the first sanitary landfills in China.

Innovative approach

The study was funded by the International Bank for Reconstruction and Development (World Bank). It was one of the first to employ a relatively innovative approach to project organisation and management. The international consultants from Environmental Resources Management (ERM) had the role of assisting the Chinese consultant team (many of whom initially had very little waste management

knowledge or experience) in undertaking the study. There was a total of 15 months international input as compared to 235 months from Chinese consultants. This situation was significantly different and more challenging than more conventional projects where international consultants are committed to undertake the bulk of the work.

The joint international and local team developed a very good working relationship based on the on-going building of trust and understanding, within the team and with the client during the study period. This approach demanded considerable time for discussion and negotiation. However, using this approach helped ensure that the final Action Plan and Feasibility Study were fully endorsed by the World Bank and local client.

Municipal solid waste collection in Chongqing

Primary collection

MSW collection in Chongqing is well established and where sufficient infrastructure and vehicles are available works well. MSW collection is a two stage process in the city. Waste is stored in centralised collection stations between primary and secondary collection. In general, secondary collection is provided by the municipal authorities whereas primary collection is carried out by a range of municipal and private workers.

Waste from high-rise apartments and commercial buildings is often taken to collection stations by professional collector teams or residents' committee workers. Some large institutions e.g. Chongqing University may even have their own collection trucks to transport waste to the disposal site. Social unit cleaners are responsible for collection from schools, factories, shops etc. In all, about 5,000 people are engaged in primary collection and some 1,500 in secondary collection. There are: 2,634 professional team workers; 1,715 residents' committee workers; and 2161 social unit cleaners.

Collection stations

There are currently 280 MSW collection stations operating in Chongqing. *Table 1* indicates how these collection stations are distributed throughout the nine districts.

Many of the modern collection stations are designed to provide housing for the operator but smaller or older facilities do not have living quarters. Waste is deposited and stored on the first floor until the collection vehicle arrives. The vehicle backs into the station directly below the stored

Table 1. MSW collection stations in Chongqing's nine districts

District Name	Number of MSW Collection Station	District Name	Number of MSW Collection Station
Yuzhong	58	Shapingba	18
Jiulongpo	20	Yubei	39
Dadukou	11	Banan	20
Nanan	43	Beibei	31
Jiangbei	40	Overall Total	280

Source: District Collection Survey by Local Team Summer 1998

waste. Depending on the design, either swing doors in the floor of the upper chamber are opened to allow waste to fall through into the waiting truck or waste is pushed through a hole in the floor.

Collection vehicles

A total of 155 municipal vehicles are available to serve the city's collection needs. In addition, an unknown number of vehicles are operated independently by large social units e.g. state enterprises. The type of MSW collection vehicles used has generally been selected according to local topography, distance to the disposal site and vehicle cost. Most vehicles have a maximum capacity of around 8 m³ or 5 tonnes. The average age of vehicles is high (>10 years) and their number is found to be too small to efficiently collect the MSW generated in the city.

Service coverage in Chongqing

The *Environmental Sanitary Statistic Report Forms 1992-1997* shows coverage of MSW collection ranging from 90 per cent in Yuzhong District to 40 per cent in Jiangbei with and overall coverage of about 70 per cent for the nine districts in 1996. The local team also visited each district to map the position of collection stations, establish the frequency with which stations were emptied and determine the population served by each one. The centre of the city appears to be adequately served. However, away from the city centre coverage is not as consistent and there are many areas where waste is dumped by the road or on vacant ground. Daily quantities hauled for each district are shown in *Table 3*.

Resource recovery and recycling

Resource recovery and recycling activities are well established in Chongqing and are carried out at all stages of the

waste management system from point of generation to disposal. 90 per cent of recyclables are recovered and processed by an active informal sector. Typically individual householders or waste collectors bring recyclables to a dealer and are paid on the basis of weight and condition of the material received. Materials are bulked up for transportation either direct to recycling factories or to larger dealers. The system appears similar to market driven systems which are successful and can be found in many other Asian cities.

Features of and constraints to present collection system

The features and constraints of the city's present collection system can be summarised by the following bullet points:

- Collection coverage and the quality of service are reasonably high in the central business district but fall as distance from the centre increases;
- The traditional two stage collection system with local centralised collection stations is widely used in Asia e.g. Hong Kong. This system is compatible with present collection methods and can be developed to meet increasing demands;
- Current collection vehicles are smaller than may be considered economically desirable in the future. In addition, existing collection stations have usually been designed to accommodate currently used vehicles and will generally not be compatible with larger, wider vehicles. Access to narrow streets in the city centre presents an additional obstacle to efficient collection;
- Current waste composition is typical of developing countries with a high organic and moisture content. However, rapid economic growth is noticeable in Chongqing and there is likely to be an equivalent rapid

Table 2. Types and numbers of collection vehicles serving Chongqing's nine districts

District Name	Total	District Name	Total
Yuzhong	60	Shapingba	18
Jiulongpo	17	Yubei	10
Dadukou	5	Banan	7
Nanan	14	Beibei	9
Jiangbei	15	Overall Total	155

Table 3. Daily quantity of MSW Hauled in Chongqing's nine districts

Districts	Total Quantity Generated (t/d)	Total Collected (t/d)	Transported by Special Collection Team		Transported by other Collection Teams	
			t/d	per cent of total generated	t/d	per cent of total generated
Yuzhong	798	718	399	50%	319	40%
Jiulongpo	455	200	161	35%	39	9%
Dadukou	153	92	67	43%	25	17%
Nanan	312	234	182	58%	52	17%
Jiangei	385	154	136	35%	18	5%
Shapingba	411	349	125	30%	225	55%
Yubei	98	88	74	76%	14	14%
Banan	113	68	37	32%	31	28%
Beibei	223	201	141	63%	60	27%
Total	2948	2104	1320	45%	784	27%

change in waste composition and quantity. As waste composition changes the use of modern compactor trucks will become an option for the city. However, the current operating system with waste being stored loose on the first floor of a collection station and being discharged into a waiting vehicle is not compatible with the use of compactor vehicles; and

- Recycling and resource recovery is a common practice in Chongqing and is a significant source of jobs and income. This practice should be encouraged and expanded especially at and close to the point of generation where cleaner higher value recyclables can be recovered.

Developing a preferred approach to MSW collection

Once the constraints to the current system had been identified the team worked to develop a strategy to improve overall MSW collection for the city. The basic principle of the strategy was to build upon the existing system in order to expand collection coverage to unserved areas. Coverage targets for each district were established by considering existing coverage; development plans for the district; and current waste management practice. Some districts needed little improvement to their service while others needed immediate actions to establish or improve collection.

Yuzhong, the central business district, is the best served in Chongqing. Nevertheless for political reasons the local client insisted that the most up-to-date systems be implemented in this district where it will have a higher profile. This is unlikely to lead to the adoption of the most cost effective strategy but does have some merits since the level of waste management practice is relatively high in Yuzhong. Overall proposals for improving the collection system should ensure collection coverage will be increased in all areas.

Considerable discussion took place on how best to improve the existing collection system while protecting the investments which have already been made. The primary collection system assessment led to the recommendation that no new two storey collection stations be built. Given the predicted changes in waste composition, the local client was keen to move towards the use of rear end loading compactors as soon as possible. The current collection station design is not compatible with this vehicle. Primary collection of MSW will continue as a two stage process but in some districts like Yuzhong the collection stations will be modified to operate on one level in conjunction with new rear loading compactor vehicles.

Another key objective of the strategy was to maximise opportunities for materials recovery at source and during primary collection where waste components are relatively clean and higher in value. In contrast materials recovery at the disposal site was to be discouraged due to the relatively low value of the waste and the significant health risks to those working on the dumpsites. Initial plans included the conversion of collection stations into a site for separation of recyclables from waste before the remainder was bagged for removal to the disposal site. This idea was revised based on comments by the Chongqing Solid Waste Company (CSWC) and the World Bank. The main concern of the company was that by combining collection and recycling, secondary collection and transportation efficiency would suffer. It was therefore agreed that collection stations will be used only for storage of waste before transportation to the landfill.

Although understanding the concerns of the company, the importance of maintaining and expanding opportunities for resource recovery and recycling still seems worth stressing. The system as proposed only allows for source separation at home. Householders will continue to be encouraged to reuse and recycle as much as possible but

there is unlikely to be a significant increase in recycling levels without additional effort on the part of the CSWC.

Conclusions

The *Solid Waste Management Component* of the *CUEP* has been cited as a successful example of strategic planning for MSWM. The final strategy represents a negotiated compromise between the step by step approach suggested by the consultant team and the desire to introduce a modern MSWM system expressed by the local client. The Action Plan and Feasibility Study have the full support of the CGM, the World Bank and the CSWC which is required to ensure that the study moves into the implementation stage. The proposed system should enable the city to consolidate the existing basic waste infrastructure while anticipating and meeting the challenges of future economic growth.

Nevertheless, in the view of the authors one of the greatest benefits this study will provide is the presence of a highly competent group of people who will act as a resource for future solid waste management projects both inside the CGM and elsewhere in China.

Acknowledgements

The MSWM collection strategy was developed by an international and local consultant team in discussion with the local client. The authors would like to acknowledge in particular the work of Mr Li Dong on the local consultant team.

MS JANE OLLEY, UK
DR RADA OLBINA, UK
