

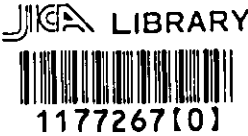
JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF HOUSING AND LOCAL GOVERNMENT, MALAYSIA

**THE STUDY ON
THE SAFE CLOSURE AND REHABILITATION OF
LANDFILL SITES
IN MALAYSIA**

**FINAL REPORT
Volume 4**

**Pilot Projects on Safe Closure and
Rehabilitation of MSW Landfill Sites**



NOVEMBER 2004

**YACHIYO ENGINEERING CO., LTD.
EX CORPORATION**

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The Final Report of “The Study on The Safe Closure and Rehabilitation of Landfill Sites in Malaysia” is composed of seven Volumes as shown below:

- | | |
|-----------------|--|
| Volume 1 | Summary |
| Volume 2 | Main Report |
| Volume 3 | Guideline for Safe Closure and Rehabilitation of MSW Landfill Sites |
| Volume 4 | Pilot Projects on Safe Closure and Rehabilitation of Landfill Sites |
| Volume 5 | Technical Guideline for Sanitary Landfill, Design and Operation (Revised Draft, 2004) |
| Volume 6 | User Manual of LACMIS (Landfill Closure Management Information System) |
| Volume 7 | Data Book |

This Report is “**Volume 4 Pilot Projects on Safe Closure and Rehabilitation of Landfill Sites**”.

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DEFINITION OF TERMS

Landfill site: The site where municipal wastes are disposed off by land filling. Such sites may be provided with various landfill facilities. In accordance with the “Technical Guideline on Sanitary Landfill, Design and Operation (Revised draft)”, the landfill sites can be categorised into 4 types; i.e. from Level 1 (L1) to Level 4 (L4). Open Dumpsite is categorised as Level Zero (L0.)

Closed landfill site: The landfill site where the waste filling activities have been completed.

Abandoned site: The landfill site where the owners/operators could not be identified “Illegal dump site” will be included in this category.

Safe closure (SC): “Safe closure” consists of the activities of “Physical closure (PC)” and “Post-closure management (PCM)”.

Physical closure (PC): The action by which the necessary measures for safe closure has been applied to the entire landfill area.

Closure levels (C1, C2, C3, C4): There are 4 closure levels, i.e. from C1 to C4. These closure levels indicate the countermeasures necessary to control the environmental pollution and hazards from the landfill sites. Each landfill site should be assigned with a targeted closure level at the initial stages of the safe closure process.

Post-closure management (PCM): The management activities necessary to operate, maintain and monitor the landfill facilities such as the leachate treatment, landfill gas treatment, cover soil etc. The activities also include the environmental monitoring, landfill stabilization monitoring and management of information/ records of the closed landfills.

Post-closure land use: The re-utilization of closed landfill sites for purposes other than for waste filling. The PCM activities should be continued through out the post-closure land use.

CHAPTER 1 INTRODUCTION

1.1 PURPOSE

The three Pilot Projects (PP) for safe closure of landfills have been implemented at the Ampang Jajar Landfill Site, Pekan Nenasi Landfill Site and the Ampang Jaya Closed Landfill Site. The purpose and the scope of work of the Pilot Projects are as follows;

- To develop and to analyse/examine the standards as set out in the Guideline for landfills under different conditions.
- To consider the suitability of construction methods and materials.
- To estimate the necessary construction costs.
- To identify the issues associated with the construction programme and the project period.
- To ascertain the capability of local engineers and contractors with regards to design, construct and monitoring.
- To show and learn from the progress and results of the safe closure and rehabilitation of landfills.
- To establish standard monitoring and maintenance requirements in the post safe closure phase.
- To provide actual pilot project case study and implementation examples for future references.

A brief outline of the pilot projects implementation is shown in **Table 1.1.1**.

Table 1.1.1 Outline of the Pilot Projects

| Item | Ampang Jajar PP | Pekan Nenasi PP | Ampang Jaya PP |
|---|--|---|---|
| 1. Status of landfill | Landfill just before closure | Operating landfill | Closed landfill |
| 2. Key points in safe closure consideration | Safe closure of landfill that has been operated under improved conditions | Model for rehabilitation of operating landfill located on wetlands in order to ease safe closure after completion of landfill operation | Safe closure of landfill originally not having suitable siting and operating conditions |
| 3. Targeted safe closure (improvement) levels | Landscaping and safe closure to Level C3 | Safe closure to Level C3 | Safe closure to Level C2 |
| 4. Brief description of the pilot projects | <ul style="list-style-type: none"> ⇒ Improvement of Step 1 slope (bottommost slope) ⇒ Facilities provision at Step 2 slope and above (storm water and leachate drainage, gas vents) ⇒ Length approx. 250m ⇒ Southern part or eastern slope | <ul style="list-style-type: none"> ⇒ Western part (Cell 1, Phase 1) upgrading to semi-aerobic landfill ⇒ Area 0.9ha | <ul style="list-style-type: none"> ⇒ Facilities provision for western valley portion ⇒ Channelling of storm water away from the site through drainage system installation ⇒ Area approx. 3.0ha |

CHAPTER 2 SELECTION OF PILOT PROJECT SITES

2.1 PROCEDURE FOR PILOT PROJECTS SITE SELECTION AND CANDIDATE SITES

The pilot project (PP) sites were selected based on the landfill inventory data for both operating and closed landfill sites prepared by MHLG, and the site reconnaissance survey carried out by the JICA Study Team. A total of 19 landfill sites in the Peninsular Malaysia were identified as candidate sites for the pilot projects. The two main factors for the selection considerations were, i) their geographical locations, and ii) their closure stages, i.e. in operations, about-to close or closed sites. The brief descriptions of the candidate sites are shown in **Table 2.1.1**.

The conditions of the 19 identified candidate sites were examined and evaluated. Subsequently, with close discussions with the counterpart members from MHLG and members of the Technical Working Group (TWG), the 3 Pilot Project sites were selected.

The general procedures for the selection of the PP sites are shown in **Figure 2.1.1**.

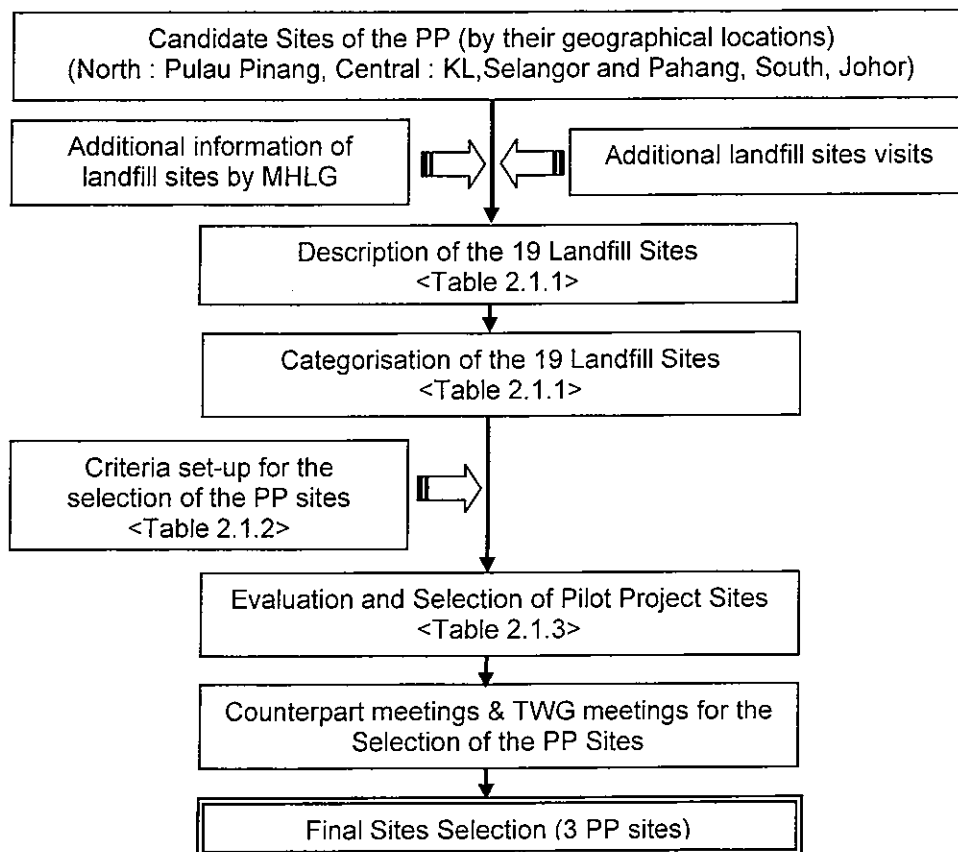


Figure 2.1.1 Site Selection Procedure for the Pilot Projects

Table 2.1.1 Descriptions of Candidate Sites for the Pilot Projects

| No | Name | State | Area (ha) | Operation year | Landfill level | Waste amount received (ton/day) | Sitting condition | Distance from City/Town Centre (Km) | Managed by | Post closure utilisation |
|----|------------------|--------------|-----------|----------------|----------------|---------------------------------|-------------------|-------------------------------------|-----------------|--------------------------|
| 1 | Ampang Jajar | Pulau Pinang | 17 | 1980' / 2003 | 3/4 | 400 | Flatland | 5 | Local authority | (Operating) |
| 2 | Pulau Burung | Pulau Pinang | 64 | 1980' / 2006 | 3 | 1000 | Flatland | 25 | Private | (Operating) |
| 3 | Jelutong | Pulau Pinang | 20 | 1980' / 2001 | 0/1 | n.a. | Sea shore | 4 | Local authority | None |
| 4 | Matang (Taiping) | Perak | 8 | 2000' / 2010 | 1/2 | 200 | Swamp area | 8 | Local authority | (Operating) |
| 5 | Jabor (Kuantan) | Pahang | 24 | 1990' / 2005 | 3 | 400 | Swamp area | 20 | Private | (Operating) |
| 6 | Gambang | Pahang | 7 | 1980' / 2001 | 0 | n.a. | Hilly slope | 30 | Local authority | None |
| 7 | Pekan Nenas | Pahang | 5 | 1970' / 2010 | 0/1 | n.a. | Swamp area | 8 | Private | (Operating) |
| 8 | Larkin | Johor | 15 | 1980' / 1998 | 1/2 | n.a. | Hilly slope | 5 | Local authority | None |
| 9 | Ulu Tiram | Johor | 44 | 1997' / 2003 | 3 | 1500 | Hilly area | 30 | Private | (Operating) |
| 10 | Pasir Gudang | Johor | 12 | 1980' / 2002 | 0/1 | n.a. | Swamp | 12 | Local authority | None |
| 11 | Tanjung Langsat | Johor | 25 | 2002' / 2015 | 4 | 250 | Flat land | 16 | Local authority | (Operating) |
| 12 | Air Hitam | Selangor | 45 | 1998' / 2008 | 4 | 1200 | Hilly area | 35 | Private | (Operating) |
| 13 | Kelana Jaya | Selangor | 48 | 1981' / 1996 | 1/2 | 400 | Former quarry | 6 | Local authority | None |
| 14 | Sri Petaling | FTKL | 21 | 1979 / 1991 | 1 | 1500 | Former quarry | 15 | Local authority | Park |
| 15 | Paka I | FTKL | 13 | 1989 / 1994 | 0/1 | 1400 | Flatland | 1 | Local authority | Housing |
| 16 | Sungai Besti | FTKL | 14 | 1989 / 1995 | 1/2 | 1200 | Former quarry | 10 | Local authority | Commercial |
| 17 | Taman Beringin | FTKL | 12 | 1991 / 2003 | 1/2 | 600 | Former quarry | 3 | Private | (Operating) |
| 18 | Jinjang Utara | FTKL | 65 | 1979 / 1996 | 0/1 | 1000 | Former quarry | 20 | Local authority | None |
| 19 | Ampang Jaya | Selangor | 10 | 1980' / 1997 | 1/2 | n.a. | Hilly slope | 5 | Local authority | Fruits field |

2.2 CATEGORISATION, EVALUATION AND SELECTION OF PILOT PROJECT SITES

2.2.1 Categorisation of Candidate Sites

In order to examine and to evaluate the characteristics of the 19 pilot project candidate sites, they were categorised into the following parameters;

- i. Closure stage of landfill
- ii. Risk to the environment
- iii. Potential for post closure utilisation
- iv. Landfill facility level

From the evaluation, it was found that, of the 19 landfill sites, 10 sites were still in operations or were about to close. The remaining 9 sites were already closed. From the categorisation, it was found that 14 of 19 sites were categorised as being “high risk to the environment” (5 sites are still in operations and 9 were closed sites). It should be noted that all the closed landfill sites evaluated were considered to have some risks to the environment. This could be due to the fact that the landfill levels of closed sites were comparatively low. Nevertheless, 11 of the 19 sites were considered to have high potential for post closure utilisation.

The results of the categorisation for the pilot project candidate sites are shown in **Table 2.2.1**. Based on the results, it was decided to select the pilot project sites from each of the landfill category; i.e. category A, B and C, with considerations given to the “geographical location”. No candidate site was listed in category D.

Table 2.2.1 Categorisation of Candidate Sites for the Pilot Projects

| Landfill category | Closure Stage | Impact on environment | Post closure land-use | Landfill facility level | Landfill sites |
|-------------------|---------------------------------------|-----------------------|-----------------------|--|---|
| A | Operating (Incl. just before closing) | High risk | High potential | 0 / 1 / 2 3 / 4 | 3. Jelutong, 17. Taman Beringin NIL |
| | | | Low potential | 0 / 1 / 2 3 / 4 | 4. Matang, 7. Pekan Nenasi 5. Jabor |
| Low risk | | High potential | 0 / 1 / 2 3 / 4 | NIL 1. Ampang Jajar, 11. Tanjung Langsat, 12. Air Hitam | |
| | | Low potential | 0 / 1 / 2 3 / 4 | NIL 2. Pulau Burung, 9. Ulu Tiram | |
| C | Already closed | High risk | High potential | 0 / 1 / 2 3 / 4 | 8. Larkin, 10. Pasir Gudang, 13. Kelana Jaya, 15. Paka-1, 16. Sungai Besi, 18. Jinjang Utara NIL |
| | | | Low potential | 0 / 1 / 2 3 / 4 | 6. Gambang, 14. Sri Petaling, 19. Ampang Jaya NIL |
| Low risk | | High potential | 0 / 1 / 2 3 / 4 | NIL NIL | |
| | | Low potential | 0 / 1 / 2 3 / 4 | NIL NIL | |

2.2.2 Evaluation and Selection of Pilot Project Sites

(1) Evaluation of candidate sites

As shown in **Figure 2.1.1**, the procedures for the selection of the Pilot Project sites were based on 7 main criteria, i.e. 4 critical criteria and 3 supporting criteria. The details of the criteria are shown in **Table 2.2.2**.

The pilot project sites shall fulfil all the conditions for each of the critical criterion, whilst the supporting criteria were prepared for further consideration during the final selection.

Table 2.2.2 Site Selection Criteria for the Pilot Projects

| Item | Criteria |
|---------------------|--|
| Critical Criteria | <p>Criteria-1: The site should represent a typical landfill site in the Peninsular Malaysia.</p> <p>Criteria-2: The site should be closed within 3 years and/or is already closed.</p> <p>Criteria-3: The closed site should not be in private ownership and should be left as an open-space.</p> <p>Criteria-4: The site should be of suitable scale for the Pilot Project.</p> |
| Supporting Criteria | <p>Criteria-5: Closure levels 2 and 3, as proposed by the JICA Study Team should be applied.</p> <p>Criteria-6: The pilot projects are expected to show certain improvement to the existing conditions and to verify the results. Therefore, it is preferable that periodic monitoring has been carried out at the site.</p> <p>Criteria-7: The controlling Local Authority should be proactive and have a strong intention to improve the site.</p> |

Based on the above criteria, the results of the evaluation are tabulated in **Table 2.2.3**.

(2) Selection of Pilot Project Sites

From the evaluation the candidate sites were presented to the Technical Working Group (TWG) for discussion and their consideration. The meeting were attended by representatives from MHLG, EPU, DOE, UPM, MP Seberang Perai, MD Kuantan, JICA Advisory Committee, JICA Malaysia and the Team Members. As a result of the discussions, the 3 Pilot Project sites were selected, They are;

- i. Ampang Jajar Landfill site (Pulau Pinang)
- ii. Pekan Nenasi Landfill site (Pahang)
- iii. Ampang Jaya Closed Landfill site (Selangor)

Some of the main items discussed during the TWG meeting were as follows;

The maximum of 3 pilot project sites were selected, one site from each of the landfill category: i.e. from categories A, B and C.

I. Category A

The Jabor landfill site was preferred since it had highest priority in this category. However, a landfill gas extraction project has been planned for the site and has been committed by the Local Authority. Therefore, the landfill was not selected so as not to disturb the existing development plans for the site, and also to avoid any overlapping work on the landfill.

Alternatively, by taking into consideration of the meteorological conditions of the Eastern region of Peninsular Malaysia, the importance to introduce a safe closure model for an East coast landfill site was highlighted. Hence, the Pekan Nenasi landfill site was selected.

II. Category B

The Ampang Jajar landfill site was selected based on the following;

- The site will be closed soon and safe closure measures will be required.
- Environmental monitoring has been carried out continuously.
- The Local Authority has strong intension to implement the safe closure.

III. Category C

The Pasir Gudang, Jinjang Utara and Ampang Jaya closed landfill sites were considered. However, it was decided that the pilot project site should be located within the Klang Valley area in order to have a site closer to Kuala Lumpur. As such, the Pasir Gudang site in Johor was omitted. As for the Jinjang Utara site, it was learnt that although the site has been closed, it is still receiving construction waste, and the boundary of the landfill and the surrounding housing development and farming area were not clearly defined. Furthermore, the safe working environment at the site cannot be guaranteed due to the high volume of waste and the steep slopes. Hence, it was decided to select the Ampang Jaya closed landfill site from category C instead.

The photographs of each of the candidate site for the pilot project are tabulated in **Plate 2.2.1**.

Table 2.2.3 Evaluation of Candidate Sites for the Pilot Project

| Landfill Category | No | Name | State | Environ. Impact | Post closure utilization | Landfill level | Critical Criteria | | | Supporting Criteria | | | Pilot Project Sites | |
|-----------------------|----|-----------------|-----------|-----------------|--------------------------|----------------|-------------------|------------|------------|---------------------|------------|------------|---------------------|------------|
| | | | | | | | Criteria-1 | Criteria-2 | Criteria-3 | Criteria-4 | Criteria-5 | Criteria-6 | | Criteria-7 |
| A (Operating site) | 3 | Jelutong | P. Pinang | High | High | 0/1 | 0 | Δ | x | 3 | --- | --- | x | |
| | 17 | Taman Beringin | FTKL | | | 1/2 | 0 | --- | x | --- | 3 | --- | --- | x |
| | 4 | Matang | Perak | | | 1/2 | 0 | x | --- | --- | 3 | --- | --- | x |
| | 7 | Pekan Nenas | Pahang | | | 0/1 | 0 | Δ | --- | --- | 3 | --- | Δ | Δ |
| | 5 | Jabor | Pahang | | | 2/3 | 0 | 0 | Δ | --- | 3 | --- | 0 | 0 |
| B (Operating site) | 1 | Ampang Jajar | P. Pinang | Low | High | 3/4 | 0 | --- | 0 | 3 | 0 | 0 | 0 | |
| | 11 | Tanjung Langsat | Johor | | | 4 | x | --- | x | --- | 3 | --- | Δ | x |
| | 12 | Air Hitam | Selangor | | | 4 | x | x | --- | --- | 3 | 0 | 0 | x |
| | 2 | Pulau Burung | P. Pinang | | | 3 | 0 | --- | --- | --- | 3 | 0 | 0 | x |
| | 9 | Ulu Tiram | Johor | | | 3 | 0 | --- | x | --- | 2 | --- | Δ | x |
| C (Closed site) | 8 | Larkin | Johor | High | High | 1/2 | 0 | 0 | 0 | 2 | --- | --- | x | |
| | 10 | Pasir Gudang | Johor | | | 0/1 | 0 | 0 | 0 | 0 | 2 | --- | --- | 0 |
| | 13 | Kelana Jaya | Selangor | | | 1/2 | 0 | 0 | x | 0 | 2/3 | --- | --- | x |
| | 15 | Paka 1 | FTKL | | | 0/1 | 0 | 0 | x | 0 | 2 | --- | --- | x |
| | 16 | Sungai Besi | FTKL | | | 1/2 | 0 | 0 | x | 0 | 2 | --- | --- | x |
| | 18 | Jinjang Utara | FTKL | | | 0/1 | 0 | 0 | Δ | 0 | 2/3 | --- | --- | Δ |
| | 6 | Gambang | Pahang | | | 0 | 0 | 0 | 0 | x | 2 | --- | --- | x |
| | 14 | Sri Petaling | FTKL | | | 1 | 0 | 0 | x | 0 | 2 | --- | --- | x |
| | 19 | Ampang Jaya | Selangor | | | 1/2 | 0 | 0 | Δ | 0 | 2 | --- | Δ | Δ |

Note: O: satisfied, Δ: partially satisfied, x: not satisfied, ---: unknown

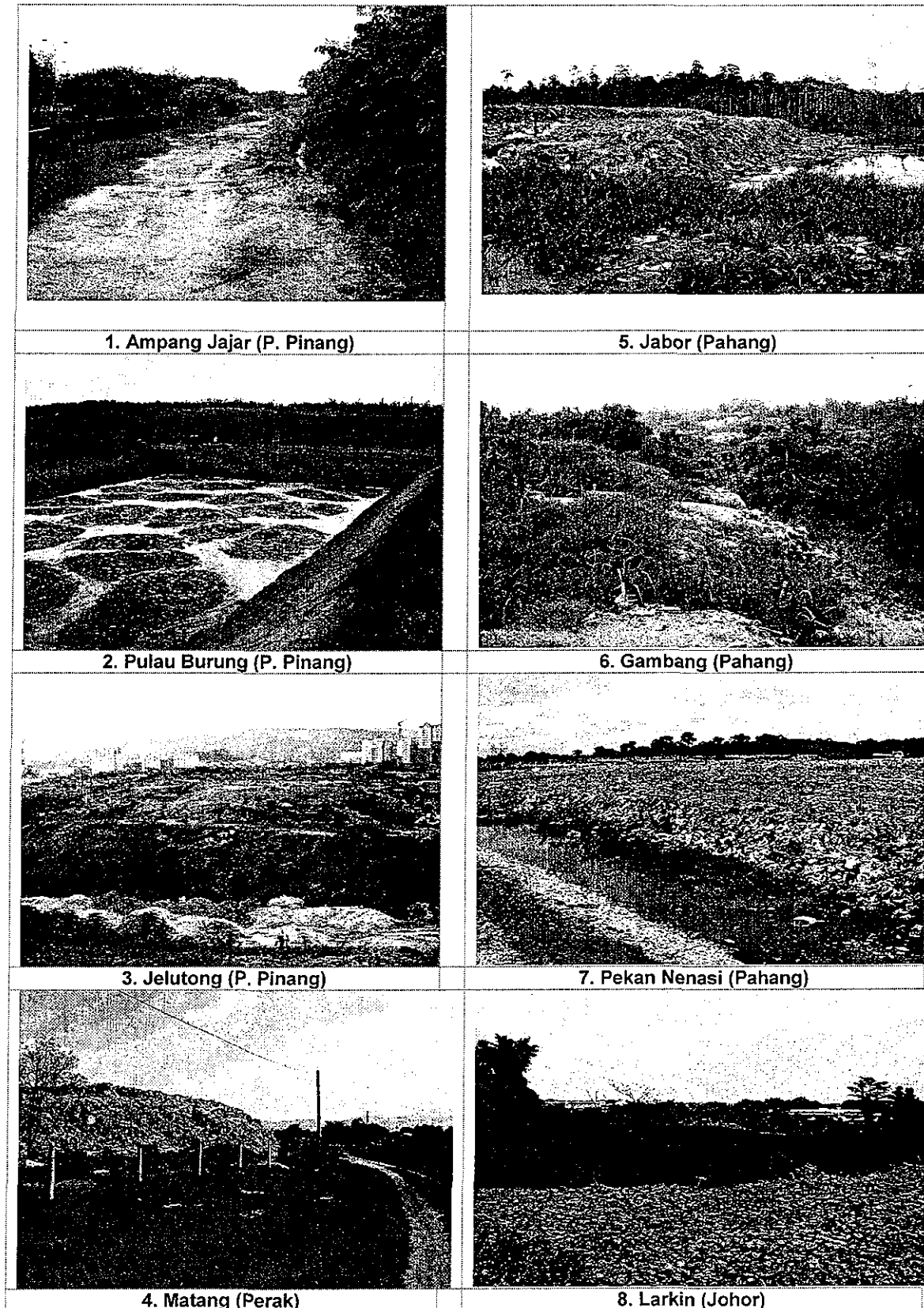


Plate 2.2.1 Candidate Sites for the Pilot Project (1/3)

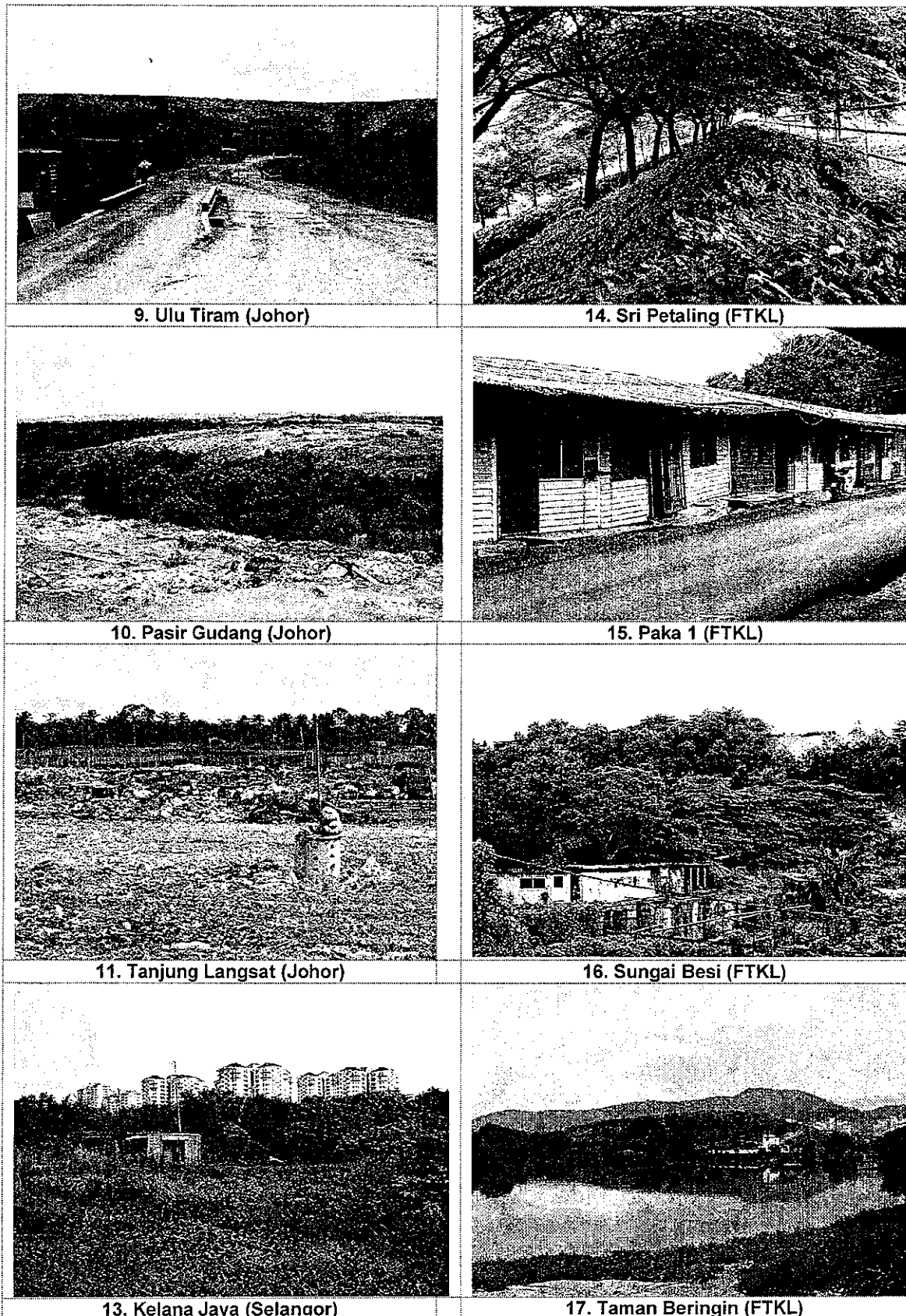


Plate 2.2.1 Candidate Sites for the Pilot Project (2/3)

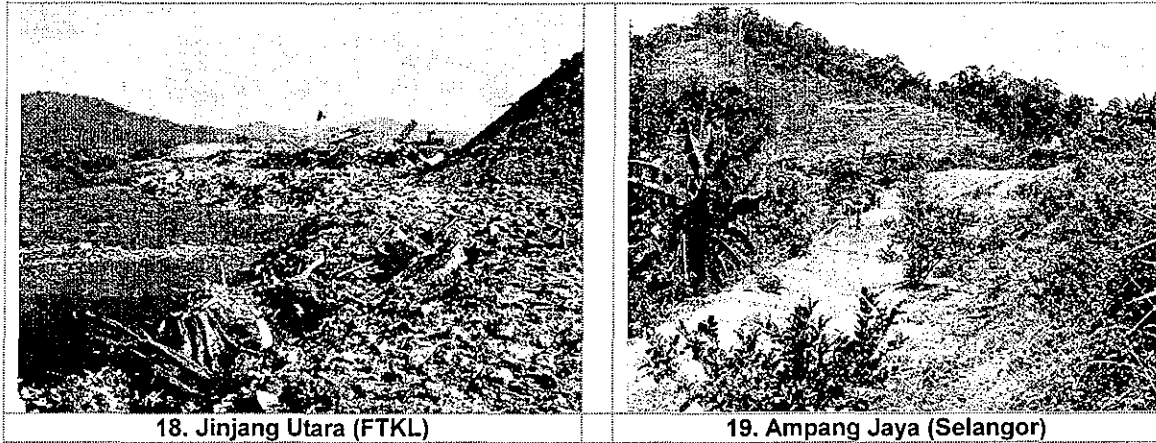


Plate 2.2.1 Candidate Sites for the Pilot Project (3/3)

CHAPTER 3 EXAMINATION OF PILOT PROJECT COMPONENTS

3.1 AMPANG JAJAR LANDFILL SITE (PULAU PINANG)

3.1.1 Outline of the site

(1) General

The Ampang Jajar landfill site started operations in the 1980s on a wetland beside the Perai River. The site was used as an open dumping site until 1988 and it was improved to level L3 sanitary landfill in 1988 with advice and cooperation from the JICA experts. For the improvement works, leachate collection pipes, gas ventilation pipes, leachate pond and leachate re-circulation system were provided. With the leachate re-circulation system, the site was operated as a semi-aerobic landfill site. The landfill site is operated by MP Seberang Perai (MPSP) and is considered to be one of the best landfill sites in Malaysia. About 400 tonne per day of municipal waste were disposed at the site and for the past 15 years, more than 2.2 million tonnes of waste has been disposed. i.e. $400 \text{ tonnes/day} \times 365 \text{ day/year} \times 15 \text{ years} = 2,190,000 \text{ tonnes}$.

The site occupies an area of about 17 ha and the final height of the waste layers is about 20 m. Ever since its closure in November 2003, all the waste are now sent to the neighbouring new transfer station and hauled to the Pulau Burung landfill site for disposal, about 40 km south of Ampang Jajar. Currently, MP Seberang Perai is providing the final cover on the top layer as part of their safe closure work.

The site is about 5 km from the MP Seberang Perai Council building and sandwiched between the riverside park on the West and the North-South Highway on the East. There are some housing development projects planed for at the neighbouring lot to the South.

At present, the site has been earmarked for development as an “urban forest/park” after closure.

(2) Basic Concept for safety closure

a) Soil condition

The site is located on a wetland next to the Perai River and situated on marine clay grounds. Since the ground is quite impervious, the level of groundwater contamination is considered to be low. At present, there is no groundwater drinking water well installed around the site and there is also no water intake point near the site.

b) Existing facilities, before Pilot Project

The site was provided with a leachate collection piping system, three leachate treatment aeration ponds and a leachate re-circulation system. The leachate was treated by filtration through a bed of activated carbon prior to discharge to the effluent discharge drains. Crude leachate retention ditches have been installed previously surrounding the site and flows to the leachate treatment aeration pond. Since the leachate treatment

facilities have already been provided, it was decided the existing facilities were to cater for Pilot Project and may be continued to be used after the Pilot Project works.

c) Proposed landfill gas extraction and utilisation project

During preliminary discussions with MP Seberang Perai, they informed that MPSP have approved the proposed landfill gas utilisation project planned for constructed at the top of the landfill. Hence, as not to interfere with the proposed project, the Pilot Project was limited to the sloped area. Also, it is necessary to construct a main drainage at the hilltop to prevent overflow of rainwater to the slope area

Since then, MPSP has recently informed that the proposed gas extraction project may not be implemented due to some technical reasons. Nevertheless, the Study Team recommends that with or without the gas extraction project, the entire site should be properly closed and consideration should be given toward the alternative use of the top of the landfill, perhaps developed as a sports field, a playground or a park.

d) Proposed land use plan

Based on discussions with MPSP, it was learnt that the landfill site have been planned to be used for redevelopment to an urban forest area that includes a park, a playground and a sports ground. The proposed zoning plan is summarised in **Table 3.1.1**.

Table 3.1.1 Proposed Land Use Plan for Ampang Jajar Landfill Site

| Area | Characteristic | Land use |
|----------------------|--|--|
| West slope | - Beside the riverside park - View from park and bridge shall be considered | Park and green zone |
| East and north slope | - View from highway shall be considered | Green zone |
| Top of hill | - Proposed temporary use for gas extraction project - Flat area | Playground and sports ground zone |
| South part | - New transfer station in operations - Near to the housing area | Facility zone including transfer station Buffer zone for housing area |

3.1.2 Safe closure plan

The proposed safe closure plan for the Ampang Jajar landfill is summarised in **Table 3.1.2**.

Table 3.1.2 Summary of the Safe Closure Plan for Ampang Jajar Landfill Site

| Items | Measures |
|--------------------------------|--|
| 1. Hydrogeologic information | Wet land covered with marine clay layer |
| 2. Final site topographic plan | Height about 20 m from ground level. Steep slope should be moderated to a gradient of 1:2 |
| 3. Final cover design | Barrier layer should be about 0.6 m thick including existing covering soil Top layer should be between 0.15m to 0.3 m thick |

| | |
|----------------------------------|--|
| 4. Covering soil material | Good topsoil |
| 5. Final landscape and site plan | Redeveloped as an urban forest |
| 6. On site facilities | Hilltop Playground / sports ground and park (Proposed temporary use for gas extraction project) Slope Urban forest & park South part Facility area including new transfer station |
| 7. Phase closure plan | Phase I Transfer station and facility area Phase II Closure of slope Phase III Closure of hilltop |
| 8. Surface water management plan | Main drainage Surrounding drainage of hill top Drainage system of slope |
| 9. Ground water management plan | Monitoring |
| 10. Leachate management plan | Leachate collection system at the bottom (already installed) Leachate and gas collection at steps of slope Leachate aeration pond (already installed) Leachate re-circulation system (already installed) Leachate filtration and discharge (already installed) |
| 11. Landfill gas management plan | Gas collection system and discharge pipe for slope (Proposed temporary use for gas extraction project at top of landfill) |
| 12. Monitoring | Groundwater monitoring well Gas and waste layer monitoring well Leachate pond and gas discharge pipe will be used for monitoring Monitoring of surrounding stream |

a) Final site elevation and gradient plan

The overall height of the site was about 20 m with slopes that have about 5-7 steps and have been covered with soil. Some parts of the slopes were gentle but other parts have been eroded and should be repaired. Generally, the first step is quite steep and should be reformed to 1:2 gradient.

b) Final cover design

The final cover should comprise of a barrier layer and a topsoil layer. Since the covering soil has been provided the recommended barrier layer should be about 600 mm thick including existing covering soil layer. The topsoil layer should be 150 mm thick at the flat area and at the gentle sloped area of less than 1:3 gradient. As it may be difficult to lay the topsoil layer on the slopes with a gradient of 1:2, the recommended minimum 50 mm topsoil layer should be applied to provide for vegetation and grass growth and to protect slopes.

c) Final landscape and site plan

In accordance with the existing zoning plan, the site is to be used as an urban forest area that includes a park, green spaces, and a playground. The entire site with the exception of the facility area at the south side has been planned to be open to public in the future. However, the Study Team recommends that the site should not be opened to the public too soon after closure as the site must be allowed time to stabilise, the leachate quality to improve, landfill gas generation to reduce and no further uneven ground settlements.

d) On site facility

For safe closure, the recommended facilities to be constructed and maintained at the Ampang Jajar landfill site should be as follows.

- Leachate treatment system Leachate aeration pond and filtration facility
(Already provided, but regular maintenance must be carried out)
- Monitoring facility Groundwater monitoring wells,
Gas monitoring wells
- After care office Office facility (Already provided)

e) Leachate management plan

Since the site has been provided with some leachate collection pipes at the base, the leachate will be collected and channelled to the existing treatment ponds. However, for the sloped area, additional leachate collection system should be installed to prevent seepage of leachate from the slopes. The leachate collected at the slopes should also be channelled to the existing leachate treatment system.

Leachate shall be treated to meet Standard B. Initially, the BOD target of less than 50 mg/l will be set in order to comply with the effluent discharge conditions of Standard B. This target should be achieved through aeration and re-circulation. The leachate from this site, in principle, should be discharged after the filtration process. The effluent from the filtration process is expected to meet Standard B.

It was noted that the site have four leachate aeration ponds, a re-circulation system and filtration facilities, with one located at the north and at the west and the others are located at the south side. These facilities will be used to ensure the leachate quality meets the effluent standard even after closure.

f) Landfill gas management

The landfill gas should have been collected and vented through the existing gas ventilation pipes. However, the Study Team recommends that horizontal gas collection system should be installed to cover the entire site in order to prevent gas hazards and accelerate the stabilisation process.

For the Pilot Project, horizontal gas collection system should be installed at the top edge of the slopes and connected to the existing gas discharge pipes and to the leachate collection pipes installed at the steps. The vertical gas venting pipes should be installed at regular intervals.

g) Monitoring facility

For environmental monitoring purposes, the recommended monitoring facilities should be provided and the monitoring activities be carried out regularly. The facilities for the monitoring activities are;

- Ground water monitoring - 3 monitoring wells
- Surface water monitoring - North and west stream, South drainage
- Landfill gas monitoring - Gas venting pipes and gas monitoring well
- Settlement - 3 settlement plates on top of the landfill
- Solid waste stabilisation - To monitor at the gas monitoring well

General plan and safe closure plan of Ampang Jajar landfill site are shown in **Figure 3.1.1** and **Figure 3.1.2**, respectively.

3.1.3 Pilot Project

a) Selection of Pilot Project area

Due to the Pilot Project is not a full scale project certain limitations and budget constraints, the Pilot Project implementation could only be carried out on a partial section of the entire site.

Two sections of the landfill site were identified, i.e. the Western Slopes, facing the park and river and the Eastern Slopes, facing the highway. The comparison between the two areas are summarised in **Table 3.1.3**.

Table 3.1.3 Comparison of Pilot Project Areas

| Item | Western Slopes (Facing the park and river) | Eastern Slopes (Facing the highway) |
|--------------------------------------|---|---|
| Approximate Area | about 3 ha | Eastern slope about 3 ha |
| Public Awareness | <ul style="list-style-type: none"> • Only visible by visitors to the park. • View of the site from the nearby road is blocked by tall trees and the new Transfer Station • Heavy traffic on the road | <ul style="list-style-type: none"> • Highly visible from major highway along side the site • Heavy traffic on the highway |
| Overall improvements / Effectiveness | Medium | High |

Based on the above comparison, the selection of the Pilot Project area was decided based on the aesthetic viewpoint, the higher public consciousness factor and the overall higher improvement factor.

b) General Scope of Work

The general scope of work for the Ampang Jajar PP is summarised as follows. The type of work is explained in more details in *Volume 4, Chapter 6*.

- Final cover and re-formation of the slopes
- Turfing and planting trees on the slopes
- Leachate collection system, leachate collection pipe, leachate pond, aerator and re-circulation pump

- Gas Collection System
- Improvement to existing perimeter roads
- Stormwater drainage
- Topographic survey
- Soil investigation test
- Installation of ground water monitoring wells and gas monitoring well

3.2 PEKAN NENASI LANDFILL SITE (PAHANG)

3.2.1 Outline of the Site

(1) General

The Pekan Nenasi landfill site is situated on a wetland, south of Pekan Town and by the side of the East-Coast trunk road. The plan of the site is shown in Figure 3.2.1.

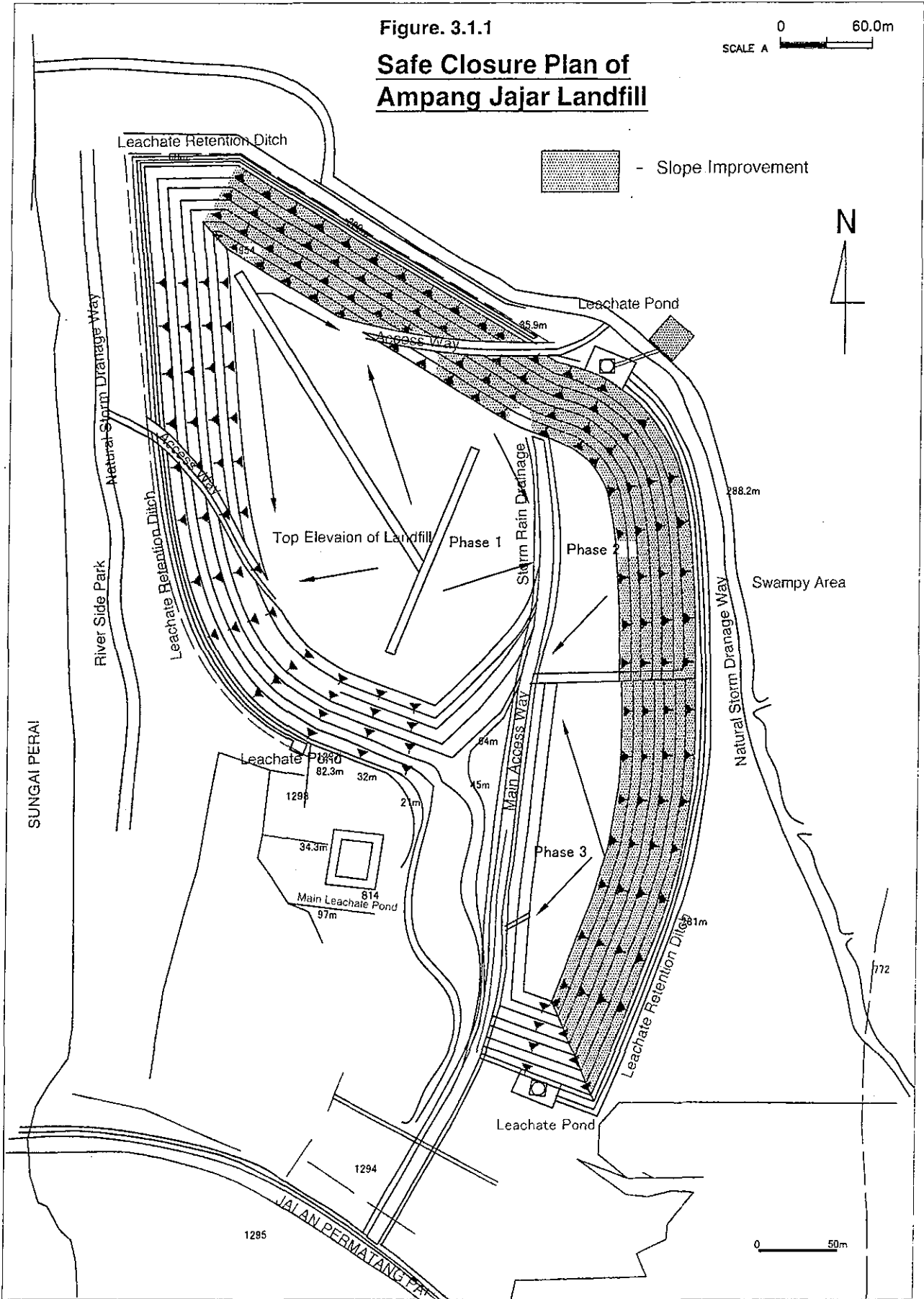
The landfill started operations in 1988 and was operated by Majlis Daerah Pekan. At present, the landfill is operated and managed by Alam Flora Sdn Bhd, under an interim concession agreement prior to the privatisation of the Solid Waste Management services. About 30 tonnes of waste per day is disposed at the site.

The site consists of two parts; i.e. the eastern front part nearest to the truck road and the western inner part, separated by the stream. The front part is about 2.8 ha and the back part is about 19 ha. Adjacent to the site is the 1.5 ha sewage sludge disposal site belonging to the sewerage services company, Indah Water Konsortium Sdn Bhd. Since April 2003, with the closure of the eastern front part, the waste is now being disposed at the new cells at the western back part.

In 2002, with the financial subsidy from MHLG, the Majlis Daerah Pekan with the assistance of Alam Flora Sdn Bhd carried out some upgrading work at the site to include the preparation of the western part, installation of the weighbridge, construction of the office building, and the vehicle maintenance workshop and yard. In 2003, further upgrading of the access road was carried out including the installation of the perimeter fence to prevent stray animals from entering the site. By the end of 2003, additional subsidy from MHLG provided for the installation of the leachate collection system, in line with the JICA pilot project, at the western part, on the second cell, and the provision of final cover for the eastern front part that was closed.

(2) Total Plan for Pekan Nenasi Landfill

The Pekan Nenasi landfill site is vast and should be able to accept waste for a long time. For the safety closure of landfill site in the future, a Total Plan for the site is urgently required. The total plan will comprise of a development plan for the operations of the western back part and the closure plan for the eastern front part. All future construction and operations will have to be carried out in line with the plan.

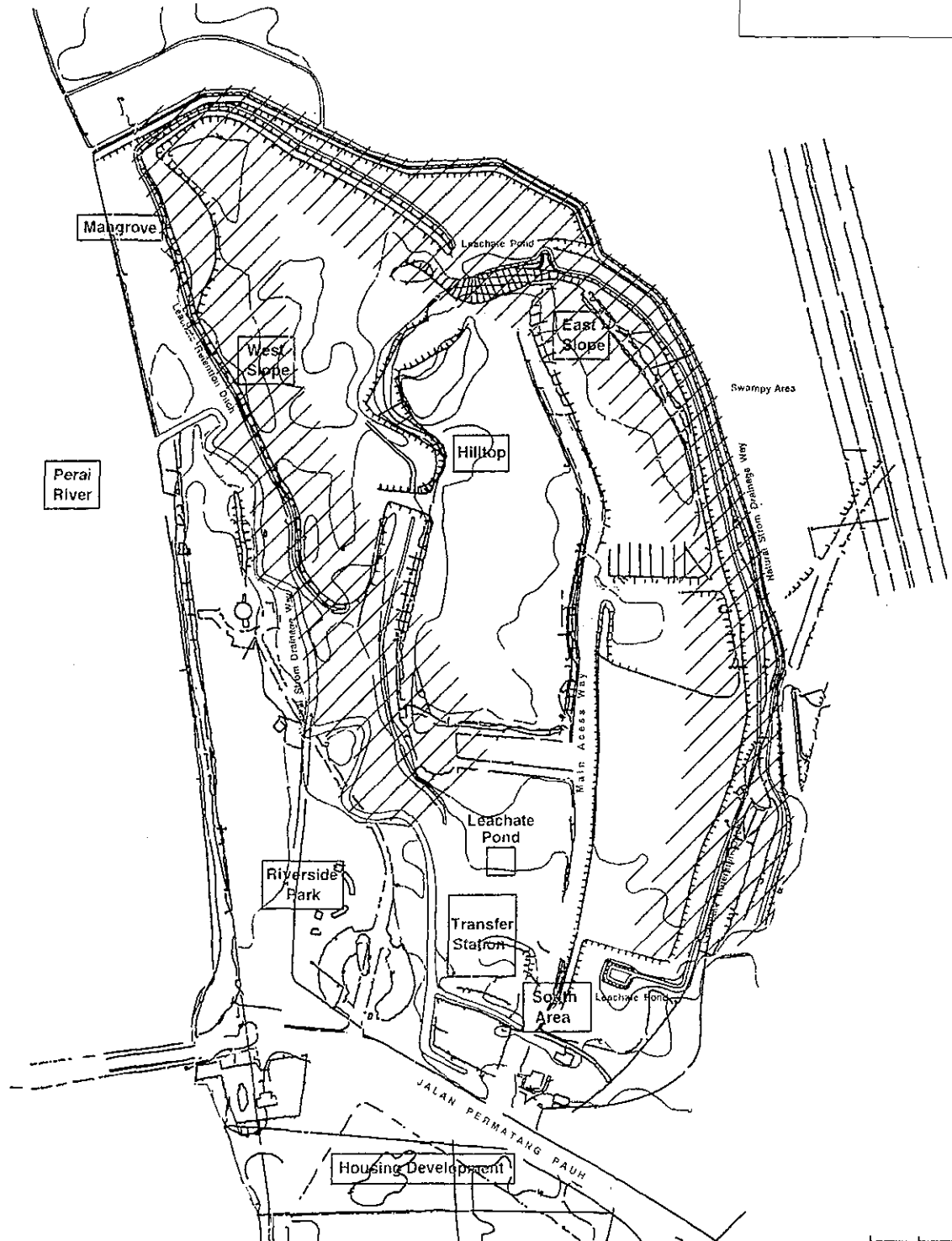
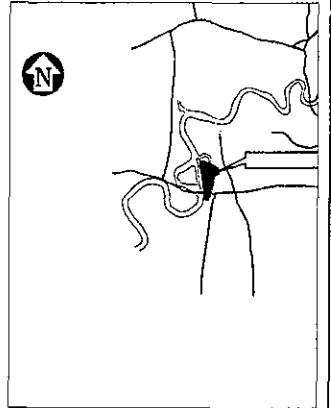


PLANT
NORTH

Figure. 3.1.2



Ampang Jajar Landfill Seberang Perai, Penang, As of May 15, 1992



3.2.2 Development plan and closure plan

(1) Development plan of the western part

The landfill is situated on a wetland that is not suitable and not recommended for use as a landfill site. Careful consideration and countermeasures, especially on the drainage and leachate collection aspects are required to prevent excessive environmental pollution and damage. However, from the soil investigation, it was discovered that there are thick marine clay layers under the site and possesses low permeability and hence groundwater contamination may be minimal. Nevertheless, continuous monitoring should be carried out. The summary of the conceptual development plan for the western part of Pekan Nenasi Landfill site is shown in **Table 3.2.1**.

Table 3.2.1 Conceptual Development Plan for the Western Part of Pekan Nenasi Landfill Site

| Items | Plan | | | | | | | | | | | | | | | | |
|---|---|-------------------|-------|--------------------|-------|--------------------|-------|--------------------|-------|-----------------------------|-------|----------|-------|---|--|--------------|--------------|
| Basic policy | <ul style="list-style-type: none"> • The site should be used for a long time • The eastern front part has been closed • The western back part is to be used for landfill disposal in phases, cell by cell • The target level is set at level 3 | | | | | | | | | | | | | | | | |
| Waste quantity | The amount of waste disposed at the site is about 30 tonnes/day (11,000 ton/year). This amount will increase annually due to population growth. | | | | | | | | | | | | | | | | |
| Available capacity | The maximum available capacity of the entire site depends on the final height and/or depth of the waste. Assuming the final height of the waste is 10m, the estimated available capacity should be about 666,000 m ³ . On the estimation based on the availability of land, the site should be able to be in operations for more than 40 years. | | | | | | | | | | | | | | | | |
| Final shape / profile of the landfill | <p>The present ground level is about 3 m and the final height should be about 10 m. The slope should be less than 1:3 gradient (33 %).</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;">First waste layer</td> <td style="width: 20%; text-align: right;">3.0 m</td> </tr> <tr> <td>Intermediate cover</td> <td style="text-align: right;">0.5 m</td> </tr> <tr> <td>Second waste layer</td> <td style="text-align: right;">3.0 m</td> </tr> <tr> <td>Intermediate cover</td> <td style="text-align: right;">0.5 m</td> </tr> <tr> <td>Final cover / barrier layer</td> <td style="text-align: right;">0.6 m</td> </tr> <tr> <td>Top soil</td> <td style="text-align: right;">0.3 m</td> </tr> <tr> <td colspan="2">(Settlement approximately 10% of waste layer)</td> </tr> <tr> <td>Total</td> <td style="text-align: right;">7.3 m</td> </tr> </table> | First waste layer | 3.0 m | Intermediate cover | 0.5 m | Second waste layer | 3.0 m | Intermediate cover | 0.5 m | Final cover / barrier layer | 0.6 m | Top soil | 0.3 m | (Settlement approximately 10% of waste layer) | | Total | 7.3 m |
| First waste layer | 3.0 m | | | | | | | | | | | | | | | | |
| Intermediate cover | 0.5 m | | | | | | | | | | | | | | | | |
| Second waste layer | 3.0 m | | | | | | | | | | | | | | | | |
| Intermediate cover | 0.5 m | | | | | | | | | | | | | | | | |
| Final cover / barrier layer | 0.6 m | | | | | | | | | | | | | | | | |
| Top soil | 0.3 m | | | | | | | | | | | | | | | | |
| (Settlement approximately 10% of waste layer) | | | | | | | | | | | | | | | | | |
| Total | 7.3 m | | | | | | | | | | | | | | | | |
| Landfill level | Targeted to Level 3, semi-aerobic landfill site with leachate re-circulation | | | | | | | | | | | | | | | | |
| Leachate management | <p>Leachate should be collected and treated before discharge. The target for BOD will be less than 50 mg/l (Standard B)</p> <p>Leachate collection system, leachate aeration pond, re-circulation system, should be provided.</p> | | | | | | | | | | | | | | | | |
| Landfill gas management | <p>Vertical gas ventilation pipes connecting to the leachate collection pipes should be provided.</p> <p>Horizontal gas collection and ventilation system will have to be provided for the final stages of the landfill.</p> | | | | | | | | | | | | | | | | |
| Surface water drainage | A ditch should be provided around the site and The surface water drainage system should also be provided and discharge to the ditch. | | | | | | | | | | | | | | | | |
| Control l facility | Weighbridge, control room, perimeter fencing and gate | | | | | | | | | | | | | | | | |
| Monitoring facility | Groundwater monitoring well, gas monitoring well, etc. | | | | | | | | | | | | | | | | |
| Others | Access road | | | | | | | | | | | | | | | | |
| Ultimate land use | Proposed to develop into a park or left as an open space | | | | | | | | | | | | | | | | |

a) Estimated amount of waste to be disposed of

The amount of waste disposed of at the site is about 30 tonnes/day. This is equivalent to about 15,640m³ of waste per year assuming 0.7 ton/m³ of compacted waste could be achieved with careful operation.

b) Estimated available capacity of the western part

Assuming that the waste will be disposed of in two (2) layers of 3m thick each With the cover soil of 0.5 m and final cover of between 0.6 –1.0 m, the final height will be about 8m. Further assume the disposal and compaction effectiveness of 60% to 70%, the estimated available capacity of the western part is between 666,000m³ and 777,000m³, or about 466,200 tonne to 543,900 tonnes.

c) Estimated disposal period

Assuming the waste generation rate is fixed throughout the entire lifespan of the landfill operations, i.e. at 30 tonnes/day, the estimated disposal period is calculated to be between 43 to 50 years.

(2) Closure plan for the eastern front part

The eastern front part of the site has been closed in 2003. At present, there is plan to redevelop the land and it is to be left as an open space. The closure plan is summarised in **Table 3.2.2**.

Table 3.2.2 Closure Plan for the Eastern Part of Pekan Nenasi Landfill Site

| Item | Plan |
|------------------------------------|--|
| 1. Hydro geologic information | Wetland with marine clay layers |
| 2. Final site topographic plan | To be the same height as the trunk road in front of the site, i.e. at EL. 3.5-4.0 m |
| 3. Final cover design | Provide barrier layer of 0.6 m thick and pop layer of 0.15 m thick |
| 4. Source of final cover material | Suitable cover soil to be purchased |
| 5. Final landscape and site plan | To be left as an open space |
| 6. On site facility | Landfill gas discharge facility |
| 8. Surface water management plan | To provide surface water drainage system |
| 9. Ground water management plan | (Marine clay layer laid under the site) |
| 10. Leachate management plan | Minimize by final cover, Leachate pump pit for emergency measure. |
| 11. Landfill gas management plan | To provide gas collection system and vents |
| 12 Environmental monitoring system | Monitor using leachate pump pit and gas discharge pipe Ground water monitoring well |

a) Elevation

The height of the top of the landfill should be higher than the highest water level during the wet season. As the elevation of the coastal trunk road is 4 m and access road is 3.0m-3.5 m, the elevation of Block A, B, and C of eastern part shall be set at 3.5-4.0 m. As present elevation is slightly higher than the access roads, the final elevation will be about 4.0 m after the final cover.

b) Surrounding bund wall

All the cells or blocks are enclosed by surrounding bund walls. The bund walls and final cover will be used as the physical barriers to prevent the water coming in from the wetland.

c) Final cover

In order to prevent landfill gases from escaping through the surface and to prevent the percolation of rainwater into the waste layers, the closed landfill should be covered with a barrier layer or final cover. The final cover should also be provided with a topsoil layer for planting and vegetation. It is important to compact the solid waste layers as much as possible prior to the laying of the final cover. The recommended thickness of the layers is as follows:

- Barrier layer soil with low permeability, about 600 mm thick
- Topsoil layer soil for planting, about 150 mm thick or thicker.

d) Leachate management

The final cover and the surface water drainage system will minimise the amount of rainwater penetrating into the waste layers. The leachate production should be reduced. A leachate pump pit may be installed at each of the cells or block to drain the leachate to the leachate pond and to prevent the leachate level from rising in the cells. The proposed gas ventilation pipes will also act as leachate collection pipes and will channel leachate to the leachate pond to be constructed at the western part.

e) Gas management system

A gas collection system comprising of a horizontal piping network should be installed to control flow of the landfill gasses. The collected landfill gas will be discharged through the vertical gas vents.

f) Surface water drainage

Drainage ditches will be constructed along the access roads to channel and drain the surface water to the nearest stream.

g) Monitoring facility

The gas collection discharge pipe and the leachate pump pit should be used for monitoring of the landfill gas and leachate quality. A number of ground water monitoring wells should also be installed at certain locations at western part.

Total Development plan and closure plan of Block B of Pekan Nenasi landfill site are shown in **Figure3.2.1** and **Figure3.2.2**, respectively.

3.2.3 Pilot Project Plan

The Pilot Project will be carried out to upgrade Cell I of Phase I in the western back part. This Pilot Project should be developed as a model for the rehabilitation of a landfill site in a wetland.

a) Rehabilitation of Cell I of Phase I landfill site

The Phase I of the landfill site shall be upgraded to a semi-aerobic, Level 3, landfill site with leachate re-circulation system. As the surrounding bund has already been constructed, the rehabilitation works will include the construction of the leachate collection system, gas discharge pipes, leachate aeration pond and monitoring facilities, structured in line with the development plan. The summary of the proposed works are as follows;

- | | |
|----------------------|---------------------------------|
| • Planned height | Elevation 10 m (2 waste layers) |
| • Area | 0.9 ha |
| • Landfill structure | Semi-aerobic landfill site |

b) Facilities to be installed by the pilot project

The scope of work for the Pekan Nenasi PP is summarised as follows. The type of work is explained in more details in *Volume 4, Chapter 7*.

- Leachate collection system, aerator and re-circulation pump
- Access Way
- Gas Collection System Topographic Survey Soil Investigation Test
- Installation of Ground Water Monitoring Well

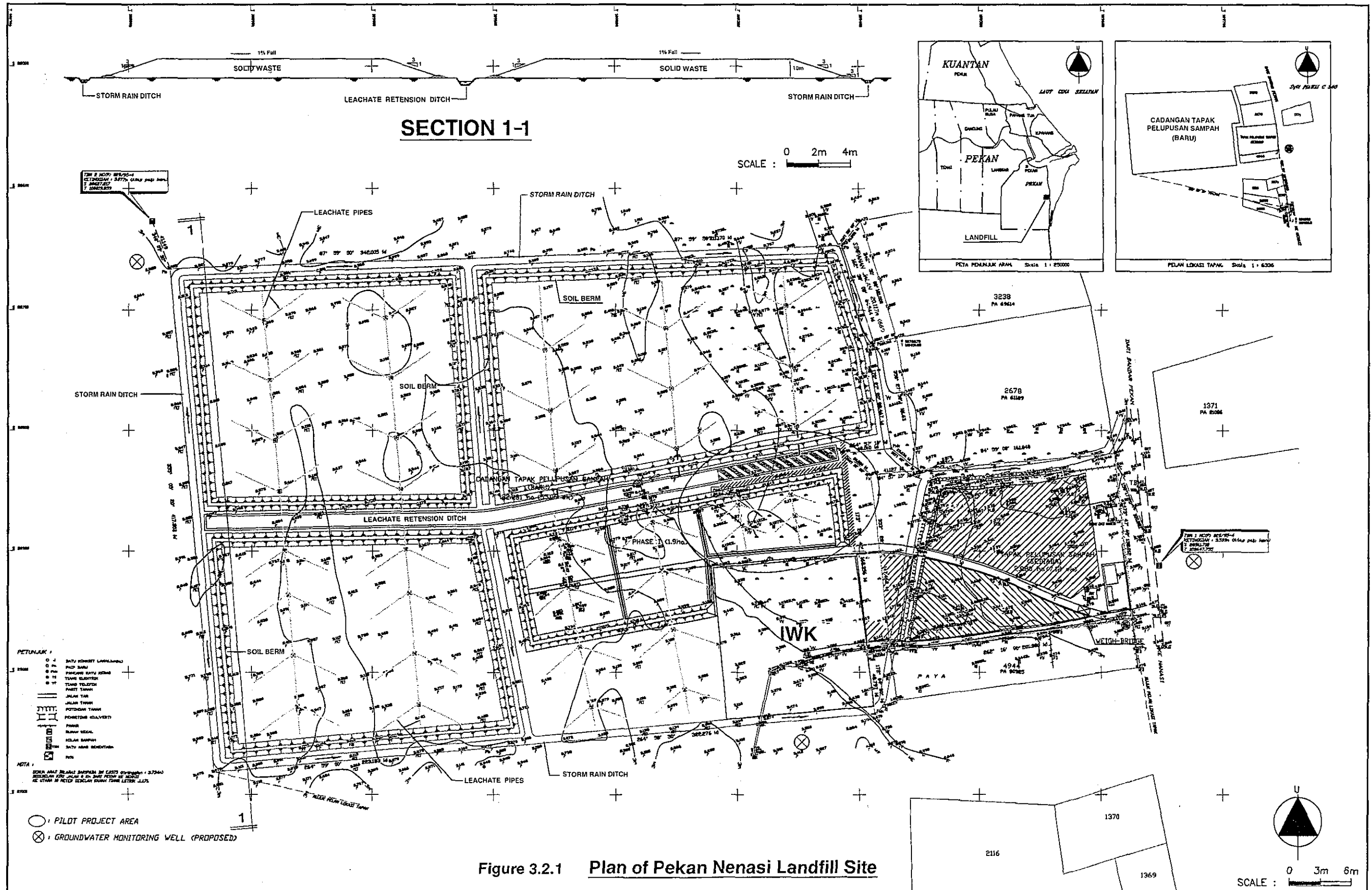


Figure 3.2.1 Plan of Pekan Nenas Landfill Site

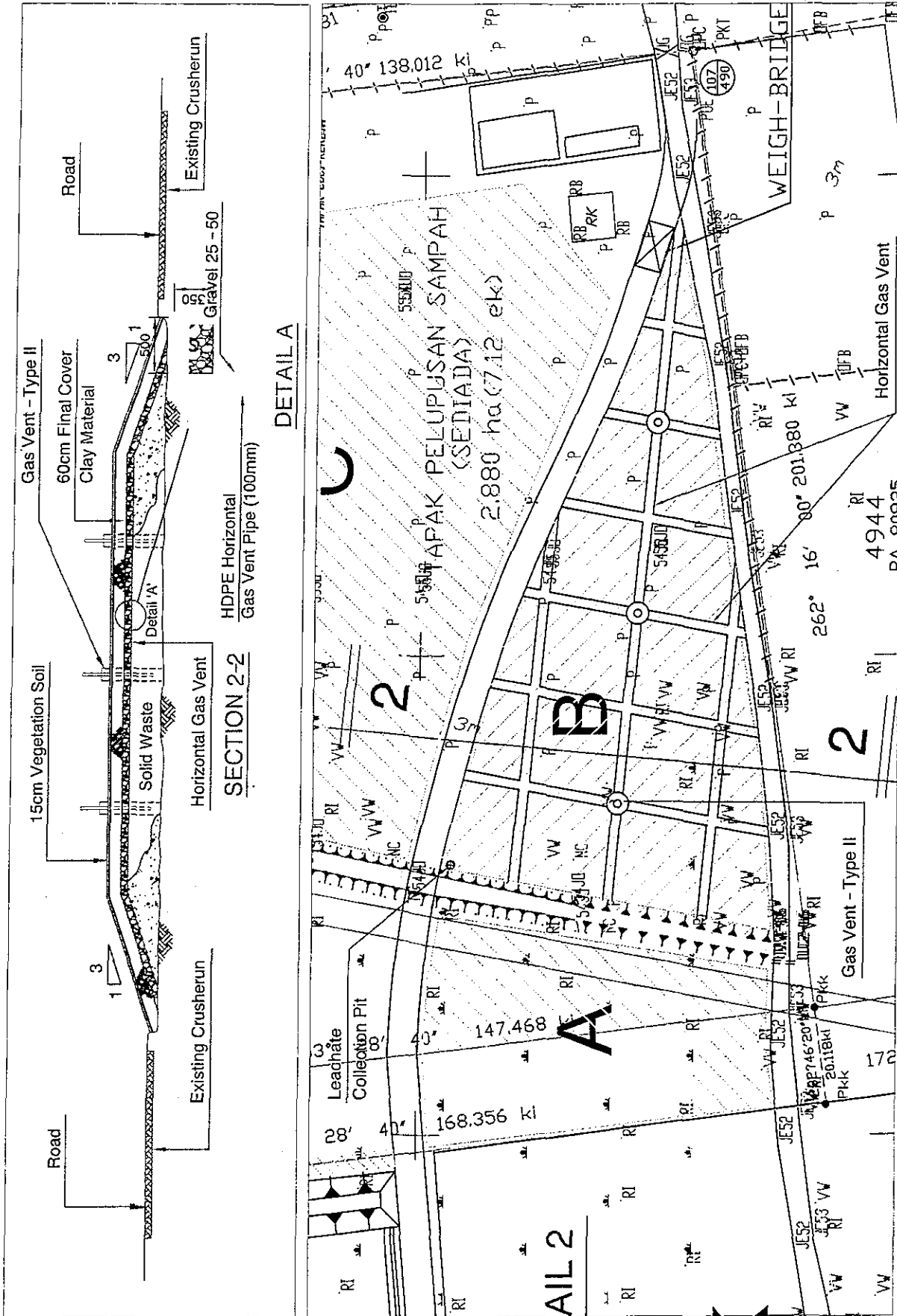


Figure 3.2.2 Closure Plan of Block B - Horizontal Gas Vent Layout Plan

3.3 AMPANG JAYA LANDFILL SITE (SELANGOR)

3.3.1 Outline of the site

The Ampang Jaya landfill site, at Hulu Langat, was in operations from 1992 to 1998. The site was operated by MP Ampang Jaya and on closure, the land, together with the site, was reverted to the control of MP Kajang.

The site is located at about 3 km east of Ampang Jaya, on a hilly area near the basin of the Langat River. The Hulu Langat water intake point is located about 8 km down stream of the site.

About 400 tonnes/day of waste was disposed at the site (about 1 million tonnes in total). The waste was dumped from the top of the hill and filled at the western slope, eastern slope and at the bottom of western valley. In 1998, western slope became unstable and collapsed and the accident resulted in the death of 2 landfill workers and subsequently, the site was urgently closed.

During the operations of the site, some improvement works were carried out to reform the slopes, provide soil coverings, installation of gas ventilation pipes, and the installation of a leachate treatment plant and leachate pond. For access purposes, a temporary access road was constructed. However, due to the premature closure of the site, the leachate treatment plant was not completed and the entire site has been abandoned.

During the preliminary site visit survey in mid 2003, it was observed that the slopes have been covered with grass and shrubs, and leachate was observed flowing from the slopes and flowing into the nearby stream. The covering soil and surface water drainage were not sufficient. The site is now being used as an orchard at the top of hill and at part of the bottom valley.

The landfill gas contains about 22 % of methane and hydrogen sulphide (H₂S), observed at the gas discharge pipe installed at the hilltop. The stream at the eastern side of the hill seemed clean but contains about 40 ppm of nitrate compound (T-N). In the valley, leachate is leaking continuously. The main outflow is a wetland located at the centre of the valley. The amount of leachate flow is estimated to be about 100m³/day.

Since the site was abandoned after the landslide, the slopes remained in precarious state and posed a dangerous risk. The temporary access road and certain low lying areas have been badly eroded due to insufficient surface water drainage and the lack of maintenance.

The summary of the remedial actions/measures to be taken and evaluation at the closure of the site are tabulated in **Table 3.3.1**.

Table 3.3.1 Closure Measures Taken in 1998 and Its Evaluation

| Items | Measures taken in 1998 | Evaluation |
|--------------------|-------------------------------------|--|
| Physical stability | Reform of eastern and western slope | The slope is covered by grass and seems to be safe but drainage system should be installed |

| | | |
|---------------------|--|---|
| Covering soil | Covering soil at top of the hill, eastern & western slope and bottom of valley | Covering soil is not sufficient at the top of the hill, eastern and western slope and bottom of valley |
| Surface drainage | Almost no drainage system | Temporary access road and main waterway is badly eroded. Drainage system should be constructed comprising of main drainage and surface drainage |
| Leachate management | Leachate treatment facility was constructed but abandoned | Leachate treatment facility has been abandoned. Leachate is flowing out mainly from the wetland located at the centre of western valley. |
| Gas management | Gas discharge pipes (Diameter 100 mm) was installed | Landfill gas is still being generated. Gas collection system should be installed when the final cover has been carried out. |
| Monitoring facility | No monitoring facility | Monitoring should be carried out on water quality of the eastern and western streams, leachate quality, landfill gas and settlements. |

3.3.2 Safe closure plan

During the closure of the site, minor mitigating measures were carried out in order to close the site urgently. No great attention was made towards the safe closure of the site and hence now, the leachate and landfill gas are still being released in great quantities. Therefore, more additional measures should be carried out for the proper safe closure.

The proposed safe closure plan is shown in **Table 3.3.2**.

Table 3.3.2 Closure Plan for the Ampang Jaya Closed Landfill Site

| Items | Proposed Action |
|----------------------------------|---|
| 1. Hydrogeological information | Hilly area and granite |
| 2. Final site topographic plan | The gradient of the slopes should be checked and steeper part 1 should be moderated to the 1:2 gradient. |
| 3. Final cover design | Barrier layer should be laid about 0.6 m thick Topsoil layer should be laid about 0.15 m thick |
| 4. Covering soil material | Low permeability soil and good topsoil |
| 5. Final landscape and site plan | Orchard or vacant land |
| 6. On site facility | Gas discharge ventilation pipes |
| 7. Surface water management plan | Installation of main drainage and surface drainage system; Monitoring the surface water quality |
| 8. Ground water management plan | Installation of monitoring wells |
| 9. Leachate management plan | Installation of leachate collection system and leachate treatment system |
| 10. Landfill gas management plan | Installation of gas collection piping system and gas discharge pipe |
| 11. Monitoring | Monitoring of water quality down stream. (East and west streams) Groundwater monitoring well Gas and waste layer monitoring well Leachate pond and gas discharge pipe will be used for sampling. |

a) Final site topographic plan

Since the site is closed and the steep slopes have already been reformed at certain areas, and the remaining sloped areas are in precarious state, it was decided not to carry out any major slope reformation works and the final topography will remain the same as the present.

b) Final cover design

The final cover should comprise of the barrier layer and the topsoil layer. The existing covering soil was considered insufficient and additional final cover should be provided. The final thickness of the barrier layer should be about 600 mm. The topsoil layer should be about 600 mm thick to allow for planting of shrubs and small trees. The flat areas should only be provided with 150mm thick soil layer. As for the sloped areas, it may be difficult to lay the topsoil layer as they have the tendency to wash away or erode. The minimum of 50 mm of topsoil layer should be applied for grass growth and to protect the slopes.

c) Final cover material

The grounds at landfill site area consist of mostly waste fill material due to the landslide that covered part of the bottom valley. Good final cover material is difficult to obtain as the grounds have already been excavated for the covering soil when the site was closed in 1998. The covering soil material for the proposed final covering will have to be brought in from the outside.

d) Final landscape and site plan

Since the site is on a valley and there is no specific land use planned for the site, it is assumed that the site will left as a vacant ground or to be used as a fruit orchard.

e) On site facilities

Under the safe closure plan, the following facilities should be provided and maintained at the site.

- Leachate and gas collection Gas discharge pipe
- Leachate treatment system Leachate aeration pond and re-circulation system
 Leachate treatment plant
- After care office Office facility

f) Leachate management plan

Leachate collection system should be constructed at the top of the hill, at the sloped area and at the bottom of the valley. The collected leachate should be treated to meet Standard A prior to discharging the effluent into the nearby stream. The site is upstream of the Hulu Langat water intake point and thus the effluent must comply with the EQA Standard A.

Although the effluent standard has many parameter, the first target will be set for the BOD to be less than 50 mg/l as stipulated in Standard B. The next step is to set the BOD to less than 20 mg/l as stipulated in Standard A.

The presence of heavy metal is an important factor for determining the type of leachate treatment to adopt. Generally, it is expected that the leachate from landfill sites that receive municipal waste will tend not to contain high concentration of heavy metals and hence the effluent quality may meet with Standard B. However, it may be necessary to provide additional treatment facilities to treat the heavy metal to meet with Standard A. Therefore, an integrated leachate treatment plant may be necessary, comprising of biological, chemical, filtration and advanced treatment process.

g) Landfill gas management

Landfill gas collection piping system should be installed comprising of the gas extraction well, horizontal gas collection pipes and gas ventilation discharge pipes. The gas extraction well should be installed at the area where waste layers are the thickest or deepest. The horizontal gas collection piping network should be installed beneath the final cover.

h) Monitoring facilities

Monitoring facilities should be installed and the following monitoring activities should be carried out continuously.

- Ground water monitoring - Monitoring at down stream of east side and west valley.
- Surface water monitoring - East and west stream
- Landfill gas monitoring - Gas extraction well and gas discharge pipe
- Ground settlement - Top of the hill, top and middle of the slope and at the bottom
- Solid waste stabilization - Monitoring at gas extraction well

General plan and proposed facilities for safe closure are shown in **Figure 3.3.1** and **Figure 3.3.2**, respectively.

3.3.3 Pilot Project

a) Pilot project alternatives

The installation of a proper drainage system, leachate collection and treatment systems, and final cover are the major components for the safe closure the site. Since it may not be possible to implement the Pilot Project to cover all the aspects and for the entire site, 3 alternatives have been proposed.

Alternative 1, since part of the sloped area has already been reformed, the proposed PP works will exclude the reshaping of the slope area.

Alternative 2, since the top of the hill is being used as a fruit orchard, the removal and transplanting of the fruit trees to make way for the PP works will be quite troublesome, hence the top area will be excluded.

Both Alternative 1 and 2 will require the upgrading of the access road for access purposes.

Alternative 3 will be limited to monitoring activities only, i.e. no construction works.

The 3 Alternatives are summarised in **Table 3.3.3**.

Table 3.3.3 Alternatives of the Pilot Project Components

| | Alternative 1 | Alternative 2 | Alternative 3 |
|-------------|--|--|-----------------|
| Outline | Measure for top of hill and bottom of western valley excluding slope area | Measure for bottom of western valley excluding fruits firm | Monitoring only |
| Major works | Access road rehabilitation Main drainage Covering soil Leachate collection Leachate aeration pond and re-circulation Gas collection and discharge Monitoring | Access road rehabilitation Main drainage Covering soil (wetland) Leachate collection Leachate pond Gas collection and discharge (wetland) Monitoring | Monitoring |

After detailed evaluation, it was concluded that the Alternative 2 options seemed to be the most appropriate for the improvement works.

b) Facilities to be installed

The scope of work for the Ampang Jaya PP is summarised as follows. The type of work is explained in more details in *Volume 4, Chapter 8*.

- Access way to the valley with side ditches and bituminous paving
- Concrete pipe culvert at crossings
- Final cover on the wet area with spot turfing
- Leachate collection system, i.e. leachate collection pipe, leachate pond, re-circulation pump
- Gas collection system
- Stormwater drainage
- Topographic survey
- Soil investigation test
- Installation of ground water monitoring well and gas monitoring well

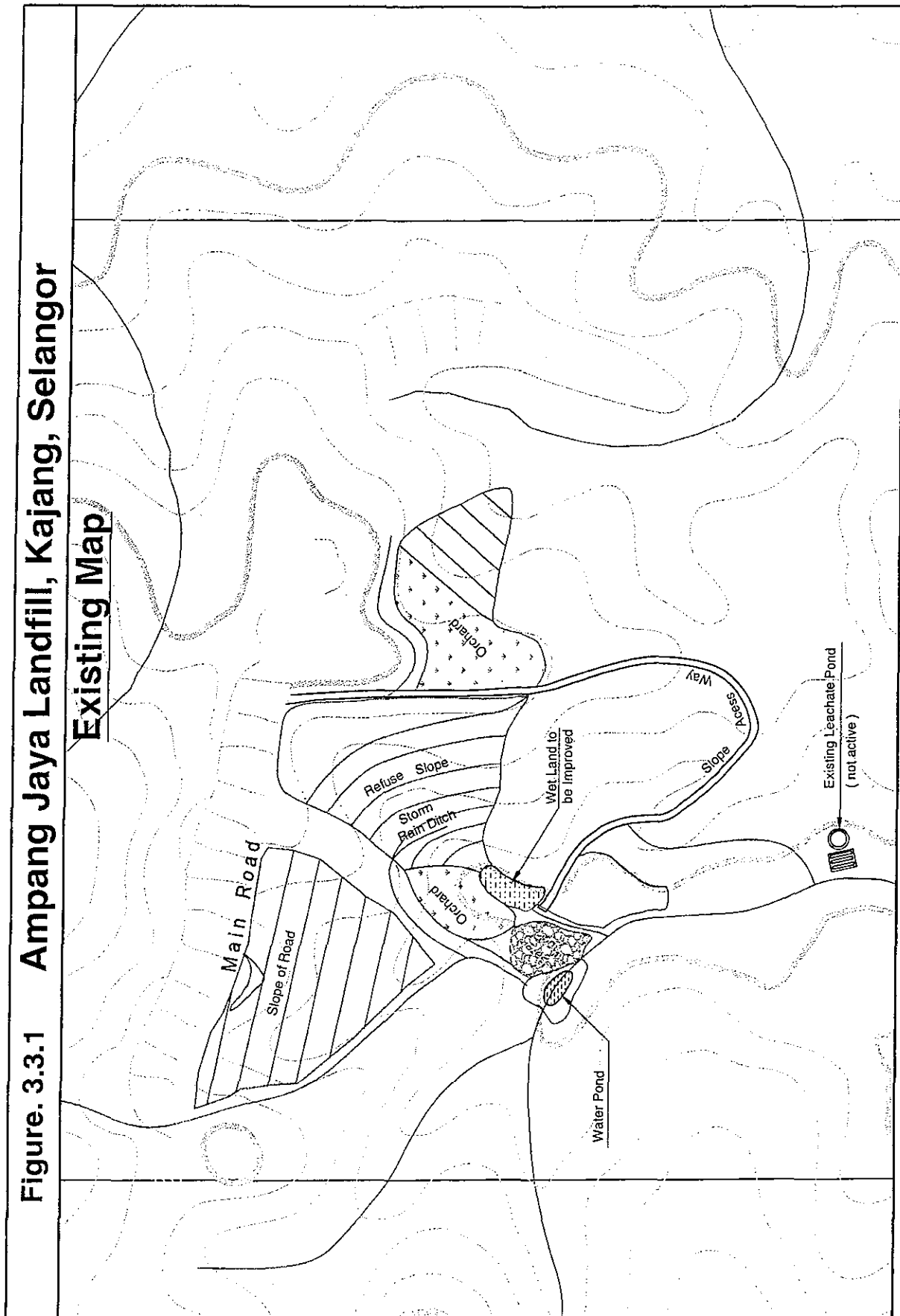
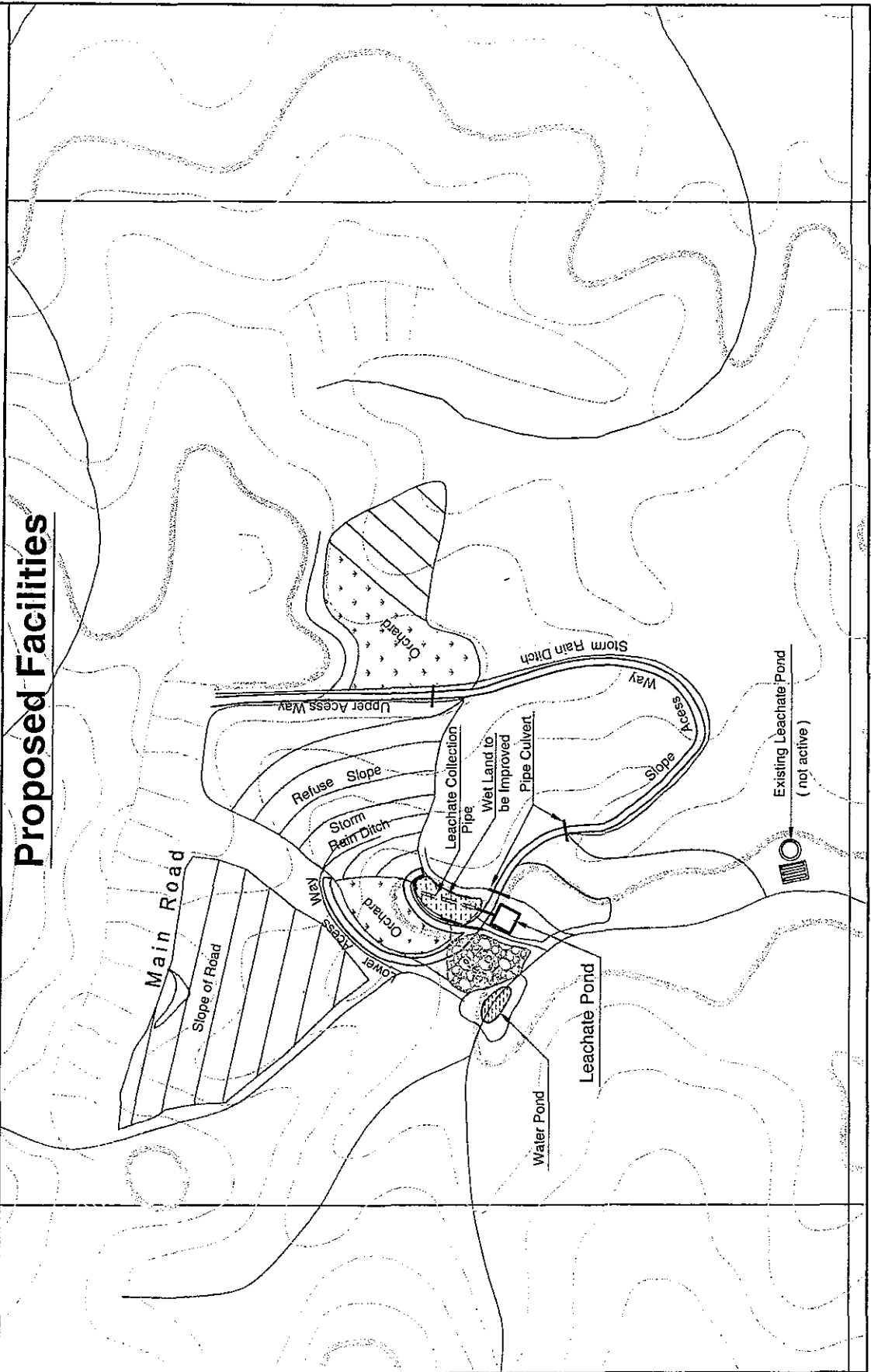


Figure. 3.3.2 Ampang Jaya Landfill, Kajang, Selangor

Proposed Facilities



CHAPTER 4 PILOT PROJECTS IMPLEMENTATION PROCESS

4.1 IMPLEMENTATION FLOWCHART

The implementation flowchart for the Pilot Project is shown in **Figure 4.1.1**.

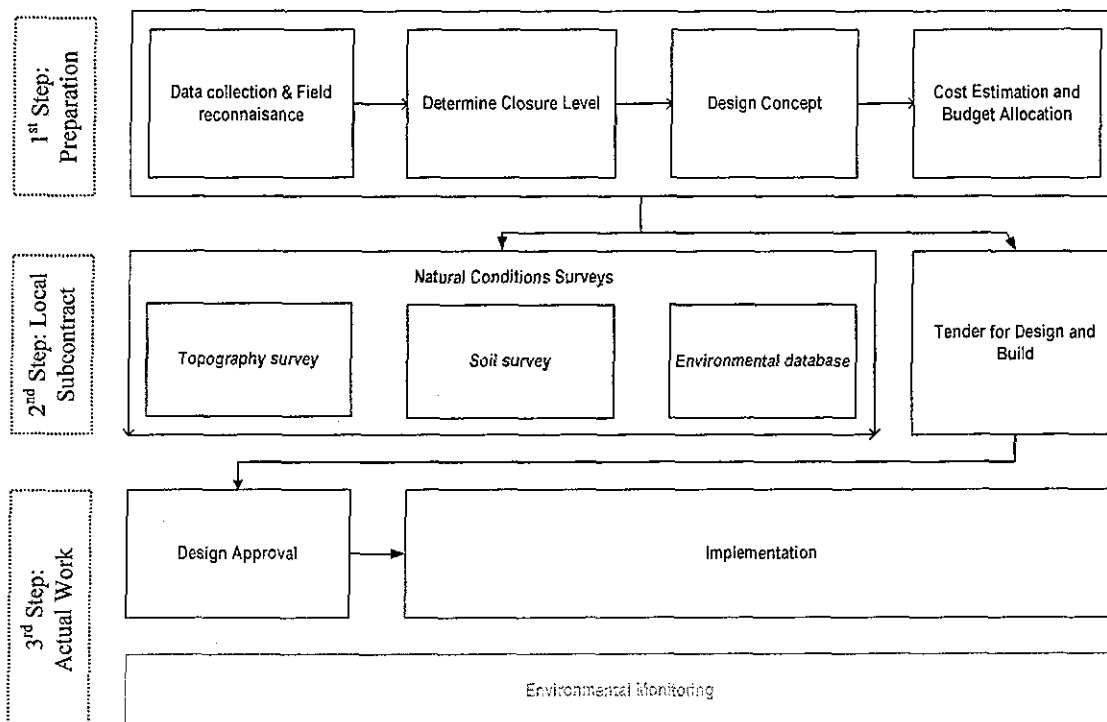


Figure 4.1.1 Implementation Flow

Once the 3 Pilot Project sites have been identified, detailed site investigations were carried out to gather site specific data for each of the sites. The data gathered were as follows:

Ampang Jajar Landfill Site

- Records of previous operations and previous improvement projects that have been carried out.
- Records on previous leachate testing and analysis results
- The land use and development surrounding the site, and information on the park area located on the western side of the site
- Plans for landfill gas utilisation on the landfill
- The effects of the new transfer station adjacent to the landfill site
- Carry out surface water, groundwater, leachate and gas sampling for the preparation of the environmental database

Pekan Nenasi Landfill Site

- Records of previous operations and details of improvement plan that has been identified by the present council appointed private operators, Alam Flora Sdn Bhd.
- Information on the adjacent Indah Water Konsortium sewage sludge disposal site
- Information on the tidal conditions as the site is situated on a swamp land near to the coast
- Carry out surface water, groundwater, leachate and gas sampling for the preparation of the environmental database

Ampang Jaya Closed Landfill Site

- Records of previous operations and to ascertain the reasons for its premature closure
- The post closure land use plan for the site and for the neighbouring land
- The potential for post closure maintenance and monitoring
- Carry out surface water, groundwater, leachate and gas sampling for the preparation of the environmental database

4.2 APPROPRIATE CLOSURE LEVEL AND DESIGN CONCEPT

In order to ascertain the necessary scope of work for each of the Pilot Project sites, the most appropriate closure level for the sites should be determined and assigned to each of the site. Based on the field surveys and data collection, the facilities that were considered necessary for each of the pilot project site have been identified in **Table 4.2.1**.

Table 4.2.1 Necessary Facilities and Closure Levels for Pilot Project Sites

| Facility | Ampang Jajar | Pekan Nenasi | Ampang Jaya |
|--|--------------|--------------|-------------|
| Level C1 | | | |
| - Final Cover Application | ● | N/A | ● |
| Level C2 | | | |
| - Suitable waste storage | ● | *1 | *2 |
| - Storm water drainage | ● | *1 | ● |
| - Gas vents | ● | ● | ● |
| Level C3 | | | |
| - Leachate collection system | ● | ● | ● |
| - Leachate re-circulation (incl. aerator) | *1 | ● | N/A |
| Level C4 | | | |
| - Leachate treatment/ groundwater protection | N/A | N/A | N/A |

Notes

- : Necessary facility to be provided
- *1: Facilities already at site will be used
- *2: Constructed facilities to support waste slope
- N/A : Not Applicable for PP

<Ampang Jajar Landfill Site>

Based on site specific requirements and since a leachate treatment pond has been provided previously, with an aerator and filtration system, the Closure Level C3 was assigned for Ampang Jajar. The associated scope of works identified for Ampang Jajar were as follows;

- to carry out the reformation of the slopes,
- to provide suitable cover material and turfing on the slopes
- to provide stormwater drainage along the sloped area
- to channel the leachate to the existing leachate treatment pond.
- to installed leachate collection system and gas ventilation system

<Pekan Nenasi Landfill Site>

Since the Pekan Nenasi landfill site is still in operations, the necessary scope of work will be towards enhancing the performance of the landfill as a whole and to prepare the site towards safe closure in the future. Nevertheless, the Closure Level C3 was adopted and the following facilities were identified'

- the installation of leachate collection system
- the provision of a leachate retention pond and treatment system to include an aerator and a leachate re-circulation pumping system.
- to install gas venting system are also provided.

<Ampang Jaya Closed Landfill Site>

Since the Ampang Jaya closed landfill site was an abandoned landfill as the result of a landslide, its post closure utilisation potential was considered low. The provision of the aerator and re-circulation system to the site was not possible because these facilities require post closure maintenance which was questionable, as the Closure Level C2 was adopted for this site. The scope-of-works were as follow;

- to provide surface water drainage system to separate the storm water from the leachate streams.
- to provide leachate collection system and leachate collection pond
- to provide gas ventilation system
- to provide access road to the project area.

4.3 COST ESTIMATION

The preliminary cost estimation was based on the available maps and data collected by the Study Team to prepare the conceptual designs for each of the 3 PP sites. From the preliminary design, separate bill-of-quantities (BQs) for each of the project construction

works and materials were prepared. With the BQs, the tender documents for each of the sites were prepared. Three tenders were called and competent contracting companies were invited to submit their tenders. From the tender submissions, the tendered values and the unit rates for the scope of works were collected. From the tender evaluation, the most suitable unit rates were adopted and the construction costs for the entire project were determined based on the tendered values. The extent and the limit to the scope of the works for each of the 3 Pilot Project site was determined by taking into consideration the budget allocations and also without compromising the technical objectives of the projects. The scope of works and the BQs have been presented in **Volume 4, Chapters 6, 7 and 8**, for the Ampang Jajar PP, the Pekan Nenas PP and the Ampang Jaya PP, respectively.

4.4 SURVEY OF EXISTING NATURAL CONDITION

Prior to the commencement of the Pilot Projects, the topography surveys and solid investigations of the existing natural condition were carried out. The topography surveys were carried out to cover the entire site area of the Ampang Jajar and Pekan Nenas Pilot Projects. The topography survey for Ampang Jaya PP only covered the valley area, waste slope and the entire length of the access road.

The final topography plans were extremely useful and allowed the Study Team Members to study the conditions and physical characteristics of the sites. Such survey plans provide an up-to-date representation of the landfills that were later used for the detailed designs for the construction works. The survey plans were updated after construction to include the new levels and to produce the new “As-Built” drawings.

The soil investigations were carried out to ascertain the subterranean conditions of the sites. The data were used to study and determine the groundwater flow both upstream and downstream of the closure works. The boreholes for the soil investigations were later converted to groundwater monitoring wells with the installation of casings and necessary piping works.

For the Ampang Jajar PP, 3 soil investigation boreholes were drilled and later converted to the groundwater monitoring wells at the foot of the slope and along the site perimeter both upstream and downstream the site. An additional borehole was drilled on top of the landfill to provide for the landfill gas ventilation and also as the gas monitoring well.

For the Pekan Nenas PP, only 3 soil investigation boreholes were drilled and since the site was previously provided with the gas ventilation pipes, the new gas monitoring well was not necessary. Borehole locations were selected with one near the site entrance and the other two upstream and downstream of the active landfill cell.

As for the Ampang Jaya PP, only 2 soil investigation boreholes and one gas ventilation borehole were provided. The soil boreholes were located at the upper elevation of the site and at the valley bed, downstream of the leachate collection system. The landfill gas monitoring well was located at the upper level of site where waste is accumulated.

The technical specifications for the surveys are explained in more details in **Volume 4, Chapters 6, 7 and 8**.

4.5 DESIGN AND BUILD CONTRACTS

Due to the time constraints with the Pilot Project Implementation Period, the “Design and Build” construction method was selected. The tendering process was initiated with close coordination with MHLG to short list the qualified construction companies for each of the Pilot Project from a list of about 5 to 7 companies suggested by each of the 3 respective Local Authorities. The companies were short listed based on the evaluation of their capabilities, experiences, staffing levels, availability of equipment, and their registration with the Malaysian Construction Industry Development Board (CIDB).

The short listed companies were then invited to bid for the “Design and Build” contract for detailed design and construction work. The pre-tender briefing and site visits were held at each of the Pilot Project sites with the participation of the respective Local Authorities. As for the Ampang Jaya PP, the meeting was held in MHLG and attended by the Counterpart members.

The summary of the pre-tender briefing including the explanation of the tendering process and scope of work were as follows:

- Presentation of the design concept of the Pilot Project
- Explanation of the Bill of Quantities (BQ)
- The proposed project schedule, i.e. 4 weeks for detailed design, submission and approval, and 3 months for construction, followed by three months of the defects liability period.
- Presentation of the proposed technical specifications and design requirements such as the appropriate piping materials, piping dimensions, civil work requirements, and the materials for slope formation and embankment construction.
- Presentation of the “Design and Build” conditions of contract that included the General Conditions, the Technical Specifications and Concept Design, and the Additional Specifications. The “General Conditions” included aspects such as project duration and phasing, responsibilities of contract parties, payment system, etc. The “Technical Specifications” covered concept design, bill of quantities, works description and standards for design, drawings and reporting. The “Additional Specifications” included cautionary items for the contractor and his staffs as the projects are implemented in landfills. These dealt with excavation depths within waste (not more than 1.5m), immediate cessation of works in case of facing oxygen deficiency syndrome or other landfill gases, cooperation with landfill operators for operating sites, care for surrounding residents, etc.
- Request for additional information from the contractors such as the names of key and responsible personnel to be assigned to the project, and the contractor’s proposed engineering consultant to carry out the detailed design

The pre-tender briefings were followed by the visit to the respective Pilot Project site and the tenders were given to opportunity to ask questions and to clarify any matters that may have arisen.

The short listed companies invited to bid for the tender and those that responded were as follows;

- Ampang Jajar Pilot Project - 3 Companies, all submitted their tender proposals
- Pekan Nenasi Pilot Project - 6 Companies but only 3 submitted their proposals
- Ampang Jaya Pilot Project - 5 Companies but only 3 submitted their proposals

The companies that did not submit their tender proposals informed that they were not able to comply with the tender requirements for the nomination of their engineering consultant on such short notice, and thus they declined to participate in the tender.

All the tenders submitted their proposals as required, including copies of their company profiles and financial proposals. On evaluation, the company that bid the lowest for the tender was eventually selected for each of the Pilot Projects.

4.6 DESIGN SUBMISSION AND APPROVAL

The successful contractors for each of the Pilot Projects were notified and the contracts awarded to them. All the contractors were provided with the necessary topographical plans and were given the 3 weeks period to prepare and submit their detailed designs to the JICA Study Team for approval.

During the design period, two separate meetings were held each with the respective contractors and their consultants to check on their progress and design review. Some of the issues identified during the design review meeting were as follows:

- Clarification on the discrepancies between the actual site measurements with the values as provided in the concept design drawings. The discrepancies were discussed and later clarified
- Seeking approval for the use of alternative method and material of construction. for example, the proposed spraying of bituminous tack coat on the crusher run for the access road at the Ampang Jaya PP, the use of HDPE pipe as alternative to concrete pipes, etc.

Once all the issues were discussed and agreed upon, the final approval was given by the Study Team. Copies of the final detailed designs were submitted to MHLG and the respective Local Authorities for their reference and perusal.

4.7 PILOT PROJECT IMPLEMENTATION

Once the detailed designs have been approved, the Pilot Projects were implemented and construction work commenced at each of the 3 sites. Some of the major activities carried out by the Study Team Members during the project implementation period included:

1. The assignment of a local engineer to each of the 3 PP sites to acts as Study Team Site Supervisors. Their main tasks included the supervision of the works, preparation of the daily and weekly reports, liaison with the contractors, Study

Team HQ and LA, monitoring of project progress and schedule, certifying contractor's work, and the preparation of the completion report.

2. Coordination and liaison with the site engineer, the respective Local Authorities and MHLG.
3. To ensure that the work schedule is adhered to, especially during the rainy seasons, and to review the contractor's daily log of the construction progress for any prolong delays.
4. To ensure that the PP work will not disrupt the day to day operations of the Ampang Jajar and Pekan Nenasi landfill sites.
5. To ensure that the contractors adhere to strict safety standards and practices so as to prevent accidents at the sites.
6. To ensure that, for the Pekan Nenasi PP, the Local Authority has provided the necessary electric power supply for the aerator and the pump.

