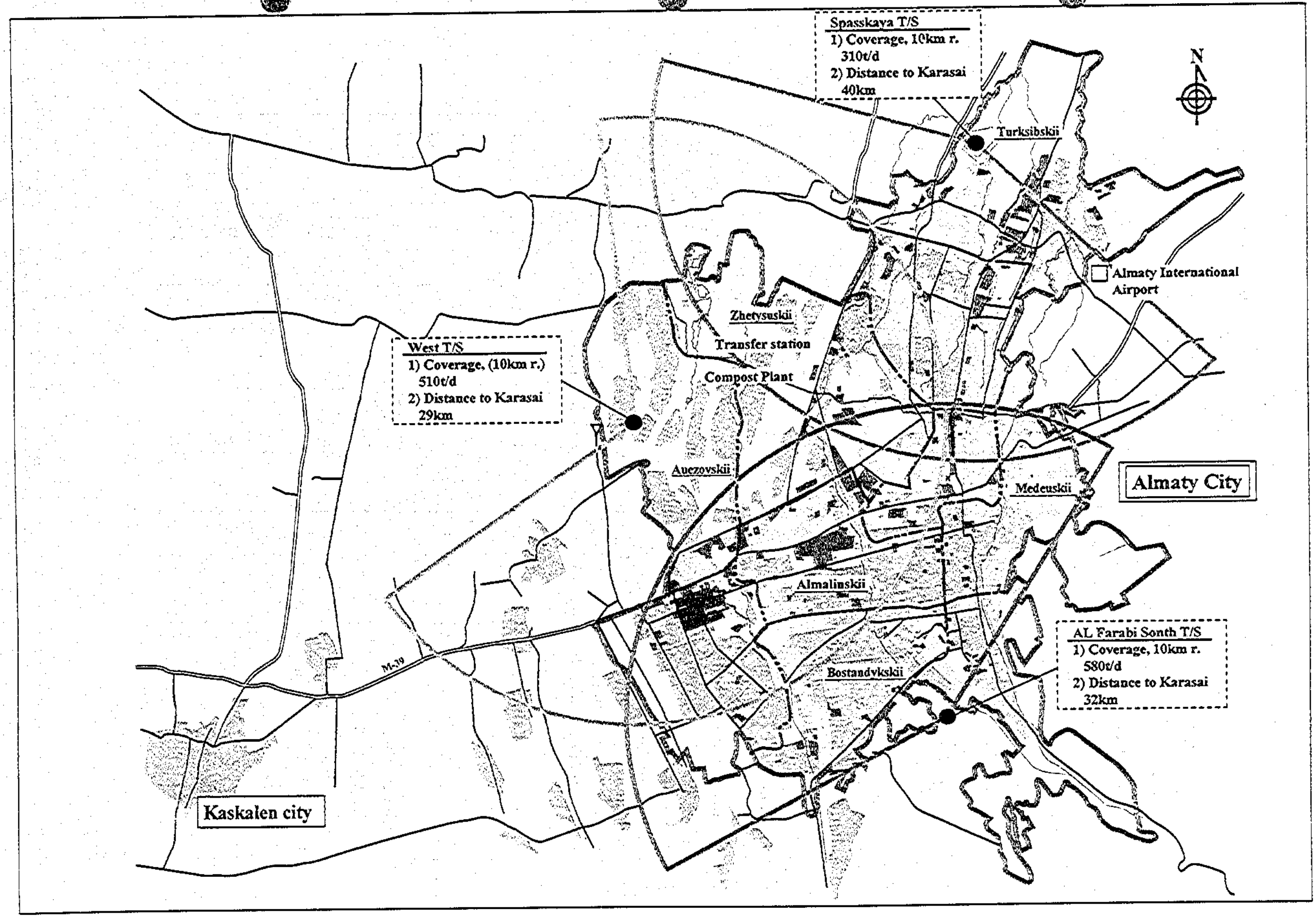


Figure 7.1.3 Potential Sites for Transfer Station Construction

Analysis of the conditions described in the table show the following:

- In case of one T/S consideration either West site or South site can serve the city
- In case of two T/S consideration, three cases with combinations of the three sites may be considered
- It does not appear necessary to consider construction of three stations at this time because either West site or South site can serve the southern area of the city and the distance between them is within 15 km. If three stations are constructed the service radius of each would be in the range of 5 – 10 km which is too short to produce effective savings in the collection costs to offset the construction and operation costs for three stations
- Spasskaya site is suitably located to serve as a regional station for Turksibskii district and the northern area of Medeuskii district
- Either of West site or South site coupled with Spasskaya site have more opportunity to serve all the city
- Distances between the three stations are almost equal, but West site provides the closest distance to Karasai disposal site.

Based on the above it was decided to form two alternatives for consideration; the first alternative with one station at either West site of South site serving all the city, and the second with a combination of two stations of the three serving all the city.

The numbers of collection trucks and transfer trucks required in each case were estimated as shown in Table7.1.11. In the one transfer station alternative, a transfer station at West site would require more collection trucks. T/S West was selected for this purpose and also for its advantages over the South site discussed in the earlier Table7.1.10, as Alternative 1. Of the three combinations for selection of two sites, the two sites of West and Spasskaya were clearly the best combination in terms of reduction in required number of collection trucks and accordingly Alternative 2 was formed. For comparison purposes the number of collection trucks that would be required in case of direct haul is shown. The savings incurred in collection trucks required when using transfer facility is obvious.

Table 7.1.11 Comparison of Truck Number Requirements

Case	Collection Trucks				Transfer Trucks
	Compactor $8m^3$	Compactor $12m^3$	Arm roll $6m^3$	Total	
1) One Transfer Station					
a. T/S West	40	45	38	123	21
b. T/S South	38	41	35	114	27
2) Two Transfer Stations					
c. T/S West + Spasskaya	33	40	28	101	23
d. T/S South + Spasskaya	39	42	31	112	21
e. T/S West + South	44	44	36	124	20
3) Direct Haul	66	73	110	249	0

(4) Transfer Station Types

Transfer station (T/S) is used to transfer solid waste from small collection vehicles into large vehicles designed for bulk haulage of waste over long distances to disposal site.

Direct-Load method : The wastes in the collection vehicles are emptied directly into the large transfer vehicle, sometimes through hopper. A transfer station is usually constructed in two level arrangement. In-coming collection vehicles will discharge the waste from upper platform to large transfer vehicles waiting at the lower level. Open-top transfer vehicles/trailers shall be used for transfer haulage.

Compactor method : The compactor method (mechanical system) is commonly used in developed countries. In this method, first collection vehicles discharge the waste into the waste receiving pit through hopper, the stationary feeder/compaction cylinder then pushes the waste into large transportation containers or transfer vehicles/trailers hydraulically by the compactor, which are then transported to the disposal site.

Baling method : Baling method (mechanical system) has been developed especially for the recycling purposes, that is, treating/packing of papers, plastics, cans, etc. for their easy handling. Recently, it has also been applied for handling municipal domestic waste in some European countries. In this method, the collection vehicles discharge the waste in the designated discharge zone, after which wheel loader/bulldozer equipment are used to move the waste to conveyor-belts which lead to the bailing machine. The waste is then compacted, packed and bound with steel wires by the baling machine, and then loaded onto larger transfer vehicles.

In order to choose a suitable and plausible option for the waste transfer method as a technical alternative of the SWM M/P in Almaty (target year is in 2010), several characteristics/ factors of each method were compared as summarized in Table7.1.12. Schematic drawings of each method are shown in Figure7.1.4.

Table 7.1.12 Characteristics of Waste Transfer Methods

No	Item	Direct-Load	Compactor	Baling
1	Ease of operation and maintenance	+++++	+++	++
2	Waste reduction in volume / saving for waste transportation cost (Bulk density of transferred waste)	++ 0.3 - 0.4 ton/m³	+++ 0.5 – 0.6 ton/m³	++++ 0.8 – 0.9 ton/m³
3	Extension of disposal site life time	++	++	++++
4	Waste handling at disposal site	+++	+++	++++
5	Waste stabilization period at disposal site (waste conditions at sanitary landfill site)	++++ (aerobic)	++++ (aerobic)	++ (anaerobic)
6	Leachate production at T/S	++++	+++	++
7	Environmental impact at T/S	+++	+++	+++
8	Environmental impact at sanitary landfill	+++	+++	++
9	Investment cost	+++++	++	+++
10	Operation & maintenance cost	+++++	+++	++

Note: [+] shows magnitude of plus factors for its introduction

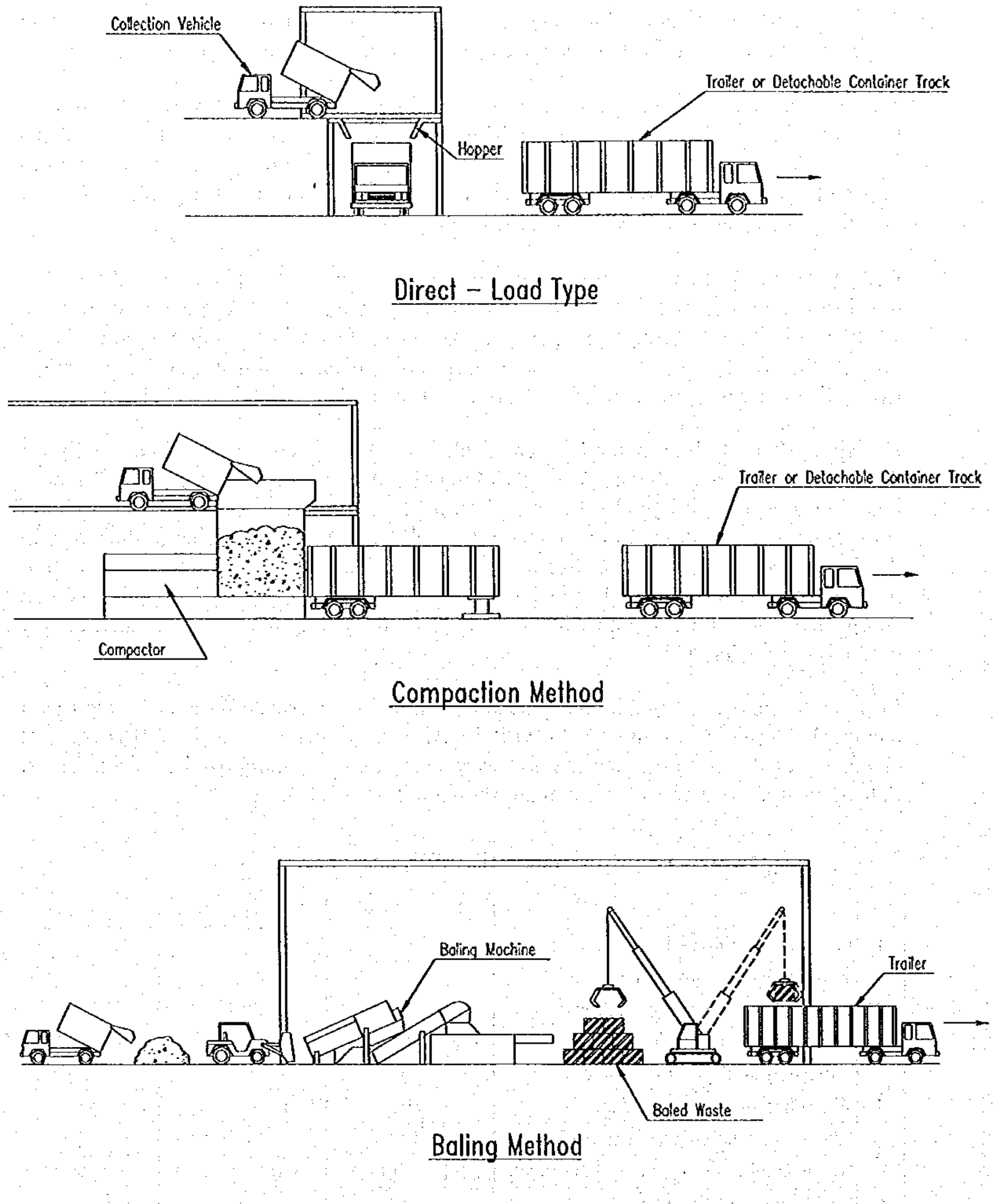


Figure 7.1.4 Schematic Diagrams of Waste Transfer Method

Based on the comparison of each method as shown in the preceding table, the following key issues for the selection of the suitable transfer method in Almaty were identified.

a. Waste volume reduction

In the direct load method there is little change in the volume of the waste transferred from collection trucks to the transfer trucks. However with the compactor method, outgoing volume is approximately 60% of the incoming volume; with the bailing method outgoing volume is approximately 40% of the incoming volume. Therefore, the baling method has the greatest potential for reducing waste transport costs.

Potentially the bailing method can extend the life of the disposal site, due to the reduced volume of the waste delivered to the site. When the compaction method is used, the waste is discharged freely at the disposal site, so little reduction in volume of the waste is achieved initially at the disposal site, though some further compaction occurs over time with the decomposition of the waste after burying.

When considering the effectiveness of the bailing method in reducing volumes, the following points should also be considered:

First. in the Almaty city region, it is reasonably easy to find large vacant and/or little used sites which can be developed as waste disposal sites.

Second. As a waste volume reduction method, bailing should be compared to the much more effective, though much costlier incineration option which reduces the volume to 5 -10% of it initial volume (as discussed in the following section). In other words, incineration is about five times as effective as baling for reducing volume.

Consideration of the bailing method should take account of both existing conditions and future plans for waste disposal.

b. Waste characteristics at sanitary landfill site

At a sanitary landfill site, aerobic conditions in the waste layers are basically maintained by a combination of leachate collection pipes, gas removal facilities and the supply of air/oxygen into the waste layers. In the direct-load and compactor methods which discharge loose waste at the disposal site, it is possible to keep the waste in aerobic conditions. However, in case of bailing method, the waste condition at the site will not be aerobic but anaerobic, because the discharged baled waste is stiffly bound with wire which limits the exposure of the waste to air/oxygen.

The biological process for decomposition of organic waste at a disposal site, which leads to waste volume reduction and stabilization, differs between aerobic and anaerobic conditions, and the processes are very complicated. In general, under aerobic conditions, organic matter finally disintegrates into CO_2 and H_2O (which are non-hazardous). Decomposition to a stable final structure is more rapid under aerobic conditions. When decomposition occurs under anaerobic conditions, the biological processes generate organic acids (the major pollutant in leachates), methane (combustible gas), H2S (malodorous gas), etc., and it takes a long time for the waste to stabilize.

In Japan, wastes in disposal sites are commonly kept in aerobic conditions in order to stabilize the waste rapidly and prevent the production of pollutants. The direct-load or compactor method is recommended as it facilitates the maintenance of aerobic conditions in the waste layers of disposal site.

c. **Financial burden**

Investment costs of each method are estimated at US$ 7,200/ton for direct-load, US$ 29,600/ton for compactor and US$ 15,100/ton for bailing method. (These costs are total investment cost divided by plant capacity). The costs of mechanical systems, - compactor or bailing systems - are over double the simpler direct-load method. In addition, the bailing method incurs additional daily operational costs for the steel wire to wrap around the bales.

The cost comparison, including the reduction of secondary transfer cost due to the volume reduction effect by adopting compactor and/or baling method, are summarized as shown in Table 7.1.13. The cost of mechanical systems are about 1.6 to 1.9 times the direct-load method. It can be found that the financial burden of the introduction of compactor and/or bailing method is much higher than that of direct-load method.

Table 7.1.13 Cost Comparison of Transfer Methods

Item	Direct-Load	Compactor	Baling
Implementation cost	100	410	300
Operation & Maintenance cost	105	260	315
Secondary transfer cost	265	210	140
Total	470	880	755

Note: Cost per ton for the implementation cost of Direct-load method is set to "100", and other costs are shown the comparative cost value based on this "100"

d. **Overall evaluation**

The basic concept of the M/P was set to re-establish SWM in Almaty city under the "minimum requirement" acceptable, mainly taking into account the recent financial constraints of Almaty city. The minimum requirement may therefore be considered to be the collection and transport of the waste from city area to a designated site for proper waste disposal, which will be the most basic and important target for Almaty.

The "direct-load method" is therefore recommended for the system of transfer station in the master plan of Almaty city.

3) Intermediate Processing

(1) Introduction

In recent years, securing of landfill sites adjacent to large cities has been getting rather difficult especially in developed countries. On the other hand, more than 85% of solid waste generated worldwide is hauled to disposal sites. Under these conditions, several kinds of intermediate treatment systems have been developed and adopted by local governments of European countries and Japan for the purpose of volume reduction and resource recovery/recycling etc. of solid waste. Incineration is the most common method in developed countries. Other processing methods, such as composting, methanization, pyrolysis, RDF (refuse derived fuel), etc. have been introduced on a very limited scale.

The introduction of sorting and sometimes crushing or shredding is necessary as part of these intermediate processing options.

In Kazakhstan, intermediate processing systems for municipal waste, apart from composting are not widely applied. The compost plant in Almaty has not been operated successfully and its operation has recently been suspended.

The purposes of intermediate processing recognized world-wide as follows;

- Reduction of solid waste volume: In order to expand the life time of disposal sites and to save waste transportation cost, the volume reduction method of solid waste shall be taken into consideration.
- Resource recovery/Recycling: There are two methods for resource recovery from solid waste; i.e. one is the extraction of economically re-usable materials from solid waste, and the other is the extraction of energy from solid waste.
- Prevention of environmental pollution: In order to prevent the surrounding environment from being polluted by the disposal sites, proper treatment systems should be considered. These should certainly be adopted for toxic waste, such as specific industrial and infectious wastes.

(2) Possibilities of Intermediate Processing in Almaty

Taking account of practices in other countries, the objective of the city to improve waste management, the composition of waste in Almaty, and present social and economic conditions in Almaty, three processes; namely incineration, composting and methanization have been provisionally selected and examined for possible application in Almaty.

Incineration is mainly used in European countries and Japan. The primary purpose of incineration is to render the wastes inert and to reduce volume and weight of the wastes. It may sometimes also provide a source of energy. Initial sorting of the waste to remove metal, glass, bulky waste, etc. is necessary.

Composting is the most commonly used biological process for the conversion of organic waste to a stable humus-like material called compost. Plastic, metal, glass, and other non-combustibles are carefully separated beforehand.

Methanization is a biological process of domestic waste which recovers methane. The remaining material is similar to compost. This process or technology has been introduced during the last 20 years in European countries and the USA. Careful separation of plastic, metal, glass, and other non-combustibles is initially required.

In order to choose a suitable option for the processing of municipal waste as a technical alternative for the SWM M/P in Almaty (target year is 2010), several characteristics/factors have to be taken into account. Table 7.1.14 provides a summary of the main factors for each option. Schematic flow diagrams for incineration, composting and methanization are shown in Figures 7.1.5 , 7.1.6 and 7.1.7 respectively.

Table 7.1.14 Characteristics of Intermediate Processing Systems

No	Item	Incineration	Composting	Methanization
1	Ease of operation and maintenance	+++	++++	+
2	Contribution to recycling	++	+++	+++
3	Volume reduction	+++++	+++	+++
4	Necessity of waste sorting	+++	+	+
5	Recovery material	Heat, Electricity	Compost	Fuel gas, Compost
6	Marketability of recovered materials	+++++	+	+++
7	Environmental impact	++	+++	+++
8	Investment cost	++	+++	+
9	Operation & maintenance cost	++	+++	+

Note: [+] shows magnitude of plus factors for its introduction

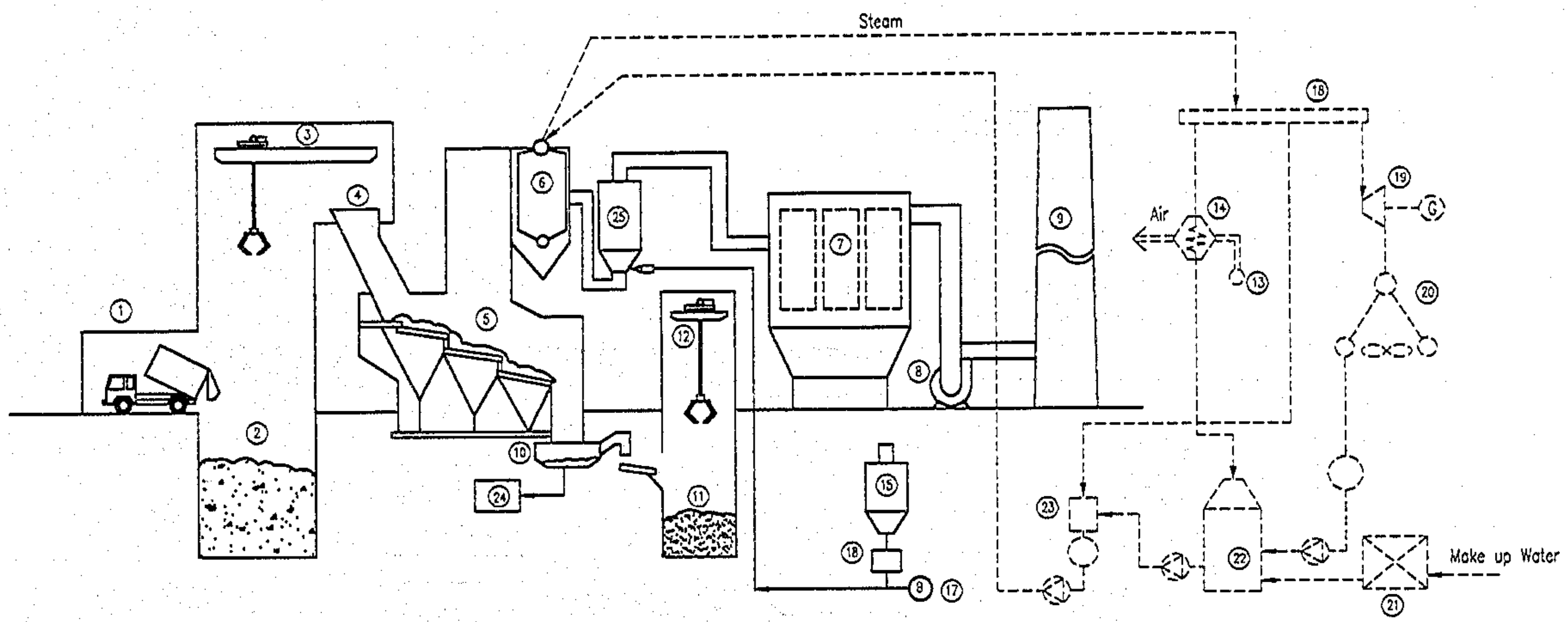
Methanization is a system which is environmentally safe and positive for energy balance (fuel gas and soil conditioner can be recovered); however, as yet no full scale processing plants for handling municipal waste have been commissioned anywhere in the world. Careful sorting of waste is critical in this process and this may be a major problem in Almaty. Therefore, methanization is not recommended as an alternative for waste processing in M/P for Almaty.

Based on the results of the waste analysis survey conducted by the study team, quality of domestic waste in Almaty is acceptable for composting; i.e. there is enough combustible matter and the moisture content is not too high. (The Carbon/Nitrogen ratio is rather low, but it may be possible to adjust this). However it is obvious from the earlier unsuccessful operation of compost plant in Almaty that market demand for compost in the region is quite low. Also, in order to sustain the quality of the compost, careful waste sorting and/or separate collection at the waste generation point is necessary. Therefore, composting can not be recommended as a technical alternative.

As the lowest calorific value of domestic waste in Almaty is more than 1,200 kcal/kg, self sustaining combustion without supplementary fuel is possible. Even though the costs of incineration are the highest of the three processing options, study of this option is recommended for the following reasons.

- The weight of the waste will be reduced by 80-85%, greatly increasing the life of the disposal site.
- Recovered energy can be easily used in the municipal heating system etc. which will be very useful/ practical in such a cold city as Almaty.

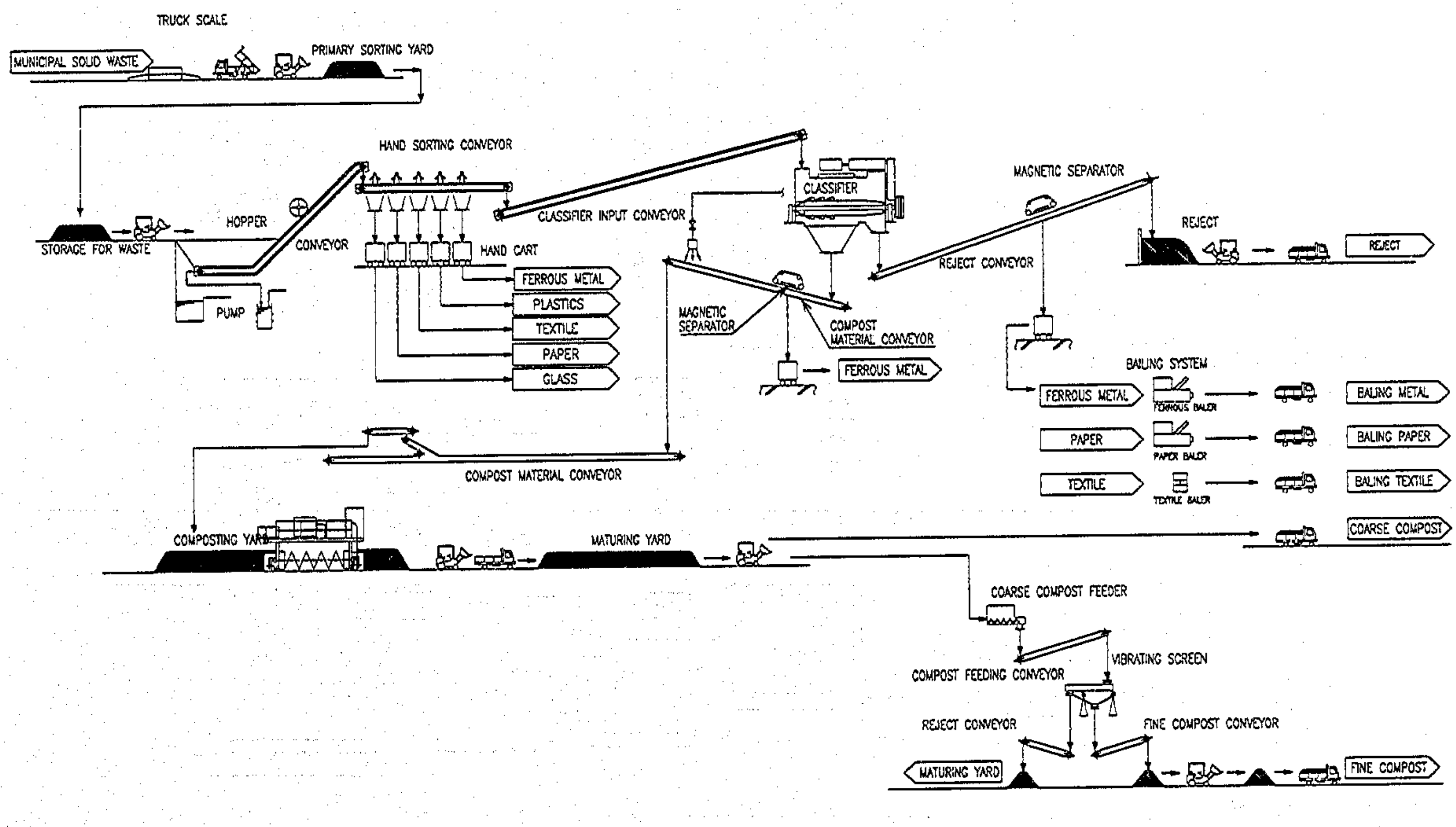
More details about incineration, composting and methanization are shown in the following figures.



Constituent of plant

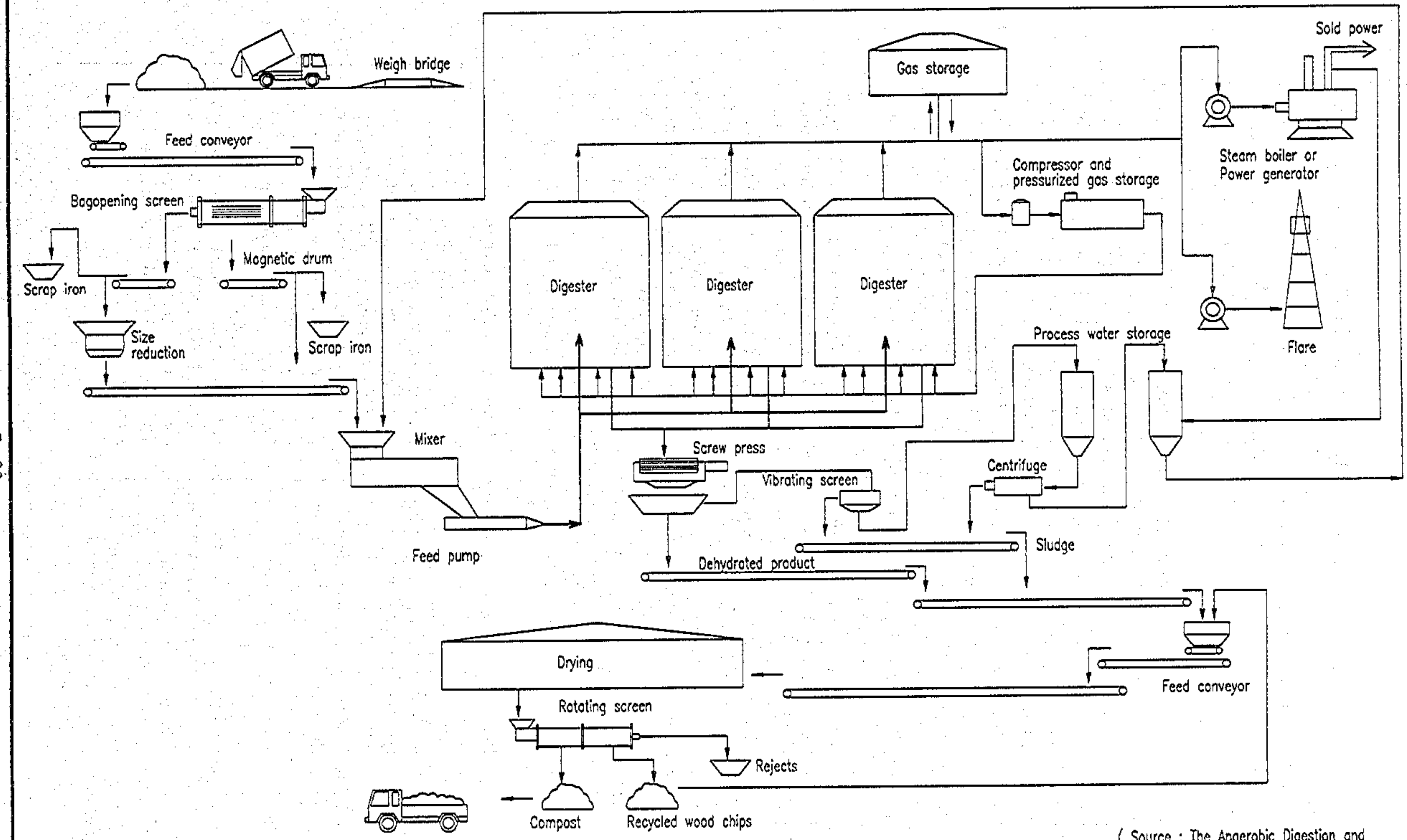
1. Tipping Yard
2. Storage Pit
3. Waste Charging Crane
4. Charging Hopper
5. Incinerator
6. Waste Heat Boiler
7. Bag Filter
8. Induced Fan
9. Stack
10. Ash Discharger
11. Ash Pit
12. Ash Chrane
13. Foraced Fan
14. Air Pre-heater
15. Lime Storage Silo
16. Table Feeder
17. Ejector Blower
18. Steam Header
19. Turbine/Generator
20. Steam Condenser
21. Water Purifier
22. Condensed Water Tank
23. Deaerator
24. Waste Water Treatment Equipment
25. Quenching Reactor

Figure 7.1.5 Schematic Flow Diagram of Incineration Plant



(Source : Basic Design Report on the Project for Improvement of SWM in Alexandria in Egypt, JICA in 1995)

Figure 7.1.6 Schematic Flow Diagram of Composting Plant



(Source : The Anaerobic Digestion and the Valorga Process in 1996)

Figure 7.1.7 Schematic Flow Diagram of Methanigation System

(3) Incineration

The feasibility of incineration depends largely on; 1) availability of land for waste disposal sites and land price, 2) costs of alternative waste treatment methods (financial aspect), and 3) waste composition and amount (technical aspect). For the following reasons, introduction of incineration in Almaty is considered applicable, for consideration as a technical alternative, however implementation may not be necessary in the immediate future.

a. Waste generated at Almaty city shall be transported to, and discharged at Karasai disposal site which is located outside of Almaty city. Inside Almaty city boundary, as is common in European and Japanese cities, large vacant and/or not highly used lands which can be used for waste disposal sites are difficult to find. By introducing an incineration plant, the burden for Karasai disposal site can be minimized, due to the effect of its waste reduction.

b. For self sustaining combustion of wastes, the lowest calorific value of the waste should be more than approx. 1,200 kcal/kg. Based on the waste composition/ analysis survey mentioned earlier, the lowest calorific values of household, commercial and market waste were 1,590, 2,252 and 1,793 kcal/kg, respectively (municipal waste in Japan is about 2,500 kcal/kg). Therefore, proper combustion of the waste without supplementary fuel is possible.

c. As shown in the following section 5.1.3, unit cost of sanitary landfill (Alt. 2), to handle/ treat one ton of waste, is 21.4 US$/ton. While, unit cost of incineration (Alt. 4) is 47.6 US$/ton which is more than double the other three alternatives.

d. In general, a minimum furnace capacity of 200 ton/day might be required for incineration plant in order to perform energy recovery to generate electricity. In Almaty, approximately 900 tons/day of waste were generated in 1999. Therefore, in case of introduction of incineration plant, treatment of waste amount of more than 200 ton/day shall be taken into account as its capacity. Recovered energy (heat/ steam) can be used for heating system etc. which will be very practical/ useful in such a cold city (in winter) as Almaty.

The advantages and disadvantages of Incineration are summarized in Table 7.1.15.

Table 7.1.15 Advantages and Disadvantages of Incineration

Advantages	Disadvantages
• The system has a wide range of applicability among waste types compared with other intermediate processing systems. • Waste volume and weight can be reduced by a high rate (volume by 5 to 10%, weight by 15 to 20%). Therefore, transportation and landfill operation costs can be lower. • Stabilization of disposal sites. • In general, environmental impact due to disposal of ash is less than that of raw waste. • Heat produced during incineration process can be recovered and used in several ways. • Revenue will be expected from the sales of surplus heat and/or electricity produced by means of power generator.	• High investment and operation/ maintenance costs are required. • Residues (approx. 15-20% of incoming waste in weight) still remain. Therefore, these wastes must be transported and discharged at the disposal site. • Pre-sorting of waste and/or separate collection is required. • Pollution control measures/ systems against dust, HCl, SOx, NOx, Dioxin, heavy metal, etc. must be equipped at the plant. Therefore, additional capital cost is required.

(4) Composting

From the point of waste reduction and recycling, composting is a useful method for the treatment/processing of municipal waste. However, three aspects, which are major conditions affecting feasibility of composting are; 1) securing of compost market and its sales routes which is related to cost recovery (financial aspect), 2) investment and operating cost (financial aspect), and 3) waste quality and plant operation (technical aspect). These need to be carefully considered and examined before introduction of composting.

In addition, operation of the existing compost plant in Almaty; capacity approx. 350 ton/day and operation started in 1981, was recently suspended. Major reasons reported are lack of compost market and worsening quality of compost produced. The reasons for failure should be carefully examined taking into account the following issues.

a. Securing of compost market and its sales routes (related to cost recovery)

Market conditions are an extremely important factor affecting composting feasibility. Worldwide many compost plants have failed due to insufficient demand for compost. For farmers, the costs of using compost depend on the price of compost products and transportation cost from the plant to their place of use. In general, if the transport distance is within 20 km from the plant, it may be feasible for farmers to use compost products. It should also be noted that compost demand is not constant through the year.

b. Investment and operation cost

As shown in the following Table 7.1.16, unit cost of composting is 32.2 US$/ton. On the other hand unit cost of sanitary landfill (Alt. 2) is 21.4 US$/ton which is shown in the following section 7.1.3.

Table 7.1.16 Unit Cost of Composting

No	Items	Composting
1.	Construction and equipment	$ 300,000/ year
2.	Operation and maintenance	$ 280,000/ year
3.	Secondary transportation	$150,000/ year
4.	Total cost (= 1 + 2 + 3)	$730,000/ year
5.	Benefit for compost sales	$ 31,000/ year
6.	Net cost (= 4 – 5)	$699,000/ year
7.	Waste amount processed by composting	21,700 ton/ year
8.	Unit cost of composting	$32.2/ ton

Note: Plant capacity for composting is assumed to be 300 ton/day

c. Waste quality and plant operation

According to the result of the waste composition/ analysis survey the wet base content of combustible matter of domestic waste, comprised of kitchen waste, paper, textile, plastic, leather, wood/ leaves, was 83.7%. The content for kitchen waste was 50.8%. The survey result shows that the waste in Almaty is suitable for composting if properly treated. However, following characteristics of the waste should be carefully examined and necessary countermeasures taken during processing to ensure that the quality of the compost produced is acceptable.

- Based on the survey, average moisture content of domestic, commercial and market wastes in Almaty was 43.7%, 26.1% and 43.9%, respectively. In each case it was less than 55%. (When the moisture content exceeds 55%, water begins to fill the interstices between the particles of wastes, reducing interstitial oxygen and causing anaerobic conditions; this results in a rapid fall in temperature and production of an offensive odor.) A moisture content below 55% is required for proper fermentation.
- Based on the survey, an average of C/N ratio (the Carbon/Nitrogen ratio determines the speed at which decomposition takes place) of domestic, commercial and market waste in Almaty was 25, 69 and 34, respectively. However, the ideal C/N ratio of incoming waste for waste composting is between 25 and 35. Therefore, some adjustment for the commercial waste will be required for proper fermentation.
- The glass content of domestic, commercial and market wastes was 6.6%, 7.9% and 5.6% respectively. Since these figures are on the high side care must be taken to ensure that there is a proper waste separation system in the plant and/or separate collection for glass at the waste generation points. Similarly plastic content of the waste is high and will have to be reduced by similar methods (plastic content of domestic waste is 12.0%).

The following additional points should also be taken into account when considering composting. These points should also be noted if rehabilitation of the existing compost plant is considered.

- Delivery of suitable waste types such as domestic waste, market waste, etc. to the compost plant (Separate collection, introduction of suitable sorting system etc. should be taken into consideration.)
- Support of agricultural authorities concerned, and coordination with other government agencies
- Quality control and standardization of compost products
- Confirm the advantages of combined usage of compost and chemical fertilizer
- Financial analysis and evaluation, and, if necessary, introduction of subsidy system

Table 7.1.17 sums up the advantages and disadvantages of composting.

Table 7.1.17 Advantages and Disadvantages of Composting

Advantages	Disadvantages
• Compost products are used as organic fertilizer and/or soil conditioner. • A certain quantity of usable materials (cans, bottles, glasses, etc.) can be recovered by sorting, either manual or mechanical, at the pre-treatment stage of the system. • A certain reduction in the volume of organic wastes can be expected. • Stabilization of organic wastes is performed in the fermentation process. • Rendering harmless certain hazardous substances can be expected in the fermentation process.	• Recovery rates for compost products range between 20-40% of the total weight of receiving waste. Residues must be hauled to disposal site. • Suitable waste for composting is limited to organic waste only (even for organic waste; moisture content, C/N ratio etc. must be controlled for proper operation). Therefore, in order to collect suitable waste for composting, either some modification of waste collection systems or sorting system at the pre-treatment stage is required. • It takes a long time for fermentation (2-4 weeks, in windrow type systems) and large stock yards for fermentation/ storage are required. • It is usually difficult to maintain stable demand and compost marketing outlets. • Generation of offensive odor may create environmental problems in surrounding areas.

(5) Methanization

The feasibility of methanization depends largely on; 1) proof that existing process can be scaled up to a commercial scale (technical aspect), 2) investment and operation cost (financial aspect), and 3) waste characteristics (technical aspect). These should be carefully examined before the possible introduction of methanization in the future.

a. Technical evaluation

Anaerobic digestion system (called methanization) for municipal solid waste is of great interest because methane and fertilizer can be recovered by this system. Approximately 55 plants have started operating in recent years, mainly in the European countries. The basic idea of the system is anaerobic digestion, however, it can be divided into 10 types of processing method[1]. Most of the systems are reportedly at the stage of trial and error operation. Therefore, an appropriate process should be selected taking into consideration incoming waste types/ characteristics, waste amount to be treated, etc.

b. Investment and operation cost

Investment cost of plant is reported to be approximately 50 to 60 US$/ton (plant depreciation is set for 10 years), while operation and maintenance cost is between 50 to 80 US$/ton[2]. These investment and operating costs are high when compared with other

[1] "Biogas from Municipal Solid Waste, IEA Bioenergy Agreement," p.16

[2] "The Japan Society of Waste Management Experts", Vol.10 No.3 1999

processing options of incineration and composting which were discussed earlier in this section.

c. Waste characteristics

As discussed in composting, the waste in Almaty is suitable for biological aerobic process. However the waste composition in Almaty should be carefully examined for its suitability for anaerobic digestion taking into account the experience of plants in Europe. In order to produce an acceptable fertilizer, there should be some pre-treatment of the waste through proper waste separation system in the plant and/or separate collection at the waste generation points.

Advantages and disadvantages of methanization are summed up in Table 7.1.18.

Table 7.1.18 Advantages and Disadvantages of Methanization

Advantages	Disadvantages
• Fuel/ methane gas can be recovered and used in several ways and fertilizer products are used as organic fertilizer/ soil conditioner. • Revenue expected from the sales of fuel gas, and also fertilizer. • A certain quantity of usable materials (cans, bottles, glasses, etc.) can be recovered by sorting, either manual or mechanical, at the pre-treatment stage of the system. • Reduction in the volume of organic wastes can be expected. • Stabilization of organic wastes and/or rendering harmlessness certain hazardous substances is performed in the digestion process.	• Technical system of methanization is not yet established on a large scale. • Difficult to maintain stable plant operation. • Suitable waste for methanization is limited to organic waste only. Therefore, in order to collect suitable waste for methanization, either some modification of waste collection systems or sorting system at the pre-treatment stage is required. • It is usually difficult to keep stable market demand and sales routes of fertilizer. • Government's will, incentive and leadership is necessary for the system's introduction.

4) Disposal System

(1) Introduction

This part presents the formulation of alternative disposal sites and a sanitary level of landfill system for Almaty City.

In principle, the existing dumpsite in Karasai should be used solely for disposal of solid waste generated in Almaty City. However, current operations at the Karasai site do not fully meet environmental standards. Moreover, the solid waste amount survey conducted in this study period shows that about 250 to 450 tons of waste, i.e., 26-47% of the total waste collected, are being carried to dumpsites other than Karasai. In fact, seven (7) dumpsites are being operated in the Oblast territory. Therefore, the necessity of an alternative disposal site for city waste has to be considered.

Although open dumping as currently practiced in Almaty and its environs is the cheapest method of disposal, it causes environmental pollution and can potentially affect the health of residents near the disposal sites. Therefore, it is necessary for Almaty City to adopt the sanitary landfill method. A sanitary landfill of the highest environmental standards is still much more economical than other disposal methods such as incineration and other intermediate treatment.

(2) Alternatives of Final Disposal Sites

a. Policy of Formulation

The currently existing dumping sites in the Oblast territory are the alternative disposal sites in this study. Since it may take a long time to authorize a new site for final disposal because of political and institutional constraints, it is extremely difficult to decide on a certain site or to come to some conclusions during this study period.

Furthermore, the selection of a new final disposal site is out of the scope of this study. The currently existing dumping sites in the Oblast territory may not necessarily require such a long procedure because the Almaty Oblast Department of Environmental Protection has already authorized the use of these sites.

b. Alternative Potential Sites

Seven (7) sites in the Oblast territory are receiving waste from the city. The location of these sites is shown in Figure 7.1.8.

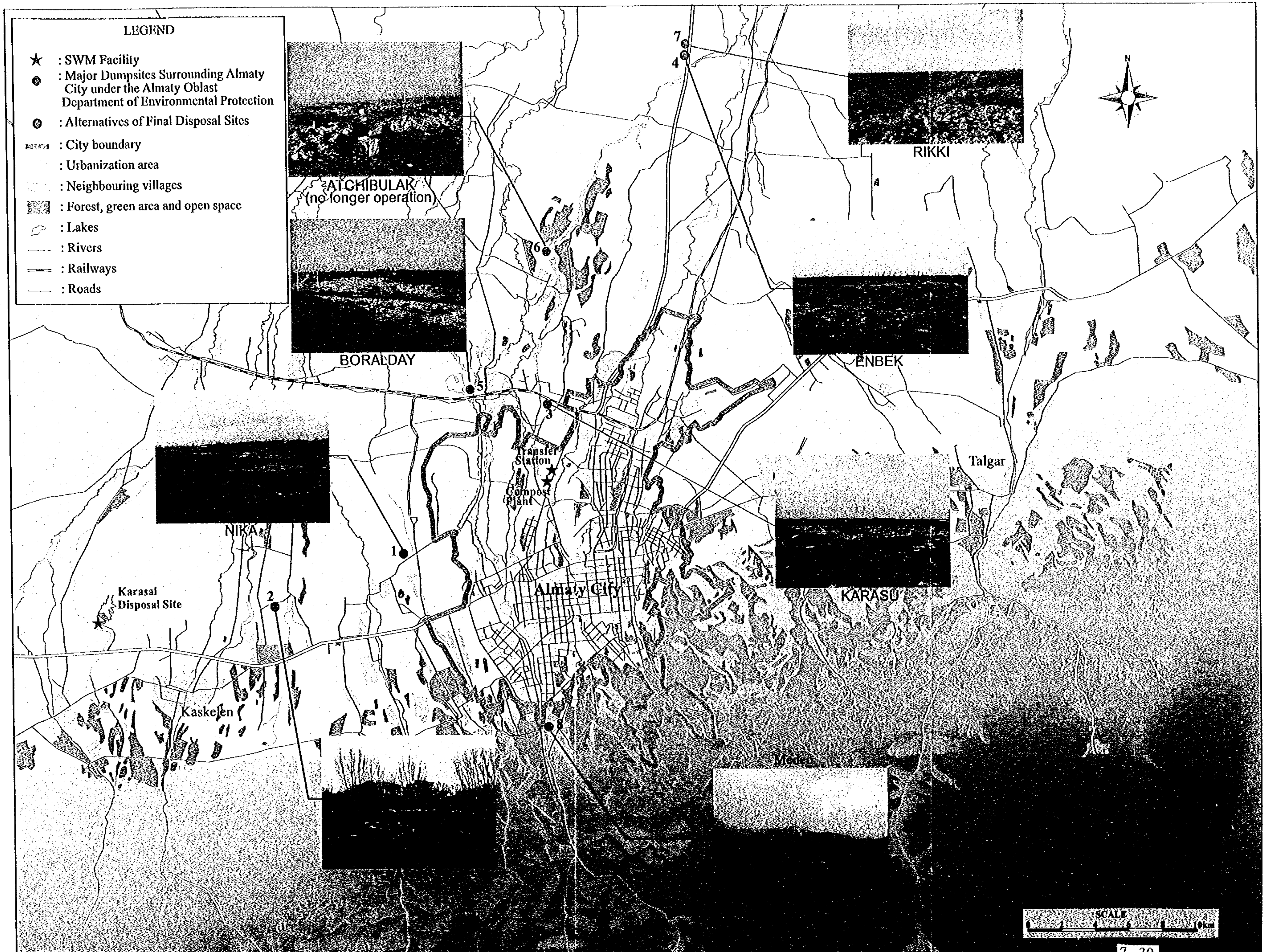


Figure 7.1.8 Major Dumpsites Surrounding Almaty City under the Almaty Oblast Department of Environmental Protection

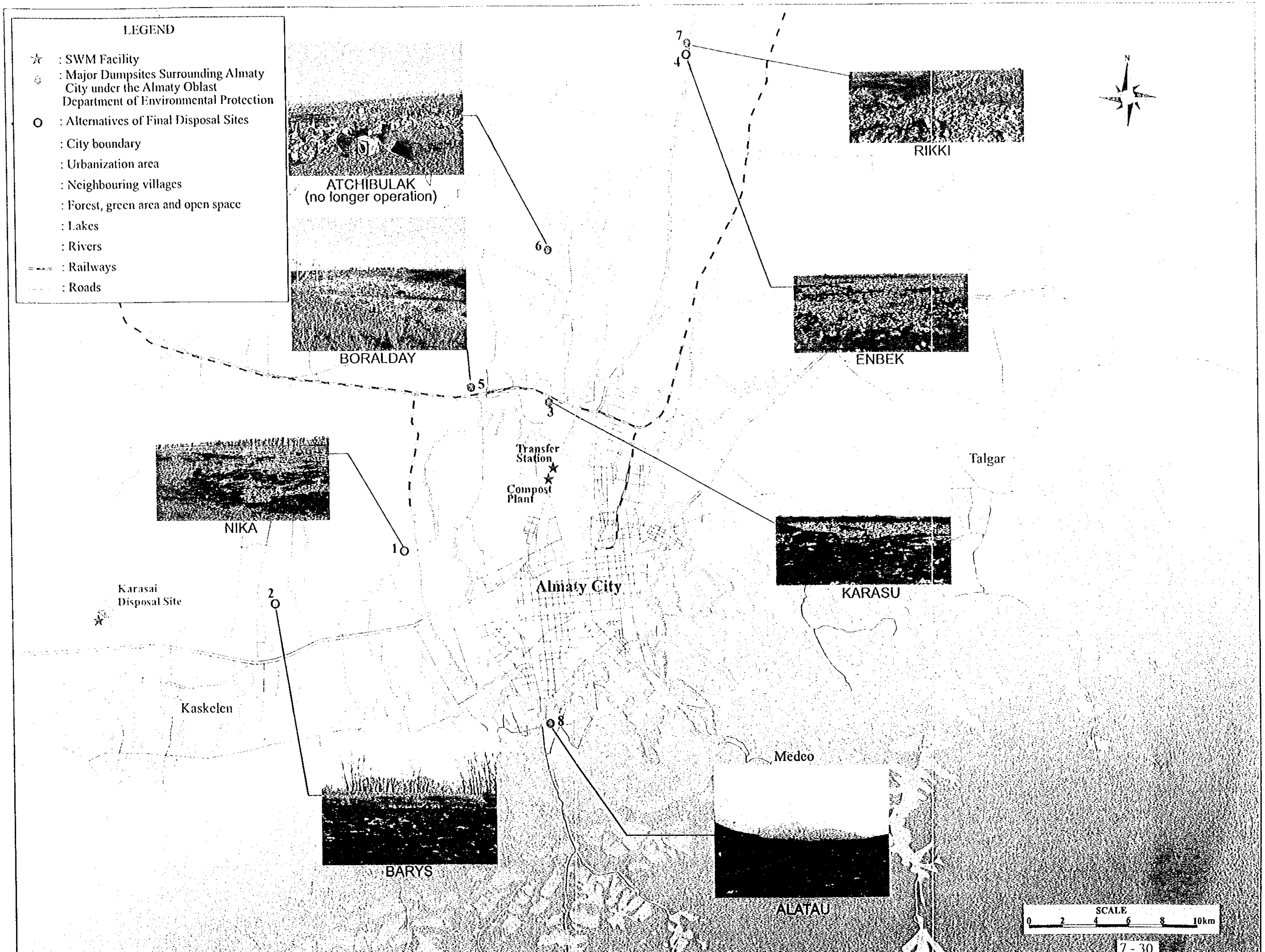


Figure 7.1.8 Major Dumpsites Surrounding Almaty City under the Almaty Oblast Department of Environmental Protection

Based on the field reconnaissance, only three (3) of these seven (7) sites, i.e., Nika, Barys and Enbek are selected as potential alternative final disposal sites for the following reasons:

- Karasu disposal site is located in a sandbank between two rivers and it is not suitable to establish a final disposal site in such a floodplain.
- Boralday disposal site is in a low land, which is a natural swamp area, and it cannot be recommended as a final disposal site because of potential adverse impacts to the environment.
- Rikki disposal site is situated just 600 m north of Enbek. Hauled-in waste is dumped into a dry ravine. Dimensions of the ravine are estimated to be 6-8 m in height, 50-100 m in width and 300 m in length; hence, approximately 160,000 cubic meter[3] (m^3) of waste can be disposed. This capacity is equivalent to only one or two years volume of waste to be collected[4] and is considered to be too small for a final disposal site.
- Alatau is located near a residential area. The residents have already made a complaint about the existing conditions of this dumping site. It seems to be difficult to establish a new disposal site here because of the residents' objection.

c. Recommendable Alternative Disposal Site for Evaluation

According to the Initial Environmental Examination (IEE) as stated in the Supporting Report, Chapter 7, an Environmental Impact Assessment (EIA) is required to be carried out for the remaining three sites, namely Nika, Barys and Enbek. This means that there is no much difference among these three sites from viewpoints of natural and social conditions.

On the other hand, the appropriate location of another disposal site is generally determined by the efficiency of transportation. In this sense, taking into account the location of the Karasai disposal site in the west of the city center, Enbek is the most favorable location among the three. While Nika and Barys are located in the same direction of Karasai, Enbek is in the north of the city. Details are discussed in the preceding Part 2), Transportation.

(3) Introduction of Sanitary Landfill

a. Concept of Sanitary Landfill

The purpose of landfill disposal is to stabilize the solid waste and to make it hygienic through proper dumping of waste and use of natural metabolic functions. It is therefore important to select a practical method of disposal that suitable for local conditions and organizational situation. In making this decision, it is necessary to take into account the type, form, composition of waste, location of landfill site, and geological, hydrological and climatic conditions of the site.

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[3] The volume of the ravine is calculated as follows:
$7 \times 75 \times 300 = 157500\ m^3$, which is about 160,000 m^3

[4] If 250 tons of waste are collected and carried to the site daily, the life of disposal site will be as follows:
160,000/250/365 = 1.75 years

b. Appropriate Sanitary Level of Landfill System for Almaty City

A complete landfill system requires a large amount of capital investment. Taking into consideration the size of Akimate's annual budget and its financial situation, it is expected that various problems with regard to funding a complete landfill system will ensue. It is thus more realistic at the moment to accomplish a complete landfill system step by step; in other words, staged construction will be introduced.

The sanitary level of landfill system can be divided into four (4) classifications as tabulated below. Appropriate sanitary level of the system will be determined in consideration of financial viability and degree of environmental conservation.

Table 7.1.19 Classification of Sanitary Level of Landfill System

Level 1	Controlled tipping
Level 2	Berm construction and daily cover soil
Level 3	Effluent control of leachate and monitoring
Level 4	Leachate treatment and liner system

The primary target of disposal system for the M/P is Level 3+ (plus), according to the result of the Environmental Survey. Level 3 is defined in this study as the introduction of controlled tipping, berm construction and daily cover soil, and effluent control of leachate and monitoring. Treatment of leachate is added to these components so as to fulfill the required level in the case of Level 3+.

The result of the survey shows that the water quality of leachate retention ponds at the Karasai disposal site is slightly worse than that of rivers flowing in the city. However, the water quality of retention ponds is still within the acceptable level of the Japanese standards, while the quality standard of discharged water in Kazakhstan was not obtained. In terms of biochemical oxygen demand (BOD), for example, around 21 to 24 milligrams per liter (mg/l) was recorded at the downstream retention pond although the limit of BOD in the Japanese standards is 160 mg/l. Therefore, the existing retention ponds are to be improved in accordance with the volume of leachate to be treated, which can be managed with low maintenance cost. Also, a leachate re-circulation system is to be considered to mitigate the capacity of retention ponds, if appropriate.

c. Method of Filling

Depending on details of site operation and conditions, variations in landfilling techniques can be distinguished by the following three methods:

Trench method

This involves the excavation of a trench into which waste is deposited. The excavated material is then used as cover. This technique is a variation of the cell method described below and is ideally suited to areas where an adequate depth of cover material is available at the site and where the water table is not near the ground level.

Area method

Waste may be deposited in layers and form terraces over the available area. This method is applied to the terrain that is unsuitable for the excavation of cells or trenches in which to place the solid waste because of, for example, high groundwater conditions.

Cell method

This technique involves the deposition of waste within pre-constructed bunded area. At a shallow site it is considered preferable to place one daily cell on top of another so that the larger cell is brought up to final level before moving onto the next larger cell thereby.

Among these methods, the Karasai site is suitable for the cell method since the site is still ongoing and had already a large amount of deposited waste and, consequently, the foundation is very weak and it is very difficult to excavate a trench. On the other hand, a combination of the trench and cell methods is recommended for the Enbek site. This is because the Enbek site is naturally formed at several depressions and it also has plain areas where solid waste can be dumped. Use of these existing conditions will reduce costs.

7.1.3 Selection of Optimum Alternative

The technical systems in each alternative were selected as explained in preceding sub-sections. Table 7.1.20 provides a summary of the alternatives formed and a general evaluation of the advantages and disadvantages of each.

Table 7.1.20 Summation of Technical Alternatives Formulated

Alternative 1	Alternative 2	Alternative 3	Alternative 4
1) Facilities provided			
• Collection equipment • One transfer station • One disposal site • Recycling plan	• Collection equipment • Two transfer stations • One disposal site • Recycling plan	• Collection equipment • One transfer station • Two disposal sites • Recycling plan	• Collection equipment • One transfer station • One processing plant • One disposal site • Recycling plan
2) Advantages			
• Only one facility requires construction • Lowest investments • Low operation and maintenance costs	• Two T/S offer more stable SWM • Collection equipment efficiency is highest • Comparatively low investment costs • Low operation and maintenance costs	• Development of a second disposal site and prolonging of Karasai disposal site life • Less reliance on transfer operations	• Stabilization of waste through treatment • Large decrease in volume reduction • Increases disposal site life time • Reduces reliance on transfer operations • Generates heat and electricity
3) Disadvantages			
• Reliance on only one T/S for all city's waste	• Construction of more than one SWM facility • Operation and monitoring of more than one facility	• Construction of more than one SWM facility • Operation and monitoring of more than one facility	• High investment costs • High O&M costs • Waste separation required

The final criteria for selection of optimum alternative for the M/P has been done through comparison of the operation and maintenance costs of each alternative in the year 2010, the master plan target year. Table 7.1.21 shows these costs. Investment costs during the M/P period (2000 to 2010) are shown in Table 7.1.22.

The operation and maintenance costs were prepared as follows:

- The base unit costs were those collected in April – May , 1999.
- The O&M costs in 2010 were used for the comparison purposes.
- The contents of the recycling plan are explained in the following section 7.2.
- Costs of medical waste collection, transport and disposal are included in the costs however treatment at the hospital is excluded (responsibility of the hospital)
- Costs of street sweeping waste transfer transport (from the transfer station to the disposal site) are included in the transfer costs, but sweeping and collection costs are not included (responsibility of the street sweeping company).
- Costs of non-hazardous industrial waste disposal at the disposal site is included in the costs, however collection and transport of this waste type is excluded (these costs are the responsibility of the industrial generators themselves).

Alternative 2 provides the lowest operation and maintenance costs of the four alternatives and alternative 4, the largest. Although there is only a small difference between alternatives 1 and 2, implementation of alternative 2 over alternative 1 will secure a saving in operation and maintenance costs of about US$ 3.6 million during the year 2010.

Construction of two transfer stations (alternative 2) compared to one transfer station (alternative 1) will also allow for more secure SWM operation because two stations will provide more stability.

In case of Alternative 4, while introduction of an incineration plant will provide savings in O&M costs for collection and transfer of 45% and 50% in sanitary landfill costs (compared to Alternative 2), these savings are still insufficient to offset the high costs in operation and maintenance of the incineration plant, in spite of the revenues incurred from the plant.

At this time where the financial base of Almaty city is not so strong and the SWM M/P aims at securing a stable SWM system at minimum acceptable standards, Alternative 2 is considered the most suitable option. Therefore this alternative has been selected for the M/P, and will be discussed in detail in Chapter 9.

Table 7.1.21 O&M Costs in 2010 of M/P Alternatives

	Item	Alt. 1 W T/S Karasai	Alt. 2 W+N T/S Karasai	Alt. 3 W T/S K + Emb	Alt. 4 N T/S W P/P Karasai
1	COLLECTION				
	1) Personnel	48,449	40,246	61,280	52,700
	2) Fuel and lubricants	31,562	22,501	46,872	28,566
	3) Maintenance and Repairs	59,461	49,347	74,879	63,780
	4) Others	34,868	28,023	45,758	36,262
	5) Overhead	33,915	28,172	42,896	36,890
	6) Depreciation	245,473	220,188	284,017	256,531
	Total 1.	453,728	388,477	555,702	474,729
2	TRANSFER STATION(S)				
	2.1 Facility Operation				
	1) Personnel	7,987	8,885	5,001	3,885
	2) Fuel and lubricants	913	1,003	547	456
	3) Maintenance and Repairs	11,500	13,764	7,967	5,798
	4) Others	5,100	5,913	3,379	2,534
	5) Overhead	5,591	6,219	3,501	2,720
	6) Depreciation	28,750	34,411	19,917	14,495
	Sub-total 2.1	59,841	70,195	40,312	29,888
	2.2 Transfer and Equipment Operation				
	1) Personnel	5,184	5,616	3,672	2,808
	2) Fuel and lubricants	19,001	22,800	13,572	10,374
	3) Maintenance and Repairs	23,063	25,040	16,364	11,644
	4) Others	11,812	13,364	8,402	6,207
	5) Overhead	3,629	3,932	2,571	1,966
	6) Depreciation	57,656	62,600	40,910	29,109
	Sub-total 2.2	120,345	133,352	85,491	62,108
	Total 2.	180,186	203,547	125,803	91,996
3	PROCESSING PLANT				
	3.1 Plant Operation				
	1) Personnel	-----	-----	-----	12,650
	2) Fuel and lubricants	-----	-----	-----	216,545
	3) Maintenance and Repairs	-----	-----	-----	365,125
	4) Others	-----	-----	-----	148,580
	5) Overhead	-----	-----	-----	8,855
	6) Depreciation	-----	-----	-----	690,000
	7) Revenues from elecricity and steam sales	-----	-----	-----	-375,015
	Sub-total 3.1	0	0	0	1,066,740
	3.2 Residual Materials transport to D/S				
	1) Personnel	-----	-----	-----	288
	2) Fuel and lubricants	-----	-----	-----	1,448
	3) Maintenance and Repairs	-----	-----	-----	824
	4) Others	-----	-----	-----	640
	5) Overhead	-----	-----	-----	202
	6) Depreciation	-----	-----	-----	2,059
	Sub-total 3.2	0	0	0	5,460
	Total 3.	0	0	0	1,072,200
4	SANITARY LANDFILL				
	1) Personnel	4,757	4,757	7,643	3,893
	2) Fuel and lubricants	12,122	12,122	15,070	8,114
	3) Maintenance and Repairs	28,260	28,260	37,917	20,086
	4) Others	9,028	9,028	12,126	6,419
	5) Overhead	3,330	3,330	5,350	2,725
	6) Depreciation - Equipment	35,325	35,325	47,396	25,107
	7) Depreciation - Facility	109,316	109,316	102,734	38,023
	Total 4.	202,138	202,138	228,236	104,367
5	RECYCLING				
	1) Personnel	8,420	8,420	8,420	8,420
	2) Fuel and lubricants	7,870	7,870	7,870	7,870
	3) Maintenance and Repairs	6,777	6,777	6,777	6,777
	4) Others	2,549	2,549	2,549	2,549
	5) Overhead	9,512	9,512	9,512	9,512
	6) Depreciation	33,722	33,722	33,722	33,722
	Total 5.	68,851	68,851	68,851	68,851
	GRAND TOTAL	904,903	863,013	978,592	1,812,143
	T/Ton	2,574	2,455	2,784	5,156
	(USD/ton)	22.4	21.4	24.2	44.8

7.2 RECYCLING OF REUSABLE MATERIAL

The purpose of recycling is to conserve natural resources by re-utilizing and reuse of recoverable/ recyclable waste materials and to reduce/ minimize the amount of solid waste required to be transported and disposed of. Recycling can be defined as a process incorporating the following steps;

i. Separation and collection of recyclable waste materials
ii. Preparation of the recyclable materials for reuse, re-utilizing and re-manufacture
iii. Reuse, re-utilize and re-manufacture of these materials

Item i is heavily dependent on citizens' cooperation

item ii and *item iii* require stable economic conditions in the country as stable markets and prices for the recyclable materials are needed to support continuous operation.

7.2.1 Present Conditions and Issues for Recycling in Almaty

It is recognized that the Kazakhstan economy is currently in such a stagnant condition, that recycling activities in Almaty have practically collapsed. Demand for the recyclable materials and the market value of these materials are reported to be reduced to near zero levels during the last five years. For example, paper recycling amount in Almaty in 1995 was 3,322 ton/year, however it has fallen to 340 ton/year, in 1998. Similar trends can be found for other recyclable materials such as plastic, textile, glasses/ bottles, ferrous metal and non-ferrous metal.

Under these conditions, large amounts of broken glass and plastic are found in the disposal site which threaten the landfill operation and scavenging activities.

7.2.2 Target of Recycling

The target recycling amount for the M/P in 2010 is 94 ton/day which is 10% of domestic and commercial waste forecast to be generated in Almaty in that year.

Waste amounts generated by waste type and estimated amount of recyclable materials in 2010 are shown in Table 7.2.1. As shown in the table, there is potential for recycling of 119 ton/day of waste in 2010; i.e. 82 ton/day of paper, 16 ton/day of glass, 12 ton/day of metals, etc. In other words, target recycling amount for the master plan (94 ton/day) is approximately 80% of the potential recycling amount.

The waste materials which are proposed to be recycled in Almaty are as follows:

- Paper : newspaper, magazine, cardboard, office paper
- Textile : clothes
- Plastic : pet-bottles, plastic bag, packaging, etc.
- Metal : ferrous and non-ferrous metal including steel and aluminum cans
- Glass : bottles and cullet (whitecullet)

Table 7.2.1 Recyclable Waste Materials Amount in 2010

(unit: ton/day)

Waste types		Domestic w. amount in 2010	Commercial w. amount in 2010	Total w. amount in 2010	Recyclable w. materials	
					Ratio (%)	Amount (ton/day)
	Combustible					
x	Paper	100.1	133.4	233.5	35 %	82
x	Textile	12.4	9.7	22.1	20 %	4
x	Plastic	61.3	31.5	92.8	5 %	5
	Leather	5.1	3.4	8.5	--	--
	Leaves	12.9	4.1	17.0	--	--
	Food	303.5	152.9	456.4	--	--
	Non-combustible					
x	Metal	14.6	10.1	24.7	50 %	12
x	Glass	31.5	20.2	51.7	30 %	16
	Ceramic	3.9	2.6	6.5	--	--
	Sand	17.4	3.4	20.8	--	--
	Total	562.1	374.7	936.8		119

Note: 1. "x" shows proposed recyclable waste types in 2010
2. Waste amount in each waste type in 2010 is estimated based on the waste composition survey in Almaty in 1999, conducted by JICA study team
3. Ratio of recyclable waste material is settled based on Japan's experience and recent recycling conditions in Almaty
4. "Metal" includes ferrous and non-ferrous metal

7.2.3 Recycling Options

The following two key issues shall be taken into consideration in order to achieve the recycling target.

- Source separation and collection of the recyclable waste materials
- Re-establishment of sustainable activities of recycling/ processing companies

In addition to the above, in order to promote an affordable recycling system, it is proposed to establish a "social system for recycling". In this social system, each responsible body; i.e. manufacture/ producer, merchandising company, consumer/ waste generator (Almaty citizens), collection/ disposal company, recycling/ processing company and local government, should understand their position in the recyclable society and the necessity to carry out their responsibilities properly. (Establishment of this recycling society in full scale is not a target for the M/P, because it may probably take much longer time, however the M/P introduces the necessary process in as a first step to developing such a society).

Figure 7.2.1 shows a social system for recycling and the status/ responsibilities of each responsible body.

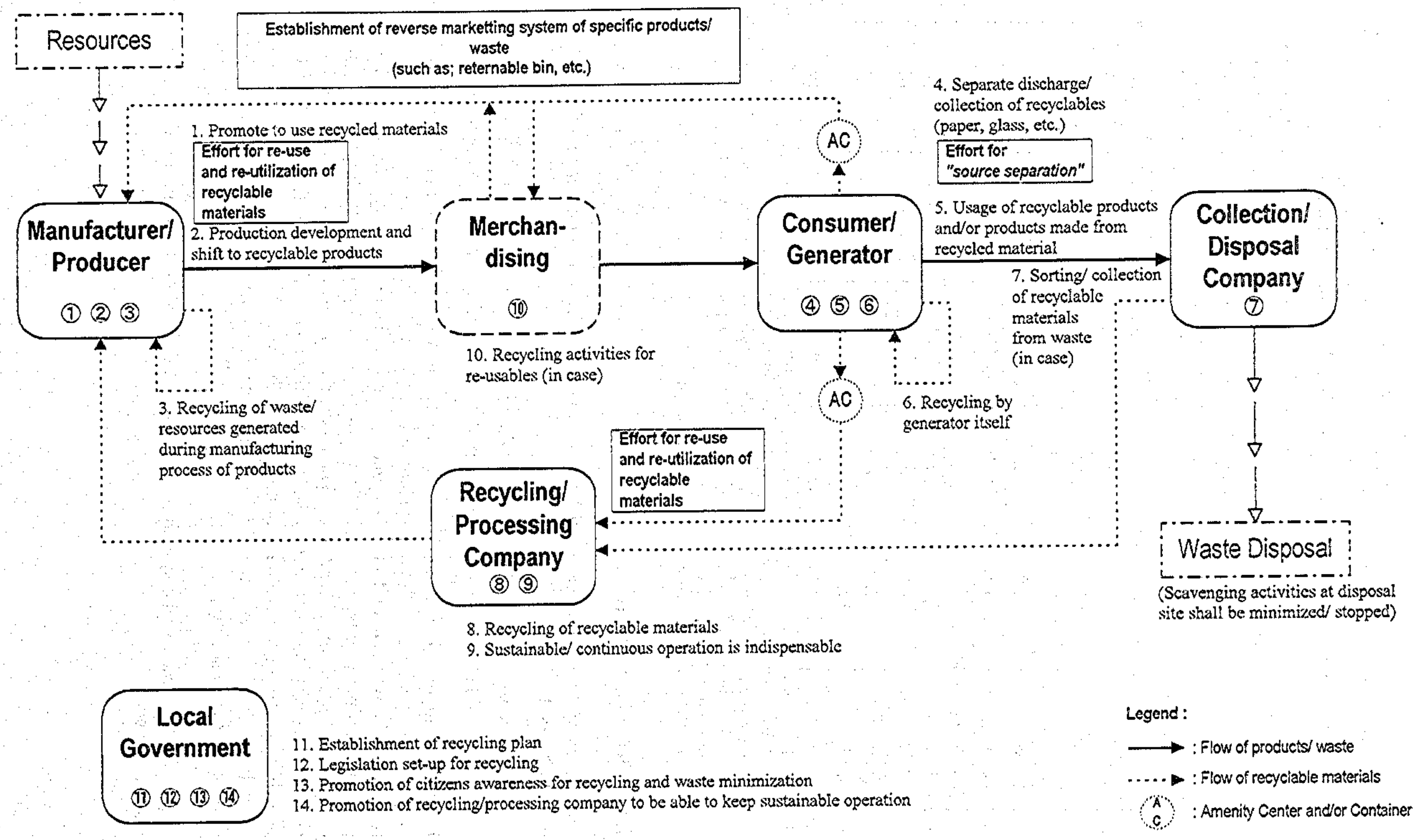

Figure 7.2.1 Recycling Flow and Responsible Bodies

7.2.4 Source Separation and Collection of Recyclable Materials

Separation and collection of recyclable waste materials from domestic waste is the starting point for introduction of an affordable recycling system in Almaty. There are two ways to separate and collect the recyclable waste materials;

i. Separate/ collection at the source ("*source separation*")
ii. Sorting/ collection at transfer station and/or processing plant from collected mixed waste

However, it is noted that sorting/collection at transfer station and/or processing plant of recyclable materials from the collected mixed wastes is not economical because recyclable material amount is only 12% of the mixed wastes as shown in Table 7.2.1.

Source separation which relies heavily on citizens' cooperation is the common practice in developed countries. Citizens are requested to separate recyclable materials from their waste at their houses. The separated/ recyclable materials are kept at their houses then discharged at collection points on designated days.

An "Amenity Center" is proposed for Almaty, in order to collect separated recyclable materials from domestic and commercial waste by citizens and proprietors of small business. Proposed materials separated by citizens and collected at amenity centers will be paper, glass, ferrous metal, non-ferrous metal, plastic and textile. The centers may also accept pre-separated hazardous domestic waste (such as; oils, surplus paints, batteries, etc.). In the future, the centers may receive bulky reusable waste (such as; old furniture, broken electric products, etc.) and renew/ repair them there then sell them. Layout plan of amenity center is shown in Figure 7.2.2.

Besides amenity centers, it is also proposed to install dedicated containers/bins at certain points in the city (called "city pick-up stations"), to collect recyclable materials separately.

On the other hand, in some developed countries, waste sorting facilities have been set up to further separate the source separated waste. At these facilities, in addition to manual separation, some processing equipment such as classifier, magnetic separator, shredder, baler etc. are used.

However, to equip these facilities, larger capital investments would be required and technical difficulties would be faced when compared with the introduction of source separation. Taking into account the social/communal based process and minimum requirements concept of the M/P, source separation system is proposed in the year 2010. Introduction of waste sorting facilities on a large scale shall be taken into account where and when the sale of recovered materials justifies the costs. Figure 7.2.3 shows the system flow of a recycling plant in Yokohama city, Japan.

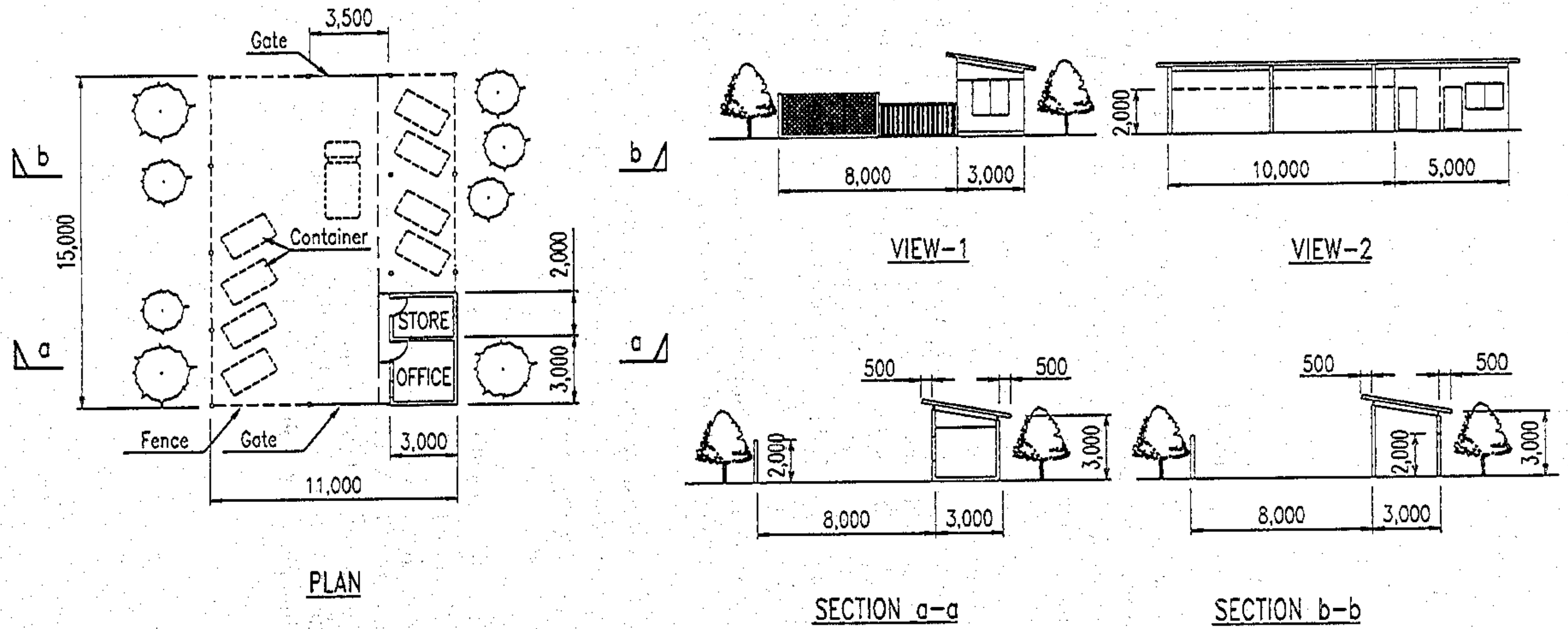

Figure 7.2.2 Amenity Center Layout Plan

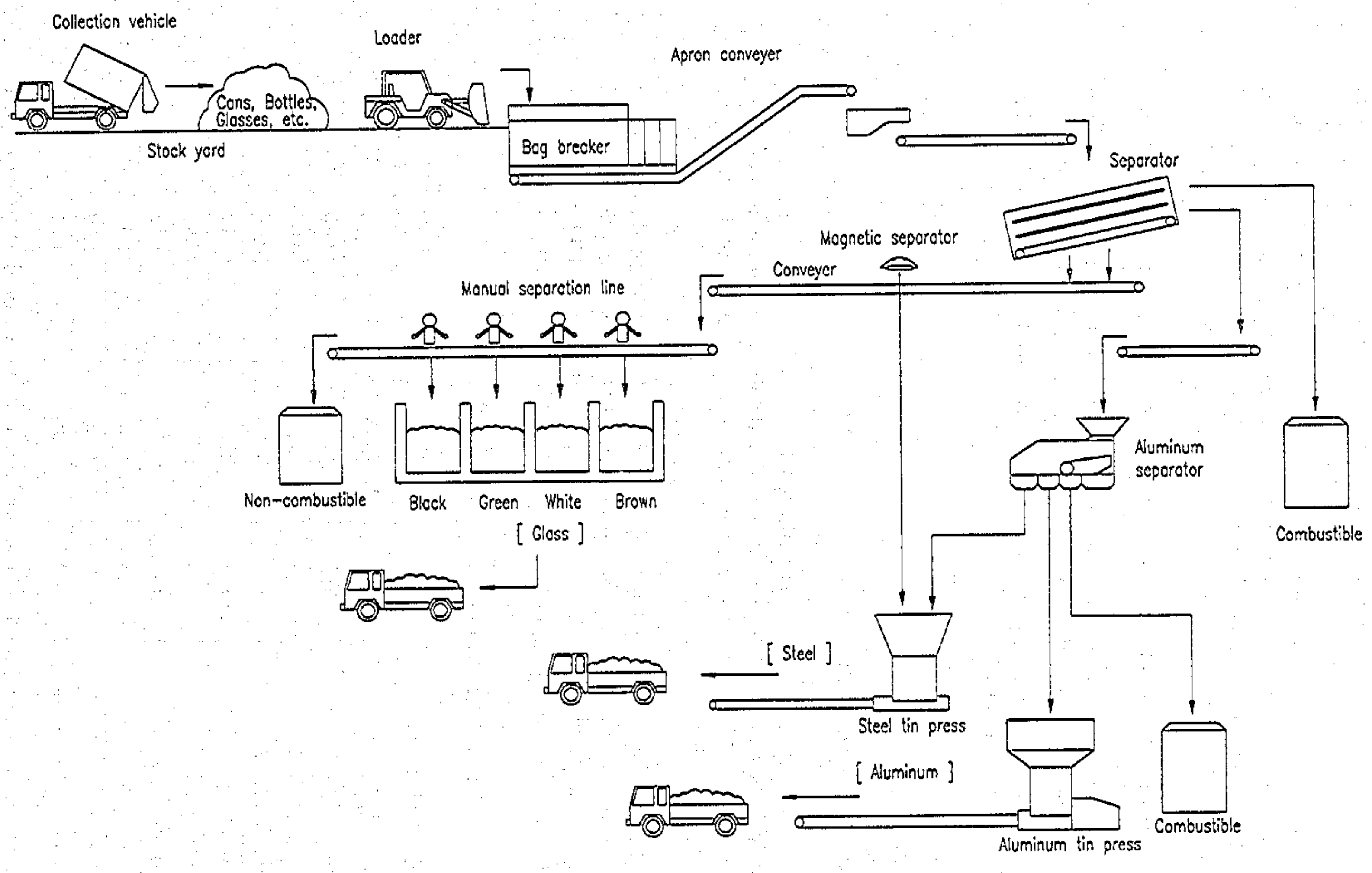

Figure 7.2.3 System Flow of Reusable Material Separation (Yokohama City, Japan)

7.2.5 Re-establishment of Sustainable Activities of Recycling/Processing Company

Stable economic conditions of the country which may secure stable and lasting market values of recyclable waste materials and may lead to sustainable activities of recycling/ processing company are indispensable for the successful introduction of the recycling system. The M/P considers the operation and maintenance of the proposed recycling plan to be initially included in the overall SWM costs so as not to put a burden on end users of recyclable materials at the start.

In addition the following aspects should be considered to support their activities.

- A strategy by the local government authorities in order to encourage the recycling/ processing companies through favorable legislative and/or financial incentives
- Efforts of recycling/ processing companies themselves to reuse and re-utilize the recyclable waste materials

7.3 MEDICAL WASTE

7.3.1 Quantity of medical waste

The contradictions observed in numerous collected figures of waste generation at the medical establishments could not lead to a realistic database for forming elaborate technical alternatives for the medical waste management and particularly the infectious waste.

As shown in the following Table 7.3.1 the collected data of some hospitals show large discrepancies. According to the data the specific medical waste generation varied between 0.08 kg/bed/day and 72.9 kg/bed/day). This ratio (more than 900 times) is very high. These data from the recent inquiry cannot be considered as representative.

Table 7.3.1 Data collected from 10 hospitals

Medical Establishment	Number of beds	Total waste quantity (t/a)	Specific waste generation (kg/bed/day)
Central Clinic Hospital	550	1000	6.56
City Clinic Hospital No 1	615	750	2.60
City Clinic Hospital No 2	330	10	0.08
City Clinic Hospital No 7	835	3000	10.06
Emergency Hospital	515	2500	12.17
City Infection Hospital	160	5000	72.95
Infection CCH for Children	405	200	1.13
Maternity No 1	115	1000	21.41
Maternity No 2	90	1000	25.69
Medeuski Rayon Phthisis Hospital	60	40	1.81

The Study Team carried out at all medical establishments a survey on the waste quantity generated in the hospitals and clinics depending on the City Health Care Department. Excluding unrealistic data the results shows that variation lies between 0.3 and 4.6 kg/bed/day, with an average value of 1.61 kg/bed/day.

The Study Team will take into consideration these results on medical waste generation for further analysis. Due to the fact that no separation is being done at the hospitals and based on experiences in similar countries, the Study Team will consider the following distinction of waste generation at medical establishment:

Total waste generated:	100% (1.61 kg/bed/day)
Food waste	15 – 25%
Similar household waste	40 – 60%
Infectious waste	25 – 35%

Taking into account the different hospitals in the Almaty City the following waste generated at the hospitals can be expected:

Table 7.3.2 Quantity of Medical Waste Generation

Medical Establishment	Number of beds	Total waste quantity expected (t/a)	Infectious waste quantity (t/a)	Non Infectious waste quantity (t/a)
City Hospitals & Clinics	5,872	3,897	1,169	2,728
Oblast Hospitals & Clinics	640	469	141	328
National Hospital & Clinics	4,648	3,452	1,036	2,416
Other Hospitals	2,077	1,221	366	855
Total	13,237	9,039	2,712	6,327

7.3.2 Proposed Alternatives

Waste separation inside the different services at the hospitals and clinics should be introduced. Infectious waste should be collected and treated (eliminated) separately to avoid and reduce risks of any contamination during collection, transport and at the landfill. Furthermore, and in order to preview mid and long term medical waste management, records on the waste generation should be made and documented.

The total waste generation at all medical establishment's amounts to approximately 9,600 ton/year where the infectious waste quantity is estimated at about 2,700 ton/year that has to be treated prior to disposing of at the municipal landfill site.

The optimal management of infectious waste would be achieved, when each hospital or clinic is equipped with a facility rendering infectious waste harmless. Taking into account the financial and economical situation of the medical establishments, steam sterilization autoclave is the most appropriate for the treatment of infectious waste.

In a first stage the hospitals that are generating the highest quantity of infectious waste should be provided with steam sterilization facility are presented in the following Table 7.3.3, according to our estimation on waste generation as well the estimated investment costs for the facilities.

It is necessary to establish a system to treat infectious waste. One alternative will be centralized treatment system and another will be individual treatment system. As the first step, individual treatment system shall be established because waste separation at the hospital and clinics is essential for proper treatment of infectious waste. And it can be done only at the hospital and clinics.

Also it is recommended to have special arrangement for collection of medical waste to handle medical waste carefully. Waste amount to be collected will be 9,600 ton/year (31 ton/day) including treated infectious waste.

Table 7.3.3 Proposed Hospitals to be equipped with steam sterilization facility

Medical Establishment	Infectious waste quantity to be treated (kg/day)	Estimated investment cost (US $)
Central Clinic Hospital	355	22,000
City Clinic Hospital No 1 *)	518	22,000
City Clinic Hospital No 7 *)		
City Clinic Hospital No 2	200	14,000
City Clinic Hospital No 4	427	22,000
CCH for Children No 1	173	14,000
Emergency Hospital	308	22,000
Total	1,981	116,000

Note: *) Due to the close locations of the City Clinic Hospitals No 1 and No 7, it is recommended to consider one steam sterilization facility for both medical establishments.

7.4 NON HAZARDOUS INDUSTRIAL WASTE

7.4.1 Quantity of Industrial Waste

The industrial solid waste quantity generated in Almaty should be recorded continuously. In order to be able to control the industrial waste generation, the records should be kept also at the landfill site, when the trucks are delivering industrial waste.

According to authorized waste amount that is registered at ACDEP for the different 394 industries in Almaty City, the waste generation amount is approximately 26,000 t for 1998. The following Table 7.4.1 presents the different sectors and their expected waste generation.

Table 7.4.1 Industrial Waste Quantity expected in 1998

Company	Waste quantities (t for1998)
Metal Processing	6,904.854
Oil Processing & Oil Products	597.000
Car & Transport	42.500
Building Construction	4,695.600
Plastic Processing	134.960
Glass Processing	792.000
Wood Processing	391.400
Leather Processing	1.750
Food Processing	1,656.500
Paper & Cardboard	5,451.015
Textile	180.400
Tobacco	1,500.000
Ash & Slag	1,084.500
Others	1,793.020
Total	**25,225.50**

7.4.2 Proposed Alternatives

Concerning industrial waste, each factory shall be responsible to treat, transport and dispose of it's solid waste because the generator itself is most familiar with the characteristics of the waste and should therefore bear the responsibility for its proper treatment. Also it would be allowed to entrust treatment, transportation and/or disposal of solid waste to specialized companies of solid waste. However, it is recommended to arrange a system to accept non-hazardous industrial waste at disposal site with payment of tipping fee. Also, it is necessary to have a system of registration for specialized companies to deal with solid waste.

Also it is necessary to formulate recording and documentation of industrial waste. Based on clear industrial waste definition, the recorded waste generation and classification would give the real figures on the industrial waste quantities and their composition. These would be used to determine the potential of recycling and reusable components.

According to the survey carried out by JICA Study Team, three main issues can be pointed out in order to help environmental protection, recover resources and reduce industrial waste generation in Almaty:

- Existing recycling companies for ferrous and non ferrous metal scrap (such as Kaztorchermet or Vtorzetmet) should be preserved and strengthened as necessary. They have available recycling capacities for ferrous metal scrap of approximately 8,000 t/month and for non ferrous metal scrap of about 180 t/month.
- The existing plastic recycling plant, designed for 2,000t/year, currently is not recycling plastics at all. This means that the required plastic recycling capacity is already available and should be used.
- Glass recycling is unfortunately not existing in Almaty region. Facilities for glass recycling should be promoted in the region (i.e. through involving private sector).

It is noted that recycling of industrial waste will be an initial step for promotion of recycling because waste generated through certain processes will be uniform. Also volume reduction of industrial waste can be achieved mainly by reuse of abandoned material.

7.5 CLOSURE AND RECLAMATION OF ILLEGAL DUMPSITES

7.5.1 Introduction

This section presents the closure and reclamation plan for illegal dumpsites in the city. The closure and reclamation plan is an integral part of the final disposal system. No matter how well and how scientifically the site has been selected, prepared and operated, it is by the standard of closure and continuing satisfactory performance of the reclaimed land that the acceptability of landfill will be judged.

ACDEP recognizes 12 illegal sites but the number of illegal dumpsites is actually more than that as described in Chapter 1, Section E, Supporting Report. While almost all sites have stopped operation, some of the sites shall be treated in a proper manner for closure and reclamation in order to minimize impacts to the environmental, social and aesthetic conditions.

7.5.2 Identification of the Illegal Dumpsites to be Closed/Reclaimed

As the Sanitary and Epidemiological Center of Almaty City inspected and monitored, over 200 unauthorized dumpsites are identified in the city. However, these sites are categorized into relatively small trash sites and are not intended to be closed/reclaimed in the plan, because regular collection/transportation service will be able to remove such a small amount of waste if the service is maintained properly. Thus, the closure and reclamation plan will be established for the following six (6) major illegal dumpsites except sites already liquidated with cover soil and small-scale dumpsites that were identified in the study period in Almaty.

a. South-west from Zhetysu residential area, north side of Abai Avenue, Auezovsky (hereinafter referred to as "Zhetysu south-west");
b. North of Ryskulov Avenue, south edge of Shanyrak AK-4, Auezovskii Rayon (hereinafter referred to as "Ryskulov north");
c. North of Raiymbek Ave., west side of the city cemetery, Almalinsky (hereinafter referred to as "Raiymbek north");
d. South of a sludge retention pond from the water heating station, north of Ryskulov Ave., Zhetysusky (hereinafter referred to as "Near the sludge retention pond");
e. North side of Kulagher residential area, close to Sultanka River and a horse race field, Zhetysuskii Rayon (hereinafter referred to as "Kulagher north");
f. Spasskaya Street, north side of residential area between drainage and KNS DKP, Turksibskii Rayon (hereinafter referred to as "Spasskaya").

In addition, a large amount of waste is stored at the existing transfer station along the Severnoe Koltso. No maintenance work or any mitigation measures has been undertaken to mitigate the environmental problems. Smoke, dust and offensive odors emanate from the site which may be harmful to the surrounding residents. Therefore, a reclamation plan for the transfer station will also be required.

7.5.3 Development of Closure and Reclamation Plan

1) Components of the Plan

In general, the closure and reclamation plan should include the following components:

- land reclamation work, such as removal or burying waste,
- landfill cover to landscape the final site and
- post-closure care including leachate and gas management.

The contents of each component actually depend on the site conditions, such as area and volume of accumulated waste, impacts on the environment and existing land use.

2) Land Reclamation

Scattered wastes have to collected in a designated area or trench, and then the dumpsite should be graded and compacted. This will reduce the area where waste is distributed. Either the area or the trench method is generally used in closing the dumpsite.

In the area method, wastes are spread in thin layers, compacted and then covered with a minimum of 0.5 m of compacted soil. If the dumped waste is spread over a large area, it must be consolidated and compacted to reduce the amount of settlement and cover material required. The cover material shall be graded to avoid ponding of surface water. The trench method also involves spreading the wastes in thin layers, compacting, and then covering with the excavated soil. The cover material should be compacted to keep flies and rats out, and it should be graded to keep surface water from ponding. The bottom of the trench should be kept above the level of high groundwater.

3) Final Cover Design

After completion of waste gathering and its removal or burial, all exposed surfaces should be covered with soil to a depth of not less than 0.5 m. The cover material should be selected to its ability to limit the access of vectors to the waste, control moisture entering the fill, control the movement of gas from the decomposing waste, support vegetation, and so forth; however, not all soil types perform these functions equally well. Thus, the soil is to be selected from the site or nearby.

The cover soil should be compacted and graded to a slope of 2 percent or greater. Proper grading is important since it prevents excessive soil erosion and ponding. Ponding tends to infiltrate and saturate the fill, resulting in water pollution.

To further reduce erosion, the area should be seeded with grass or other vegetation. Some 50 centimeters (cm) of soil are usually sufficient for grass, but more is necessary for shrubs and trees. Selecting plant species must require special care because it depends on not only the local natural conditions but also the chosen end use of the site as described in the following part 5).

4) Leachate and Gas Management

If the dumped waste is composed mainly of decomposable rubbish or food waste and is relatively fresh, the leachate control system should be considered. Rainfall and snowmelt must be removed from the final cover surface without soil erosion or excessive water infiltration. Drainage facilities will be therefore built in the edge of the final cover and around the landfill area.

Also, various gases and vapors are emitted during the decomposition of the organic materials by biological activity in the waste. The gas poses hazards, in particular through the risk of fires or explosions, and gas control facilities, such as extraction wells, and collector and transmission piping, should be installed.

5) Post-closure Land Use Plan

The landfill process will finally result in the formation of a useful land area. Therefore, it is desirable that the completed filled-up area should be utilized as early as possible and, in the meantime, it should be easily manageable as well. The post-closure land use plan aims at reclaiming a piece of land with value-added.

In an urban area where most of the natural environment has been destroyed by development activities, the filled-up site can be transformed into urban woods or other community facility, such as a haven against natural disaster or fire. The planning which can reconcile SWM with the improvement of the living and urban environments should be the final goal and strategy of the integrated SWM system for the city.

On the other hand, the following points should be considered before starting the post-closure land use:

- Rate of subsidence
- Leachate quality
- Quality and quantity of gaseous products
- Internal temperature of landfill

Very often, the problems caused by subsidence and gas emission affect the post closure land use plan. In controlling the land use, it is necessary to continuously measure these indicators so as to decide when the site can be duly utilized.

Even though many studies are still being made on the evaluation of landfill stability, it would be better to utilize the landfill site immediately by adopting temporary measures to counteract land subsidence, corrosion caused by leachate and emission gases.

In the past, post closure land use planning was never included in planning stages of final disposal system; that is, the emphasis of improvement plan was rather on how much solid waste can be buried or how much the system can be economically functioning, etc. This is because the pressing problem focused mainly on how to dispose of increasing volume and types of solid waste in a safe and efficient manner. As a result, the completed filled-up site often experience problems relating to poor soil condition, emission of combustible gases or offensive odor, land subsidence and weak foundation.

In considering the ultimate usage of landfill site, the period required for the completed landfill to stabilize depends on the following issues:

- Types and volume of filled-up solid waste;
- Types and volume (thickness) of cover material applied;
- Intermediate treatment processes, such as crushing and compaction; and
- Heavy machine, such as bulldozers used for crushing and compacting the filled-up waste.

All the above factors relating to land formation will in return affect the type of land use to be adopted.

In general, closed sites are used for agriculture, public parks, sports ground, and houses and buildings. Considerations that arise are summarized as follows:

(1) Agricultural Area

Final cover soil should be more than 1 m thick and the soil should be suitable for crops. Gas generated from the filled-up waste will give an adverse impact to crops. Therefore, proper arrangement of gas outlet pipes should be installed in the area.

(2) Public Park and Sports Ground

These facilities are constructed only in open spaces; therefore, the management of facilities is easier than that of the land-use for agriculture. However, the management of a gas outlet facility has to be done carefully since many people will come together and use the facility for their rest and recreation.

(3) Residential Houses and Buildings

Ground subsidence will continue for 10 to 50 years depending on thickness of filled-up waste. The area should be checked for rate of subsidence, quality and quantity of gaseous products and internal temperature of waste layer periodically.

7.6 STREET SWEEPING

Under the Landscaping Department of Almaty City, a state owned entity JSC Road Maintenance Board (RMB) is responsible for cleaning of road surfaces, underpasses and public transport terminals.

The work is seasonal. In Winter it includes snow removal and salt and sand sprinkling. In Summer street cleaning and washing is done. The Road Maintenance Board contracts out these works to one joint stock company.

In order to implement these tasks 277 specialized vehicles (dump trucks, street sweepers, snow loaders, water tankers, etc.) are used and 600 staff are employed. The average age of vehicles is 10 years. Obviously procurement of new trucks is urgently required.

The RMB already has a plan approved by the city and based on the technical specifications for the works under which RMB operates to procure 910 additional units of trucks. Already two new European made trucks, a road salt and sand sprinkling truck and a sweeping machine have been purchased this year at a total cost of US$ 350,000.

Under these circumstances it is considered that the institutional framework of the road sweeping activity is established and the equipment procurement plan has been developed. At present this activity is completely separated from the general SWM activities of the city in terms of institutional set up, availability of development plan and budget and financing. The scale in terms of equipment and manpower available to RMB is more than that for other SWM activities combined. The street sweeping waste collected by RMB is transported to dump sites within the city.

The M/P therefore considers that the street sweeping activity should continue under its present system because transferring the responsibility of such a large operation will unnecessarily burden the proposed new Waste Authority at too early a stage.

However two issues need to be dealt with by RMB:

- The street sweeping waste should be disposed of in a sanitary manner.
- The planned procurement of such a large number of trucks may be decreased in case of providing more efficient secondary transfer of the collected street sweeping wastes.

Therefore the M/P considers that all the street sweeping waste should be transported to the transfer stations for transfer to Karasai Disposal Site. This will ensure sanitary disposal of the street sweeping waste and allow RMB to re-estimate their truck requirements based on more efficient transport. Accordingly the transfer operation and disposal of the street sweeping wastes have been incorporated in the M/P.