

7.1.4 Management of the Landfill Database

Handling procedure of landfill database “Landfill Closure Management Information System (LACMIS)” is shown in **Figure 7.1.4**. Landfill database shall be opened especially to developers who are going to develop the closed landfill site for other purposes. Responsible authorities of State government (LSMC) take on this role.

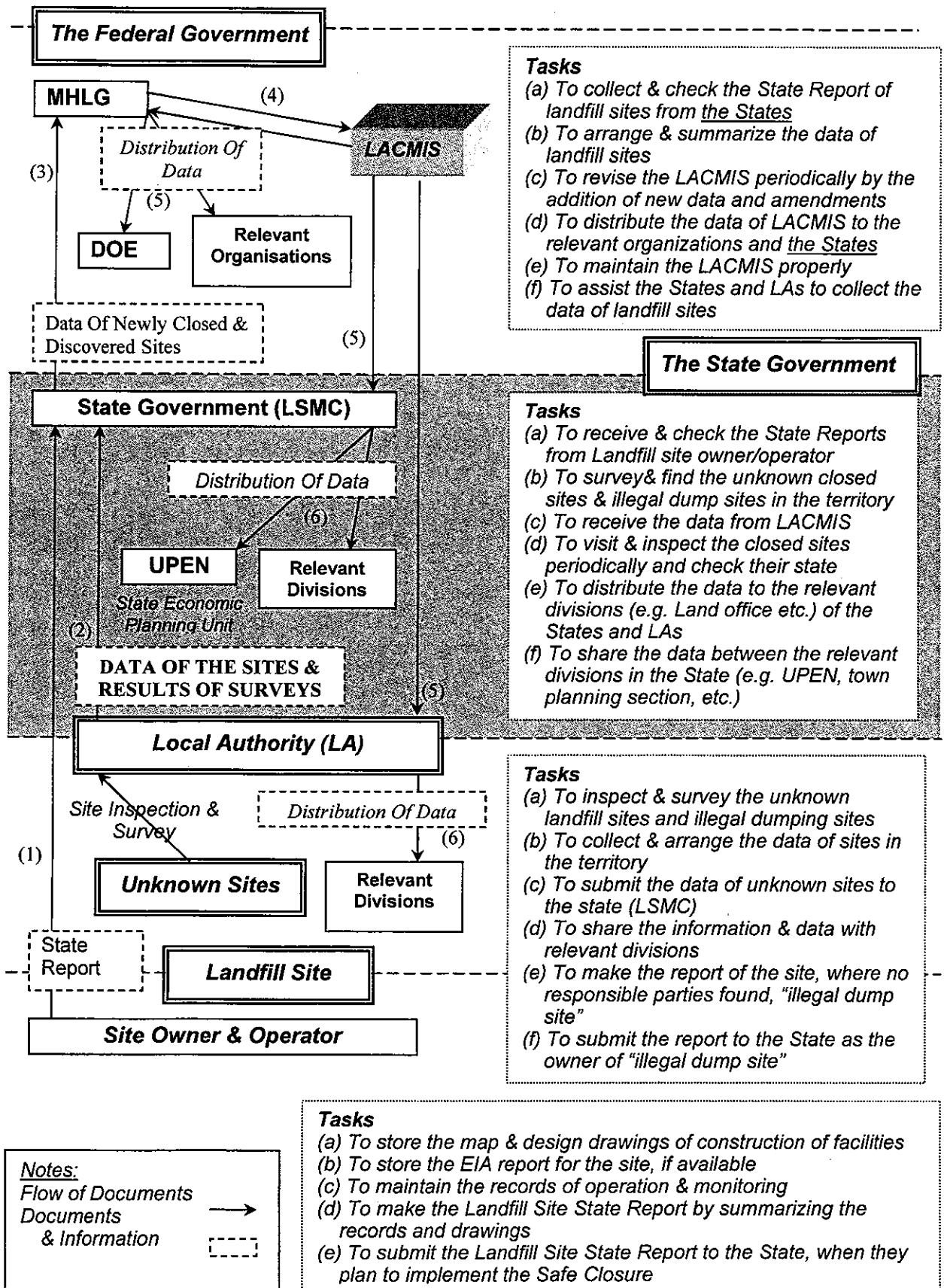


Figure 7.1.4 Roles of the Stakeholders for Management of the LACMIS

7.2 LANDFILL CLOSURE MANAGEMENT INFORMATION SYSTEM (LACMIS)

7.2.1 Introduction

Geographical Information System (GIS) is a computer-based system that is used to input, store, manipulate, display and analyse geographically referenced data. The system is useful where map projections, spatial analysis and the design of the spatial database were required. GIS has the ability to integrate both attribute and spatial data. The system provides a means to link both the information and display them for the ease of viewing and manipulation.

7.2.2 Scope of GIS development

The scope of work for the development of the GIS involves the following:

- Review the data that is collected from the survey of Local Authorities and identify the scope of database that may be developed;
- Assess, based on discussions with the JICA Study team, the database that needs to be developed to support its implementation;
- Prepare the GIS database design and the manual that is required for landfill closure study.

7.2.3 Methodology for development of GIS

(1) Conceptual Design of GIS

The conceptual design of the GIS is primarily an exercise to translate the needs of the client into a specification of the required GIS. It includes formal modelling of the intended GIS database and the initial stages of the planning and design activity. ArcView GIS will be the GIS software.

It begins with the identification of the client needs and goes on to include the creation of interface to facilitate all phases of data collection. This would be followed by the maintenance, design and definition of the GIS database. The output of the conceptual design activity is a data model, which rigorously defines the GIS database and supports the detailed database planning activity.

(2) Data Acquisition

The data shall be sourced from maps and database provided by the questionnaires that have been collected and compiled by JICA Study Team and other consultants that involved in this study. The data that will be captured and converted include those that are spatial (for mapping) that is available from Department of Survey and Mapping Malaysia (JUPEM), other relevant agencies such as Department of Irrigation and Drainage (DID), Town and Planning Department (JPBD) and etc, and attribute data (for database construction) that is generated by the JICA Study Team.

(3) Pre-processing

This involves manipulating the data in several ways so that it may be entered into the GIS. The principal task of pre-processing includes data format conversion. The conversion involves the exercise of extracting information from maps, and printed records (such as Water Intake Points location from Environmental Quality Act and Regulations book) and then recording this information in a computer database.

Coordinate system and projections used will be taken into consideration within this stage. The data layers to be used in the GIS system shall be represented using the same coordinate system and projection. Therefore, rectangular coordinates shall be based on the Malaysia Rectified Skew Orthomorphic (MRSO) Projection system, which has been adopted by the Department of Survey and Mapping Malaysia (JUPEM).

Some errors may occur as a result of computational miscalculations and rounding error in the GIS software, and this does happen from time to time. There are two types of errors; entity error (positional error) and attribute error (typing error). Therefore, the process of the error detection and correction is needed from data quality point of view.

(4) GIS Database Construction

Database construction is the process of building the digital database from the source data, spatial and tabular files. The baseline data in the form of topographic maps for the study area will be integrated in the GIS to allow project planning of landfill closure management. The following attributes will be incorporated:

- Administrative Maps
- Transportation Maps
- Hydrological Maps
- Landfill sites

Figure 7.2.1 shows the database model for this study.

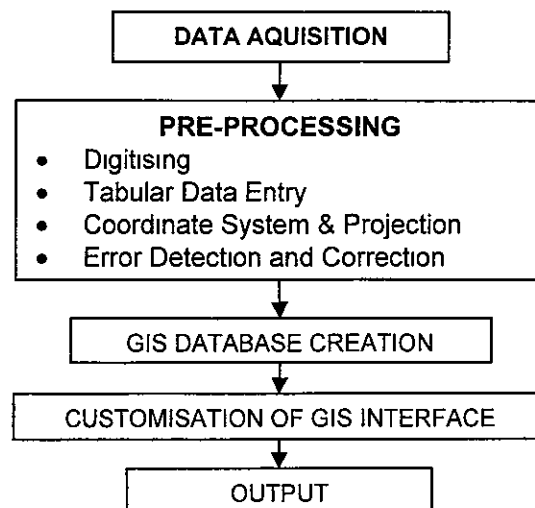


Figure 7.2.1 GIS Methodology Flowchart

(5) Customisation of GIS Interface

Interface of ArcView GIS software will be used and customize to suit the requirement of the end users. Programming language i.e. Avenue will be use in this customisation to create the user friendly environment.

(6) Output

The outputs that may be derived from the information will be those that are useful for planning and management. This include information on the landfill level, the priority of the landfill that required safety closure, environmental impact level for the landfill sites and land utilisation after closure.

7.2.4 GIS System and analysis

(1) Spatial Data Management

The following spatial database was developed:

- Transportation networks which included Road and Rail system for the Peninsular Malaysia (**Figure 7.2.2**);
- Administration boundaries of State and location of major town (**Figure 7.2.3**);
- Landfill Sites location throughout the Peninsular Malaysia (**Figure 7.2.4**);
- Hydrological maps which include river network (obtained from Department of Irrigation and Drainage) and water intake points location throughout the Peninsular Malaysia (**Figure 7.2.5**).

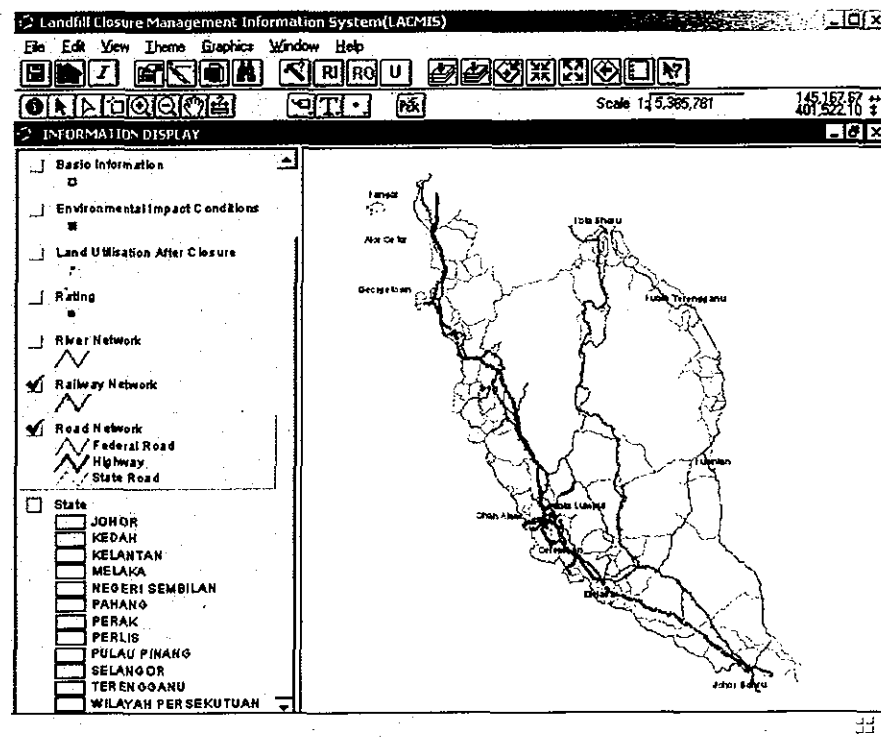


Figure 7.2.2 Spatial Database – Transportation Network

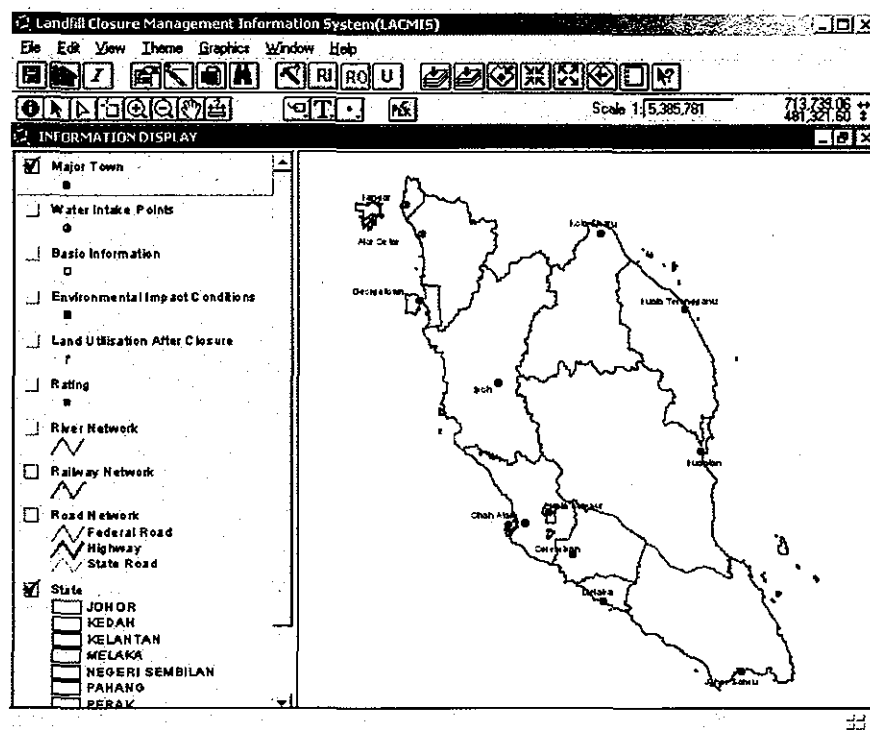


Figure 7.2.3 Spatial Database – Administration Map

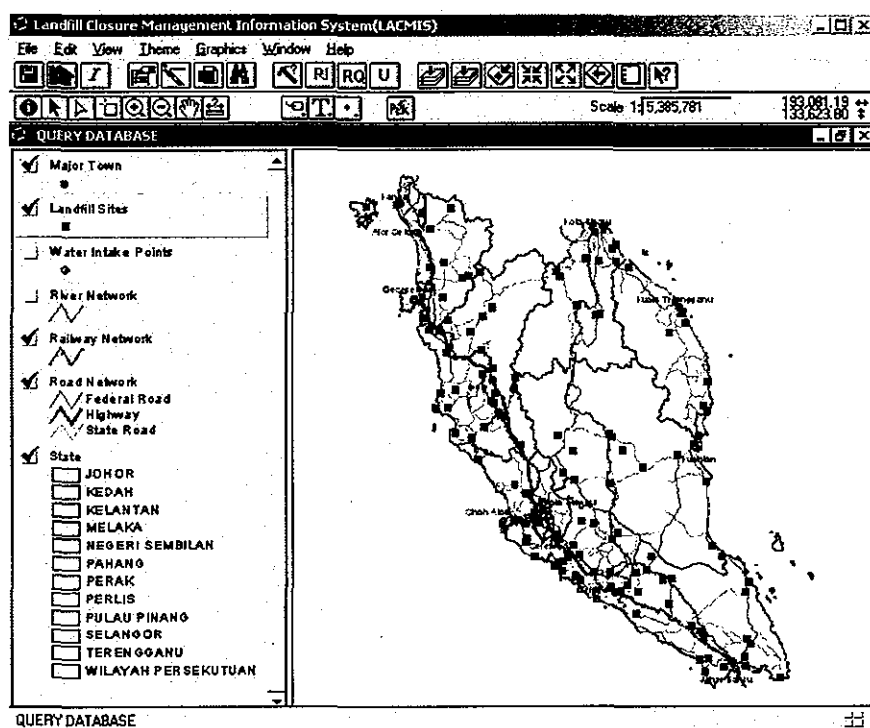


Figure 7.2.4 Spatial Database – Landfill Site Location

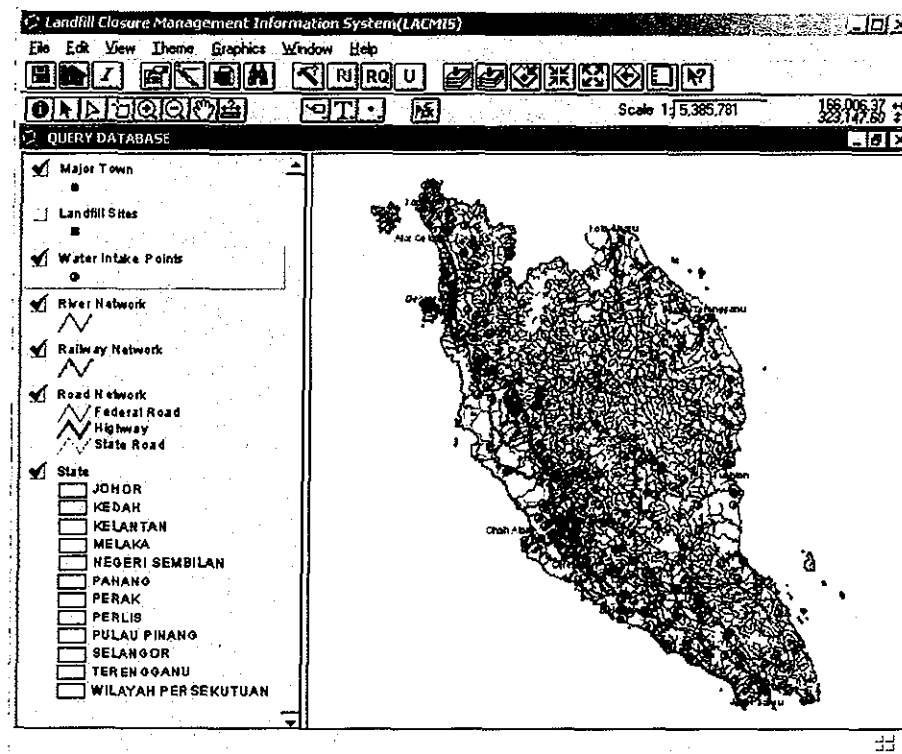


Figure 7.2.5 Spatial Database – Hydrological Maps

(2) Attribute Data Management

Four non-spatial attribute databases were created. These databases captured all the data derived from survey and they form the main elements for the database structure and are categorised as follows:

- Administration – covering Basic Information database;
- Environment – covering Environmental Impact Condition database;
- Planning – covering Land Utilisation database and Rating database.

The Basic Information database consists field name such as Name of Local Authority, Name of Site, Address of Site, Layout site attached, Category, Remaining Life Span, Managed by, Remarks of “Others”, Land Ownership, Remarks on Ownership, Gazetted, Disposal Operation-Year Start, Disposal Operation-Year End, Area (ha), Waste Disposed Daily (t/d), Reasons for Closure, Remarks on Closure and Remarks on Basic Info. **Figure 7.2.6** shows a sample of the data that is in the database.

State	No.	Name of LA	Name of Site	Address of Site
Selangor	SL-01	MP Petaling Jaya	Kelana Jaya	
Selangor	SL-02	MP Klang	Telok Kapas	Telok Kapas, Bande
Selangor	SL-03	MP Kajang	Sungai Kenbong	TP Sementara Sung
Selangor	SL-04	MP Selayang	Kundang	TP Pelupusan Kund
DBKL	DB-01	DB Kuala Lumpur	Taman Beringin	Taman Beringin
N.Sembilan	NS-01	MP Nilai	Pajam	Kg. Gebok, Pajam
N.Sembilan	NS-02	MP Nilai	Kuala Sawah	Jln Kg Stesyen, Rar
N.Sembilan	NS-03	MP Seremban	Sikamat	Sikamat, mukim Par
N.Sembilan	NS-04	MP Port Dickson	Quarters MPPD	Jln By Pass, Port Di
N.Sembilan	NS-05	MP Port Dickson	Bukit Pakung	Jln PD - Bkt Peland

Figure 7.2.6 Basic Information Database

The Environmental Impact database consists of field name such as Landfill Level, Site Condition, Remarks on Site Condition, Waste Covered, Remarks on Waste Covered, Type of Vegetation, Remarks on Vegetation, Landslide, Remarks on Landslide, Soil Subsidence, Remarks on Soil Subsidence, Vector and Animals, Remarks on Vector and Animals, Odour, Gas and Smoke, Remarks on Odour, Gas and Smoke, Leachate Quantity, Remarks on Leachate Quantity, Location on Intake Point, Distance from Intake Point (km), Remarks on Distance from IP, Location of Drinking Water Well, Remarks on Location of DWW, Geological Condition, Remarks on Geological Condition, Public Complaint, Remarks on Public Complaint, Distance to Residential Area, Remarks on Distance to RA, and Remarks on Env Impact Cond. Figure 7.2.7 shows a sample of the database that was created.

No.	Landfill Level	Remarks on Landfill Level	Site Condition	Remarks on Site
SL-01	Level 1		ex Quarry/Mines	
SL-02	Level 1		Swampy area	
SL-03	Open dumping		ex Quarry/Mines	
SL-04	Level 1		ex Quarry/Mines	
DB-01	Level 2		ex Quarry/Mines	
NS-01	Level 1		Swampy area	
NS-02	Level 1		Swampy area	
NS-03	Level 1		Swampy area	
NS-04	Open dumping		Flatland	
NS-05	Open dumping		Flatland, Swampy area	

Figure 7.2.7 Environmental Impact Database

The Land Utilisation database consists of field name such as Existing Land Utilisation, Remarks on Existing Land Utilisation, Surrounding Area, Remarks on Surrounding Area, Ultimate Land Use, Remarks on Ultimate Land Use, Including in Local Dev. Plan, Remarks on Local Dev Plan, Probability of Development, Remarks on Probability of

Development, Distance from Town Centre (km), Remarks on Distance from TC and Remarks on Land Utilisation. **Figure 7.2.8** shows a sample of the database in LACMIS.

No	Existing Land Use	Remarks on Existing Land Use	Surrounding Area	Remarks on Surrounding Area
SL-01	Others	underdeveloping	Industry/Commerce,Housing,R	
SL-02	Vacant		Agriculture,Industry/Commerce	
SL-03	Vacant		Agriculture	
SL-04	Vacant		Vacant	
DB-01	Vacant		Housing	
NS-01	Vacant		Agriculture	
NS-02	Vacant		Agriculture	oil palm plantation
NS-03	Vacant		Industry	oil palm plantation

Figure 7.2.8 Land Utilisation Database

The Rating database consists of field name such as E1 until E14, U1 until U6, Environmental Risk, Value of Land Utilisation and the necessity of safe closure; C1, C2, C3 and C4. **Figure 7.2.9** shows the sample of the database.

No	E1	E2	E3	E4	E5	E6
SL-01	7.5	1.0	2.3	2.0	0.0	
SL-02	7.5	1.0	0.0	2.0	0.0	
SL-03	10.0	1.0	1.5	2.0	0.0	
SL-04	7.5	1.0	0.0	2.0	0.0	
DB-01	5.0	1.0	0.8	2.0	2.5	
NS-01	7.5	1.0	2.3	2.0	0.0	
NS-02	7.5	1.0	0.8	2.0	0.0	
NS-03	7.5	1.0	0.0	2.0	2.5	

Figure 7.2.9 Rating Database

(3) Database Management

All the four database are managed using the Relational Database Management System (RDBMS). This system is most widely accepted for handling non-spatial attribute data in GIS applications and well-adapted to the unpredictable nature of GIS analyses. It organises attribute data into a series of tables that can be used individually or together. Therefore, it is easy to understand and provides efficient data storage capabilities.

The RDBMS system is more flexible due to its ability to retrieve information using any attribute as a key and the data in separate tables can be related using any attribute field that they share in common. As a result, it provides the space for linking the spatial data such as Landfill Site for example, with any of the four non-spatial databases as

mentioned earlier, by using “No_” field as common key. An example will be shown in the next section of this report on how the relational model works.

Since the relational database model does not restrict the range of queries, the user does not need to know the structure of the database to construct a query. A query language that is not dependant on the structure of the database is termed a non-procedural language. The query language SQL (for Standard Query Language) is a widely used example of such a non-procedural language. Non-procedural query languages have become very popular because they are easy to learn yet powerful. They have made information databases much more accessible to users with little or no computer training.

Due to the tremendous functionality of the RDBMS and SQL, both were adapted to link and query the GIS databases for this Landfill Closure Study. Five major components were created for the GIS databases: and these are Information Display, Query Database, Printing/Exporting, Updating and Add/Delete Theme.

(4) Information Display

The relationship between the spatial and non-spatial database can be displayed using the RDBMS. It enables the information of an area of interest to be identified as well as all the other related non-spatial information to be listed within one results window. For example, the environment database can be linked to the base map of Landfill Site through the “No_” field as the common key field. In this way, the information for both spatial and non-spatial will be listed for ease of viewing (Figure 7.2.10 and 7.2.11). The linkage also been created for the viewing of maps and photos. This is based on assigned ID for the spatial data. Figure 7.2.12 shows the sample of linkage between spatial and non-spatial.

No	Longitude	Latitude
SL-01	101 35 30	03 06 35
SL-02	101 23 28	03 02 22
SL-03	101 43 24	02 53 09
SL-04	101 30 27	03 18 45
DB-01	101 40 20	03 13 46
NS-01	101 51 07	02 50 05
NS-02	101 56 24	02 38 05
NS-03	101 59 27	02 45 47
NS-04	101 48 16	02 32 31
NS-05	101 49 57	02 35 00
NS-06	102 01 18	02 26 34
NS-07	101 52 20	02 29 56
ML-01	102 04 00	02 23 47
ML-02	102 12 23	02 28 53
ML-03	102 15 05	02 17 10
ML-05	102 14 50	02 11 37
ML-06	102 26 27	02 16 31
JH-01	102 30 22	02 17 33
JH-02	102 40 20	02 02 30
JH-03	103 50 00	01 35 00
JH-04	103 37 15	01 28 57
JH-05	103 41 43	01 32 29
JH-06	103 51 22	01 29 33
JH-07	103 51 56	01 46 20
JH-09	103 54 17	01 43 38
JH-10	103 51 08	02 16 44

No	Level	L_area
SL-01	Level 1	
SL-02	Level 1	
SL-03	Open dumping	
SL-04	Level 1	
DB-01	Level 2	
NS-01	Level 1	
NS-02	Level 1	
NS-03	Level 1	
NS-04	Open dumping	
NS-05	Open dumping	
NS-06	Open dumping	
NS-07	Open dumping	
ML-01	Open dumping	
ML-02	Open dumping	
ML-03	Level 2	
ML-04	Open dumping	
ML-05	Open dumping	
ML-06	Level 1	
ML-07	Open dumping	
ML-08	Open dumping	
JH-01	Open dumping	
JH-02	Level 1	
JH-03	Level 2	
JH-04	Open dumping	
JH-05	Open dumping	
JH-06	Open dumping	

Figure 7.2.10 Relational Database Linkage between Two Set of Data

(Highlighted areas in both tables are based on a common field name – SL-01)

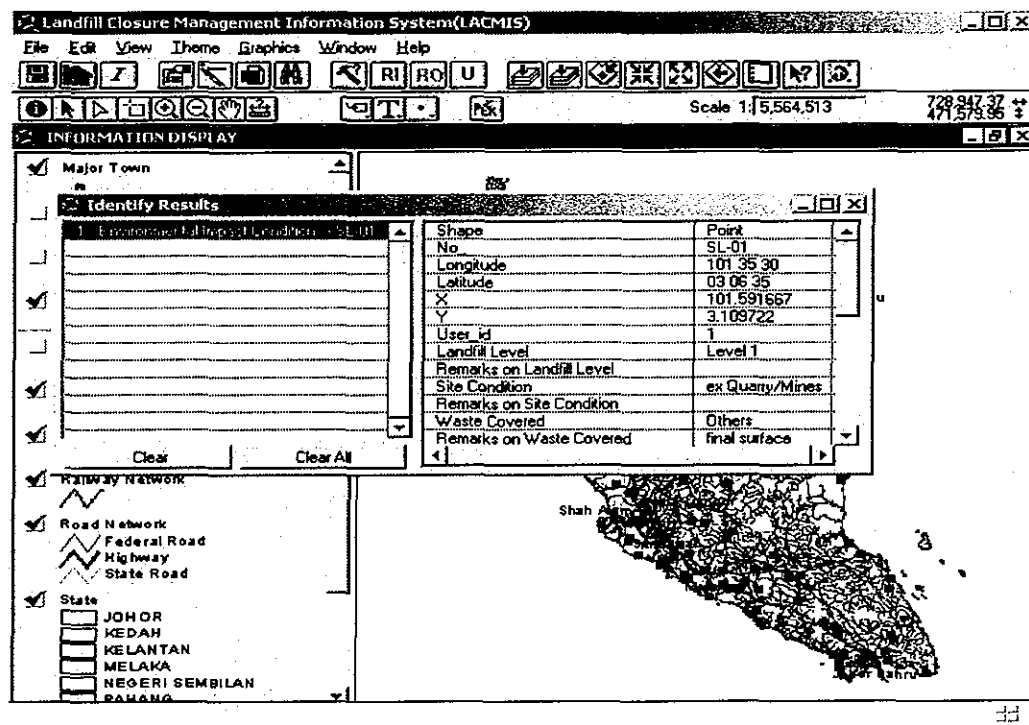


Figure 7.2.11 Linkage between Spatial and Non-spatial Databases

(The Identify Results list box showing information on Environment of the highlighted area in the map)

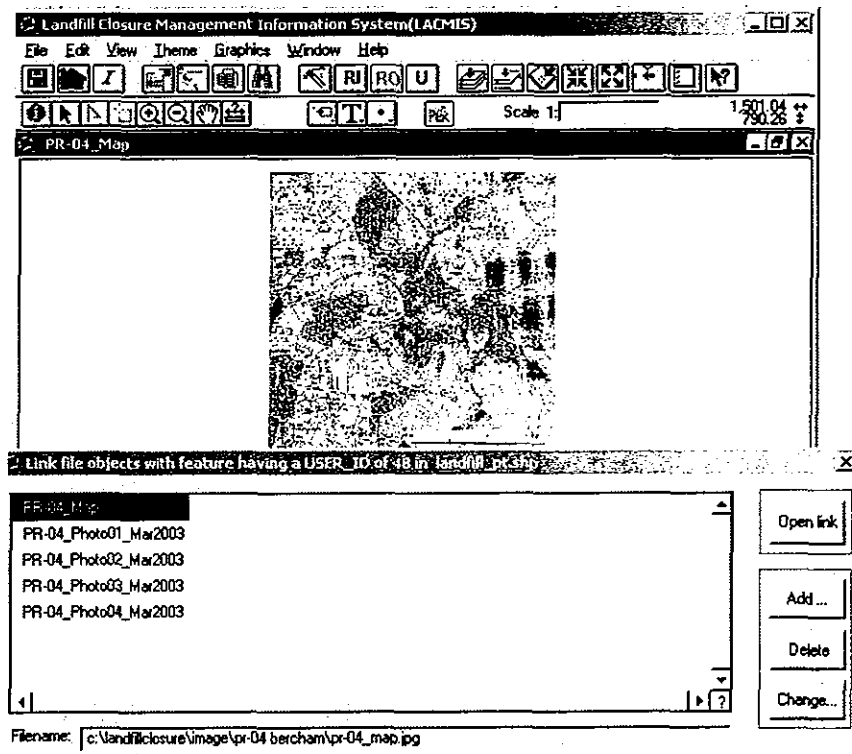


Figure 7.2.12 Linkage between Spatial and Non-spatial Databases

(The map shown that linked to the landfill site)

(5) Query Database

By utilising the non-procedural language SQL that is in-built within the GIS application, it enhances the ability of querying the databases that has been created. In this example, a query expression is set to find out the landfill sites that started after 1995 and still operating now with the level in category of Level 1 or Open Dumping in state of Selangor (**Figure 7.2.13**). As a result, this query expression will invoke the SQL function to select and highlight the features that match the expression to display both the non-spatial (**Figure 7.2.14**) and spatial (**Figure 7.2.15**) information simultaneously. The continuation of the query was shown in **Figure 7.2.16** and **7.2.17**.

Figure 7.2.13 Query Dialog Box of Landfill Sites

Shape	Layer ID	No	Longitude	Latitude	X	Y
Point	1	SL-01	101 35 30	03 06 35	101.591667	3.109722
Point	2	SL-02	101 23 28	03 02 22	101.391111	3.039444
Point	3	SL-03	101 49 24	02 53 09	101.823333	2.885833
Point	4	SL-04	101 30 27	03 18 46	101.507500	3.312778
Point	70	SL-05				
Point	71	SL-06				
Point	72	SL-07				
Point	98	SL-08				
Point	99	SL-09				
Point	100	SL-10				
Point	101	SL-11				
Point	5	DB-01	101 40 20	03 13 40	101.667222	3.227778
Point	6	NS-01	101 51 07	02 50 05	101.851944	2.834722
Point	7	NS-02	101 56 24	02 38 05	101.940000	2.634722
Point	8	NS-03	101 59 27	02 45 47	101.990833	2.763056
Point	9	NS-04	101 48 16	02 32 31	101.804444	2.541944
Point	10	NS-05	101 49 57	02 35 00	101.832500	2.593333
Point	11	NS-06	102 01 18	02 26 34	102.021667	2.442778
Point	12	NS-07	101 52 20	02 29 56	101.872222	2.498889
Point	13	ML-01	102 04 00	02 23 47	102.066667	2.396389
Point	14	ML-02	102 12 23	02 28 53	102.206389	2.481389
Point	15	ML-03	102 15 05	02 17 10	102.251389	2.286111
Point	16	ML-05	102 14 50	02 11 37	102.247222	2.193611
Point	17	ML-06	102 26 27	02 16 31	102.440833	2.275278
Point	18	JH-01	102 30 22	02 17 33	102.506111	2.292500
Point	19	JH-02	102 40 20	02 02 30	102.672222	2.041667

Figure 7.2.14 The Results of the Query Highlighted in the Non-spatial Database
(Highlighted in yellow colour)

Landfill Closure Management Information System(LACMIS)

File Edit Table Field Window Help

4 of 141 selected

Attributes of Landfill Sites

Shape	Layer Id	No	Longitude	Latitude	X	Y
Point	1	SL-01	101 35 30	03 06 35	101.591667	3.109722
Point	2	SL-02	101 23 28	03 02 22	101.391111	3.039444
Point	3	SL-03	101 49 24	02 53 09	101.823333	2.885833
Point	4	SL-04	101 30 27	03 18 46	101.507500	3.312778
Point	70	SL-05				
Point	71	SL-06				
Point	72	SL-07				
Point	98	SL-08				
Point	99	SL-09				
Point	100	SL-10				
Point	101	SL-11				
Point	5	DB-01	101 40 20	03 13 40	101.667222	3.227778
Point	6	NS-01	101 51 07	02 50 05	101.851944	2.834722
Point	7	NS-02	101 56 24	02 38 05	101.940000	2.634722
Point	8	NS-03	101 59 27	02 45 47	101.990833	2.763056
Point	9	NS-04	101 48 16	02 32 31	101.804444	2.541944
Point	10	NS-05	101 49 57	02 35 00	101.832500	2.583333
Point	11	NS-06	102 01 18	02 26 34	102.021667	2.442778

Figure 7.2.17 Results of Query Highlighted in the Non-spatial Database
(Highlighted in yellow colour)

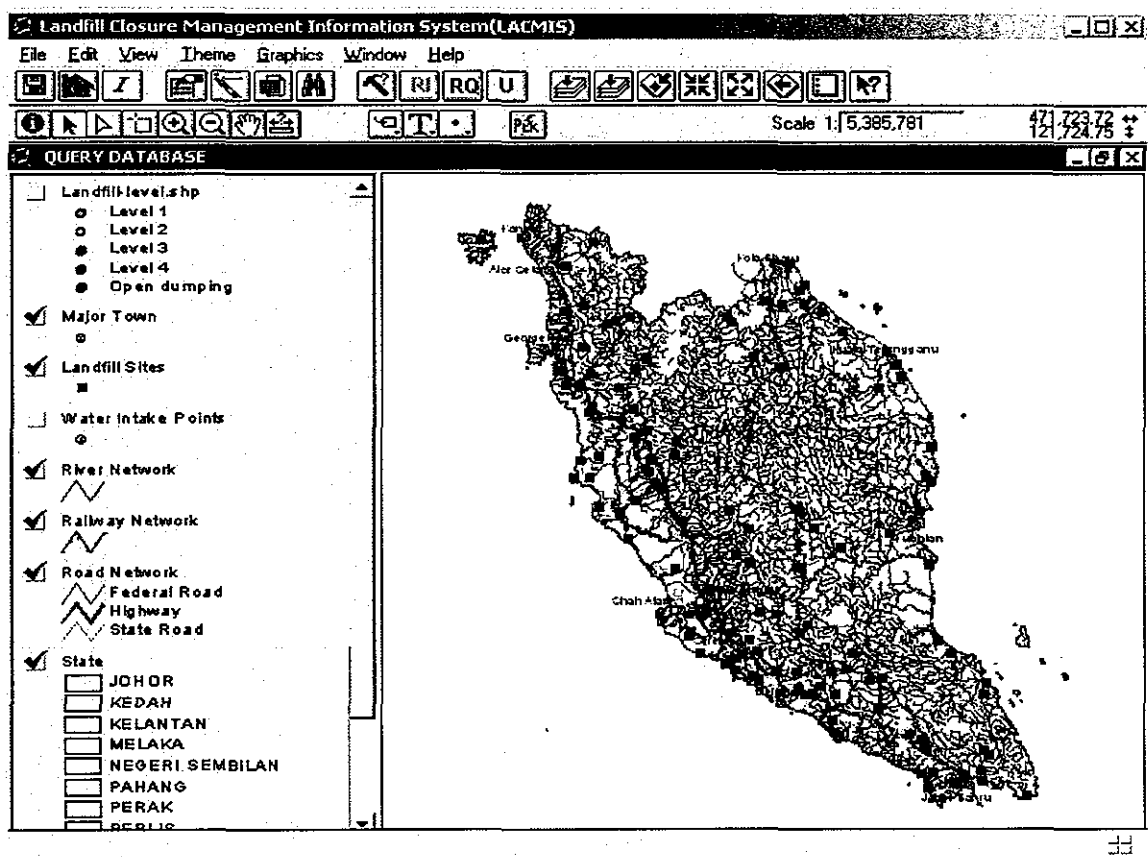


Figure 7.2.18 The Results of the Query Highlighted in the Spatial Database
(Highlighted in yellow colour)

(6) Printing/Exporting

The LACMIS application can produce maps and exporting it to another program according to the user needs. Summary on the table can also be done whereby producing only the items that were required by the users. Producing maps and table based on the query that been done also can be printed out easily. **Figure 7.2.19** shows an example of the map that can be created. **Figure 7.2.20** shows an example of the table summary that was created in LACMIS and can be exported to Microsoft Excel for further analysis.

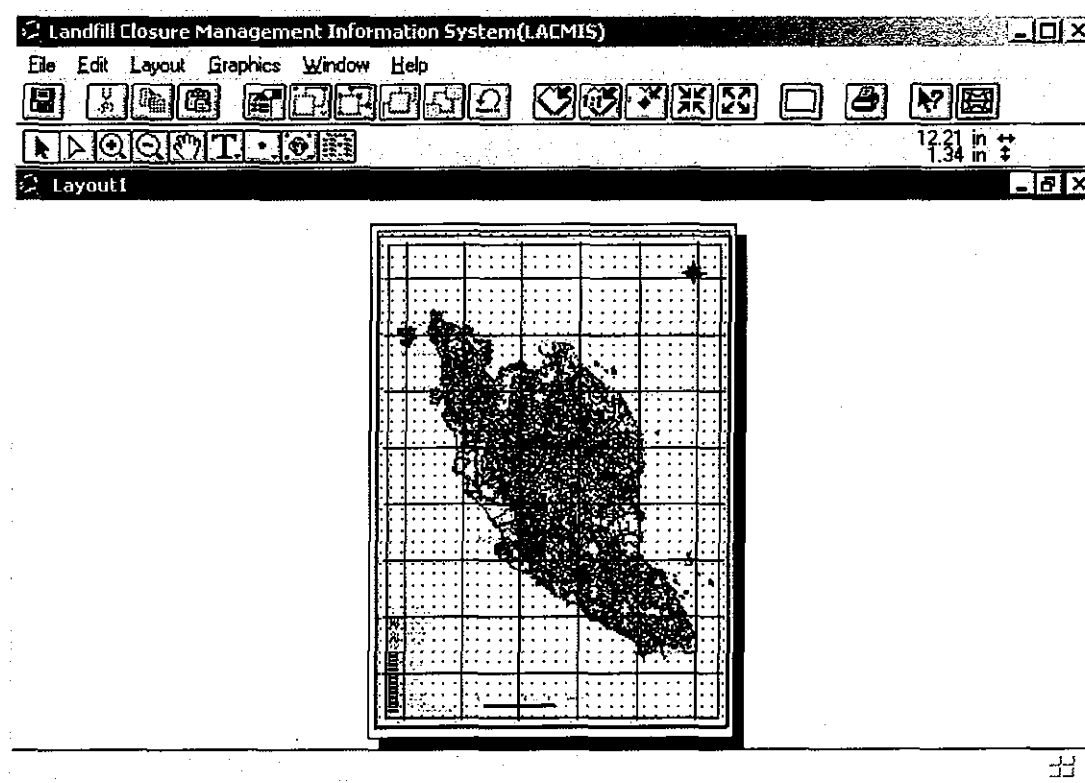


Figure 7.2.19 Map Created in LACMIS Application

No.	Count	First state	First name	First name	Ave
DB-01	1	DBKL	DB Kuala Lumpur	Taman Beringin	
JH-02	1	Johor	MP Muar	Bakri	
JH-03	1	Johor	MP JB Tengah	Ulu Tiram	
JH-07	1	Johor	MD Kota Tinggi	Batu Empat	
JH-13	1	Johor	MD Labis	Pusat Membuang Sampah Jala	
JH-22	1	Johor	MD Tangkak	Tapak Pelupusan Sampah Bat	
JH-27	1	Johor	MD Yong Peng	Tapak Pelupusan Sampah MD	
KD-07	1	Kedah	MD Kubang Pasu	Paya Kemunting	
KL-02	1	Kelantan	MP Kota Baru	Tebing Tinggi	
ML-03	1	Melaka	MB Melaka	Krubong	
MS-02	1	NI Sembilan	MD Sembilan	Garang	

Figure 7.2.20 Table Summary Created in LACMIS

(7) Updating Database

LACMIS application provides the updating of database to help maintaining the latest information. Updating has to be done by the user directly in LACMIS application. Landfill sites and its information with maps and photos can be updated. The database also can be change in Excel if the database was changed totally. **Figure 7.2.21** shows the example of putting in a new site for landfill and **Figure 7.2.22** shows the example of inputing information regarding the site.

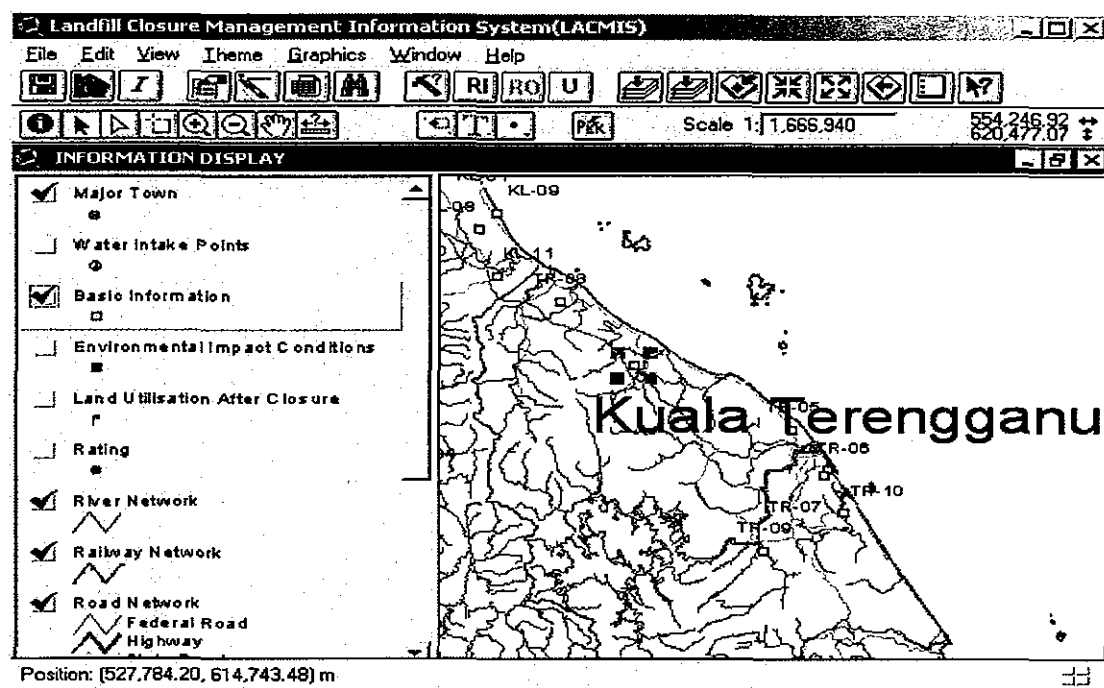


Figure 7.2.21 Inputing New Point in LACMIS

The screenshot shows the LACMIS application interface with a table titled 'Attributes of Basic Information'. The table has columns for Latitude, X, Y, User_id, State, and a final column for site identification. The table contains 141 rows of data, with the first 10 rows showing coordinates and site IDs for Terengganu and Selangor.

Latitude	X	Y	User_id	State	
			70	Selangor	MD K
			71	Selangor	MD K
			72	Selangor	MD K
			98	Selangor	MB S
			99	Selangor	MP S
			100	Selangor	MD K
			101	Selangor	MD S
04 12 22	103.433889	4.206111	34	Terengganu	MP K
04 31 37	103.448333	4.526944	35	Terengganu	MP K
04 31 24	103.445278	4.523333	36	Terengganu	MP K
04 15 42	103.400000	4.261667	37	Terengganu	MP K
05 22 55	103.091111	5.381944	38	Terengganu	MP K
05 16 01	103.167500	5.266944	39	Terengganu	MP K
05 15 12	103.162222	5.253333	40	Terengganu	MP K
			112	Terengganu	MD B
			110	Terengganu	MD H
			111	Terengganu	MD M
			141		

Figure 7.2.22 Data that been Keyed in to LACMIS

7.3 ADD/DELETE THEME

LACMIS application also provide the user with function of adding and deleting the theme that been display in the program. By adding the theme, the user must have the theme existing in the directory that stores the information. The theme that needs to be deleted must be in active form to make it deletable. The file however is not deleted from the folder in the directory that it been stored.

CHAPTER 8 REVIEW OF TECHNICAL GUIDELINE ON SANITARY LANDFILL

8.1 BACKGROUND

8.1.1 Technical Guideline on Sanitary Landfill (draft), 1990

In the late 1980's, in line with JICA's long-term corporation with the Government of Malaysia, JICA's SWM experts were dispatched to Malaysia on 3 occasions to advise on SWM in Malaysia. The results of the activities produced a number of important plans on waste management in Malaysia, such as "The ABC Plan (Action Plan for Beautiful and Clean Malaysia)" which is a comprehensive guide for waste management, and the "Technical Guideline on Sanitary Landfill, Design and Operation (Draft)".

The "Proposed Guideline for the Closure and Rehabilitation of Landfill Sites" was also prepared based on the investigative studies carried out by the Department of Environment, Malaysia (DOE) and the University of Putra Malaysia (UPM) in 1999 on the 10 closed landfill sites in Kuala Lumpur.

The "Technical Guideline on Sanitary Landfill Design and Operation (Draft)" was prepared by the JICA expert, Professor Dr. Matsufuji of the Fukuoka University, Japan in October 1990. The Technical Guideline (Draft) is essential for Solid Waste Management as it focussed on the sanitary landfill as the basic final disposal method for solid wastes.

The Technical Guideline (draft) was prepared and edited with reference to the "Guideline for Construction of Landfill Disposal Site (1989)" published by the Japan Waste Management Association, and also by taking into consideration of the existing conditions of the landfill sites and appropriate technology in Malaysia. The Technical Guideline (draft) also incorporated information and inputs provided by the Malaysian side, such as the information on the regional characteristics of the Local Authorities, the activities of the waste disposal operators, and the technical and economical aspects of sanitary landfill.

The Technical Guideline (draft) is still in the "draft" stage and is currently still under referred by the related authorities of the Government of Malaysia.

8.1.2 Purpose of the Review

Recently in Malaysia, with the growing awareness and urgent need to introduce more advanced concepts in landfill design and operation, has prompted the review of the Technical Guideline on Sanitary Landfill (draft). As such, the previously existing Technical Guideline had to be reviewed and updated to reflect changes in current technology and the standard practices in Malaysia. The review process also looked into the development of the environmentally safe landfill site and the appropriate approach towards development of the concept plan, design and physical work, and the ultimate influence on the closure of the landfill site. The outcome and results of the review was closely related to the development of the new safe closure guideline that was to be the main output of the Study.

Based on the review, "Technical Guideline on Sanitary Landfill, Design and Operation (revised draft 2004)" has been prepared.

8.2 ITEMS TO BE REVIEWED

The items or section in the Technical Guideline that were reviewed were generally to reflect the changes in the present conditions of solid waste management activities in Malaysia, and with consideration and reference to the "Designing procedures and development planning of landfill sites(2001)" and "Guideline for Construction of Landfill Disposal Site (1989)" published by the Japan Waste Management Association. The key items for consideration were as follows.

8.2.1 Recommendation for Semi-aerobic Landfill System

To prevent the various problems caused by the landfill site, it is necessary to provide appropriate structures to the landfill site so as to minimise negative environmental effects to the surroundings. It is also crucial to minimise the potential environment risks of landfill operations by promoting the acceleration of the stabilisation process of the filled waste. The early stabilisation process is important for the safe closure of the landfill site as the environmental risks are reduced, and effective utilisation of the land resources becomes possible.

In order to minimise the environmental impact caused by the existing landfill sites, the introduction of the semi-aerobic landfill system and the proper techniques of construction and operations of the landfills are necessary. The concept of semi-aerobic system, which has been adopted as the standard landfill system for Japan will be used as the basis for the review.

8.2.2 Sanitary Landfill Levels

During the site visits by the JICA Study Team in 2003 for the landfill inventory and data collection exercise, it was noticed that there were some differences in the understanding and interpretation of the sanitary landfill levels by the Malaysian side as a whole. There is the need to develop and establish a standard description for the sanitary landfill levels that should be applied throughout Malaysia.

The review was based on the proposed concept of each of the 4 sanitary landfill levels follows.

<Primitive level>

Level 1 Primitive Landfill required for basic urban sanitation*

(*waste removal from the living environment.)

<Minimum level>

Level 2 Maintain a healthy sanitary environment in and around the landfill at a minimum level

<Basic level>

Level 3 Alleviate the environmental impact of leachate by collecting and circulating the leachate, and accelerate the stabilization of the landfill by maintaining a semi aerobic state

<Advanced level>

Level 4 Control the impact of leachate to the ground water system by treating the leachate and constructing a seepage control works.

8.2.3 Function of the Landfill

The description and functions of the landfill were also reviewed in order to clearly define the main functions, i.e. the "storage and treatment function", "environmental protection function", and "land development function". Since the land development function was considered an important issue for the landfill sites in Malaysia, additional aspects on the land development were included.

8.2.4 Necessity of the Cover Soil

During the site visits, it was also noticed that majority of landfill sites in Malaysia do not have adequate cover soil and daily application of cover soil were not practiced. It was learnt that the main factor for such inadequacy was in the lack of knowledge in landfill operations and the lack of funds for procurement of the cover material. In order ensure that the proper landfill daily covering activities are realised, the relevant technical requirement and procedures were added to the Technical Guideline.

8.2.5 Environmental Monitoring

In the development of a landfill site, it is important to implement the appropriate monitoring activities from the operation stage through to the post-closure stage. From the initial planning stage, it is necessary to consider the monitoring of leachate, effluent discharge, groundwater, landfill gas, etc. The description and recommendations for the preparation of the monitoring programme was included in the Technical Guideline.

8.2.6 Countermeasures for Heavy Rainfalls

In Malaysia, there are heavy rainfalls throughout the year especially during the monsoon season and also experienced the short burst of heavy downpour. It is necessary to plan the storm water drainage system, leachate collection system and leachate treatment system to cater for the sudden increased in the amount of rainwater. The heavy rain will also cause erosion of the slopes, access road, etc. The recommendations and countermeasures for adequate drainage systems have been addressed and included in the Technical Guideline.

In order to minimise the amount of leachate and to provide adequate capacity for the facilities, it is important to drain the storm water quickly by introduction of sectional landfilling and the appropriate intermediate cover soil.

As the heavy rain will cause erosion of the slopes, damage the access road, etc., proper countermeasures were also included.

8.2.7 Sectional Land filling

When dealing with relatively large landfill site, the land filling process should be carried out in cells or in sectional manner. Compartmental land filling has the benefit of

encouraging better surface water drainage, reducing leachate and minimising the operation and maintenance cost. The recommendations for compartmental land filling have also been included.

8.2.8 Design Requirements for Leachate Control Systems

The design requirements for the leachate control system have been included in the Technical Guideline. These included the recommendations on the calculations of leachate treatment facilities.

8.2.9 Treatment Method of Leachate

The typical domestic waste compositions of Malaysia are mainly organic matters and chemical products waste such as plastics have been increasing. Based on future SWM plans, the incineration of waste may be introduced and will result in the increase of ash that will be disposed of at the landfills. Such ashes have some levels of dioxins, heavy metals, etc. and will affect the quality of the leachate generated. Hence, there will be the need for more sophisticated leachate treatment methods to cater for such adverse effects. Landfills corresponding to Levels 3 and 4 are expected to be introduced mainly in Malaysia.

The recommended techniques for leachate pre-treatment, leachate circulation, biological treatment, physical treatment and natural treatment have been addressed and included in the guideline. However, due to the varying composition and quality of the leachate, the recommendations only address the most suitable methods for leachate treatment. The actual design of the treatment system will not be addresses and should be carried out externally with the assistance of wastewater treatment experts.

8.2.10 Occupational Health and Safety

The occupational health and safety directives are essential for all landfill operations and managements. The recommendations and precautionary items on the sanitary and working conditions have been addressed and included.

8.2.11 Landfill Operation and Maintenance Control

Recently, some landfill sites have been handed over to private contractors to operate and maintain the sites for the LAs, and privatisation process is expected to be introduced in the near future in Malaysia. Under such conditions, the Government will have the responsibility to monitor all the landfill operations and to check on the activities of the operators. Certain performance indicators have been considered and included. The main indicators included the recording of the incoming waste, landfill activities, conditions of the facilities and equipment, the outcome of environmental protection and monitoring, and the social considerations.

The newly developed “Part III Operation and Maintenance Control of Sanitary Landfill” has been added to the Technical Guideline.

8.2.12 Rehabilitation of Existing Landfill Site

From the landfill inventory survey, it was found that more than 90% of landfill sites in Peninsular Malaysia are operated as open dumping grounds. The necessity and recommendations for rehabilitation of the existing landfill sites were reviewed and addressed in the Guideline.

8.2.13 Cost for Landfill Construction and Operation

The assumptions and cost estimations for landfill construction were addressed and included for references. The actual cost estimation for each site should be carried out individually depending on site specific requirements.

8.2.14 Explanation of Intermediate Treatment

To refine the waste management plan comprehensively by introduction of the appropriate intermediate treatment, such as recycling, incineration system, etc. is important for the effective utilisation of resources and construction of a recycle-based sustainable society. It is also important for the reduction of environmental load to the landfill site, and for the early stabilisation of landfill site.

Therefore, introduction on the related intermediate treatment systems such as recycling, incineration system, were added.

8.2.15 Updating of Data

The outdated information and data were reviewed and updated based on the new information attained from the Study.

8.2.16 Revision of the Contents

The overall contents of the original Guideline (draft) have been reviewed and revised to reflect the necessary changes and updating works. The salient points of each chapter have been highlighted and presented for ease of reference.

The comparisons of the contents of original guideline and reviewed guideline are shown in **Table 8.2.1**.

Table 8.2.1 Comparison of the Contents of Original Guideline and the Reviewed Guideline

Technical Guideline (2003) -revised draft -		T. Guideline (1990)	Main point of review
Part I Introduction and Basic Design of Sanitary Landfill			
Chapter 1 Landfill Disposal Concept			
1.1	Landfill Disposal Concept	I Chap 1	- The description with focus on the landfill Level 3 and 4 (early stabilization by semi-aerobic structure), recycling and intermediate treatment.
1.2	Classification of Landfill Types	II Chap 1 1.1 2	
1.3	Decomposition and Stabilisation of Waste at the Sanitary Landfill	II Chap 1 1.1 1	
Chapter 2 Scope of Application			
2.1	Scope of Application	I Chap 2	
Chapter 3 Planning Sanitary Landfill System			
3.1	Solid Wastes Management Master Plan	I Chap 3 3.1 (1)	
3.2	Laws and Regulations Related to Solid Waste Management	I Chap 3 3.1 (1)	- Updating the information about the laws and regulations.
3.3	SWM Intermediate Treatment	I Chap 3 3.1 (2)	
3.4	Formulation of The Implementation Plan	I Chap 3 3.2	- The inter-relationship with other processes
3.5	Basic Design Parameters	I Chap 3 3.3	- Updating the information about the waste generation amount and composition - The necessity of the landfill cover. - The way of calculating the cover material volume.
Chapter 4 Formulation of Sanitary Landfill System			
4.1	Functions of Sanitary Landfill System	II Chap 1 1.1 II Chap 1 1.2	- The review of landfill functions. - The prevention of vectors. - The addition of "Post-Closure Land-use"
4.2	Determination of Site Location	I Chap 4 4.1 I Chap 4 4.2	
4.3	Environment Protection	I Chap 4 4.3 I Chap 4 4.4	- The addition of "environmental monitoring plan".
4.4	Management of Sanitary Landfill System	I Chap 4 4.5	- The explanation about three management (operations management, environmental management, Closure management)
4.5	Post closure land use Plan	I Chap 4 4.6	- The addition of the viewpoint about early stabilization
4.6	Other Considerations	I Chap 4 4.7 I Chap 4 4.8 I Chap 4 4.11 I Chap 4 4.12	- The addition of "occupational health and safety" and "Weather Conditions"
4.7	Performance Indicators for the Landfill Management / Control		- The condition report about the landfill management / control (from the private sector to the government)

Technical Guideline (2003) - revised draft -		T. Guideline (1990)	Main point of review
Part II Technical Guideline on Sanitary Landfill System			
Chapter 1 General			
1.1	Integrated Landfill Facilities	II Chap 2 2.1	
1.2	Classification of Sanitary Landfill Levels	II Chap 1 1.3	- The additional explanation about the characteristic of the Level 1 to 4.
Chapter 2 Waste Retaining Facility			
2.1	Functions of Waste Retaining Facility	II Chap 2 2.2 1	
2.2	Planning and Design Concepts	II Chap 2 2.2 2	
2.3	Selection of Waste Retaining Facility and Structural Configuration	II Chap 2 2.2 3	
2.4	Loading on Waste Retaining Facility	II Chap 2 2.2 4	
2.5	Corrosion Control	II Chap 2 2.2 5	
Chapter 3 Stormwater Drainage Facility			
3.1	Functions of Stormwater Drainage Facility	II Chap 2 2.3 1	
3.2	Types of Stormwater Drainage Facility	II Chap 2 2.3 2	
3.3	Planning and Design of Stormwater Drainage Facility	II Chap 2 2.3 3	
Chapter 4 Leachate Collection Facility			
4.1	Functions of Leachate Collection Facility	II Chap 2 2.4 1	
4.2	Components of Leachate Collection Facility	II Chap 2 2.4 2	
4.3	General Structure of Leachate Collection Facility	II Chap 2 2.4 3	
4.4	Design Flow and Cross Sectional Area	II Chap 2 2.4 4	
4.5	Loading Conditions	II Chap 2 2.4 5	
4.6	Other Aspects in Planning	II Chap 2 2.4 6	
Chapter 5 Liner Facility			
5.1	Functions of Liner Facility	II Chap 2 2.5 1	
5.2	Types of Liner Facility	II Chap 2 2.5 2	
5.3	Structural Characteristics and Construction of Liner Facility	II Chap 2 2.5 3	- The required function of the earth lining - The landfilling method which doesn't break the liner facility
5.4	Underground Water Drainage Facility	II Chap 2 2.5 4	

Technical Guideline (2003)- revised draft -		T. Guideline (1990)	Main point of review
Chapter 6 Gas Venting Facility			
6.1	Necessity of Gas Venting Facility at Landfill Site	II Chap 2 2.6 1	
6.2	Planning and Design Concepts	II Chap 2 2.6 2	
Chapter 7 Leachate Treatment Facility			
7.1	General	II Chap 2 2.7 1)	
7.2	Design for Capacity of Leachate Controlling and Treatment Facilities	II Chap 2 2.7 2), 3) 1, 2, 3	- The additional explanation about the calculation method for capacity of leachate control facility and designed leachate volume.
7.3	Design for Raw and Treated Leachate Quality	II Chap 2 2.7 3) 4, 5	
7.4	Methods for Leachate Treatment	II Chap 2 2.7 3) 6	- The additional explanation about the combination of treatment process - The additional explanation about outline for each treatment method (recirculation system, biological treatment, physio-chemical treatment, natural attenuation, sludge treatment)
7.5	Operation and Maintenance for Leachate Treatment Facility	II Chap 2 2.7 4)	
Chapter 8 The Landfilling Process			
8.1	General	II Chap 3 3.1	
8.2	Methods of Landfilling	II Chap 3 3.2	
8.3	Section Landfilling		- The reduction of leachate by stepwise approach such as section landfilling.
8.4	Working Face	II Chap 3 3.3	
8.5	Construction of Landfill Slopes	II Chap 3 3.6	
8.6	Cover Soil	II Chap 3 3.4	
8.7	Landfill Equipment	II Chap 3 3.2 5 2)	
Chapter 9 Landfill Control Facilities			
9.1	Types of Control Facilities	II Chap 4 4.1	
9.2	Waste Inspection and Measurement	II Chap 4 4.2	
9.3	Monitoring	II Chap 4 4.3	
9.4	Site Office	II Chap 4 4.4 1, 2	
9.5	Safety Measures	II Chap 4 4.4 3	

Technical Guideline (2003) - revised draft -		T. Guideline (1990)	Main point of review
Chapter 10 Other Related Facilities			
10.1	Composition of Other Related Facilities	II Chap 5 5.1	
10.2	Access Roads	II Chap 3 3.5	
10.3	Littering Prevention Facility	II Chap 5 5.3	
10.4	Notice Boards, Fencing, Gates and Security	II Chap 5 5.4	
10.5	Fire Prevention Facility	II Chap 5 5.5	
10.6	Disaster Prevention Facility	II Chap 5 5.6	- The additional explanation about the appropriate disaster prevention facilities.
Chapter 11 Capital Costs for Construction of Landfill Sites			
11.1	Basis for Estimation		- The criteria for selection of the facilities.
11.2	Cost Estimation		- The estimated capital expenditure for the procurement, installation and construction of the core facilities.
Part III Management of Sanitary Landfill			
	Newly added	none	
Part IV Appendix			
Appendix 1	Master Plans for Solid Waste Disposal		- The main points of the master plan for solid waste management.
Appendix 2	SWM Intermediate Treatment Technologies		- The overview of the intermediate treatment technologies (physical processing, biological treatment, thermal treatment)
Appendix 3	Example of Design Calculation for Leachate Treatment and Controlling Facility		- Two example of calculation for leachate treatment and controlling facility.

