

THE SAFE CLOSURE AND REHABILITATION OF LANDFILL SITES IN MALAYSIA

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ABSTRACT

The Government of Malaysia has embarked on a development policy related to solid waste management by formulating various plans and policies to provide strategic framework to the overall management of solid waste. Such include the setting up of relevant institutional and legislative bodies, formulation of guidelines, and the development of the action plan for future implementation. It is from here that the study on The Safe Closure and Rehabilitation of Landfill Sites in Malaysia was conceived by JICA.

The main objectives of the Study were to formulate the relevant guidelines and setting up of the action plan for the safe closure and rehabilitation of landfill sites. The scope of the study also included the landfill database set up, implementation of the three pilot projects, and the development of human resources on the management of safe closure of landfill sites.

INTRODUCTION

The solid waste management activities especially with regards to the waste disposal are generally lacking in Malaysia. Almost all the collected wastes are being disposed of at open dumpsites or at landfill sites. Only a very small percentage of the waste is recycled or reused.

The Government of Malaysia and the nation as a whole are increasingly more aware of the negative impacts to the environment and the potential health risks that may arisen due to the years of neglect and indifference towards the solid waste management issue. As such, the Government of Malaysia is continuing and has been for the past few years embarked on a mission to improve and streamline the solid waste management activities in the country.

In 2002, inline with the Government of Japan's Technical Cooperation Programme and in response to the official request of the Government of Malaysia, the Japan International Cooperation Agency (JICA) dispatched a study team to Malaysia to conduct the study on The Safe Closure and Rehabilitation of Landfill Sites in Malaysia.

JICA had selected Yachiyo Engineering Co. Ltd to conduct the study and it was undertaken in close cooperation with The Ministry of Housing and Local Government, Malaysia, and with the other relevant authorities.

The Study was carried out in two phases. Phase 1 (from January to June, 2003) included the basic survey and site visits to some of the landfill sites, landfill database set up, and the preparation of the pilot projects. Phase 2 (from July 2003 to October 2004) included the preparation of the safe closure guideline and action plan together with the implementation of the pilot projects.

Part of the deliverables of the Study was the organising of two technical seminars and two technical workshops sections to present the findings and progress / output of the Study and to obtain feedback and discussions amongst the participants.

EXISTING CONDITIONS AND ISSUES

The total amount of waste generated in Malaysia in the recent years is estimated to be about 19,800 tonnes per day, or about 7.2 million tonnes per year. However, not all generated waste are collected and the amount of waste disposed of at various landfill sites is estimated to be about 13,500 tonnes per day, or about 4.9 million

tonnes per year. The remainder of the waste are dumped illegally, recycled or disposed off by other means.

There are approximately 170 officially recorded landfill sites in operations in Malaysia and only about 10% of them are classified as sanitary landfills. Majority of landfills are operated as open-dump sites with little attention to their impact on the environment. There are also a substantial number of illegal or unrecorded open-dumps in existence.

During the last 10 years, about 50 landfill sites seized operations and were considered "closed", without proper closure measures taken to close the site in a safe and sanitary manner. Some of the closed sites have been re-utilised for redevelopment, for example, a 23 storey low cost apartment building is currently under construction at the Kelana Jaya closed landfill site in Petaling Jaya, Selangor. Similarly, a 5-storey apartment building is under construction at the West side of the Taman Beringin landfill site in Kuala Lumpur. The effects of such re-development will have to be monitored closely in the future. However, the long houses that were constructed at the Paka-1 closed landfill site in Kuala Lumpur in 1998 are now showing signs of damage due to uneven land settlement and subsidence.

In Malaysia, with the exception of the Environmental Quality Act, there is no Federal Legislation that deals directly with Solid Waste Management. The States and the Local Authorities undertake the management of solid waste. The waste collection and disposal services are governed by various acts and regulations such as the Local Government Act, Environment Quality Act, the Refuse Collection & Disposal By-Law, etc.

In general, the Local Authorities are under the administrative control by their respective State Governments. However, in the Federal level, the Ministry of Housing and Local Government (MHLG) is ultimately responsible for the overall legislative administration of the Local Governments. The MHLG is responsible to monitor and to ensure that all the Local Governments adhere to the federal policies and that effective Local Government public services have been provided. MHLG is also responsible for the appropriation of federal funds and grants for financial and development assistance to the Local Government.

Under the Eighth Malaysian Plan 2001-2005, The Government of Malaysia outlined the national development policy related to the solid waste management and emphasised on the privatising of solid waste management in Malaysia to include the

collection services and landfill site management and operations. In 2002, The Government of Malaysia prepared the National Strategic Plan for Solid Waste Management that outlined the framework for the overall management of solid waste including privatisation.

GUIDELINE ON LANDFILL SAFE CLOSURE

The main objectives of the study on The Safe Closure and Rehabilitation of Landfill Sites in Malaysia are to formulate the relevant guidelines and setting up of the action plan for the safe closure and rehabilitation of landfill sites that accept predominantly municipal solid waste.

The Guideline is divided into two sections, viz. Section I and Section II. Section I addresses the issues with regards to the general procedures for safe closure, and the legislation, institutional and financial aspects. Section II explains the technical requirements in more details.

The Guideline recommends that for all landfills, and illegal dumpsites, where waste-filling work have been completed should be closed properly for the safe storage of the wastes and to prevent pollution to the surrounding environment. The "Safe closure plan" should be formulated to include the physical closure (PC) and the post-closure management (PCM) activities. The safe closure plan should be prepared based on the priority and the closure level of the landfill site.

The closure-levels are classified into 4 categories as follows.

- Level C1: Minimal closure level (to provide final cover and drainage system around the site)
- Level C2: Low closure level (similar to C1, but with the addition of dike, controlled slope and gas ventilation system)
- Level C3: Middle closure level (similar to C2, but with the addition of semi-aerobic landfill system with leachate re-circulation)
- Level C4: High closure level (similar to C3, but with the addition of groundwater pollution control measures with leachate treatment)

The schematic diagrams of the landfill closure levels are shown in Figures 1, 2, 3 and 4, below.

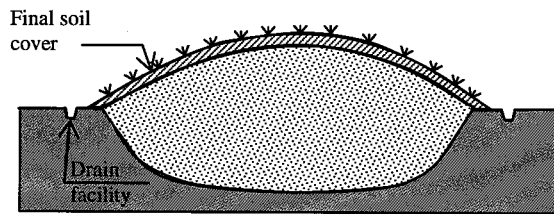


Figure 1. Landfill safe closure level: C1

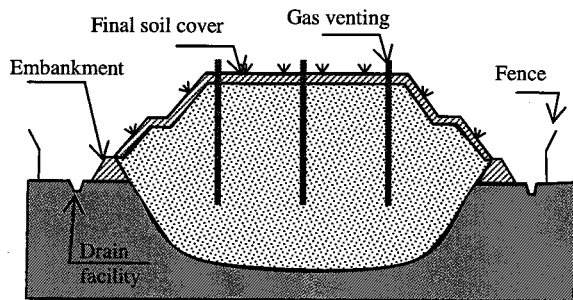


Figure 2. Landfill safe closure level: C2

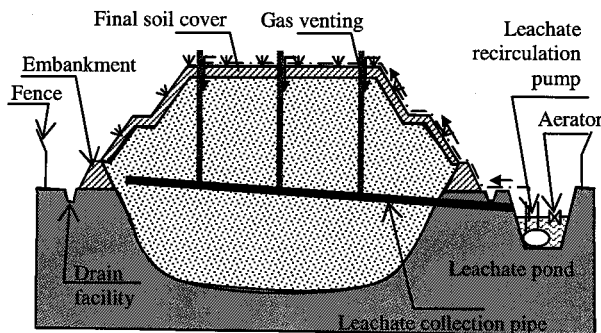


Figure 3. Landfill safe closure level: C3

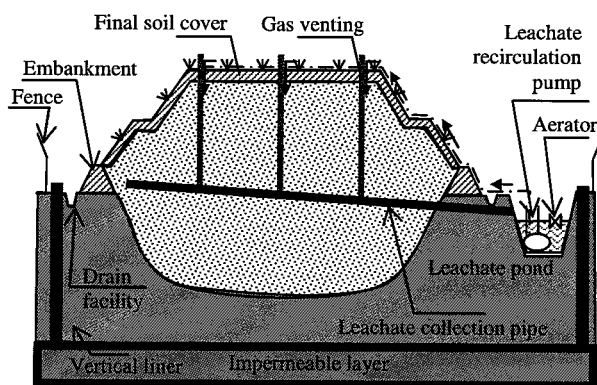


Figure 4. Landfill safe closure level: C4

The technical requirements included such activities as the installation of the necessary facilities, i.e. the leachate treatment facility; the provision of adequate protection, i.e. top covering; and the environmental

monitoring activities and schedule. The PCM (operation and maintenance of the landfill facilities and monitoring) will have to be continued even after the new land use has been implemented for the closed landfill site.

The "Post-closure Land Use" is also addressed and it recommends that all future post-closure land use of closed landfill sites should be carefully considered based on the clear understanding of the landfill during its term of operation and closure as well as the impacts it has had on the surroundings. The proposed land use should not endanger the lives of the public and the users.

The Guideline also addressed the necessity of setting up the relevant advisory and regulatory bodies at both the Federal Government and the State Government. All these are to ensure the necessary legislations are in place, and to streamline the inter-departmental or cross-ministerial bureaucracy by the dissemination and mutual understanding of the procedures as set out in the guideline. In general, The Federal Government, as it has continued to do so in the past, shall ensure that the waste management activities are in compliance with the current laws, and the Federal Government will provide the State Governments and the Local Authorities with necessary technical advises and assist them in the development of their human resources. The individual State Government is responsible for all land management issues and should be responsible for registration of landfills, management of landfill safety closure and monitoring of post-closure land use. The Local Authorities shall support the role of the State Government.

Another key issue that is addressed in the Guideline relates to the financial resources and funding structure. The Guideline recommends that a strategic funding system be set up at the Federal Governmental level to cater for the implementation of the sustainable landfill safe closure. The Federal Government will then manage the *Fund* and apportion the funds accordingly upon the requests from the State Governments and by taking into account of the landfill closure priorities.

ACTION PLAN

The Action Plan for the Safe Closure of Landfill Site in Malaysia was developed in order to determine the necessary actions required to address the landfill closure issues raised from the Study. The target year of satisfactory implementation of the Action Plan is by the year 2010 and should cover 72 landfill sites.

Under the proposal of the Malaysia National Strategic Plan, the present existing landfills should all be closed

and phased out by the year 2020. New and larger regional sanitary landfills sites will be provided instead. In line with such proposed requirement, the Study concluded that 111 landfill sites will have to be rehabilitated by the proposed end of the target year of 2010. However, based on their priority, only 72 of the 111 sites require more urgent consideration, these are for the high to medium-low priority sites, i.e. 33 closed sites and 39 operating sites. The proposed schedule for the Action Plan is tabulated in Table 1. As for the remaining sites, the rehabilitation works should commence after 2010.

for the Financial Plan is about RM275.5 Million (or about USD71.63 Million)

One of the major activities addressed by the Action Plan is on the establishment of the landfill registration system. This is to ensure the continuation of the appropriate post-closure management and also to prevent and minimise the unrestrained development and overexploitation of the closed landfill sites. As such, all the existing landfill sites, closed sites and the newly developed sites should have been registered. The registration system can then be used to check and

Table 1 Action Plan Schedule on Landfill Safe Closure

	Item	2004	2005	2006	2007	2008	2009	2010
	JICA Study on landfill safe closure	+++++						
I	Landfill closure implementation		+++++	+++++	+++++	+++++	+++++	+++++
	- Closed sites: (High Priority - 7 sites)		+++++					
	- Closed sites: (Medium Priority - 9 sites)			+++++				
	- Closed sites: (Medium-Low Priority - 17 sites)				+++++			
	- Operation sites: (High to Medium-Low Priority - 39 sites)			+++++	+++++	+++++	+++++	+++++
II	Guideline for landfill safe closure	+++++						
III	Landfill registration system (set-up committee in State Gov.)	+++++						
IV	Landfill sites list	+++++						
V	Funding system set-up	+++++	+++++					
VI	Human resource development	+++++	+++++	+++++	+++++	+++++	+++++	+++++

As per the proposed schedule, the Action Plan can only be implemented when all the necessary registration system and institutional systems have been set up by the end of 2004. The funding system may take time to be established. Nevertheless, the target year is by the end of 2005. Once the decision and funding have been approved, the 7 high priority closed sites should be rehabilitated first, by end of 2005. The medium priority sites and the medium-low priority sites will follow suit and to be completed by end of 2006 and 2007, respectively. However, for the 39 operations sites, they should be closed in phases, commencing from 2006 and target completion by end of 2010.

From the Study, the Financial Plan estimated that the necessary capital expenditure (CAPEX) to carry out the works, and the operation expenditure (OPEX) necessary to maintain and operate the facilities, for the closed sites (i.e. from 2005 to 2007) are about RM72.5 Million and RM23.6 Million respectively (RM1.00 = USD0.26). The CAPEX and OPEX for safe closure of the operating landfill sites for the period from 2005 – 2010 are estimated to be about RM136.5 Million and RM42.9 Million respectively. The total estimated cost

monitor on the activities of the landfills, including the control and prevention of illegal dump and unsanitary landfill sites. The registration exercise should be the responsibility of the Federal Government, the State Governments and the Local Authorities, and should be updated from time to time.

One of the key recommendations as set up in the Action Plan is the establishment of the institutional structure. This will eventually form the legislative body to oversee, manage and decide upon all landfill development matters. Two such bodies have been proposed, they are

- The establishment of the Technical Advisory Board for Landfill Site Management (TABLF), at the Federal Government level, and
- The establishment of the Landfill Site Management Committee (LSMC), at the State Government level.

The Study recommends the setting up of the TABLF under the administration of MHLG. The board

members will constitute representatives from the institutions concerned with landfill management. The main activity of the TABLF is to provide technical support and advisory services to the State Government, and the appropriation of funds for landfill management.

At the State level, the LSMC will have more direct control and authority on all the landfill related matters. The three main functions are, i) to manage the landfill registration system, ii) to review and provide approval for all landfill related projects or developments, i.e. the approval of the "safe closure plans", and iii) to monitor the activities of the landfill operators.

Thus, in order to implement the Action Plan, substantial amount of financial investment is required. Funding of capital projects should be responsibility of the Federal Government. As part of the Action Plan, it was recommended that the National Fund for Landfill Closure be set up. The fund should be administered by the Ministry of Finance and under the stewardship of MHLG. The resources for the fund should be from the allocated annual national budget and from the tipping fees collected at the landfill sites. The funds can be provided to the State in the form of subsidy or grants, upon the request of the State Government. The apportionment of the funds should be under the discretion of the TABLF and the Ministry of Finance.

PILOT PROJECTS

The Pilot Projects for the safe closure and rehabilitation of landfill sites were developed and implemented to provide hands-on approach and better understanding of the standard practices and applied technical systems as provided in the technical guideline of safe closure. They were also used to promote the transfer of technical know how in order to develop the sustainable landfill management knowledge for Malaysia to expend and continue the rehabilitation works for the other landfill sites.

For the purpose of the study, three landfill sites were selected for the Pilot Projects. The sites were determined based on a few key selection criteria, such as the geographical location of the sites, the size and closure stages of the landfills, the environmental impact, and the possibilities for post-closure utilisation. The actual Pilot Project sites were selected by the Malaysian Counterparts in close cooperation with the JICA Team.

The three Pilot Project sites that were selected are:

1. The Ampang Jajar Landfill Site

Situated in the Northern State of Penang, on the mainland side, managed by the Seberang Perai

Municipal Council. Started operations in 1980 and was subsequently upgraded in 1988 with the installation of leachate collection pipes, collection pond, leachate recirculation system and gas vent pipes. It was operated as a semi-aerobic landfill and was closed recently. Currently, the final top cover is being laid and it is proposed to redevelop the closed site into a public park.

2. The Pekan Nenasi Landfill Site

Situated in the Central-Eastern State of Pahang, in the Eastern Royal Town of Pekan, previously managed by the Pekan Municipal Council and currently managed by the council appointed private contractors, which is also responsible for the waste collection. Started operations in 1988 and provided with a weighbridge and administrative building in 2002. The site is situated on swampy grounds. The site will remain in operation for another 20 years.

3. The Ampang Jaya Closed Landfill Site

Situated in the Central-Western State of Selangor, South-East of Kuala Lumpur, previously managed by the Ampang Jaya Municipal Council and subsequent handed back to the Kajang Municipal Council, which owns the land. Started operations in 1992 by the side of a valley as an open dump. It was later closed in 1998 due to a disastrous landslide that claimed the life of 2 workers at the site. The site is situated 8km upstream of a water intake point. The site is abandoned and presently used as an orchard.

A brief description of the Pilot Projects is tabulated in Table 2, below

Figures 5, 6 and 7, below, shows the progress status of the Ampang Jajar Landfill site before, during and after the Pilot Project works being carried out.



Figure 5. Ampang Jajar Landfill – Before Pilot Project Implementation



Figure 6. Ampang Jajar Landfill – During Pilot Project Implementation



Figure 7. Ampang Jajar Landfill – After Pilot Project Implementation

Table 2. Brief Description of the Pilot Projects for Landfill Safe Closure in Malaysia

Item	Pilot Projects		
	Ampang Jajar Landfill	Pekan Nenasi Landfill	Ampang Jaya Closed Landfill
Status of landfill	Closed (2003)	In Operations	Closed (1998)
Key points in safe closure consideration	Safety closure of landfill that has been operated under improved conditions	Model for rehabilitation of landfill located on wetlands	Safety closure of landfill previously operated as an open dump site
Targeted safe closure levels	Landscaping and safety closure to Level C3	Safety closure to Level C3	Safety closure to Level C2
Brief description of the pilot projects	Improvement of the slopes and installation of storm water drains, leachate collection pipes and gas vents	Upgrading to semi-aerobic landfill with leachate collection pipes, recirculation system and gas vents	Provision of leachate collection pipes and gas vents. Installation of surface storm water drainage system
Major works carried out	<ul style="list-style-type: none"> □ Re-forming 250m stretch of slopes from 3.2m to 7m high □ Applying 8,000m² cover soil (150mm thick) □ Plant 11,400m² turfing & 240 trees □ Installing 275m of 450mm dia. leachate collection pipes □ Installing 600m of 150mm dia. Leachate/gas pipes □ Installing 900m of pre-cast surface / stormwater drains 	<ul style="list-style-type: none"> □ Install 84m of 450mm dia leachate collection pipe □ Install 330m of 225mm dia branch pipes □ Excavation of 100m x 10m x 2m(deep) leachate collection pond □ Installation of one 7.5kw surface aerator c/w control systems □ Installation of one 5kw recirculation pump c/w piping and control panel 	<ul style="list-style-type: none"> □ Construct 1km, 7m wide access road □ Install 1km stormwater drains alongside access road □ Install 126m of 450mm dia HDPE leachate collection pipe □ Install 500m of 100mm dia leachate / gas collection pipes □ Install 500m stormwater drains □ Excavation of wetland area for leachate pond

LANDFILL DATABASE

Generally, in Malaysia, there is a lack of detailed records or database of the landfill sites. Since the management and operations of landfills are the responsibility of the Local Authorities, it was left to the individual Local Authorities to keep and maintain the records and database of their respective landfills. Hence, in order to have a better understanding of the status and conditions of the existing and closed landfills, a series of surveys were carried out.

Two survey exercises were carried out, one was the actual site visit and inspection survey and the other was the desk-top questionnaire survey whereby proforma questionnaires were sent to all the Local Authorities for them to provide as much information and details about their respective landfills.

The purpose of the surveys was to collate the information in order to prepare the inventory list of landfill sites in Malaysia. For the purpose of the Study, the survey was limited to all operating or closed landfill sites in the Peninsula of Malaysia, and for landfill sites that only accepts municipal solid waste.

From the results of the surveys and information collated in the inventory list, the database of landfills in Malaysia for 147 landfill sites was created. This led to the formation of the Landfill Closure Management Information System (LACMIS).

Figure 8 below, shows the example page of the LACMIS visual display with the map of the Peninsular Malaysia, indicating the locations of the major cities / town, roads, rivers, and the locations of the landfill sites.

The LACMIS database is based upon the Geographical Information System (GIS) that comprises of a series of spatial data and non-spatial attribute data. The Spatial Data include geographical information on the Administration boundaries, the landfill site location, the location of water intake points, hydrological map and the transportation network. The non-spatial attribute data include information on the administrative database, the environmental database, the land utilisation database and the rating database of each landfill site.

CONCLUSIONS

The study on The Safe Closure and Rehabilitation of Landfill Sites in Malaysia was initiated in response to the urgent need to improve and streamline the solid waste management and disposal problems experienced in Malaysia. The study was carried out to highlight the shortfalls in the present solid waste disposal system and to find solutions, to develop relevant guidelines, and to set up the standard procedures, intuitional framework, and funding system necessary for the smooth implementations of the safe closure of landfills.

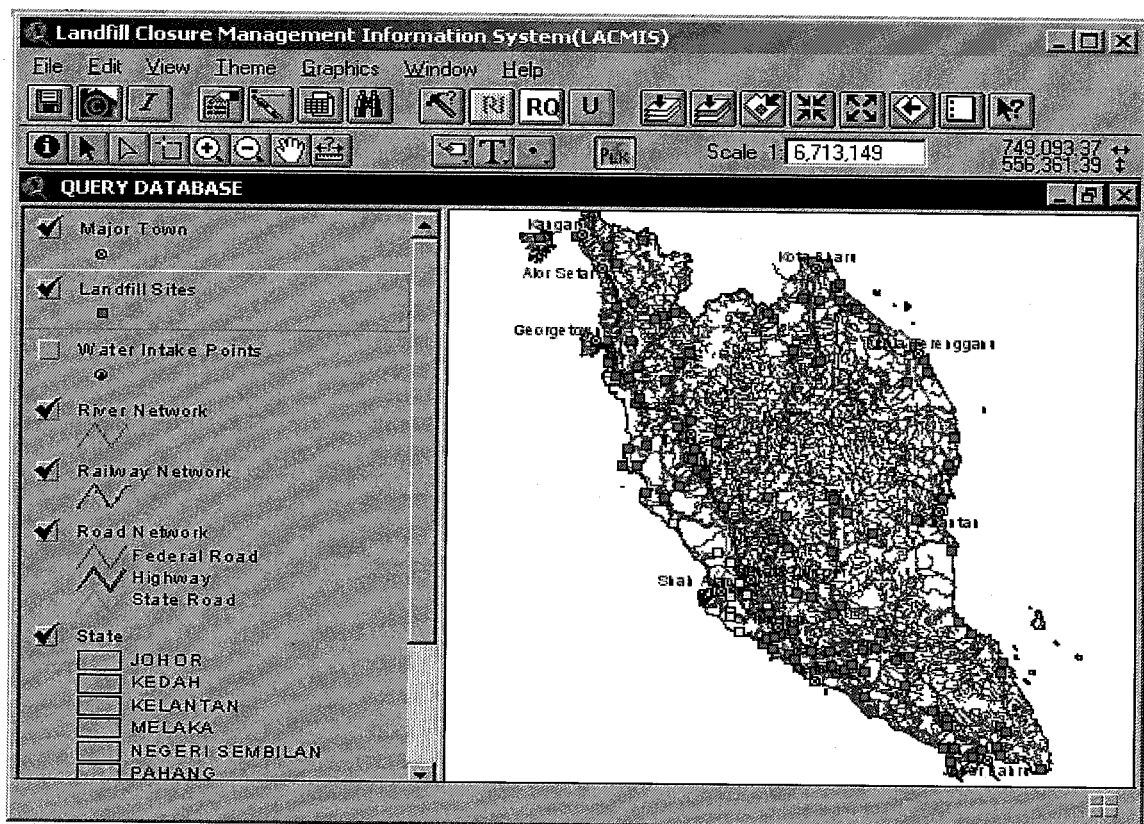


Figure 8. Example of LACMIS Visual Display

The five main tasks of the study have been carried out, i.e. carrying out data collection and surveys including landfill database establishment, the formulation of the Action Plan, the implementation of the Pilot Projects, the preparation of the guidelines and human resource development.

Issues such as the preventions of environmental pollution and the protection of public health have also been addressed. The preparation of the Guideline for Safe Closure and Rehabilitation of Landfill Sites sets out to provide the recommended steps necessary to close the landfill in a safe manner, including steps to rehabilitate the closed landfills and on how to manage/monitor the closed landfill site properly. The guideline also provides the recommendations for the post closure land use of closed landfill sites.

The study was implemented in close corporation with the counterpart members and the stakeholders related to solid waste management and waste disposal activities. It was used as a platform to foster closer working relationships between the stakeholders, such as the Government and the private sectors who are involved in this field. In accordance with the ownership of the Malaysian stakeholders, it is expected that the safe closure guideline will be authorized in the Federal government level and the action plan will be implemented in each State government without any delay.

The study is by no mean finite and should be improved upon and reviewed in the years to come in order to ensure the effectiveness and sustainability of the landfill safe closure system.

In September 2003 and 2004, MHLG and JICA co-organised two 2-day seminars for the Study on the Safe Closure and Rehabilitation of Landfill Sites in Malaysia. In both the seminars, officials from nine neighbouring countries were invited to participate and exchange opinions on SWM and on the landfill issues. The participants were from Cambodia, China, Indonesia, Laos, Myanmar, Nepal, Philippines, Thailand and Vietnam. It is envisage that Malaysia shall be the information and technology hub for landfill matters in the region and such activities will be continued by the Malaysian leadership.