Annex 7

Pilot Project

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7 Pilot Project

7.1 Plan of Pilot Project

7.1.1 Objectives

The implementation of the plans proposed in the M/P are predicted to encounter many difficulties. To determine the problems that may arise and how to overcome them pilot projects were planned to carry out during the course of this study with the close co-operation of the Turkish counterparts. The objectives of the pilot projects are summarised below.

1. Confirm the feasibility of the technical system proposed in the M/P (i.e., feasibility of separate collection, etc.),
2. Acquire base data to devise the design outline of the F/S (i.e., rehabilitation and closure of present open dumpsite, improvement method of compost quality and verification of its marketability, etc.),
3. Raise public awareness on solid waste management and gain public co-operation, and
4. Demonstrate improvement methods to residents and authorities concerned with SWM.

7.1.2 Selection of Pilot Projects

a. Experiment on the Improvement of the Sofulu Disposal Site

Regardless of which scenario is selected for the M/P, sanitary landfilling would still be given top priority in this study. In this regard, the numerous problems that are foreseen to arise with the rehabilitation and closure of the present open dumpsite should be overcome. Relevant agencies, including the MoE, are strongly requesting the adoption of realistic and feasible methods. Accordingly, the development and proposal of methods that are agreeable to these agencies both in terms of advantages and disadvantages are highly crucial. The study team, therefore, with the approval of JICA, proposed to urgently improve the present disposal site at Sofulu as a pilot project with the co-operation of relevant Turkish agencies.

Taking the above into account, in January 1999 the study team drafted a plan of the experiment. The plan was approved by JICA and the budget for the work items done by the team was allocated by JICA.

b. Experiment on the Separate Collection and Compost Quality Improvement

The MoE elaborated an "Environmental Manual for Municipalities (Belediyeler Icin Cevre El Kitabi), 1998". In the manual the ministry expresses their intention of more than 90 % of municipal solid waste (MSW) recycling by means of reuse, recycling and recovery. Turkish Solid Waste Regulation amended in September 15th, 1998, obligates a separate collection to municipalities. Furthermore, in the SWM M/P of the target cities the recovery of kitchen waste (may be by composting), which shares more than 65 % in current composition of their MSW, is one of the most important issues. In this context to identify the feasibility of the separate collection is an indispensable

subject in this study. Proving the appropriateness of these undertakings is a major issue. The study team proposed the improvement of the existing compost plant and its production method, through the separate discharge and collection of compostable and non-compostable wastes, and the installation of a recovery line for non-compostable waste, to determine whether it is possible to improve compost quality. In addition, the verification of improved compost marketability was also proposed.

Taking the above into account, in January 1999 the study team drafted a plan. The plan was approved by JICA and the budget for the work items done by the team was allocated by JICA.

7.1.3 Implementation Schedule

The pilot projects have been conducted in the second and third study works in Turkey (mid-February 1999 to end of March 1999, and early May 1999 to mid-June 1999, respectively). However, some components of the projects will be continued by Turkish counterparts, i.e., sanitary landfill operation at Sofulu disposal site by Adana GM and improved compost production by Mersin GM.

Table 7-1: Implementation Schedule of the Pilot Project

Item	98 Dec	99 Jan	99 Feb	99 Mar	99 Apr	99 May	99 Jun	99July	99 Aug
1.Draft Plan	▬	▬							
2.JICA Approval		▲							
3.Preparation Tender Document			▬	▬					
4.Contract					▲				
5-1. Sofulu Improvement of JICA Responsible Work					▬	▬			
5-2. Sofulu Improvement of AGM Responsible Work					▬	▬	▬	▬	▬
6.-1 Separate Collection and Compost Quality Improvement of JICA Responsible Work						▬	▬		
6.-2 Separate Collection and Compost Quality Improvement of MGM Responsible Work						▬	▬	▬	▬

7.2 Experiment on the Improvement of the Sofulu Disposal Site

7.2.1 Background

Sofulu Landfill is located 10 km north of Adana City Centre next to Old Kozan Road as shown in Figure 7-1. The figure also indicates the present City Planning for Adana. A new housing area (heavy density) is planned to be erected immediately west of the landfill and a new housing area (scattered) is planned north of the landfill.

The operation of the Sofulu dump site started in 1990 but no precautions whatsoever were taken to protect the environment. The landfill has been operated as a simple open dump for ten years and people has been complaining for many years mainly due to the continuous smoking of the landfill. When wind direction is towards the Mediterranean Sea people living in the city centre of Adana can smell the smoke from the landfill. In addition the leachate from the dump site is flowing into the stream, contaminating its surface water. Furthermore, odour, scattering waste, etc. caused by open dumping are subjects of the complains from the residents in Sofulu municipality nearby the landfill. Therefore, measures to improve the present disposal site in Sofulu should be taken as quickly as possible in consideration of the serious impacts of the site's conditions on the daily life of the Adana GM residents.

The Study Team evaluated 6 candidate final disposal sites for Adana GM proposed by the C/P. It was recommended the present landfill site in Sofulu to be operated for maybe another 10 years to serve the Greater Municipality of Adana, and to be the final disposal site for the F/S (Feasibility Study). The recommendation was agreed by the C/P. However, the continued operation of Sofulu Landfill is subject to:

- Urgently required rehabilitation works of the landfill be undertaken as soon as possible. The rehabilitation works can be carried out in a cost effective way if combined with continued operation of the landfill.
- New procedures for operating the landfill, sanitary landfill, be introduced.
- The construction of residential areas immediately north and west of the landfill site be postponed.

Therefore taking this into consideration, the team and counterpart have decided to combine the improvement work (rehabilitation of the site) and future use of it as a sanitary landfill. Based on the decision the experiment on the improvement of the Sofulu disposal site was planned.

7.2.2 Plan of the Experiment

a. Targets

The targets of the improvement by the experiment are summarised as follows:

1. Extinguish fire,
2. Control and minimise the leachate, and
3. Minimise other adverse impacts than the fire and leachate

b. Conditions to be Considered for the Plan

In order to achieve the above mentioned targets the improvement plan carefully consider the following conditions:

1. At present the landfill is burning mainly at the working faces and due to the dumping operation it creates very steep slope. It make covering soil of the burning parts difficult.

2. For covering soil operation it needs to flatten the steep slope. However, the foot of the slope has already reached to the stream of the ravine.
3. Topographical figure which has a water catchment area other than landfilled part but the catchment area is limited.
4. Due to the present dump site the landfill operation should not stop.

c. Plan of the Experiment

The above-mentioned topographical figure indicates the need of extended landfill operation to minimise leachate generation and to fully utilise a completed landfill site. Taking this into consideration, the experiment was planned as described below.

c.1 Overall Plan

Prior to the implementation the team prepared a present topographic map of the Sofulu site. In order to combine the rehabilitation work and future use of the Sofulu site as a sanitary landfill corresponding to the actual situation of the site, an overall plan was prepared as shown in Figure 7-2. As shown in the figure the Sofulu disposal site is planned to be developed and operated in 3 phases. The phase 1 is considered to be the main improvement target area of the experiment. A-A cross sections in Figure 7-3 indicates mounting up of the dumped area is necessary for the minimisation of leachate generation as well as future land use of the site.

c.1.1 Leachate control system

Adana city's annual rain fall is 650 mm, as opposed to evaporation of 1,600 mm, a 2.4 times difference between the two. A pilot facility was constructed at the disposal site to verify the effectiveness of the leachate treatment system that uses this precipitation/evaporation differential. A brief outline of the leachate circulation system is as follows.

Leachate from Landfill➔Main Leachate Drain➔Regulation Pond

➔Pump Station➔➔Leachate Pipe➔Valve & Leachate Feeding Drum➔

➔Leachate Feeding Drain➔ Landfill

The costs to construct a leachate circulation system that would circulate leachate for the entire the year, without discharging it into the environment, would be immense. The design of the pilot project, therefore, accommodates for leachate for only seven months (i.e., between April and October). Because the leachate generation would exceed the design criteria for the rest of the year, the excess leachate produced during the November to March period will be discharged to public waters, that have an abundance of flowing water during the raining season, and diluted. However for the feasibility study, the leachate circulation facility is designed to treat leachate throughout the year.

c.1.2 Fire Prevention

The following fire extinguishing measures were included in the design as countermeasures to extinguish spontaneous fires at the site.

i Sprinkling of water

Water sprays from a fire truck ensures that all fires at the disposal site are extinguished.

ii Flatting steep slope

Heavy equipment, such as bulldozers, flattened the steep slopes that have been a result of open dumping, so that soil covering is made easy.

iii Soil covering

After the slope was flattened, there was daily soil covering to prevent spontaneous fires, scattering of waste, and diffusion of noxious odours.

c.1.3. Other Measures

i Gas removal facility

The purpose of the gas removal facility is to exhaust the gas produced from the landfill layers, as soon as it is generated, in order to reduce spontaneous fires at the landfill. A Gabion, with a diameter of 500mm and an inner perforated pipe of 100mm in diameter, was installed in the existing waste layer. Small rocks (ø 100 - 200 mm) filled the gap between the two pipes. The gas removal facility is illustrated in Figure 7-8.

ii Drainage facilities to block rainwater infiltration from outside of the area

In order the prevent the infiltration of rainwater into the leachate pipes, an embankment was constructed to prevent rainwater intrusion.

iii Mitigation of adverse impacts on the surrounding environment

A green belt, approximately 30m wide, was constructed at the disposal site facility in order to reduce the impact on the surrounding environment and to prevent waste from scattering beyond the disposal site.

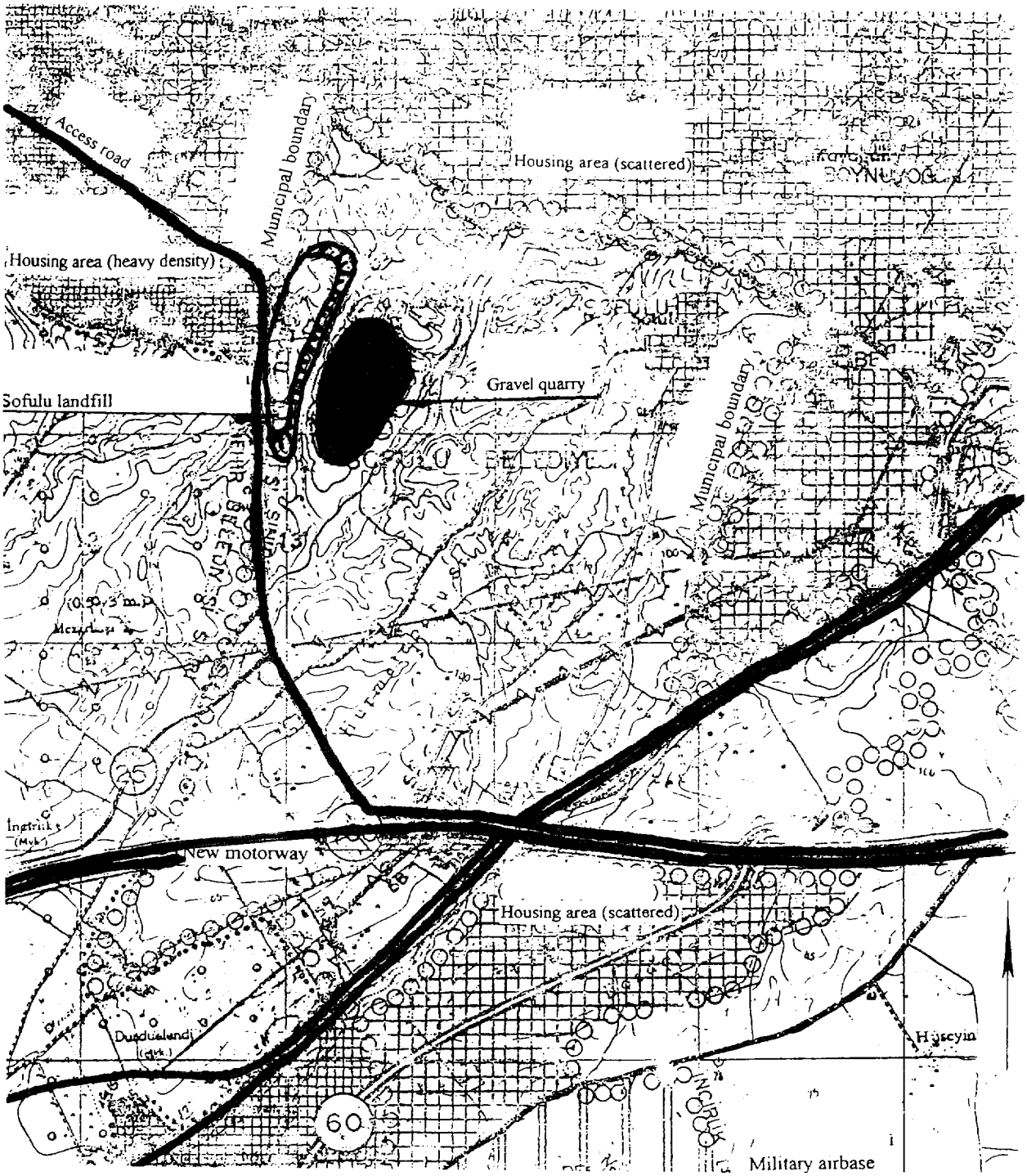

Figure 7-1: Location, Adana City Master Plan 1996

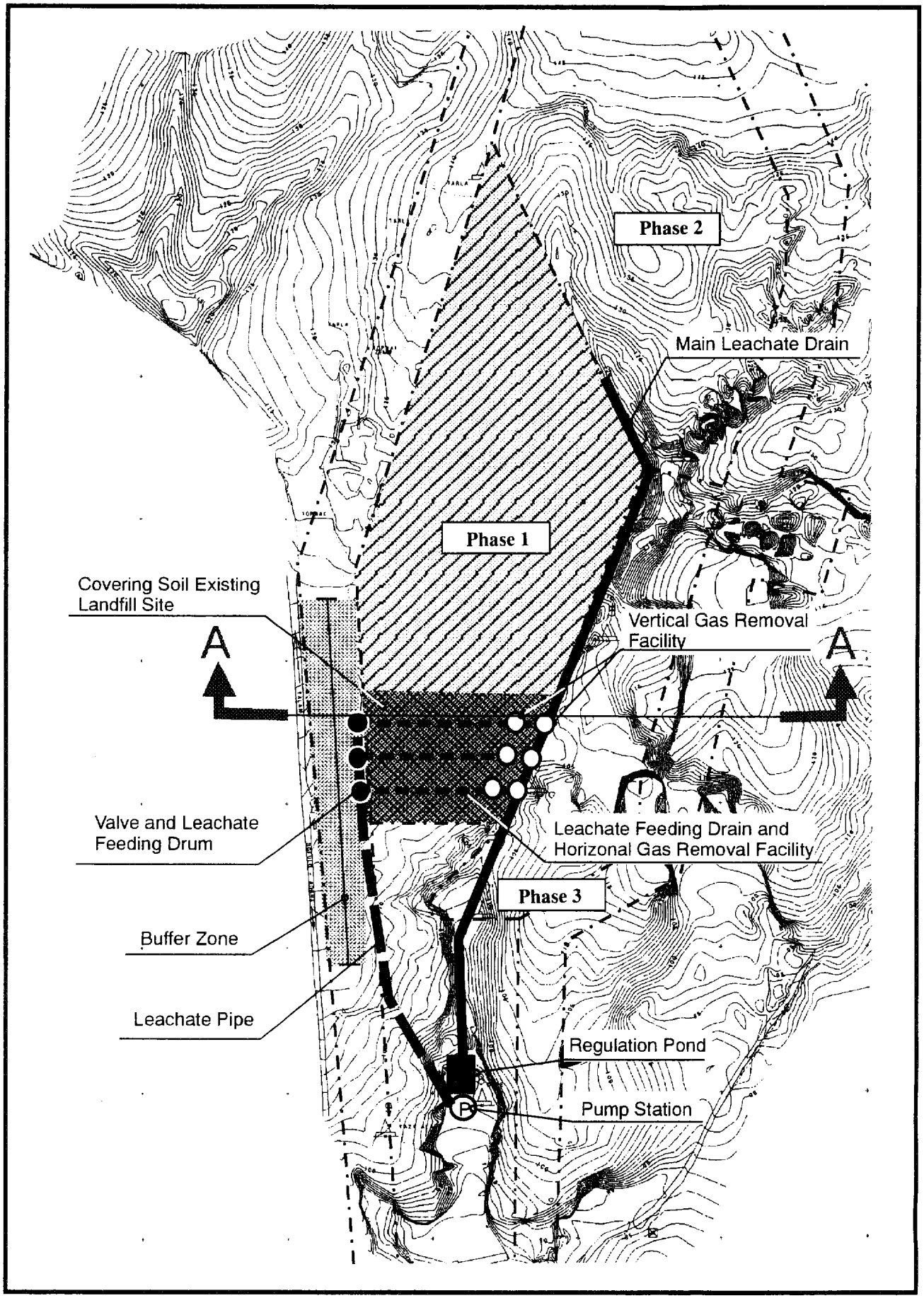

Figure 7-2: Overall Plan of the Experiment on the Improvement of Sofulu Disposal Site

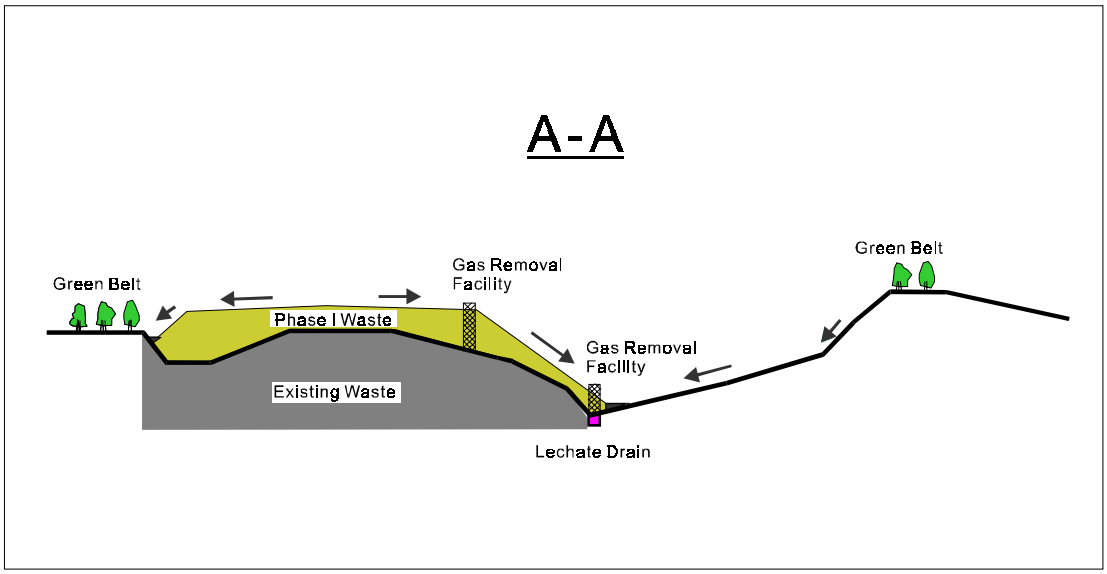

Figure 7-3: Cross Section of Phase 1 Landfill Operation in Sofulu

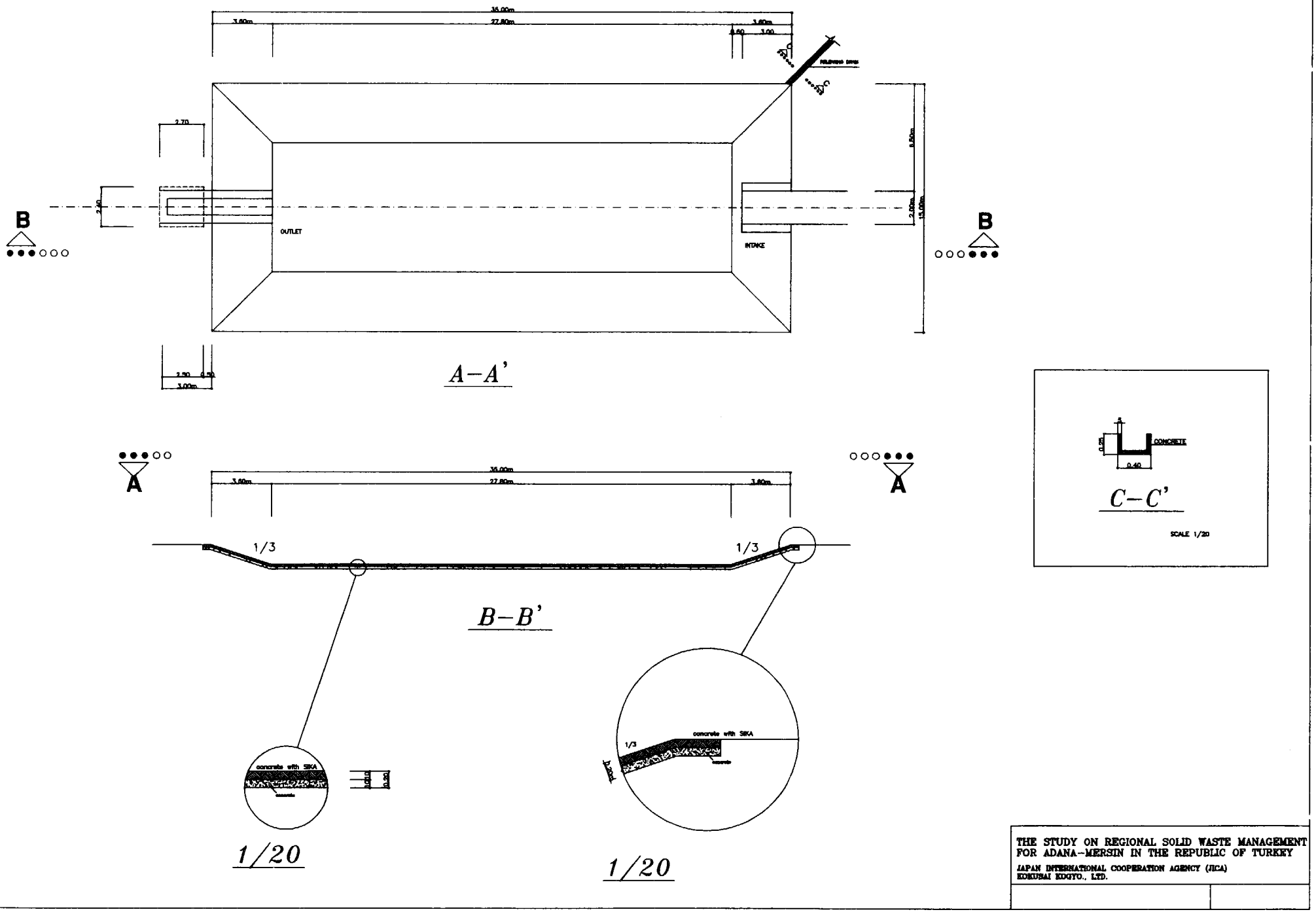

Figure 7-4: Plan of the Regulation Pond in Sofulu

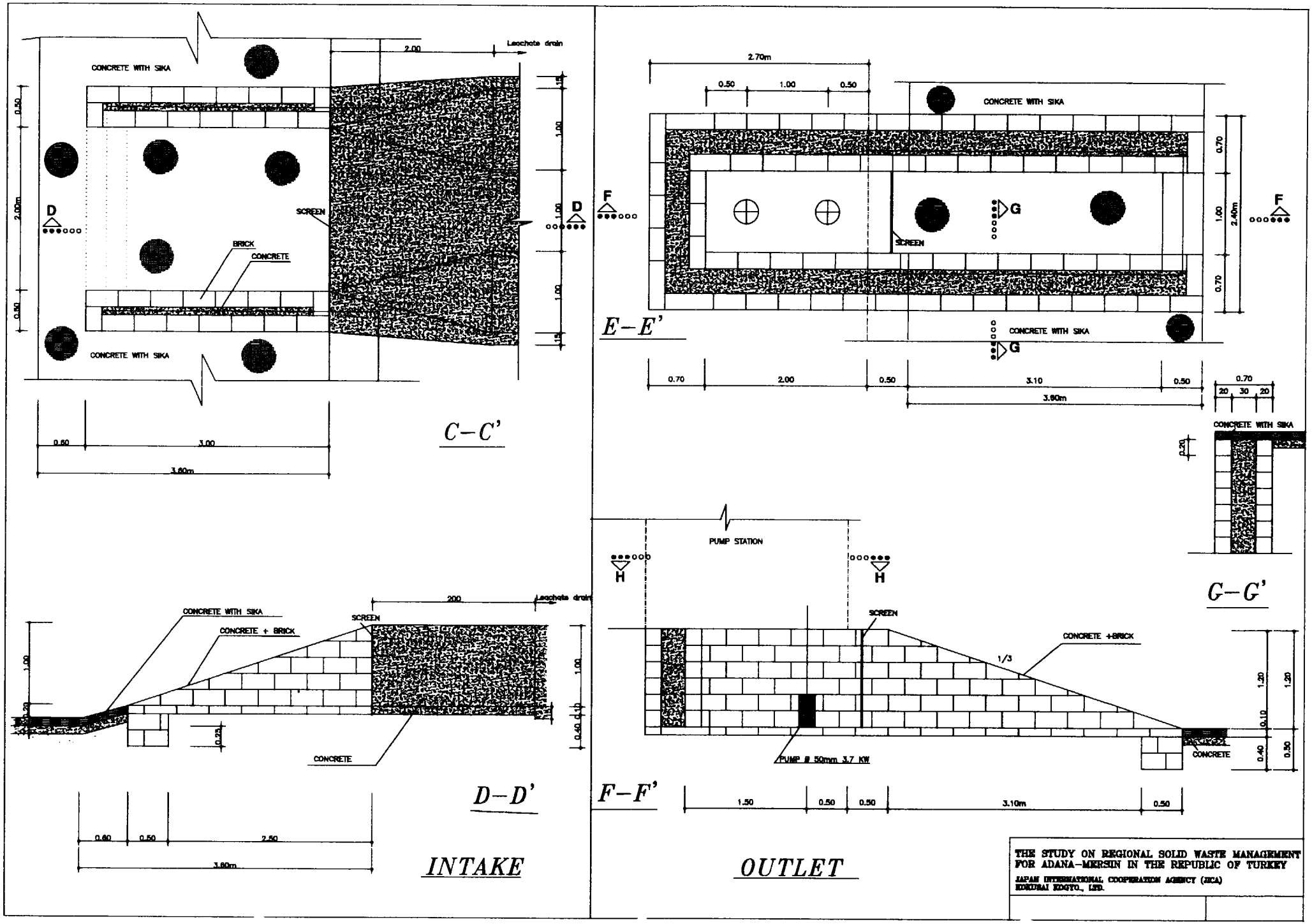

Figure 7-5: Plan of the Intake & Outlet of the Regulation Pond in Sofulu

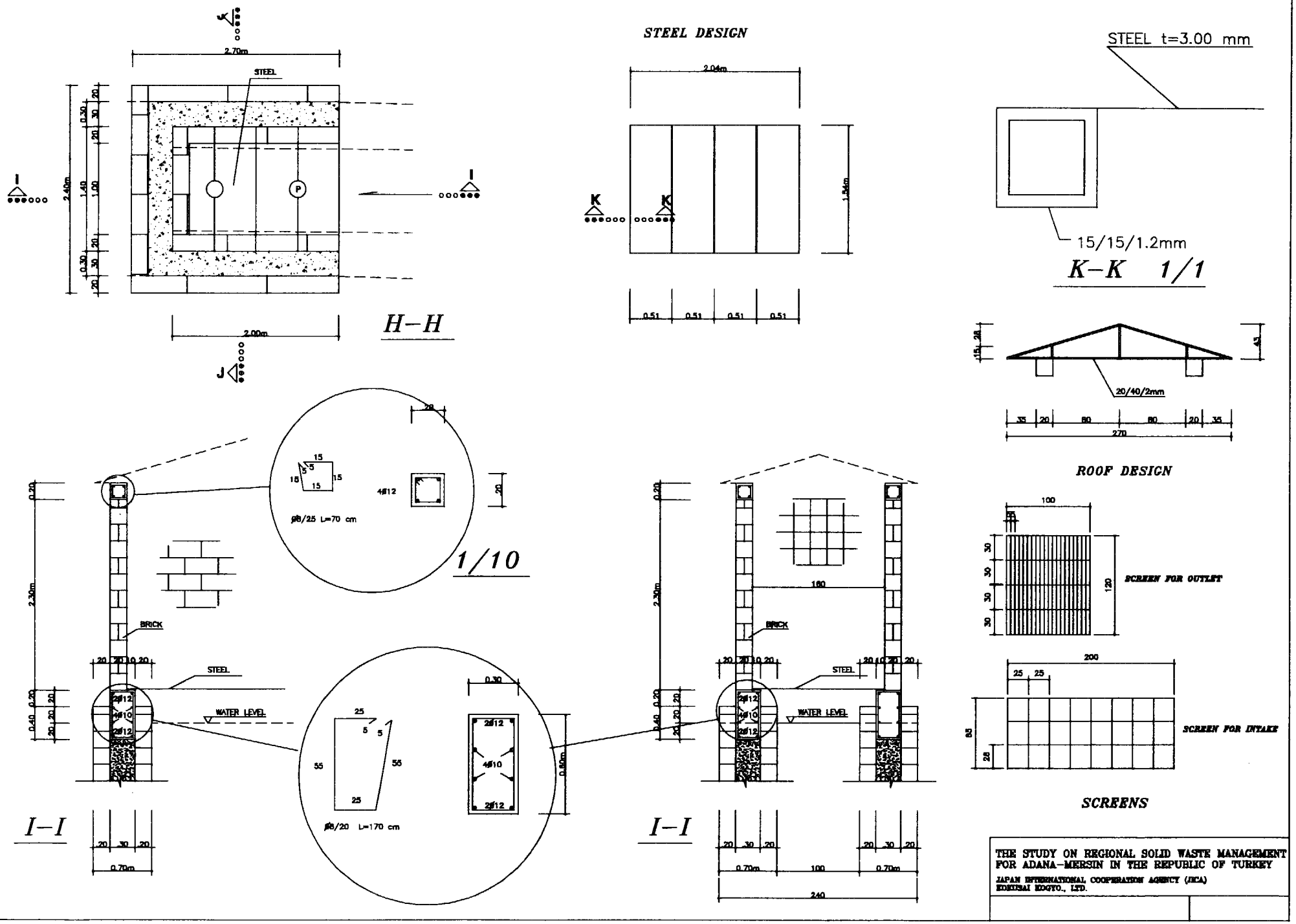

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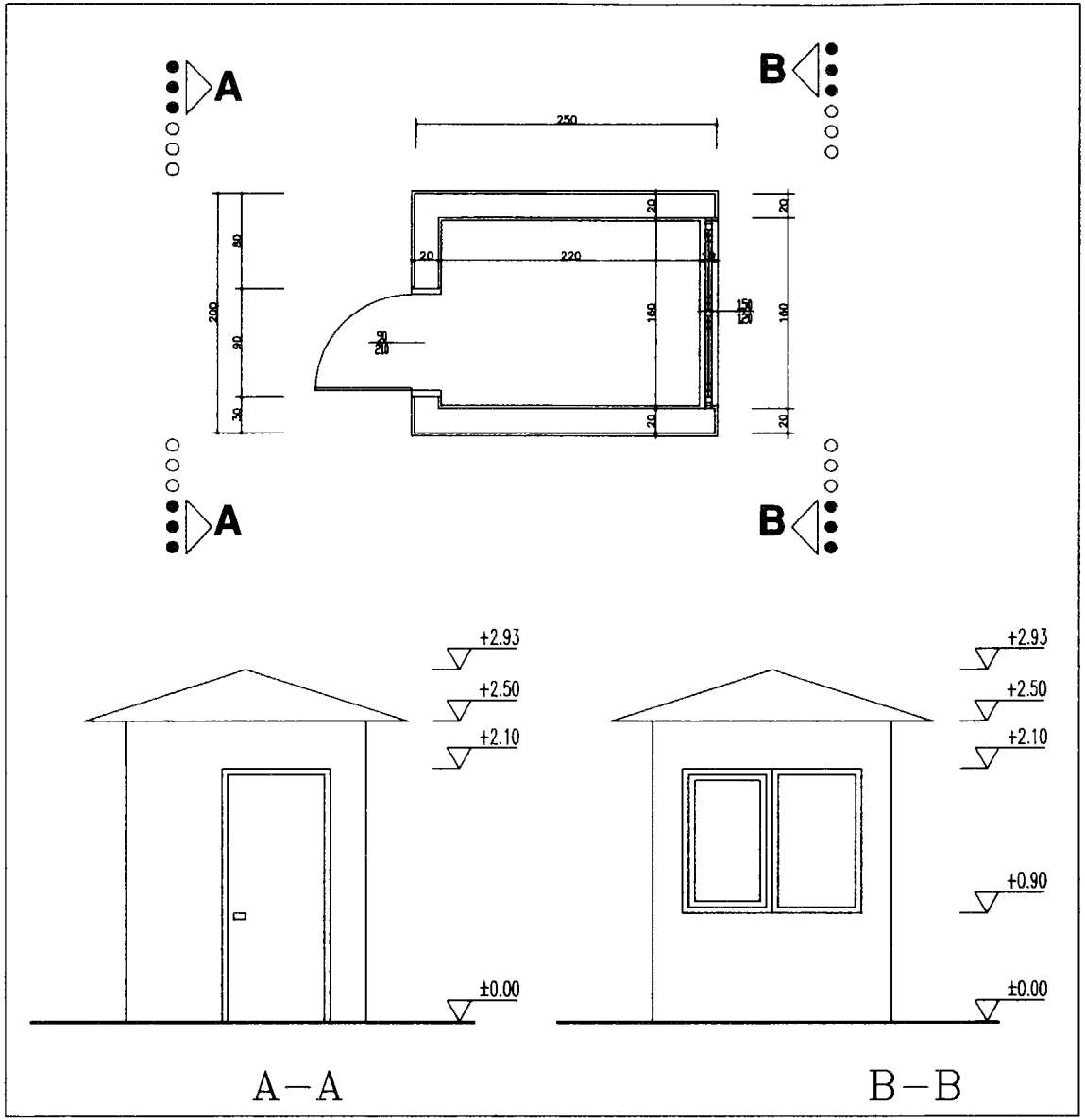
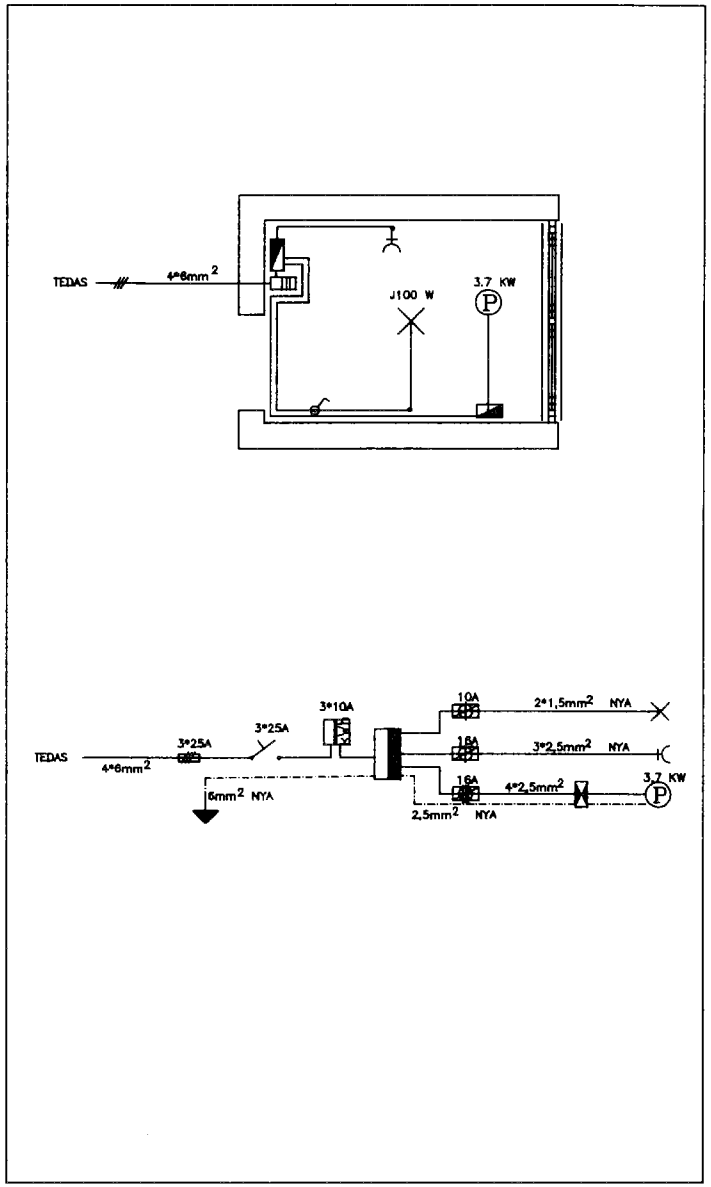
Figure 7-6: Plan of the Pump Station (1) in Sofulu





THE STUDY ON REGIONAL SOLID WASTE MANAGEMENT FOR ADANA–MERSIN IN THE REPUBLIC OF TURKEY

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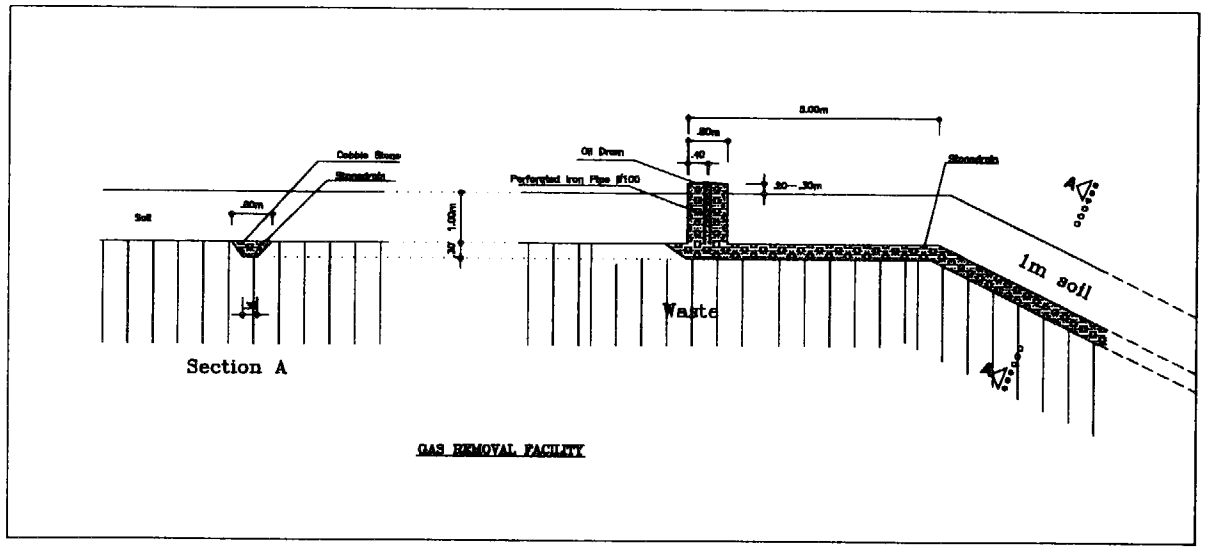
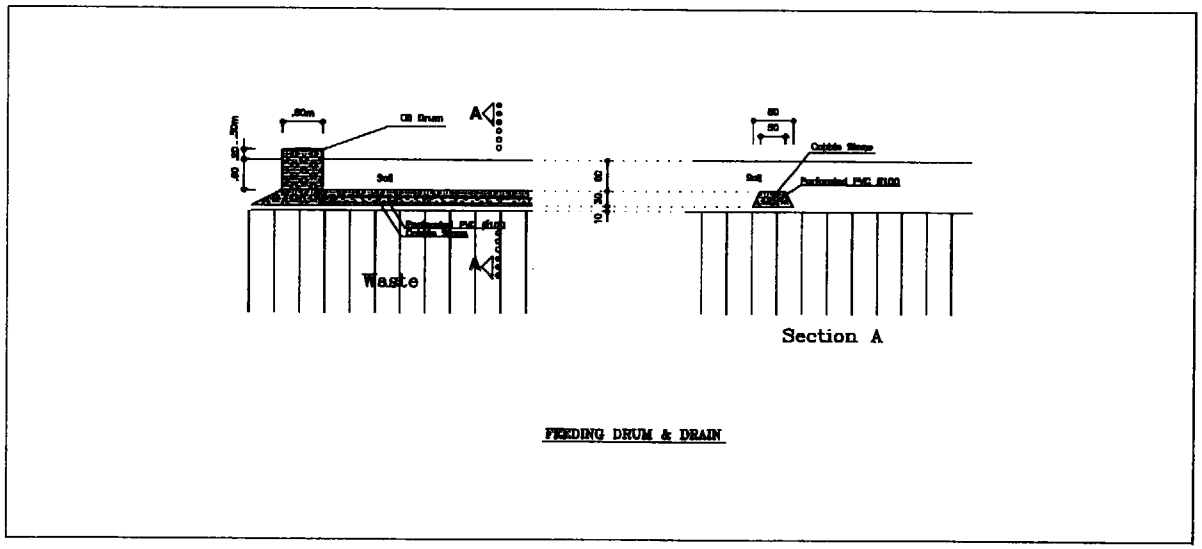
Figure 7-7: Plan of the Pump Station(2) in Sofulu





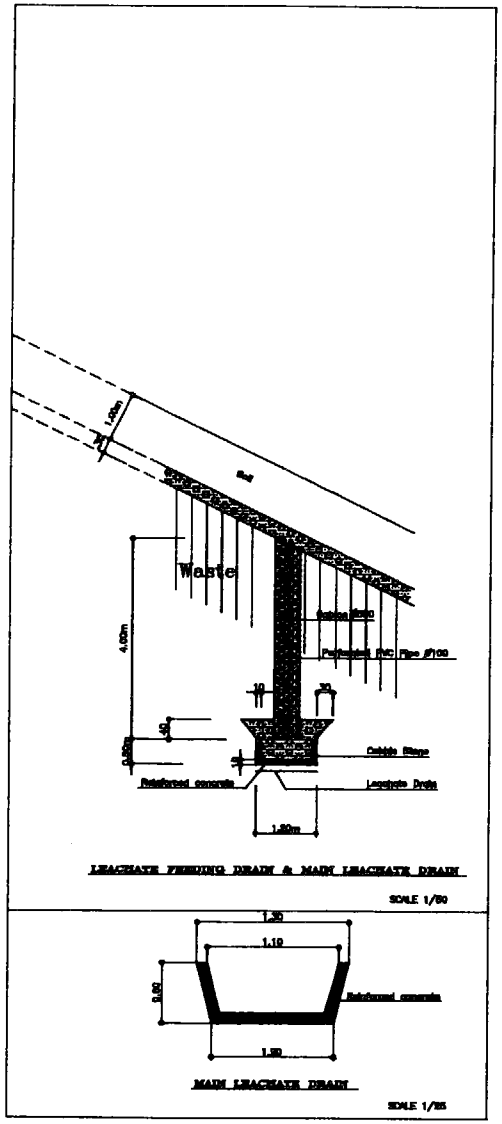


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Figure 7-8: Plan of the Gas Removal Facility & Circulation Facility in Sofulu

c.2 Design of Leachate Control Facility

The aim of the pilot project's leachate control facility was to treat leachate produced from April to October. The facility was designed taking into account the high precipitation in April and May for the design of the facility.

The main leachate drain, however, was designed based on the rainfall data in December, the wettest month, because there is a need to drain leachate throughout the year.

c.2.1 Precipitation & Evaporation

According the precipitation & evaporation data between 1929 and 1990 for Adana City, average rainfall was 647.1mm per annum. In the course of the year, 80% of the rainfall is concentrated between November and April, the rainy season; on the other hand, average annual evaporation is 1,571.7mm, which is 2.4 times the average annual rainfall. The dry months, between May and October, sees 70% of the annual evaporation. Average Precipitation and Average Evaporation are shown in Table 7-2.

Table 7-2: Average Precipitation & Average Evaporation (1929-1990)

	Jan (mm /month)	Feb (mm /month)	Mar (mm /month)	Apr (mm /month)	May (mm /month)	Jun (mm /month)	July (mm /month)	Aug (mm /month)	Sep (mm /month)	Oct (mm /month)	Nov (mm /month)	Dec (mm /month)	Annual (mm)
Average Precipitation	111.7	92.8	67.9	51.4	46.7	22.4	5.4	5.1	14.8	43.6	67.2	118.1	647.1
Average Evaporation	47.3	56.1	84.9	119.7	170.5	210.1	243.4	224.6	181.0	120.8	66.3	47.0	1571.7

Source: Meteorological Station in Adana

c.2.2 Calculation of the Design Leachate Amount

To determine the scale of the leachate control facility the daily leachate generation figures are required to calculate the design leachate amount. There are two ways to calculate design leachate amount: 1) based on rational formula 2)based on empirical data, but for the purpose of the pilot project, the rational formula was used. The following is the mathematical formula used to calculate design leachate amount.

$$Qj=1/1000 \times Ij \times (C_1A_1+C_2A_2) \qquad \text{(Formula1)}$$

- Qj : Design leachate generation amount (m^3/d) for day (j) in a given year.
- Ij : Rainfall amount (mm/d)for day (j) in a given year.
- C1 : Leachate generation coefficient from the disposal area
- C2 : Leachate generation coefficient from the existing disposal area.
- A1 : Area of the disposal surface (m^2)
- A2 : Area of the present disposal area (m^2)

c.2.3 Leachate Generation Coefficient

In this study, because Adana Municipality did not have the daily meteorological data that is required to calculate the leachate generation coefficient, the figure used was the

coefficient used in Japanese, that would give a degree of safety at an average annual precipitation of 1,600 mm.

C1=0.5

C2=0.3

In future there is a need to calculate an accurate generation coefficient, based on the observed leachate generation amount from the pilot project.

c.2.4 Design Leachate Generation Amount

The design leachate generation amount is determined as follows: the most important condition is that drainage facilities to block rainwater infiltration from outside of the area are constructed by AGM and the disposal area is completely blocked from the infiltration of rainwater from outside the boundaries.

i Leachate Control Facility（Excluding the Main Leachate Drain）

The leachate control facility, excluding the main leachate drain, was designed so that the leachate generated in the wettest months during the pilot period, April to May, can be treated by the facility. The design leachate generation amounts for April and May (Qapr, Qmay) are calculated from the following formula.

Qapr=1/1000 x1.71 x (0.5x0＋0.3x220,000)=112.86=113m^3/day

Qmay=1/1000 x1.51 x (0.5x0＋0.3x220,000)=99.66=100m^3/day

Where: Iapr = 51.4(mm/month)/30(days) =1.71 mm/day

Imay = 46.7(mm/month)/31(days) =1.51 mm/day

C1 = 0.5

C2 = 0.3

A1 = 0 m^2

A2 = 220,000 m^2

ii Main Leachate Drain

Because the main leachate drain needs to function throughout the year, it was designed to discharge with the leachate generated even during the wettest month of the year, December. The design leachate generation amount for December (Qdec) is calculated from the following formula.

Qdec=1/1000 x3.81 x (0.5x0＋0.3x220,000)=251.46=251m^3/day

Where Idec = 118.1(mm/month)/31(days) =3.81 mm/day

C1 = 0.5
C2 = 0.3
A1 = 0 (m^2)
A2 = 220,000 (m^2)

c.2.5 Regulation Pond & Pump

i. Determining the Regulation Pond & Pump Capacity

In order to determine the appropriate size of the regulation pond & the pump capacity, the amount of leachate to be generated from the disposal area in April and in May and the regulation pond capacity (Aj) were used in the calculation. The variables were altered to calculate the most appropriate size and capacity.

In this case, fifty percent of the leachate that is circulated to the disposal site by the pump will evaporate, and the rest is assumed to return to the regulation pond from the disposal site as part of the design leachate generation amount. The amount of leachate that will flow into the regulation pond, ΣQj, is calculated as follows:

$$\Sigma Qj = Qj + (C_1 \times R_{j-1})$$

Where Qj : Design leachate amount (m^3/d)on day (j) in a given year
$C1$: Generation coefficient for the disposal area. (0.5)
Rj : Amount of leachate circulated (m^3/d) to the disposal area by the pump on day (j) in a given year.

The results of the calculations are shown in Table 7-3, and the breakdown is shown in Table 7-3. The shadow indicates the ideal capacity.

Table 7-3: Results of the Calculation

Capacity of Pump (m^3/day)	Capacity of Regulation Pond （m^3）
170	1,249
180	949
190	649
200	350
210	210
220	74

ii. Design of the Regulation Pond

The leachate that is collected via the main leachate drain flows into the regulation pond, and is then pumped back to the disposal area.

The design of the regulation pond must clear the following conditions.

- Regulation Pond Capacity＞＝210（m^3）

Regulation pond is designed to have a margin of greater than of 20% of the desirable size, with a dimension 15m (w) X 35m (l) X 0.85m (d), a total volume of 268.8 m^3. The pond was made of reinforced concrete, and on its surfaces waterproof lining (SIKA) was laid.

iii. Design of the Pump & the Pumping Station

Considering the height difference of 35m between the pump station and the leachate feeding drum, and the head loss, the pump output is designed to meet the following criteria.

- Pump capacity＞＝210 m^3/day
- Total pump head（actual pump head＋head loss）＝45m

The pump, designed with a margin greater than 20% of the desired capacity, has a discharge volume of 11.0 m^3/h; one pump with a pump head of 55m, operating for 24 hours/day, was constructed. The pumping station is designed so that there is enough space for another pump if Adana Municipality decides to install one in the future.

11.0 m^3/h x24 h＝264 m^3/day

c.2.6 Design of the Main Leachate Drain

The purpose of the main leachate drain is to collect the leachate generated from the present landfill site and conduct the leachate to the regulation pond.

The main leachate drain is designed to meet the following criteria.

- The drain cross section can conduct the design leachate amount for December Qdec=215m^3/day=0.0024m^3/sec
- The ground conditions are such that the height difference between the starting point and the finishing point is 40 m, and the length of the drain is 1,225m

In order to meet these criteria, the main leachate drain, designed to exceed a 20% margin of the desirable capacity, is an open drain made of reinforced concrete (1,100mm X 1,000mm X 500mm, flow capacity 0.0024m^3/sec). Further in order to prevent the intrusion of waste the drains are filled with approximately 20 cm of rocks. The flow capacity is calculated as follows.

$V = 1/n \cdot R^{(2/3)} \cdot I^{(1/2)}$

$Q = A \cdot V$

Where V : Rate of flow
Q : Flow capacity
n : Roughness coefficient 0.013
A : Cross section of the flow1/2x(1.1x1.0)x0.5=0.53(m^2)
P : Wetted perimeter 0.5x2+1.0=2.0(m)
R : Hydraulic perimeter A/P=0.53/2.0=0.27
I : Gradient 40/1,225＝0.03

Degree of opening in the drain after the rock packing ＝0.1%

$V=1/0.013 \times 0.27^{(2/3)} \times 0.03^{(1/2)}=5.6$(m/sec)

$Q=0.53 \times 5.6 \times 1/1.2 \times 0.001=0.0024$($m^3$/sec)

7.2.3 Implementation of the Experiment

a. Division of the Work

The experiment was conducted in collaboration with the Adana GM and JICA study team as follows:

1. The Adana GM provided and operated the heavy machinery, e.g., bulldozers, etc. to the maximum and the uppermost objective to prevent disasters and fire outbreaks at minimum cost. The study team determined the effectiveness of extending guidance in daily sanitary landfill practices, i.e., waste levelling/compaction and soil covering, to mitigate adverse environmental impacts. The study team provided gas removal facilities to determine how effective they are.
2. In order to mitigate water contamination due to leachate generation – another major environmental pollutant in addition to fire outbreaks at the disposal site –a leachate control system (leachate circulation facility) was provided by the team. The storm water drains would be installed by the Adana GM to decrease leachate generation volume.
3. In order to gain the permission of the surrounding residents and persons concerned for the continued use of the present disposal site, a buffer zone (greenery belt) was constructed by the Adana GM. In addition, site visits/observation and questionnaire surveys before and after the improvement of the site would be organised by the Adana GM to evaluate the effects of the improvement by the experiment and the opinion of those people.
4. To create an example that is as effective as can be, the study team let the Adana GM experience proper operation by having them provide the heavy machinery, dump trucks, fire trucks, and manpower, in order for them to take the initiative to improve the present disposal site in Sofulu.

The above-mentioned division of the improvement work is summarised in the table below.

Table 7-4: Work Division of the Sofulu Disposal Site Improvement

Work Items	Machinery & Facilities Requirement	Responsible Body
1. Leachate control	leachate drains Regulation pond Pumping station Circulation facility	JICA
2. Extinguish fire • Flattening steep slope • Soil covering and sprinkling of water	heavy machinery, dump truck, fire trucks	Adana GM
3. Prevention of spontaneous fire	gas removal facilities	JICA
4. Reduction of leachate generation	drainage facilities to block rainwater infiltration from outside of the area	Adana GM
5. Mitigation of adverse impacts on surrounding environment	buffer zone	Adana GM
6. Assessment of the improvement work by a questionnaire survey to the people	bus	Adana GM

b. Implementation Schedule

The experiment has been conducted according to the schedule as shown in the table below. The works to be done by the Team, such as leachate control facility, etc., have been completed by mid-June 1999. The Adana GM has continued their responsible works and completed the works by mid-September. After the completion of the experiment Adana GM will continue sanitary landfill operation on the Sofulu disposal site.

Table 7-5: Implementation Schedule of the Sofulu Improvement

Work Items	99 Apr	99 May	99 Jun	99 July	99 Aug	99 Sep
1. Leachate control						
2. Extinguish fire						
3. Prevention of spontaneous fire						
4. Reduction of leachate generation						
5. Mitigation of adverse impacts on surrounding environment						
6. Assessment of the improvement work by a questionnaire survey to the people						

c. Improvement by the Experiment

The Sofulu dump site has been considerably improved through the experiment. In order to show the change of the landfill from an open dump to a preliminary sanitary landfill, the improvements are presented in the photos below.

Regulation Pond
Leachate collected via the main leachate drain flows into the regulation pond.

Pump Station
Leachate is pumped back to the disposal area from regulation pond.

Gas Removal Facilities
Gas removal facilities were installed to remove gases from the landfill.

Circulation Facilities (Feeding Drum and Drain)
Leachate pumped up to leachate feeding drum and drain is back discharged into the landfill.

Cover Soil
Cover soil was applied by Adana GM to extinguish fire and smoke.

Buffer Zone
A 50m wide buffer zone was constructed to isolate the disposal site from the surrounding area.

Figure 7-9: Improvement by the Experiment