

Annex 10

*Operation Plan of Sofulu Site
Development*

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10 Operation Plan of Sofulu Site Development

10.1 Sorting Plant

10.1.1 Fundamental Issues

This part describes the operation plan of the sorting plant proposed for the AGM. The operation plan will cover the work flow from waste reception to recyclable materials storage.

a. Working Hours

This sorting plant is open the following hours.

- Mondays - Saturdays: 7:00 - 23:00 (16 hour/day)
- Sundays and National Holidays: Closed
- Equipment operation hours 13 hours/day

Table 10-1: Work Schedule of Sorting Plant in Sofulu

| | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | |
|---------------------|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|
| Waste Received Time | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Equipment Operation | | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | | |

b. Types of Solid Wastes

The sorting plant will receive the following types of wastes.

- Non-compostable MSW separated at source such as households and commercial enterprises.

c. Main Design Parameters

Table 10-2 summarises the design parameters based on the above design assumptions.

Table 10-2: Design Parameters of the Sorting Plant

| | | |
|----------------------------|--|----|
| Raw Material | | |
| Amount | 54,538 ton/year (2005) | |
| Moisture content | 55.7 % | *1 |
| Bulk density | 300 kg/m ³ | *1 |
| Plant Specification | | |
| Type | Hand-sorting + a magnetic separator | |
| Treatment line | One line | |
| Treatment Capacity | 190 ton/day | |
| Operation | 300 day/year | |
| | 16 hour/day by two shifts | |
| Recovered Material | (1) Paper (mainly Cardboard) | |
| | (2) Plastics (Film and PET bottles) | |
| | (3) Glass (Bottles and Cullet) | |
| | (4) Ferrous metal | |
| | (5) Non-ferrous metal (mainly Aluminium cans) | |
| | (6) Textile | |

Note *1 : Estimates from the pilot project

d. Process Flow of the Plant

Figure 10-1 shows the process flow of the proposed sorting plant.

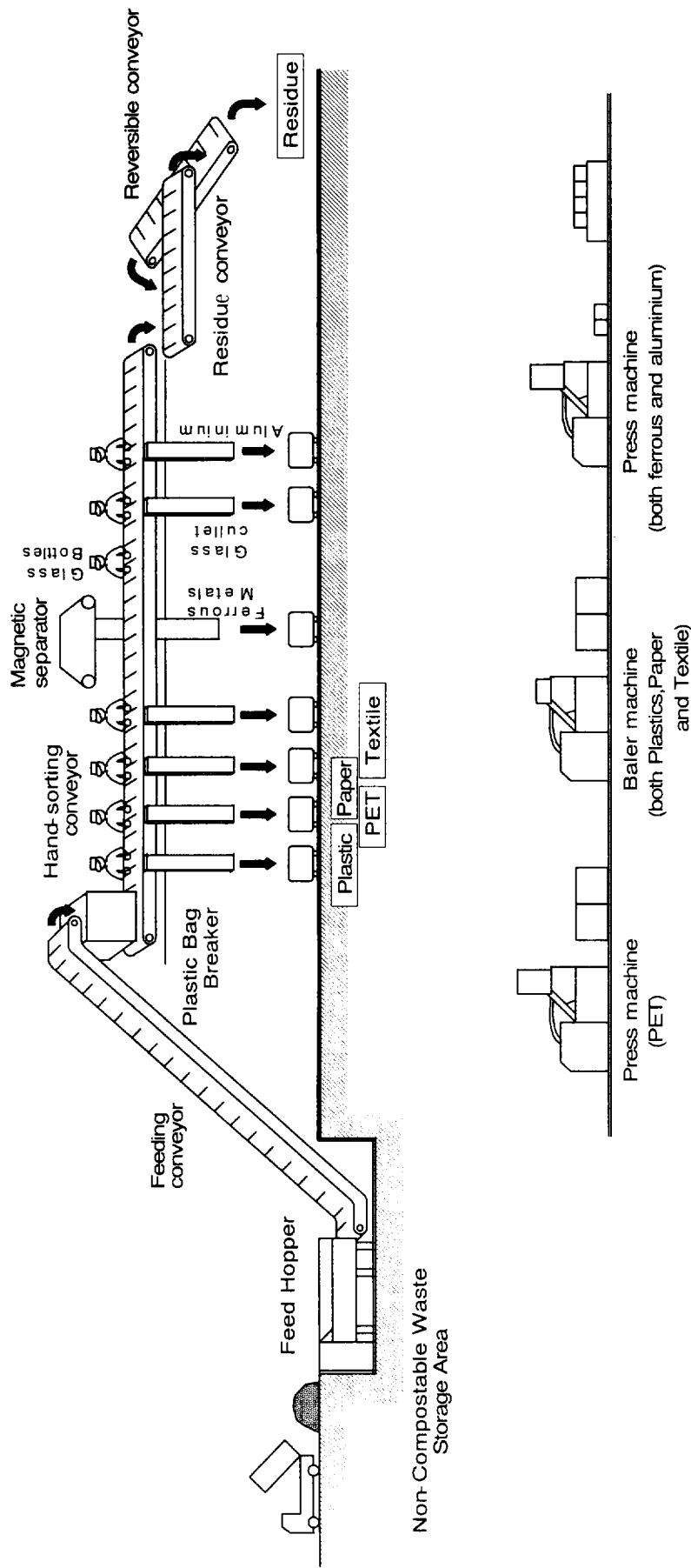


Figure 10-1: Process Flow Sheet of the Proposed Sorting Plant in Sofulu

e. Layout of Proposed Sorting Plant

The layout of the proposed sorting plant is presented in Figure 10-2.

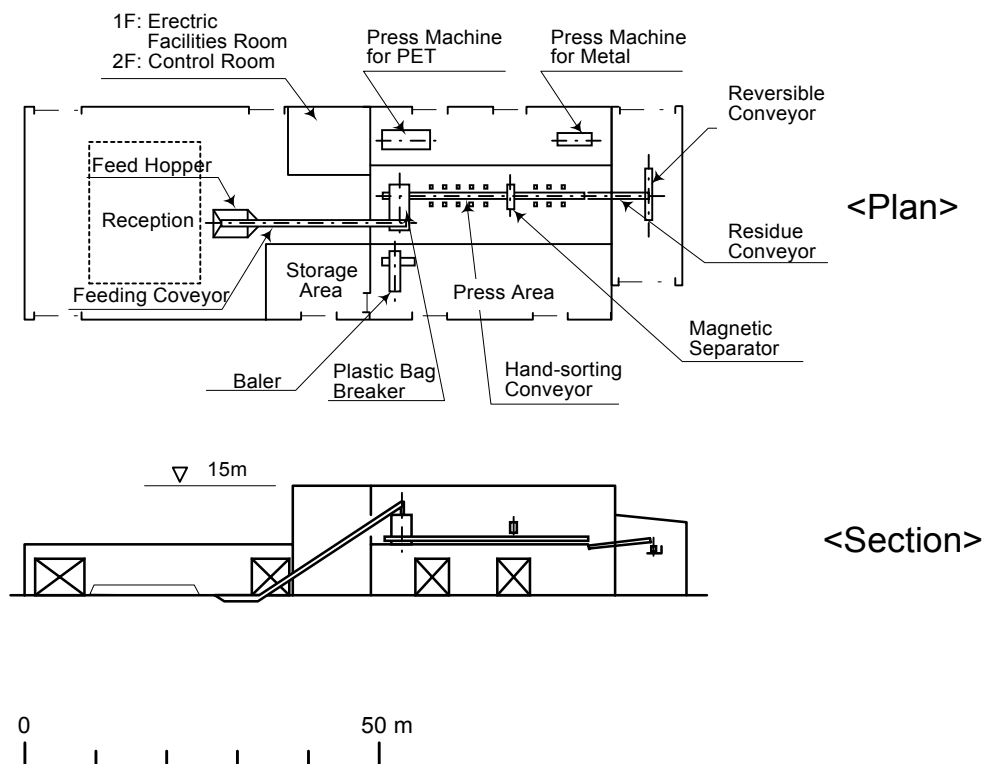


Figure 10-2: Layout of the Sorting Plant in Sofulu

f. Staff and Job Description

Operation and maintenance (O&M) will be contracted out to the private sector, while the AGM will instruct and supervise the plant and bear responsibility to prevent any adverse impacts on the environment.

Table 10-3 is the staff allocation schedule of the plant. The number of operators and manual workers is derived from the volume of materials to be processed and plant operation capacity.

f.1 Administration

Administrative work will be executed by a director, who oversees the operation and management of the sorting plant, and supporting staff including an accountant and secretary.

f.2 Operation

Plant operation is overseen by a sub-manager of the plant involving five sections. Each is headed by one supervisor for one shift.

- Waste Reception Section

Wastes are received in this section and fed to the plant. Wastes unsuitable for the sorting process such as bulky wastes should be manually rejected by the workers. A

wheel-loader is used to feed wastes to a hopper. These works are managed by the waste reception supervisor.

- Facility Operation Section

The workers of this section, headed by the sub-manager, operates the facility such as the feed hoppers and hand-sorting conveyors. The entire operation work will be done in a central control room. This section shall also take responsibility of the electrical control system.

This section is in a key position coordinating the preceding waste reception section and the following hand-sorting section. The capability to assess the situation of the plant as a whole is required.

- Manual Sorting Section

This is the section where recyclable materials are sorted out from wastes on a conveyor belt. The manual sorting supervisor looks after waste composition and sorting works, and adjust the speed of the conveyor. The line workers are allocated on the both sides of the conveyor and manually pick up a specific item assigned to each worker in advance.

- Product Section

The product section conditions recyclable materials separated by the manual sorting section and store it if needed. The supervisor of this section gives instruction on product handling and storage to the product separation workers, press machine operators, baling machine operator and folk lift driver.

- Transport Section

This section manages the transport of waste residue form the plant to the final disposal site. The truck drivers supervise waste residue loading onto the trucks, transport it, and maintain the vehicles.

Table 10-3: Staffing Schedule for Sorting Plant in Sofulu

| Position | | Shift | | total |
|-----------------------|--------------------------|-------|-----|-------|
| | | 1 | 2 | |
| ADMINISTRATION | | | | |
| | Sub-manager | 1 | --- | 1 |
| | Accountant | 1 | --- | 1 |
| | Secretary | 1 | --- | 1 |
| | sub-total | 3 | --- | 3 |
| OPERATION | | | | |
| | Pre-treated section | | | |
| | Supervisor | 1 | 1 | 2 |
| | Facility operate section | | | |
| | Machine operator | 2 | 2 | 4 |
| | Reception section | | | |
| | Loader operator | 1 | 1 | 2 |
| | Labourer | 1 | 1 | 2 |
| | Hand-sorting section | | | |
| | Hand-sorting supervisor | 1 | 1 | 2 |
| | Hand-sorting labourer | 12 | 12 | 24 |

| Position | | Shift | | total |
|-------------------|------------------------|-------|----|-------|
| | | 1 | 2 | |
| Product section | | | | |
| | Supervisor | 1 | 1 | 2 |
| | Labourer | 7 | 7 | 14 |
| | Press machine operator | 2 | 2 | 4 |
| | Baler machine operator | 1 | 1 | 2 |
| | Fork lift driver | 1 | 1 | 2 |
| Transport section | | | | |
| | Truck driver | 1 | 1 | 2 |
| | Labourer | 1 | 1 | 2 |
| sub-total | | 32 | 32 | 64 |
| Total | | 35 | 32 | 67 |

10.1.2 Operation Plan

a. Weighbridge

The sorting plant, composting plant and final disposal site, which are to be sited in the same land plot, will share two weighbridges.

The weight of the following items will be measured by them.

- Mixed wastes directly delivered to the landfill.
- Medical wastes directly delivered to the landfill.
- Non-compostable wastes fed to the sorting plant.
- Recyclable materials and residue segregated at the sorting plant.
- Compost and residue from the compost plant.

Technical notes:

- The importance of wastes and materials measurement for the prudent management of the sorting plant, composting plant and the final disposal site can not be stressed. All of the trucks which coming in and going out of the area must be weighed and the weighbridges should be regularly inspected and surely maintained.

b. Waste Reception and Waste Storage Area

b.1 Waste Reception Area

Non-compostable wastes are unloaded from the collection vehicles and fed to the waste hopper by the wheel loaders in this area.

Technical Notes:

- Wastes which would give physical damages to equipment, such as bulky ones, paper and plastics bound into a large bulk, must be removed in this stage. Those removed are to be separated into recyclable and non-recyclable materials. The former is handled together with the materials recovered by hand-sorting, while the latter is disposed of with other waste residue.

b.2 Waste Storage Area

This is the area to store wastes beyond of plant capacity and wastes delivered during the plant closure, i.e., on Sundays and national holidays.

Technical Notes:

- It should be ensured that the amount of waste storage in this area is as small as possible in order to maintain good work environment. Wastes should be neatly stored to keep the area clean.

c. Feed Hopper and Feeding Conveyor

This equipment conveys received wastes to the subsequent operation line.

Technical Notes:

- The speed of the conveyor belts must be adjustable. The belt speed should be appropriate for waste composition and the work condition of hand-sorting line.
- Wastes which drop from the feed hopper or the conveyor needs to be picked up while operation is temporally stopped or after daily operation.

d. Plastic Bag Breaker

Most wastes are delivered in plastic bags. They are torn within a box, in which a plastic bag breaker is installed, to facilitate the manual work in the sorting lines.

Technical notes:

- The plastic bag breaker has special parts to tear plastic bags. They must be regularly inspected to see if they are worn out.
- The performance of the plastic bag breaker should be monitored at all times by specific workers in order to immediately detect any trouble such as waste jams in the box.
- After daily operation, the breaker must be inspected and cleaned.

e. Hand-sorting Conveyor

The hand-sorting belt conveyor is designed to be set horizontally and in the upper position of the plant. Recyclable materials picked up along the sorting line are to be dropped to the boxes arranged under the belt conveyor through the shoots.

The several shoots are equipped on the both sides of the conveyor. Each of them is to be used for a specific recyclable item except glass bottles, for which specific boxes are provided beside the line workers since they are fragile.

Waste items to be sorted by the manual workers along the belt conveyor include paper, plastic, glass cullet, glass bottles, textile and non-ferrous metal. Ferrous metal will be sorted by the magnetic separator which is arranged perpendicularly to the belt conveyor.

Technical Notes:

- Similarly to the feeding conveyor, the speed of the hand-sorting belt conveyor should be adjustable. The belt speed should be appropriate for waste composition, waste amount and the work condition of the hand-sorting line.
- The work along the running belt conveyor can be risky. Emergency switches to stop the conveyor should be accessible to all hand-sorting workers.
- Non-recyclable wastes dropped from the belt conveyor should be picked up while the operation is temporarily stopped or after operation.

f. Residue Conveyor

Wastes remained on the hand-sorting conveyor are further conveyed by the residue conveyor. The speed of the residue conveyor is fixed and its handling capacity is designed to be higher than that of the hand-sorting conveyor.

Each end of the residue conveyor has a shoot which leads waste residue to a dump truck under the shoot. The residue conveyor can move in both directions. When a dump truck is full with residue, the direction of the conveyor is converted to load waste residue into another dump truck of the other end.

The waste residue loaded into the dump truck is weighed and transported to the landfill nearby.

Technical Notes:

- The truck drivers must ensure that wastes are properly loaded into the dump trucks.
- In order to prevent waste residue from dropping during transport, it will need to use tarpaulin or spray water over the wastes.
- Since residue tends to be scattered, the area around the residue conveyor and the dump trucks must be regularly cleaned.

g. Recovered Recyclable Materials

Recyclable materials, recovered from the hand-sorting line or the magnetic separator, are put into specific boxes. The boxes are made of wire netting enforced with metal frames, and are mobile on casters. They may serve as temporal storage.

The boxes for the recovered glass bottles, which are smaller than the other boxes and arranged beside the sorting lines, must be brought down when full and the bottles will be temporarily stored in them.

Technical Notes:

- The boxes are set to receive the recovered materials except glass bottles from the sorting lines through the shoots. They should be carefully watched in order to be replaced with others when they are full. The work must be synchronised with sorting operation.
- It is preferable to hand over the recovered materials to the dealers on the same day.

- The recovered materials should be neatly stored to keep the area clean.

h. Press Machines

h.1 Ferrous Metal and Aluminium

Ferrous metal and aluminium cans stored in the boxes are pressed by a press machine to reduce their volume and efficiently use the storage area. The press machine will be used to press the two items in turn.

Technical Notes:

- The pressed metal and aluminium are loaded into trucks in bulk. They will have to be temporarily set aside in order, until their amount reaches to a certain level.

h.2 PET Bottle

PET bottles stored in the boxes are pressed by another press machine to reduce their volume and efficiently use the storage area. The press machine will be used to press PET bottles exclusively.

Technical Notes:

- The pressed PET bottles are loaded into trucks in bulk. They will have to be temporarily set aside in order, until their amount reaches to a certain level.

i. Baling Machine

The recovered plastic, paper and textile are separately baled and compacted by a baling machine to save space and make their transport easy. The baling machine is used for three items in turn.

Technical Notes:

- The baled plastic, paper and textile are loaded into trucks in bulk. They will have to be temporarily set aside in order, until their amount reaches to a certain level.

j. Stock Yard

Each of the following items should have a stock yard of proper size taking account of the amount of their recovery and sale.

- Ferrous metal (Pressed Product)
- Aluminium cans (Pressed Product)
- PET bottles (Pressed Product)
- Paper (Baled Product)
- Plastic film (Baled Product)
- Textile (Baled Product)
- Glass (Cullet and Bottles)

Technical Notes:

- The stock yards should be kept clean and neat by carefully handling the recovered materials by item not to hinder material transport by the dealers.

k. Movable Equipment

The following movable equipment is used in the sorting plant.

- Wheel loader for waste feeding
- Dump truck for waste residue transport
- Fork lift for the pressed or bailed product

Technical Notes:

- The machinery needs daily visual inspection and regular thorough inspection to be maintained in good condition.

l. Drainage

Four types of water have to be drained: domestic wastewater, leachate from wastes, wastewater from plant cleansing, and rainwater.

- Domestic wastewater is treated in a screening tank and discharged to the leachate treatment facility.
- Leachate from wastes and wastewater from plant cleansing are treated by screen equipped in the plant and discharged to the leachate treatment facility.
- Rainwater is drained to the outside of the plant without treatment by a drain system independent of the other wastewater.

m. Ventilation System

Air quality in the waste reception section and the hand-sorting section can be deteriorated by dust and odour given out from wastes, thus a ventilation system should be provided.

- In the waste reception section, air is drawn and emitted to the outside.
- In the hand-sorting section, air is drawn and emitted to the outside, and also fresh air is sent through several blowers.

Technical Notes:

- The rate of ventilation should be adjusted by monitoring the air quality condition.

n. Electricity

Electricity is supplied to plant equipment and lighting. All electricity controlling devices are installed in the central control room, in which plant equipment and lighting are centrally controlled.

Technical Notes:

The power supply system requires regular inspection and maintenance. Items and intervals of inspection and maintenance should be appropriate considering the characteristic of each equipment.

10.1.3 Monitoring Plan

a. Noise, Vibration and Odour

Noise, vibration and odour outside and inside the plant should be measured and properly recorded once a month.

b. Waste Composition Analysis

Composition of wastes received at the plant, homogeneity of the recovered materials and recovery rate of each material should be measured and properly recorded twice a year.

c. Personal Computer

The central control room is equipped with a personal computer, by which data will be dealt with to monitor plant performance. Data collected by the weighbridges is handled by another specific computer and sent to this personal computer. It will record the following data.

- Data measured by the truck scale on the amount of wastes delivered to the plant, sold recyclable materials, and waste residue.
- Financial data.
- Data on operation and maintenance of equipment
- Data on parts supplies

10.2 Compost Plant

10.2.1 Fundamental Issues

This operation plan is designed for the compost plant proposed for the AGM. It covers the process from waste reception to final product storage.

a. Working Hours

This compost plant is open the following hours.

- Mondays - Saturdays 7:00 - 23:00 (16 hour/day).
- Sundays and National Holidays Closed.
- Equipment operation hours 13 hour/day

Table 10-4: Work Schedule of Compost Plant in Sofulu

| | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | |
|------------------------|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--|
| Waste Received Time | | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | |
| Equipment Operation | | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | |
| Pre-treatment section | | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | |
| Primary screen section | | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | █ | |
| Final screen section | | | | | | | | | | | | | | | █ | █ | █ | █ | █ | |

b. Types of Solid Wastes

The compost plant will receive the following types of wastes.

- Compostable MSW separated at sources such as households, commercial enterprises, etc.
- Garden wastes (as moisture adjusting agent)

c. Main Design Parameters

A table below summarises the design parameters taking the above design assumptions into account.

Table 10-5: Design Parameters of the Compost Plant in Sofulu

| Composting section | | | |
|-----------------------------|---------------------------------|-----------------------------|----|
| Type | Aerated Static Pile | | |
| Raw Material | Amount | 250 ton/day | |
| (Compostable Waste) | Compostable Content | 20.3 % by Dry weight | *1 |
| | Moisture Content | 70 % | |
| | Apparent Specific Gravity (ASG) | 500 kg/m ³ | *2 |
| Operation | | 300 day/year 16 hour/day | |
| Treatment Capacity | | 250 ton/day | |
| Composting Period | | 28 days | |
| Pile Temperature | | >55°C | |
| Maturation (Curing) section | | | |
| Operation | | 300 day/year 16 hour/day | |
| Treatment Capacity | Mature compost product | ~ 45.7 ton/day | |
| | Moisture Content | ~ 40 % | |
| | Apparent Specific Gravity (ASG) | 500 kg/m ³ | *2 |
| Maturation Period | | 60 day | |
| Final Separation section | | | |
| Type | Trommel screen | | |
| Operation Time | | 300 day/year 16 hour/day | |
| Treatment Capacity | Fine compost product | ~ 37.0 ton/day | |
| | Coarse compost product | ~ 8.7 ton/day | |
| | Moisture Content | ~ 40 % | |
| | Apparent Specific Gravity (ASG) | 500 kg/m ³ | *2 |

Note: *1 : Obtained from the table "Composition of the Compostable Waste" in Section 8.4. (composite of kitchen waste, grass and wood)

*2 : Estimates from the pilot project.

d. Process Flow of the Plant

Figure 10-3 shows the process flow of the compost plant.

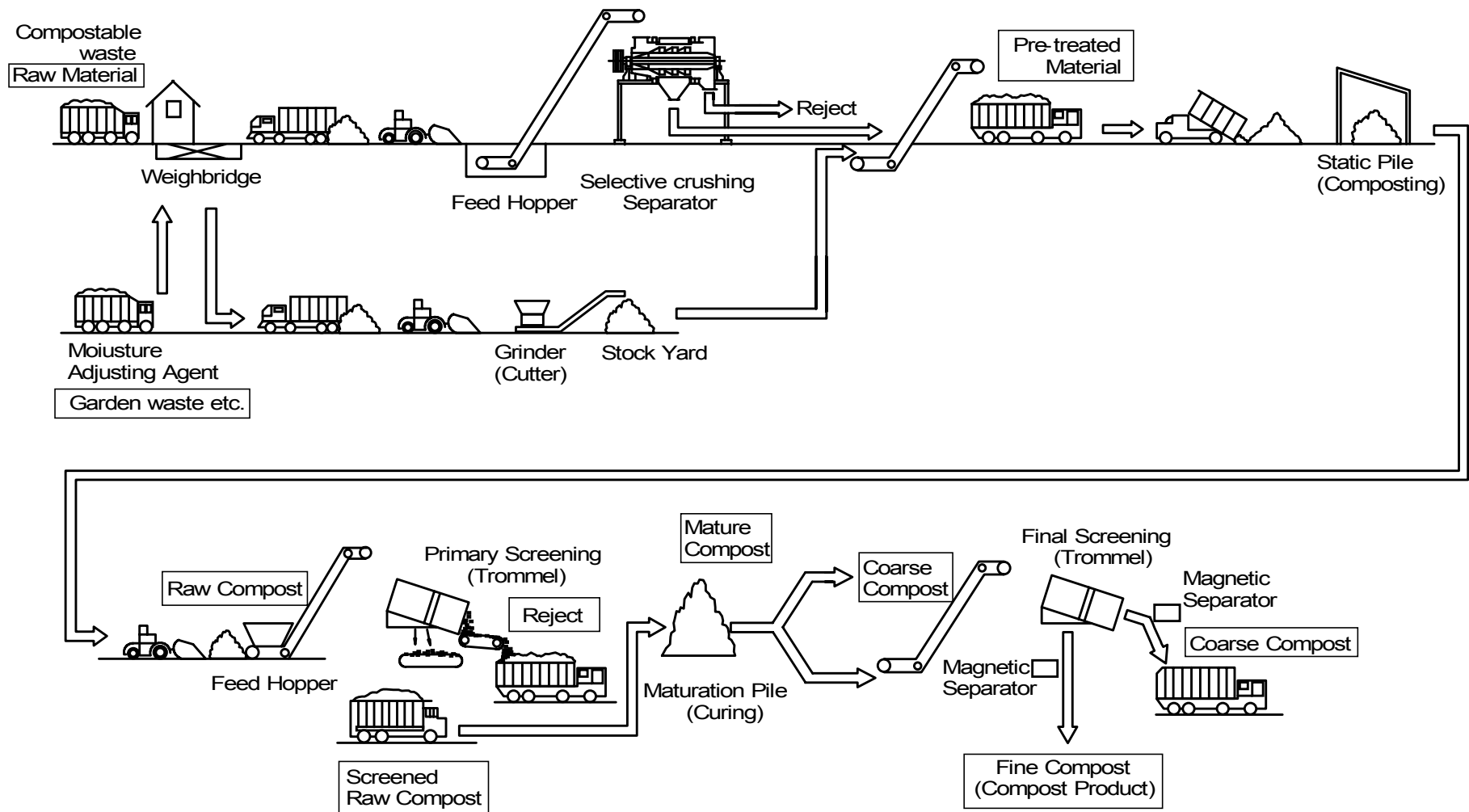


Figure 10-3: Process Flow of the Proposed Compost Plant in Sofulu

e. Layout of Proposed Compost Plant

The layout of the proposed compost plant is presented in Figure 10-4.

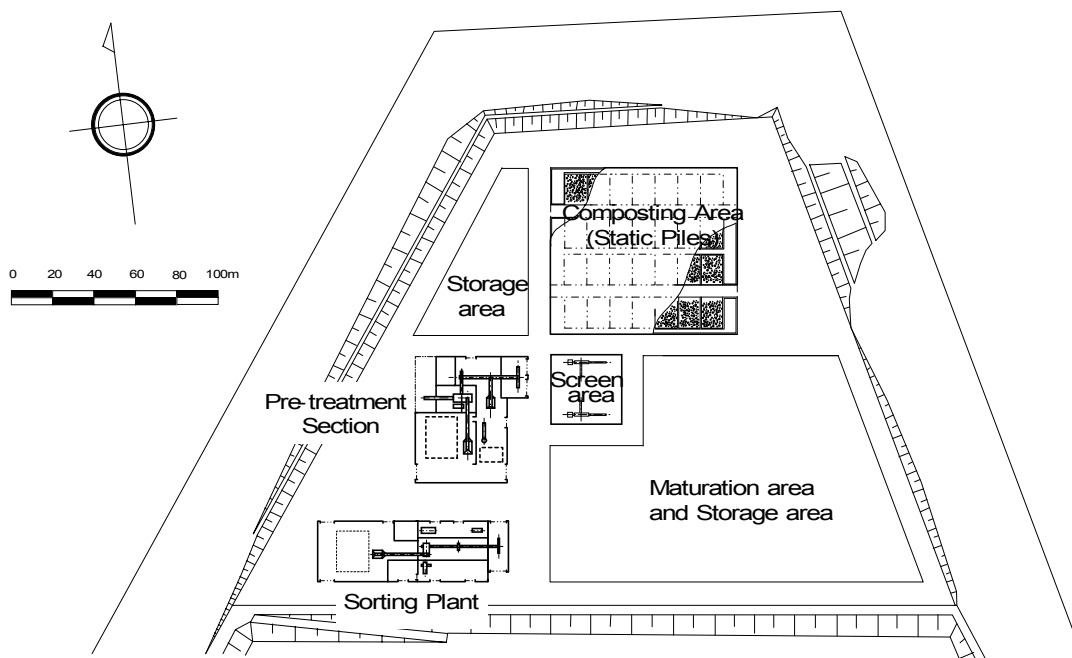


Figure 10-4: Layout of the Compost Plant in Sofulu

f. Staff and Job Descriptions

Table 10-6 is the staff allocation schedule for the proposed compost plant. The number of operators and manual workers is derived from the volume of materials to be processed and plant operation capacity.

f.1 Administration

Administrative work will be executed by a director, who supervises the operation and management of the plant, an accountant, who will be also in charge of product sales promotion, and a secretary.

f.2 Operation

Operation is managed by a sub-manager of the plant and involves two parts: pre-treatment section and composting section. Both consist of sections, each of which is headed by one supervisor for one shift. The job description of the sections is as follows.

f.2.1 Pre-treatment

- Waste Reception Section

Compostable wastes is received by this section and transferred to pre-treatment equipment. The section has workers who reject wastes unsuitable for equipment and a wheel loader operator who feeds the other wastes to a feed hopper. These works are controlled by the reception supervisor.

- **Facility Operation Section**

The facility operators, under the supervision of the sub-director, operate pre-treatment equipment such as the feed hopper, feed conveyor, and selective crushing separator (SCS). All of these will be managed in a central control room. This section is also responsible for the electricity control works.

This section is in a key position coordinating the preceding waste reception section and the following transport section. The capability to assess the entire situation of the pre-treatment section is required.

- **Selective Crushing Separation Section**

The supervisor of this section controls the performance of the SCS by observing the waste input and waste output. When the moisture content of the fed wastes is found to be high, he/she directs the operator and workers to add moisture adjusting agent. He/she also directs the transport of the materials pre-treated by the SCS.

- **Transport Section**

After the screening of the SCS, the pre-treated materials and the rejects are transported to the next proper section. The supervisor manages material transport by giving instructions to the truck drivers on when and to where to transport the materials.

f.2.2 Composting

- **Static Pile Section**

The supervisor of this section directs the loader operators to pile pre-treated materials onto an appropriate place. He/she is responsible for the maintenance of the aerobic environment in the piles by adjusting the air blowing rate. Further, he/she gives instructions to the workers about turning and water supply to the piles.

- **Screening Section**

There are two stages of screening: primary screening for raw compost and final screening for mature compost. The primary screening line and the final screening line is operated alternately by the same operators and workers. They also operate the packaging machine of the final compost product.

- **Maturation Section**

The screened raw compost from the screening section is matured by this section. Although it is usual to mature the materials to ensure stabilisation, market demand for the screened raw compost without maturation may rise. In such occasion, the plant director and sub-director have to give necessary instructions to the workers of this section.

Table 10-6: Staff Allocation Schedule in Compost Plant in Sofulu

| Position | Shift | | total |
|--------------------------|-------|-----|-------|
| | 1 | 2 | |
| ADMINISTRATION | | | |
| Sub-manager | 1 | --- | 1 |
| Accountant | 1 | --- | 1 |
| Secretary | 1 | --- | 1 |
| sub-total | 3 | --- | 3 |
| OPERATION | | | |
| Pre-treated section | | | |
| Supervisor | 1 | 1 | 2 |
| Facility operate section | | | |
| Machine operator | 2 | 2 | 4 |
| Reception section | | | |
| Loader operator | 1 | 1 | 2 |
| Labourer | 1 | 1 | 2 |
| Transport section | | | |
| Labourer | 2 | 2 | 4 |
| Truck driver | 1 | 1 | 2 |
| sub-total | 8 | 8 | 16 |
| Composting section | | | |
| Supervisor | 1 | 1 | 2 |
| Static pile section | | | |
| Loader operator | 1 | 1 | 2 |
| Labourer | 2 | 2 | 4 |
| Transport section | | | |
| Loader operator | --- | --- | --- |
| Labourer | --- | --- | --- |
| Truck driver | 1 | 1 | 2 |
| Separate section | | | |
| Operator | 1 | 1 | 2 |
| Loader operator | 1 | 1 | 2 |
| Labourer | 2 | 2 | 4 |
| Curing section | | | |
| Loader operator | 1 | 1 | 2 |
| Labourer | 2 | 2 | 4 |
| sub-total | 12 | 12 | 24 |
| Total | 23 | 20 | 43 |

10.2.2 Operation Plan

a. Weighbridge

The sorting plant, compost plant and landfill site will share two weighbridges.

The following items are measured by them.

- Mixed wastes directly delivered to the landfill.
- Medical wastes directly delivered to the landfill.
- Non-compostable wastes fed to the sorting plant.
- Recyclable materials and rejects segregated at the sorting plant.
- Compostable wastes and garden wastes delivered to the compost plant.
- Compost and rejects from the compost plant.

Technical Notes:

- Understanding the importance of weight measurement for the operation of the landfill site, sorting plant and compost plant, all trucks coming into and going out from the area must be weighed. The weighbridges must be kept in good condition by regular inspection and maintenance.

b. Waste Reception and Storage Area

b.1 Waste Reception

Compostable wastes delivered by the collection trucks is received and fed to the feed hopper by the wheel loader in this area.

Technical Notes:

- Wastes which may give physical damages to equipment, such as bulky wastes, paper and plastics bound into a large bulk, must be removed in this stage. Recyclable materials among these rejects should be transferred to the sorting plant next to the compost plant, while the rest is dealt with as wastes to be disposed of at the landfill.

b.2 Storage Area

This is the area to store wastes beyond plant capacity and wastes delivered during the plant closure, e.g., on Sundays and national holidays.

Technical Notes:

- It should be ensured that the amount of stored wastes in this area is as small as possible in order to maintain good work environment. The area must be kept clean by storing wastes neatly and washing the floor.

c. Feed Hopper and Feeding Conveyor

Wastes fed to the feed hopper are delivered to the SCS by the feeding conveyor.

Technical Notes:

- The speed of the feeding conveyor must be adjustable. The speed should be appropriate for waste composition, waste volume, and the work condition of the SCS.
- Since some wastes and water will drop from the feed hopper and the conveyor, the area must be cleaned while operation is temporarily stopped or after daily operation.
- Compostable wastes have high water content. Since the water is aggressive to steel, drainage has to be ensured and the corrosion of facilities must be carefully inspected. Cleansing the drain and repainting the facilities might be necessary.

d. Selective Crushing Separator

This consists of a rotary drum screen with holes and a turning scraper within it. It selectively crushes materials depending on hardness and separate the materials into two. Fragile wastes such as food waste and wet paper are crushed into pieces and falls through holes in the screen, while robust or flexible wastes such as cans, plastic sheet and fibres are not crushed and remained on the screen. Facilities for cooling, such as a circulation pump and a cooling tower, should be equipped to cool down the electric motor which rotates the drum.

Technical Notes:

- The SCS can not process bulky wastes or wastes in a large bundle (such as tied-up paper and plastics). Such wastes must be rejected when received at the plant.
- Water released from the compostable wastes is unsanitary. The facility must be cleaned after daily operation.
- The cooling facility requires regular inspection.

e. Conveyors

Two conveyors are used in the process after the SCS.

e.1 Conveyor for Screened Materials

After screened by the SCS, fragile wastes fractions are conveyed to a dump truck by a belt conveyor. The conveyor can run in both directions and each end has a shoot, through which the screened is loaded onto the dump truck. When the dump truck at one end becomes full, the direction of the conveyor is reversed and the materials are conveyed to another truck at the other end.

e.2 Conveyor for the Rejects

Materials remained on the rotary drum screen of the SCS, or the reject, are transferred to boxes by the other belt conveyor.

Technical Notes:

- Wastes and dirty water will be scattered in the area around the conveyors and the dump trucks. Regular cleansing should be encouraged.
- The truck drivers must watch the loading work to avoid overloading.

f. Handling the Rejects

The rejects from the SCS are delivered to the sorting plant next to the compost plant in order to recover recyclable materials from them by hand-sorting. The boxes are made of wire netting enforced with metal frames, and are mobile on casters to be moved to the sorting plant.

Technical Notes:

- The reject drops at the end of the conveyor into the box. In order to replace the box before one becomes full, attention should be paid to the flow of the rejects. Coordination with the selective crushing separate section is necessary to control the work.
- Since wastes tend to be scattered, cleansing is necessary to keep the area tidy.

g. Composting Area (Static piles)

The materials pre-treated by the SCS are carried by the dump trucks to this area to be formed into static piles. The area is divided into 28 sections. One section has concrete walls on three sides and its area is designed for the material volume handled in a day.

Since the composting period is set at 28 days, there is no extra section. The area should have a roof to prevent rainwater intrusion.

In order to maintain aerobic condition in the piles, air blowing pipes are installed under the floor of each section. These pipes also serve as drainage to get rid of leachate which will be generated from the raw materials during the early stage.

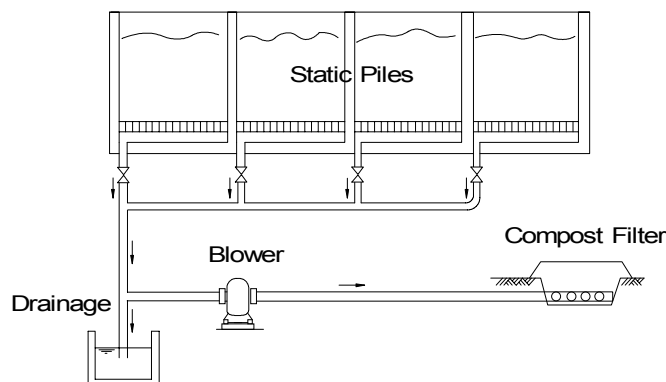


Figure 10-5: Drainage System of Composting Area in Sofulu

Technical Notes:

- Turning and adjustment of air blowing rate must be ensured to keep an aerobic condition, which is a prerequisite for composting of good quality. Moisture content also has to be properly adjusted by spraying water.
- Pile formation, turning and the delivery of raw compost have to be conducted carefully not to harm the air blowing pipes.
- The air blowing pipes need regular inspection and maintenance to ensure sound operation.

h. Maturation Area

The raw compost after the primary screening is transferred to the maturation area and formed into piles. The area is designed for the raw compost processed for 150 days to store not only materials under maturation but also final compost product which are awaiting for preferable market condition to be shipped.

The floor of the maturation area will be equipped with pipes through which odorous air is sent from the compost area by blowing fans. The air will be emitted from the pipes, and as it passes through the piles, compost under maturation adsorbs odour. The piles therefore work as an odour removal facility.

After 60 days of the maturation period, the mature compost is transferred to the final screening section. There will be some cases where the mature compost is shipped without final screening.

Technical Notes:

- Necessary area size for pile formation must be determined taking into account the raw compost amount. Date of pile formation must be recorded for each pile.
- A roof is not necessary for the maturation area. It is not a problem to have the piles get wet with rainwater during the maturation period. However, attention should be paid to avoid the compost washing out for aesthetic reasons.
- Each of the pipes can be opened or closed independently. The pipes on which no compost piles are placed should be securely closed, otherwise odour problems will be caused.

i. Screening Section

i.1 Primary Screen Equipment

Primary screen equipment is composed of a supply conveyor, trommel, product conveyor with magnetic separator, rejects conveyor, and ballistic inertial separator. The sieve size of the trommel is planned to be 25mm. The underflow materials proceed to the maturation area for quality improvement. Oversize materials are the rejects to be disposed of at the landfill. The plant will have an extra line to ship the raw compost without maturation on a request of the market.

Technical Notes:

- An appropriate volume of materials should be introduced to the trommel not to degrade the sieves' condition.
- It is necessary to inspect the trommel screen and other facilities after daily operation and clean the area.

i.2 Final Screening Equipment

The composition of final screening equipment is similar to that of primary screening equipment except for the trommel, the sieve size of which is planned to be 12mm. The screen of the trommel must be easily replaced so that the sieve size can be changed depending on market demand. The underflow of the sieves is the final compost, while the oversize materials are to be called the coarse compost.

Technical Notes:

- An appropriate volume of materials should be introduced to the trommel to maintain sieves in good condition.
- It is necessary to inspect the trommel screen and other facilities after daily operation and clean the area.

i.3 Packaging Machine

The final compost product after final screening is packed in bags by the packaging machine. The net weight of one bag is planned to be 20kg, since small users are the expected market.

Technical Notes:

- The operation of this machine should be designed considering the market demand of small users.

- Spare bags must be stocked.

j. Transport Section

The materials are transported in the following ways.

- The recyclable rejects from the reception area and the selective crushing separation section to the sorting plant.
- The pre-treated materials to the composting section and the rejects to the sorting plant after pre-treatment.
- The raw compost from the composting area to the primary screening section.
- The screened raw compost from the primary screening section to the maturation area.
- The mature compost from the maturation area to the final screening section.
- The non-recyclable rejects from the reception area and the primary screening to the landfill.

Technical Notes:

- The transport section must prepare an appropriate transport plan and efficiently use human resources and transport equipment by well observing the operation of the other sections.
- The use of tarpaulin or water spraying may be required to prevent rejected wastes from being flown away from the dump trucks during transport.
- Transport equipment needs regular maintenance.

k. Drainage System

An integrated drain system will serve for the compost plant, sorting plant and landfill. As for the composting plant, the system deals with water of the following types.

- Domestic water, leachate, water from cleansing and rainwater in the pre-treatment section.
- Leachate, water from cleansing and rainwater in the composting area.
- Water from cleansing and rainwater in the maturation area.
- Water from cleansing and rainwater in the screening area.

k.1 Pre-treatment Section

- Domestic water is treated by simplified septic tank and discharged to the leachate treatment facility for the landfill.
- Leachate and water from cleansing is treated by rapid filtration and discharged to the leachate treatment facility for the landfill.
- Rainwater is drained to the outside of the plant without treatment by a drain system independent of the other wastewater.

k.2 Composting Area

- A screen is used to remove suspended solids from leachate released from the piles in the early stage, sprayed water for moisture control, and water from cleansing. These are then discharged to the leachate treatment facility for the landfill.

k.3 Maturation Area

- Water from floor cleansing and rainwater in this area will be treated together with wastewater from the composting area.

k.4 Screening Area

- Wastewater generated in this area is also treated with wastewater from the composting area and maturation area.

l. Ventilation System

A ventilation system should be provided to the waste reception area.

Air is sucked from the waste reception area and treated by the odour absorption method in the maturation area.

Technical Notes:

- The rate of ventilation should be adjusted by monitoring the air quality condition.
- It must be ensured that in the maturation area, air must be only emitted under the piles. Where the piles are placed should be always understood.

m. Electrical Works

The electricity is provided to lighting and equipment such as the SCS and the facility for the static piles to blow air. The electrical devices is installed in a specific room so that power-driven equipment and lighting are centrally controlled, although they can be also managed *in situ* if necessary.

Technical Notes:

- The power equipment requires regular inspection with intervals appropriate for each facility.

n. Moisture Adjusting Facility

This is the facility for adding moisture adjusting agent to watery compostable wastes to be fed to the pre-treated material conveyor. Garden wastes including saw dusts, wood chips, grass and pruned wood are used as the agent. It is stored in a stock yard, and ground into fragments before used. Therefore, the facility consists of the reception area of garden wastes, stock yard and grinder with a conveyor.

Technical Notes:

- The supervisor of the selective crushing separation section determines the use of this facility by visual observation of raw materials.
- Wastes used as moisture adjusting agent have to be directed to the reception area of this facility after being weighed at the weighbridge.

o. Movable Equipment

The following movable equipment is used in the compost plant.

- Wheel loader for the reception area, static pile area and maturation area.
- Dump truck for pre-treated materials.

Technical Notes:

- The machinery needs daily visual inspection and regular thorough inspection to be maintained in good condition.

10.2.3 Monitoring Plan

a. Noise, Vibration and Odour

Noise, vibration and odour outside and inside the plant should be measured and properly recorded once a month.

b. Waste Composition Analysis

Composition of wastes received at the plant, raw compost, coarse compost and fine compost should be measured and properly recorded twice a year.

c. Personal Computer

A personal computer system will be used to integrate all data necessary to control the composting plant, sorting plant and landfill site. A series of data relevant of compost plant management is inputted to the personal computer. Data collected by the weighbridges is handled by another specific computer and sent to this personal computer. Types of data from the compost plant are as follows.

- The amount of compostable wastes and garden wastes transported to the plant, the compost product, and the rejected materials.
- Financial data.
- Data on the static piles
- Data on the maturation piles
- Data on work environment
- Data on operation and maintenance of equipment
- Data on parts supplies.

10.3 Final Disposal Site

10.3.1 Fundamental Issues

This operation plan shall be applied for the proposed disposal site in AGM.

a. Working Hours

This proposed disposal site is open the following hours.

- Mondays - Saturdays: 7:00 - 23:00 (16 hour/day)
- Sundays and National Holidays: Closed.
- Equipment operation hours 7 hours/day

b. Types of Solid Wastes

The disposal site will receive the following types of wastes.

- Mixed municipal solid waste such as households and commercial enterprises.
- Rejected waste from the Sorting plant and the Compost plant.
- Other wastes (Industrial Waste, Waste of Adjacent Municipalities)

c. Preliminary Design

Outline of the preliminary design for proposed disposal site. is shown in Table 10-7

Table 10-7: Outline of the Sofulu Disposal Site

| Items | Description | | |
|---------------------------------|------------------------------------|--------------------------|------------------------|
| Land Area and Proposed Land Use | <u>Total Area</u> :95ha | | |
| | Phase1:Landfill Area | :25ha | |
| | Phase2:Landfill Area | :13ha | |
| | Phase3:Landfill Area | :17ha | |
| | Plant :Area | :6ha | |
| | Medical waste Landfill Area | :3ha | |
| | Buffer zone Area | :25ha | |
| | Others(include regulation pond)Use | :6ha | |
| Landfill Volume | <u>Phase</u> | <u>Capacity</u> | <u>Disposal Period</u> |
| | Phase2 | 2,325,000 m ³ | 2002-2006 |
| | Phase3 | 2,351,000 m ³ | 2007-2009 |

d. Personnel and Heavy Vehicle Plan

The following personnel and heavy vehicle are required to operate at the landfill site.

Table 10-8: Personnel and Heavy Vehicle Plan of Sofulu Disposal Site

| Personnel and heavy vehicle | Number | |
|-----------------------------|----------|-------------|
| <u>Personnel</u> | | |
| Site Manager | 1 person | (2002-2005) |
| Waste controller | 1 person | (2002-2005) |
| Operator | 5 person | (2002-2005) |
| Driver | 3 person | (2002-2005) |
| Worker | 2 person | (2002-2005) |
| Security guard | 2 person | (2002-2005) |
| Total | 14 | (2002-2005) |

| Personnel and heavy vehicle | Number |
|-------------------------------|-------------------|
| <u>heavy vehicle</u> | |
| Bulldozer (230HP) | 3Unit (2002-2005) |
| Excavator (99HP) | 1Unit (2002-2005) |
| Dump truck (8m ³) | 3Unit (2002-2005) |
| Water truck | 1Unit (2002-2005) |
| Total | 8unit (2002-2005) |

10.3.2 Operation Plan

a. Weighbridge

The final disposal site, sorting plant and composting plant, which are to be sited in the same land plot, will share two weighbridges.

The weight of the following items will be measured by them.

- Mixed wastes directly delivered to the landfill.
- Medical wastes directly delivered to the landfill.
- Non-compostable wastes fed to the sorting plant.
- Recyclable materials and residue segregated at the sorting plant.
- Compost and residue from the compost plant.

Technical Notes:

- The importance of wastes and materials measurement for the prudent management of the final disposal site, sorting plant and the composting plant can not be stressed. All of the trucks which coming in and going out of the area must be weighed and the weighbridges should be regularly inspected and surely maintained.

b. Operation at Landfill Area

b.1 Landfill Method

The landfill methods are divided into three types; open dumping, sandwich and cell method. The open dumping method can not abate offensive odours, generation of disease vectors and noxious insects, and also does not make well compaction.

- With the sandwich method, soil is spread to cover solid wastes filled horizontally. Where the landfill site is narrow, this method is effective, but if the site is wide, solid wastes are left uncovered for a couple days, resulting in generation of offensive odours, etc.
- With the cell method, soil is spread daily to cover solid wastes dumped. Through this method a highly compacted landfill can be obtained and this prevents scattering of solid waste, generation of offensive odour and the breeding of disease vectors and noxious insects. Therefore, the cell method should be applied.

b.2 Cover Soil

Cover soil is to be placed as in the method shown above and the thickness of each layer is as follows.

- daily covering soil: 20 cm
- final covering soil: 100 cm (depending on the ultimate use)

Accordingly, the ratio of cover soil to the disposal volume of waste will be 20 %, excluding final covering soil.

b.3 Landfill Procedure

b.3.1 Basic Plan

JICA study team has proposed phased development that Sofulu landfill area under operation now shall be planned as Phase 1. Construction for Phase 2 will commence in 2001 and landfill operation will commence in 2002. At that time, Phase 1 site will be full and landfill operation will be ceased. Phase 2 landfill operation will be ceased in 2006. Then construction for Phase 3 will commence and landfill operation will start.

b.3.2 Landfill Procedure

Area and volume of Phase 2 landfill site shall be 13 ha and 2,325,000m³ respectively. Municipal Solid Waste can be filled for the period of 5 years at this phase. Area and volume of Phase 3 landfill site shall be 17 ha and 2,351,000m³ respectively. Municipal Solid Waste can be filled for the period of 3 years at this phase.

Technical Notes:

- In Phase 2 and Phase 3, landfill area shall be divided into some lots by the dike and area of each lot shall cover for one year operation. Landfill operation shall be executed from downstream towards upstream in order to connect leachate collection pipe easier. Rainfall drainage pipe shall be provided from upstream lot adjacent to the landfill area in order not to mix the rainfall water and leachate. This rainfall drainage pipe shall be extended according to the progress of landfill operations.
- Gas removal equipment shall be installed according to the progress of landfill operation.
- Municipal solid waste shall be covered by soil everyday in order to keep environmental conditions in the landfill area and its surroundings.
- Municipal solid waste shall be compacted by heavy vehicle in order to secure the landfill volume and stabilise the landfill waste.
- Heavy vehicle used for covering and compaction shall be inspected and maintained regularly.

c. Conditions of Landfill Site at Each Stage

Conditions of landfill site at each stage are as follows.



Figure 10-6: The Condition of Proposed Landfill Site at Development Stage in Sofulu

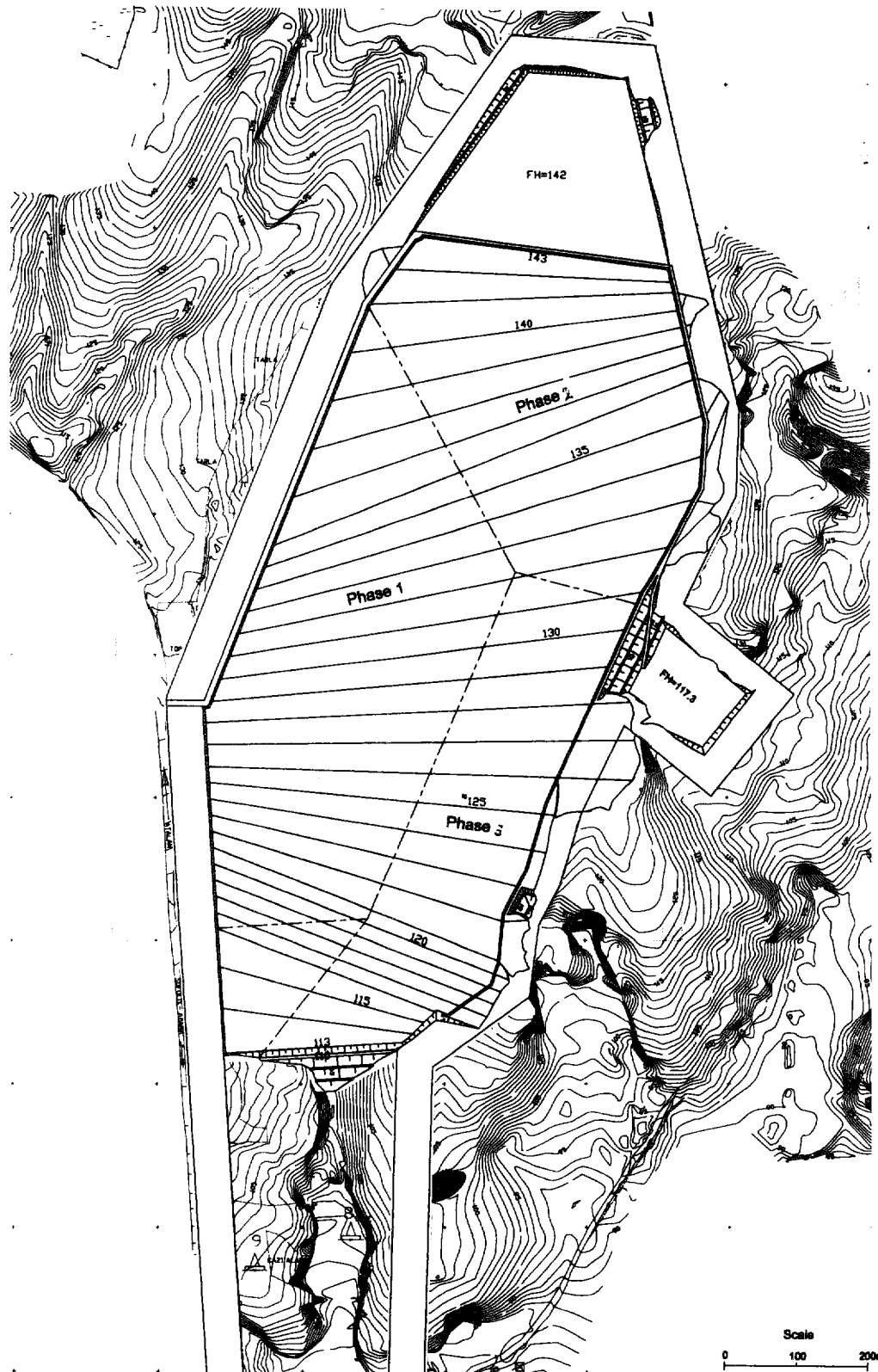
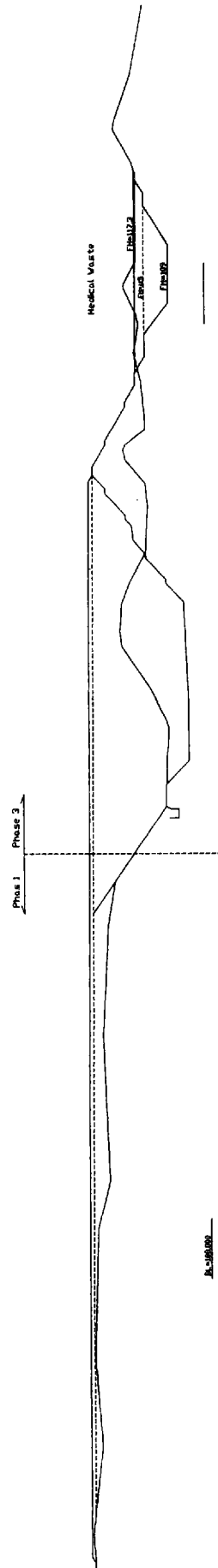


Figure 10-7: The Condition of Proposed Landfill Site at Final Earth Cover Stage

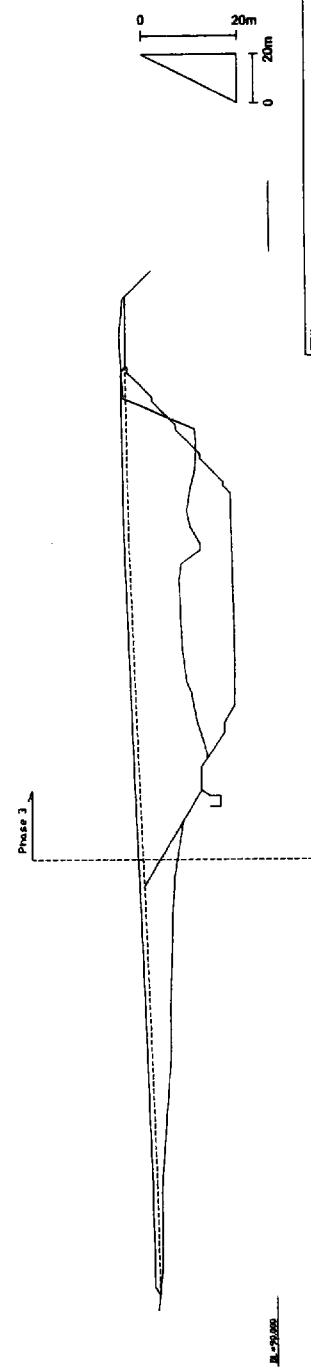
A - A



B - B



C - C



Title
Landfill Site Cross Section

Drawing No.
S7

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 for Adana-Mersin in the Republic of Turkey
 Japan International Cooperation Agency (JICA)

Figure 10-8: Each Section of Proposed Landfill Site in Sofulu

10.3.3 Monitoring Plan

a. Gas

Gas monitoring is necessary in order to detect the lateral movement of any dump gas.

b. Leachate

This will be monitored by taking sample from the inlet and outlet structure of leachate control facility.

c. Groundwater

Leachate monitoring is for detecting changes in water quality that may be caused by the intrusion of leachate and escape of the CO₂ portion of the landfill gas. Up-gradient and down-gradient wells can detect contamination of the underground aquifer by leachate from the dump site.

d. Settling

As the organic material in the landfill decompose and weight is lost through further self-compaction of the waste material itself, and to a lesser effect in the form of landfill gas and leachate, the dump settles. Monitoring of settlement is essential in order to detect cracks and ruptures in final cover, and for attaining maximum safety for a possible end-use on the site.

10.3.4 Operation Plan for Leachate Control Facility

a. Leachate Control Facility

This operation plan shall be applied for leachate treatment facility at proposed landfill site in AGM. JICA study team has leachate recirculation and evaporation as leachate treatment method.

a.1 Fundamental Issues

a.1.1 Capacity of the Recirculation Pump and Regulation Pond

Capacities of the recirculation pond and the regulation pond are as follows.

- Recirculation pump 138 m³/hour (2.3 m³/min)
- Regulation pond 11,000 m³

a.1.2 Process Flow

The flow of the proposed leachate control facility is shown in Figure 10-9.

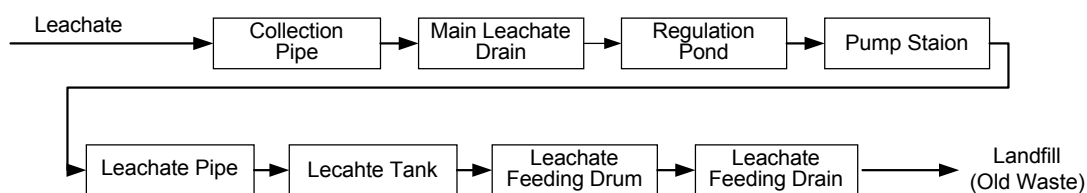


Figure 10-9: Proposed Leachate Control Facility in Sofulu

a.1.3 Operation of The Proposed Landfill

The proposed landfill is planned to be operated as follows.

Table 10-9: Forecast for the Size and Type of Surface Cover of the Landfill Sections in Sofulu

| Year | Type of Surface Cover | Landfill Section | | | Total ha |
|----------|-----------------------|------------------|------------|------------|----------|
| | | Phase 1 ha | Phase 2 ha | Phase 3 ha | |
| 2001 Dec | Open | 25 | --- | --- | 25 |
| | Final | 0 | --- | --- | |
| 2002 Jan | Open | 0 | 13 | --- | 13 |
| | Final | 25 | 0 | --- | |
| 2006 Sep | Open | 0 | 0 | 17 | 17 |
| | Final | 25 | 13 | 0 | |
| 2010 Jan | Open | 0 | 0 | 0 | 0 |
| | Final | 25 | 13 | 17 | |

a.2 Operation Plan for Leachate Control Facility

a.2.1 Leachate Generation Amount

- Landfill operation at landfill site will be done phase by phase. Therefore leachate generation amount will increase gradually according to the increasing of the landfill area.
- Leachate amount will increase according to the increasing area of landfill but this amount will change largely depend on the weather conditions such as rainfall and sunshine. Weather conditions in Adana has those features that it is less rainfall in summer and much rainfall in winter. Therefore leachate generation amount will be less in summer and much in winter.

a.2.2 Operation of the Leachate Control Facility

Landfill operation has been done and the old waste section is available at Sofulu proposed landfill site in AGM. Therefore leachate shall be treated by recirculation and evaporation method.

Technical Notes:

- Leachate circulation treatment system can be worked when generated leachate amount and recirculation amount are balanced and the regulation pond is just as a auxiliary facility. The regulation pond shall be utilised only when the generated leachate amount is more than recirculation amount. Therefore the bypass line for the anaerobic pond and direct pipe line from the anaerobic pond to the recirculation pit shall be installed for the purpose of the regulation pond to be kept empty as much as possible.
- Few sets of the Leachate recirculation pump will be provided including standby set and these shall be rotated for use and shall be inspected and maintained regularly.
- Each ponds shall be cleaned periodically during the seasons when generated leachate amount is expected to be less.

- It is difficult to check conditions of the underground pipelines for the leachate recirculation, therefore attached equipment such as recirculation pump or the conditions of the recirculation pit and tank shall be checked regularly.
- b. Monitoring Plan for Leachate Control Facility**
- Observation shall be made periodically for the raw leachate amount and appearances such as colour, odour, etc. which inflow to the waste stabilisation pond.
 - Meteorological data such as rainfall, temperature, humidity, etc. shall be kept continuously.
 - Water temperature and concentration of dissolved oxygen of the waste stabilisation pond shall be measured and kept.

10.4 Medical Waste Disposal Site

10.4.1 Fundamental Issues

a. Working Hours

This proposed disposal site is open the following hours.

- Mondays - Fridays: 7:00 - 14:00 (7 hour/day)
- Saturdays, Sundays and National Holidays: Closed.
- Equipment operation hours 7:00 - 16:00

b. Types of Solid Wastes

The disposal site will receive the following types of wastes.

- Medical waste
- Infected waste
- Pathogenic waste
- Pathological waste

c. Preliminary Design

Outline of the preliminary design for the proposed medical disposal site is shown in Table 10-10.

Table 10-10: Outline of the Medical Disposal Site in Sofulu

| Items | Description |
|-----------------|---------------------------------|
| Land Area | Total Area : 3ha |
| Landfill Volume | Capacity : 48,000m ³ |
| | Disposal Period : 2002-2009 |

10.4.2 Operation Plan

a. Weighbridge

The final disposal site, sorting plant and composting plant, which are to be sited in the same land plot, will share two weighbridges.

The weight of the following items will be measured by them.

- Mixed wastes directly delivered to the landfill.
- Medical wastes directly delivered to the landfill.
- Non-compostable wastes fed to the sorting plant.
- Recyclable materials and residue segregated at the sorting plant.
- Compost and residue from the compost plant.

Technical Notes:

- The importance of wastes and materials measurement for the prudent management of the final disposal site, sorting plant and the composting plant can not be stressed. All of the trucks which coming in and going out of the area must be weighed and the weighbridges should be regularly inspected and surely maintained.

b. Operation at Landfill Area

b.1 Landfill Implementation

Landfill implementation of the medical landfill is shown in Table 10-11.

Table 10-11: Landfill Implementation of the Medical Landfill in Sofulu

| Item | Sub-Item | During Operation |
|-------------------------|-----------------------------|--|
| Landfill Implementation | landfill method | -cover soil immediately after dumping of medical waste - landfill division by divider(1 year / divider) - cover soil from quarry site in landfill site |
| | final disposal foundation | article 34 of design standard |
| | Disposal site floor | article 35 of design standard |
| | drainage system | article 36 of design standard |
| | deposition of waste | article 37 of design standard |
| | top cover | article 38 of design standard |
| | gas removal | Every 50 meters(vertically and horizontally) |
| | vegetation of disposal site | article 39 of design standard |
| Leachate | system | - recirculation system - gravity fall from slope surface |
| Rain water | drainage system | - individual collection and direct discharge |

b.2 Landfill Procedure

The area and the volume of medical waste landfill site are 3 ha and 48,000m³ respectively. Medical waste can be filled for the period of 8 years at this site

Technical Notes:

- Medical waste landfill area shall be divided into lots by the dike and area of each lot shall be covered for one year operation. Landfill operation shall be executed from downstream towards upstream in order to prevent leachate amount to be increased due to rainfall water flowing from upstream. Therefore temporary drainage shall be constructed at upstream lot adjacent to the landfill area in order not to mix the rainfall water and leachate. This temporary drainage shall be abolished and changed to the leachate drainage system according to the progress of landfill operations.
- Gas removal equipment shall be installed according to the progress of landfill operation.
- Medical waste shall be covered by soil immediately after dumping in order to keep environmental conditions in the landfill area and its surroundings according to the Regulation on Control of Medical Wastes
- Medical waste shall be compacted by heavy vehicle in order to secure the landfill volume and stabilise the landfill waste.
- Heavy vehicle for covering and compaction shall be fixed for medical waste use only.
- Operators, drivers and workers for medical waste landfill operation shall be fixed. They have to take a shower after daily operation and have to take a periodical medical examination.
- It must be fenced and forbidden entering at Medical landfill site and must be locked at gate.

10.4.3 Monitoring Plan

Monitoring plan for the medical waste landfill is shown in Table 10-12.

Table 10-12: Monitoring Plan of The Medical Waste Landfill in Sofulu

| | Preparation stage before operation | during operation | for 10years after closure of landfill | after closure for 10 years |
|--------------------------------|--|--|--|---|
| Hauled waste | | -weighing at the entrance of Sofulu landfill site -visual observation of truck(quantity and quality) -visual observation of un-loading of medical waste at landfill site -record and report to Municipality every month | nothing | nothing |
| Leachate | | -measuring the quantities and quality of leachate -report to MoE | -gradual cancellation of leachate circulation system -closure of the system | -Open to public |
| Discharge | | -report to MoE | -gradual cancellation of leachate circulation system -closure of the system | -open to public |
| Underground water | -Installation of monitoring well at 3 points in the site -Monitoring before starting landfill | -monitoring | -monitoring | -nothing done |
| Gas Removal | -installation of gas removal facility | -continuous installation and monitoring the facility | continuous monitoring of gas removal facility | -open to public |
| Settling | - | | -periodic monitoring and maintenance | -open to public |
| Infrastructure(drainage, etc.) | - | -patrol and maintenance | patrol and maintenance | -open to public |
| Security of Landfill | -Installation of fence and gate at the entrance | -patrol and maintenance | -patrol and maintenance | -demolishing of fence and gate -open to public |