OPTIMIZATION OF SOLID WASTE COLLECTION SYSTEM OF ANTALYA

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We certify that we have read this thesis and that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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ABSTRACT

Environment which constitutes the most important agenda of the world must be protected with all values exist in the world. Nature is not a limitless source, its ability of renew itself is limited. Forming again of ecological balance is difficult and also impossible. For this reason; providing of environment protection-using balance is possible with participating of communities.

One of the factors which pollute natural environment is urban solid wastes. Solid waste problem increases rapidly as a result of rapid and crooked urbanization. For this reason, solid wastes must be collected, transported and stored as active, productive and systematic and must be made harmless.

Amount of solid waste increases according to population and consumption habits, besides, existing dumping areas have been dangerous and have connected with city.

Solid wastes collected are sent away empty fields as unsystematic in many municipalities. As a result; problems disappearing of productive agriculture fields and pollution of groundwater occur. Besides, this disposal method used affects health of people seriously.

Problem of solid waste must be examined in two sections as procedure of solid waste collection and transportation and removal of solid waste. In both two sections, economic values must take into consideration with environment and human health.

Waste collection separately system in it's source has to be considered before operation of collection, transportation and removal. Amount of solid waste which

will be brought to removed unit and also cost of collection, transportation and removal of solid wastes will reduce with applying this system.

The aim of this study; optimization of collection and transportation solid waste of Antalya. Operation of collection and transportation has been evaluated in two sections. First section is collection and transportation from regions straight to removed units and second section is collection and transportation from regions to transfer stations and transportation from transfer stations to removed units.

In this research; existing dumping area still used in Antalya and existing solid waste collection-transportation system have been examined, however, optimum collection-transportation system for Muratpaşa, Kepez, Konyaaltı sub-municipalities has been researched also taking into consideration the economy. Besides, assumptions for usage state of new dumping area planning to set in Varsak have been done.

ÖZET

Günümüz dünyasının en önemli gündemini oluşturan çevre, dünyada mevcut olan tüm değerleriyle korunması gereken bir bütündür. Doğa sınırsız bir kaynak değildir, kendini yenileme kabiliyeti sınırlıdır. Bozulan ekolojik dengenin yeniden oluşması zor hatta imkansızdır. Bu nedenle çevre koruma-kullanma dengesinin sağlanması ancak toplumların tüm kesimlerinin katılımıyla mümkündür.

Yaşadığımız doğal çevreyi kirleten unsurlardan birisi de kentsel katı atıklardır. Hızlı ve çarpık kentleşmenin doğal bir sonucu olarak, özellikle büyük kentlerde, katı atık sorunu hızla artmakta, bu nedenle de katı atıkların etkin, verimli ve düzenli bir şekilde toplanması, taşınması, depolanması ve değerlendirilip zararsız hale getirilmesi zorunludur.

Katı atık miktarında, nüfusa ve tüketim alışkanlıklarına bağlı artışların yanı sıra, çarpık kentleşme ve sürekli göç sonucunda mevcut çöp alanları kentle iç içe geçmiş, her türlü tehlikeye açık alanlar haline gelmiştir.

Bir çok belediye, toplanan katı atıkları düzensiz olarak, boş alanlara atmaktadırlar. Bunun sonucunda; verimli tarım arazilerinin yok olması, yer altı sularının kirlenmesi gibi problemler meydana gelmektedir. Ayrıca, bu bertaraf metodu insan sağlığını ciddi boyutlarda tehdit etmektedir.

Katı atık sorunu; katı atık toplama-taşıma ve katı atık bertarafı olmak üzere iki bölüm olarak ele alınmalıdır. İki bölümde de; çevre ve insan sağlığı yanı sıra ekonomik değerler de dikkate alınmalıdır.

Katı atık toplama-taşıma ve bertaraf işleminden önce, kaynağında ayrı toplama sistemi gözönünde bulundurulmalıdır. Bu sistemin uygulanması ile, bertaraf ünitesine gelecek olan katı atık miktarı ve toplama-taşıma ve bertaraf maliyeti azalacaktır.

Bu çalışmada amaç; Antalya katı atık toplama-taşıma optimizasyonudur. Toplama-taşıma işlemi, iki bölümde değerlendirilmiştir. Birinci bölümde; toplama işlemi ve direk bertaraf ünitesine taşıma işlemi; ikinci bölümde ise; toplama ve transfer istasyonlarına taşıma işlemi, transfer istasyonlarından bertaraf ünitelerine taşıma işlemi değerlendirilmiştir.

Bu çalışmada; Antalya'da halen kullanılmakta olan mevcut çöp sahası ve mevcut katı atık toplama-taşıma sistemi araştırılmış; bununla birlikte, Muratpaşa, Kepez ve Konyaaltı Belediyeleri için optimum katı atık toplama-taşıma sistemi, ekonomik değerler de göz önünde bulundurularak araştırılmıştır. Ayrıca, Varsak'ta kurulması planlanan yeni çöp döküm alanı için de varsayımlar yapılmıştır.

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CHAPTER ONE
INTRODUCTION

1. Antalya Solid Waste General Situation

Population of Antalya has begun to grow up speedly since 1985. One of the important environmental problems occured owing to this growing up is collection, transport and disposal of solid wastes.

Maincity municipalities are responsible for removal operation of solid wastes with respect to 3030 numbered municipality law and sub-municipalities are responsible for collection and transport of solid wastes, sweeping of streets etc.

2. Purpose of This Research

In this research; existing dumping area still used in Antalya and existing solid waste collection-transportation system have been examined, however, optimum collection- transportation system for Muratpaşa, Kepez, Konyaaltı sub-municipalities has been researched also taking into consideration the economy. Besides, assumptions for usage state of new dumping area planning to set in Varsak have been done.

3.The City of Antalya's Basic Data

3.1.Geographical Location and Topography

Antalya lies between latitudes 36°06 and 37°27 north and between longitudes 32°27 and 29°14 east and it has got totally 20.159 km^2 open place. It's place between the Aksu brook in the east, the Toros's south foot in the north, the Toros Beydağ's in the west and the Mediterrian sea in the south.

Antalya's general topography is peculiar to itself. The city center is on the out of order nearly 30 metres rocks with traverten step near the coast. The place has been slope 17-25 km along and it has got 120 km higher. The up stage has got the second step and it has got 300 m higher. Up to the second step, the ground is again orderly rise to the Toros mountains foot.

3.2.Climate

Climate of Antalya and its encircle is in the summer hot and dry, in the winter cold, widely set no freezing in this climate and this is typically Mediterrian climate. Avaragelly annual total raining is 1064.8 mm, avarage annual warmth is 18.6°C. The amount of annual evaporation is 1790.8 mm, avarage proportional moisture is 64 %. In the January and February the raining goes to the top.

The wind blows to the north and north-west during a year. Annual wind speed avarage is 3.1 m/s. Especially, in the January the storm goes to the top limits (38.7 m/s).

The weather usually hot and usually the weather is the hottest values in the July during a year. Normally in the February and January the weather is cold.

The weather usually dry between the June and September. But the mousture weather starts in the October and it continues to the end of the May.

At the table 3.1 there are data about the climate and meteorology. These data are the avarages of years. We are informed these informations to the Antalya meteorology station.

Table 3.1 Antalya Meteorology Values

(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu. 1997)

Months	1	2	3	4	5	6	7	8
Rainfall(mm)	255.2	171.3	90.1	43.7	29.8	9.4	2.4	2.4
Temperature °C	10.0	10.7	12.8	16.3	20.4	25.1	28.2	28.0
Evaporation(m)	72.7	70.3	101.1	128.0	159.8	227.1	279.5	248.5
Wind way	NW	NW	NW	NW	NW	NW	NW	N
Wind speed(m/s)	3.5	3.7	3.2	3.0	2.6	2.5	2.7	2.6
Avarage cleardays	5.8	5.2	6.3	6.5	7.2	15.0	21.8	23.3
Avarage cloudydays	10.3	8.4	7.4	5.4	3.2	0.6	---	0.0
Avarage rainydays	13.0	11.1	8.8	6.5	5.4	2.6	0.5	0.6
Avarage cloud cover	5.8	5.7	5.3	4.9	4.4	2.5	1.5	1.3
Humidity (%)	68	68	65	67	68	61	58	59

Table 3.1 Continued

Months	9	10	11	12	Annual
Rainfall (mm)	13.2	63.0	113.1	271.3	1064.8
Temperature °C	24.8	20.1	15.4	11.7	18.6
Evaporation (mm)	202.9	142.8	86.2	72.9	1790.8
Wind way	N	NW	NW	NW	NW
Wind speed (m/s)	2.4	2.7	2.9	3.3	2.9
Avarage cleardays	20.4	12.2	8.4	6.0	138.1
Avarage cloudydays	0.4	3.2	5.5	9.2	53.5
Avarage rainydays	1.7	5.9	7.4	12.7	76.2

Table 3.1 Continued

Months	9	10	11	12	Annual
Avarage cloud cover	1.7	3.6	4.6	5.6	3.9
Humidity (%)	58	62	66	68	64

3.3 Population

In 1990 the counting of the population is about 378,000 in Antalya. At the table 3.2 the population rising between the 1950 to 1990 are shown. Annual speed of developing ratio is 6.23% between the 1970 to 1980, between 1980 to 1990 is 7.10%. At 1997 the population is guessed 600,000.

Causes of the developing are;

-Migration from rural areas for the purpose of seeking work

-Because of the city's natural beauty and climate, higher status people come to the city

Factors which will affect population increase in Antalya in the future are as follows;

-The ratio of urban population. In the long term an urban-rural population balance will be provided.

-We guess that after 1990 migration changes from big cities to the little cities.

-It is expected that birth rates in the future will be lower, especially in urban areas.

-Developing of Antalya will be limited because of the mountains.

-The industrial developing will be limited. Besides, about 100,000 people will live at the new living area near the Organize Industry Region.

-The city's naturel beauty and historical features is effective on the migration. However, these values must be protected.

Table 3.2 Results of Counting Population and Speed of Developing

(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu.1997)

YEAR	POPULATION	ANNUAL SPEED OF DEVELOPING
1950	31 099	5.16
1955	39 996	7.12
1960	56 404	7.02
1965	79 195	5.62
1970	104 088	6.72
1975	144 088	5.75
1980	190 542	6.50
1985	261 114	7.69
1990	378 208	

3.4 Economical Structure

The agriculture is the most important factor in Antalya and it's percantage is 70 % in addition to this, the nature, history and the tourism values are more important in the economical structure of the city. The first developing of tourism started at the end of 1950's in Antalya. The tourism is encouraged by the government (1969) after that the tourism rising at the mediterrian and Ege coast.

The rates of sectors dispersions are different in urban and rural. At the urban areas the tourism has the most important effect on the service sector. So in Antalya service sector is spreading everywhere, moreover, the service sector is on the top and it's percentage is 52 %. The agriculture is the second (24 %) the industrial sector is the third one (24 %).

The tourism and because of this, the service sectors have got importance in Antalya's economy, besides, the agriculture which is doing in the rural areas has got importance both Antalya's economy and country's economy. Because of this the agriculture is at the first row in the rural areas (87 %), at the second row the service sector (8 %) and the industrial sector is at the third row (5 %) in the rural areas.

Basicly, the industrial activities process the agriculture production (wheat, sesame, cotton, olive, vegetable etc.) and forest production in Antalya. The industry has not developed except "Ferrokrom" fabric. In addition to this, because of the tourism and the rising of the population, in 1980's the building equipment industry has developed.

Nearly, all fabrics present on the two way which are at the north (Burdur-Ankara) highway and at the east (airport-Alanya) highway. The little industrial foundations present on the city, highways and near the suburbs. These are agriculture machine, plastic goods, perfume and marble.

There are 10700 companies present in Antalya with respect to numbers of 1995. The kinds and numbers of companies are at the table 3.3.

Table 3.3 Kinds and Numbers of Companies in Antalya

(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu. 1997)

KINDS OF FIRMS	NUMBERS
Collective companies	132
Limited partnership companies	7
Joint-Stock companies	1848
Limited companies	6646
Cooperative companies	2067
Total	10700

3.5 Tourism

The tourism activities are the first row according to both commercial and industrial activities in Antalya. Every season the tourism is active because of Antalya's naturel, historical and country's the most intensive tourism values. The biggest structural development of tourism has begun at 1980's. The main attractiveness points are beachs, historical and naturel environments and city surrounding (Beydağları, Toros mountains, Düden and Kurşunlu waterfalls and national parks). Lots of service sectors have spreaded because of faster development at tourism activities.

There are different standart hotels and pensions present in Antalya.

Table 3.4 Bed Capacities and Numbers of Hotels

(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu. 1997)

FOUNDATION	NUMBERS OF HOTELS	BED CAPACİTY
5 stars hotel	34	20846
4 stars hotel	38	15712
3 stars hotel	90	18578
2 stars hotel	78	8207
1 stars hotel	21	1071
First class holiday village	39	26523
Second class holiday village	1	400
Private hotel with documment	10	677
Apart hotel	15	1507
Pension	91	2679
Motel	2	298
TOTAL	419	96498

3.6 Arrival

The arrival is provided by highway, airway and seaway. Antalya has no connection to the railways. The most important highway is Burdur-Antalya highway.

Antalya has got one airport and it is on the Alanya highway, it is 18 km away from Antalya, moreover, lots of tourists come to the city by airplane.

Besides, seaway arrival is also another important potancial. At the city centre there is one yacth harbor for tourism and in Konyaaltı there is another harbor for loading.

4.Antalya Solid Waste Management Situation

As every Maincity models in Antalya sub-municipalities carry the wastes and Maincity municipality removes the wastes.

Some sub-municipalities have turn the carriying and collecting the wastes to private companies. The wastes of sub-municipalities and vicinity municipalities are collected and these wastes are removed at the Kepezüstü damping area. For separating the recycling wastes(paper, plastic etc.), a contract have been done between Maincity municipality and building contractor.

Antalya has no transfer station. All wastes are gone straight to damping area.

4.1 Collecting the Wastes

4.1.1 House Wastes

Muratpaşa Municipality

Wastes are collected from 54 neigbourhoods in Muratpaşa Municipality. Shifts of vehicles are 05.00-13.00, 13.00-21.00, 21.00-05.00. All vehicles make average 2

journies in a day. Existing solid waste collecting plan presents below.

Everyday:

Bahçelievler and Varlık neigbourhoods

Deniz and Altındağ neigbourhoods

Memurevleri and Güvenlik neigbourhoods

Meltem neigbourhoods

Kızılsaray and Üçgen neigbourhoods

Kışla, Elmalı, Tahılpazarı, Balbey, Haşimişcan neigbourhoods

Zerdalilik, Sinan and Gençlik neigbourhoods

Kaleiçi(Barbaros, Kılıçaslan, Tuzcular, Selçuk) neigbourhood

Çağlayan and Güzeloba neigbourhoods

Şirinyalı and Fener neigbourhoods

Monday, Wednesday, Friday:

Yeşilbahçe and Demircikara neigbourhoods

Çaybaşı, Meydankavağı, Yüksekalan neigbourhoods

Yenigün, Yeşildere, Gebizli, Kızılarık neigbourhoods

Etiler, Konuksever, Dutlubahçe neigbourhoods

Soğuksu, Bayındır, Yıldız neigbourhoods

Tuesday, Thursday, Saturday:

Ermenek neigbourhood

Güzeloluk, Kırcami, Zümrütova neigbourhoods

Tarım, Yeşilova, Yenigöl neigbourhoods

Kızıltoprak, Doğuyaka, Mehmetçik, Topçular neigbourhoods

Muratpaşa, Sedir, Sanayi neigbourhoods

Kepez Municipality

Wastes are collected from 50 neigbourhoods in Kepez Municipality. Shifts of vehicles are 05.00-14.00, 14.00-21.00. All vehicles make average 2 journies in a day. Existing solid waste collecting plan presents below.

Everyday:

Emek and Karşıyaka neigbourhoods

Yeni and Yeniemek neigbourhoods

Yükseliş, Ulus, Özgürlük neigbourhoods

Göksu, Sinan, Orta, Menderes, Düden, Beşkonaklar, Baraj neigbourhoods

Gazi, Hüsnü Karakaş, Habipler neigbourhoods

Yavuz Selim and Kazım Karabekir neigbourhoods

Gülveren, Duraliler, Yeşilyurt, Şafak neigbourhoods

Zafer and Atatürk neigbourhoods

Yeşiltepe and Kanal neigbourhoods

Güneş, M.Akif Ersoy, Gündoğdu neigbourhoods

Erenköy, Çamlıbel, Fatih neigbourhoods

Ünsal, Santral, Kepez neigbourhoods

Akdeniz Organize Industry Region

Monday, Wednesday, Friday:

Çankaya, Esentepe, Göçerler neigbourhoods

Barış and Kütükçü neigbourhoods

Tuesday, Thursday, Saturday:

Sütçüler, Kuzeyyaka, Fevzi Çakmak neigbourhoods

Konvaaltı Municipality

Wastes are collected from 16 neigbourhoods in Konyaaltı Municipality. Shifts of vehicles are 07.00-16.00. All vehicles make average 2 journies in a day. Existing solid waste collecting plan presents below.

Everyday:

Liman, Gürsu, Altınkum, Kuşkavağı, Arapsuyu, Pınarbaşı neigbourhoods

Monday, Wednesday, Friday:

Sarısu, Hurma, Zümrüt, Molla Yusuf, Siteler neigbourhoods

Tuesday, Thursday, Saturday:

Uluç, Uncalı, Öğretmenevi, Akkuyu, Toros neigbourhoods

4.1.2 Industrial Wastes

Muratpaşa Municipality

In Muratpaşa Municipality there are some shops, such as spare item outlets, plastic productors, marble quarry and little shops, work in little industrial region. The wastes of this region are collected by Muratpaşa Municipality.

Kepez Municipality

Akdeniz Organize Industry Region is on the Burdur-Antalya highway. It's wastes are collected by Kepez Municipality. The wastes are collected with 2 m^3 containers in this region. These wastes are removed at Kepezüstü damping area.

Konyaaltı Municipality

Harbour managements and free zone wastes are collected by Konyaaltı Municipality. Wastes of textile companies in the free zone are carried to the Kepezüstü dumping area.

4.1.3 Medical Wastes

Muratpaşa Municipality

Muratpaşa Municipality has one vehicle for collecting the medical wastes. This vehicle collects the wastes of hospitals and clinics. A part of these medical wastes are carried to Kepezüstü dumping area and these wastes are poured out different hollows and closed with lime. Another part of medical wastes are carried to incinerator in the Akdeniz University.

Kepez Municipality

Kepez Municipality has not vehicle for collecting the medical wastes separately. Medical and house wastes are collected together and carried to the dumping area.

Konyaaltı Municipality

There are 3 clinics in Konyaaltı Municipality. Wastes of these clinics are removed at dumping area.

4.1.4 Cesspool and Treatment Sludge

There is no sewer system in Antalya. The cesspool wastes are carried to the dumping area.

4.1.5 Rubble and Building Wastes

All the rubble and building wastes are removed to the Kepezüstü dumping area in Antalya.

4.2 Tecnique Substructure

4.2.1 Collecting Equipments

Muratpaşa Municipality

750 lt containers are used in the municipality. At touristic areas containers are not used such as Kaleiçi.

Kepez Municipality

Kepez Municipality's area is between Duraliler neigbourhood to Cihadiye (22 km) and Kırkgöz to Çallı-Vatan junction (27 km).750 lt and 220 lt containers are used in the municipality.Kepez Municipality collects the wastes of Akdeniz Organize Industry Region

Konyaaltı Municipality

There is no industrial living area in this municipality, however, at free zone textile wastes are collected. In this region a private company collects the recycling wastes.

4.2.2 Waste Collection Vehicle

Muratpaşa Municipality

Muratpaşa Municipality has more vehicles than other municipalities. Vehicles' garage is in Kepez-Düden junction. Besides, in this place reparation services are made.Numbers and capacities of vehicles presents below.

Table 4.1 Muratpaşa Municipality Compressing Vehicles

(Muratpaşa Belediyesi Temizlik İşleri Müdürlüğü)

Number	Capacity
2	5 m^3
13	10 m^3
13	13 m^3
2	15 m^3

Kepez Municipality

Vehicles of Kepez Municipality use same garage. Number and capacity of vehicles presents below.

Table 4.2 Kepez Municipality Compressing Vehicles

(Kepez Belediyesi Temizlik İşleri Müdürlüğü)

Number	Capacity
4	6 m^3
8	10 m^3
4	13 m^3

Konyaaltı Municipality

Vehicles' garage is in Uluç neigbourhood. Number and capacity of vehicles presents below.

Table 4.3 Konyaaltı Municipality Compressing Vehicles

(Konyaaltı Belediyesi Temizlik İşleri Müdürlüğü)

Number	Capacity
1	10 m^3
1	13 m^3
1	15 m^3

4.3 Waste Disposal

4.3.1 Kepezüstü Solid Waste Dumping Area

In Antalya, the unsystematic damping area is between Kepezüstü Yeşilbayır and Kızıllı villages, that is 750,000 m^2 totally and it is 13 km away from city centre. Totally 13 municipalities (Muratpaşa, Kepez, Konyaaltı, Çalkaya, Aksu, Varsak, Belek, Döşemealtı, Abdurrahmanlar and in Kemer Göynük, Çamyuva, Beldibi, Kemer) have poured out their garbages since 1984. But, wastes of Kemer region have been removed dumping area which has been set in Kemer since 1998.

The vehicles carry the wastes to this area and the assignet of this area show the vehicles that there they pour out the wastes. The wastes in this area are spreaded by bulldozer. However, the wastes are not closed with anything. Also there is no protection system for the damping area such as surface water, gas drainage and etc.

The dumping area forms by traverten rocks. Because of this the garbages pollute the water sources of Antalya. Besides, sewage trucks pour out the waste water to this area. A part of medical wastes are also poured out to this area.

At this area a closed compost establishment is present. This establishment was not open because of some problems so now it is not used. In part of waste operation unit completed, unloading ramps, recycling unit, last sieving and control unit are present. Ramp planned as unloading ramp is used for cleaning the trucks.

Table 4.4 Kepezüstü Dumping Area Personnel Structure

PERSONNEL	NUMBER
Engineer	1
Pour Out Assigned	2
Motopomp Assigned	1
Worker	2
Tractor Driver	2
TOTAL	8

4.3.2 Studies of Waste Collection Separately

In Antalya, the recycling wastes (such as plastics, metal, paper etc.) are separated as illegal by some people before the municipalities' vehicles collect them. In the dumping area recycling wastes are separated by some companies. The municipality let the companies as annual for separating these wastes.

Besides, in free zone the recycling wastes are separated by the private companies. In Antalya lots of hotels, motels and bars collect their recycling wastes.

5. Amount of Waste

For determining the amount of waste, municipalities are used as waste source. Wastes in Antalya have been examined as ındustrial, medical and house wastes.

Wastes of Akdeniz Organize Industry Region have been evaluated as waste of ındustrial waste. Wastes of Little Industry Site have not been able to evaluated separately.

Amount of Waste Weighted in Antalya Kepezüstü Dumping Area (tone)

SOURCE OF WASTE	31.03.1997	01.04.1997	02.04.1997	03.04.1997
Muratpaşa	190.50	211.69	196.32	240.66
Kepez	3.25	102.68	167.04	144.42
Konyaaltı	25.62	18.28	14.35	10.59
Beldibi	21.23	21.56	17.82	6.50
Göynük	5.73	9.81	6.95	9.29
Belek	14.82	7.58	18.85	15.33
Akdeniz Org. Ind. Region	---	6.00	14.38	11.69
Varsak	---	---	3.42	2.77
Döşemealtı	---	---	6.33	---
Hal	5.65	5.41	10.24	22.74
Otogar	1.40	1.20	1.40	1.00
Çamyuva	9.39	---	13.13	6.66
Çalkaya	---	4.37	2.29	3.56
Aksu	2.37	2.37	2.60	2.00
Abdurrahmanlar	---	---	---	---
Kemer	16.62	21.85	27.28	19.66
Wastes of airport	---	---	---	5.45
Wastes of hospital	3.57	4.87	6.04	3.54
Others	---	---	1.70	0.71
TOTAL	296.60	412.80	510.10	506.60

Amount of Waste Weighted in Antalya Kepezüstü Dumping Area (tone)

(Continued)

SOURCE OF WASTE	04.04.1997	05.04.1997	06.04.1997	Average (t/day)
Muratpaşa	211.31	204.32	237.48	213.18
Kepez	81.47	78.86	89.20	95.27
Konyaaltı	27.86	15.72	---	16.06
Beldibi	15.97	5.21	4.02	13.19
Göynük	11.95	9.12	15.15	9.71
Belek	20.21	24.56	15.49	16.69
Akdeniz Org. Ind. Region	12.28	5.60	4.39	7.76
Varsak	1.04	---	---	1.03
Döşemealtı	7.50	---	---	1.98
Hal	6.98	10.66	---	8.81
Otogar	1.11	1.15	1.10	1.19
Çamyuva	10.98	12.14	10.88	9.03
Çalkaya	---	---	3.29	1.93
Aksu	---	---	---	1.33
Abdurrahmanlar	---	3.34	---	0.48
Kemer	18.62	25.79	14.13	20.56
Wastes of airport	5.54	---	---	1.57
Wastes of hospital	3.65	4.37	2.37	4.06
Others	---	---	---	0.34
TOTAL	436.50	400.80	397.50	422.99

5.1 Winter Period Waste Amount

Calculating of waste amount have been done on the dumping area way in Kepez flour fabric. The periods of the evaluation are between 31.03.1997-07.04.1997.

5.1.1 House and House-Commercial Wastes

Amount of the wastes coming to the Kepezüstü dumping area is averagely 343 tone/day, these wastes come from Muratpaşa, Kepez, Konyaaltı and other municipalities. The population of Antalya is 600,000 people for 1997 so in winter season just one person waste amount is 0.57 kg/person/day.

5.1.2 Industrial Wastes

Wastes of Akdeniz Organize Industry Region have been evaluated as industrial waste. Total amount of industrial wastes has been determined averagely 8 tone/day.

5.1.3 Medical Wastes

A part of medical wastes is burnt at incinerator present in Akdeniz University. Another part of these wastes is poured out in Kepezüstü dumping area.

There is no private vehicle for collecting medical wastes at Büyükşehir and other municipalities. Medical wastes are collected by compressing vehicles. Amount of the medical wastes is averagely 4 tone/day.

5.1.4 Winter Period Total Waste Amount

The researchs show that the winter period total waste amount is averagely 355 tone/day in 1997. These amounts are shown at table 5.1.

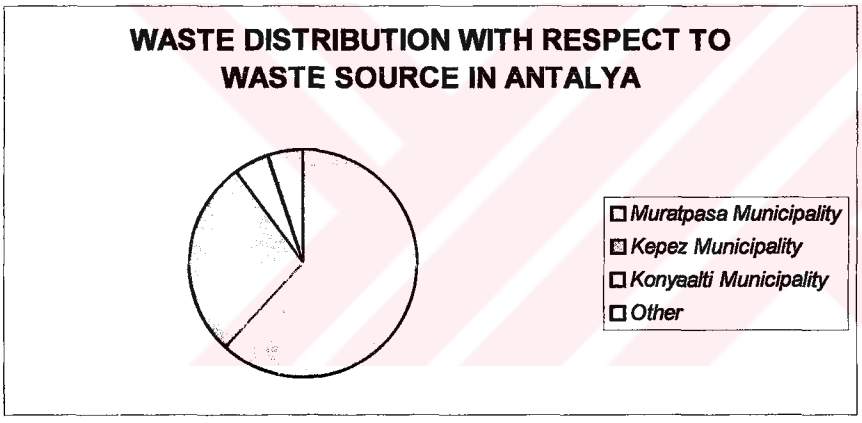
Table 5.1 Antalya Waste Amount in 1997

(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu. 1997)

TYPE OF WASTE	WASTE AMOUNT (tone/day)
House	343
Industrial	8
Medical	4
TOTAL	355

Amount of waste distribution is shown at figure 5.1. We see that the Muratpaşa Municipality has the highest percentage (62 %).

Figure 5.1 Waste Distribution With Respect to Waste Source



Muratpasa Municipality	62 %
Kepez Municipalty	28 %
Konyaalti Municipality	5 %
Other	5 %

6. Sieve Analysis

The studies of sieve analysis were done at Kepezüstü dumping area. When this search is done, Antalya city was separated as lower, middle, highest income level, commercial area and industrial area.

In the sieve analysis the wastes were separated with sieves and hands. In the sieve, thin wastes were separated such as ash, tea, street wastes, grass (<8 mm). Organic wastes were separated as 8-40 mm, mixed wastes and >40 mm wastes.

Recycling wastes such as paper, glass, metal, plastic etc. were separated with hands. Moreover, in other class, textile, wood, rock, porcelain and others were separated with hands.

At the end of the study, for lower income level thin waste ratio average is 12 %, organic waste ratio average is 56 %, recycling waste ratio average is 26 % and other wastes ratio average is 6 %.For middle income level, thin waste ratio average is 5 %, organic waste ratio average is 60 %, recycling waste ratio average is 25 % and other wastes ratio average is 10 %. For highest income level, thin waste ratio average is 3 %, organic waste ratio average is 28 %, recycling waste ratio average is 53 % and other wastes ratio average is 16 %. For the commercial region, thin waste ratio average is 11 %, organic waste ratio average is 32 %, recycling waste ratio average is 41 % and other wastes ratio average is 16 %. For the industry region, thin waste ratio average is 11 %, organic waste ratio average is 32 %, recycling waste ratio average is 41 % and other wastes ratio average is 16 %.

These results show that the organic wastes are the highest at lower and middle income level. In contrast, at industrial and commercial regions the organic wastes are lower. Recycling wastes are low at the lower and middle income level district. In contrast, at at industrial and commercial regions and highest income level district it is higher than others. For Antalya city, determined average values are shown at table 6.1.

Table 6.1 Antalya City Waste Combination

(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu. 1997)

PARAMETER	WEIGHT (%)
<8 mm thin waste, ash, sawdust etc.	**8.0**
8-40 mm mixed organic waste	16.8
>40 mm thick organic waste	21.5
Interval Total-Organic Waste	**38.3**
Paper	17.6
Pasteboard	2.5
Glass-Bottle	5.6
Tinplate-Metal	4.6
Plastic	9.5
Interval Total-Recycling Waste	**39.8**
Wood	1.4
Textile	5.5
Stone, ceramic, porcelain	1.2
Other(full food boxes, battery etc.)	5.8
Interval Total-Other	**13.9**
TOTAL	**100.0**

Figure 6.1 Solid Waste Composition of Antalya

(Antalya Buyuksehir Belediyesi. Antalya Saha Arastirma Raporu. 1997)

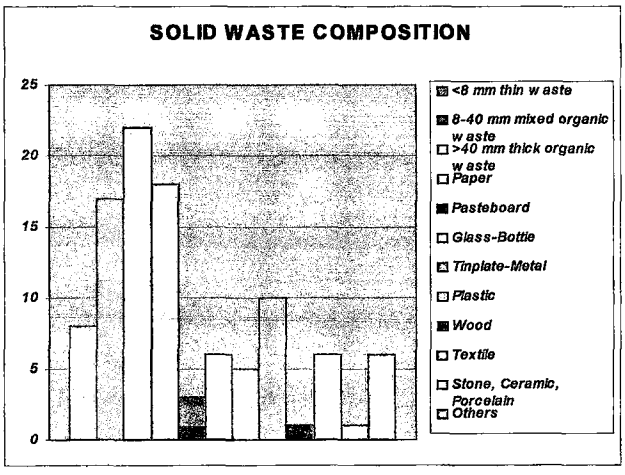


Figure 6.2 Lower Income Level, Ratio of Recycling Wastes (%)
(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu. 1997)

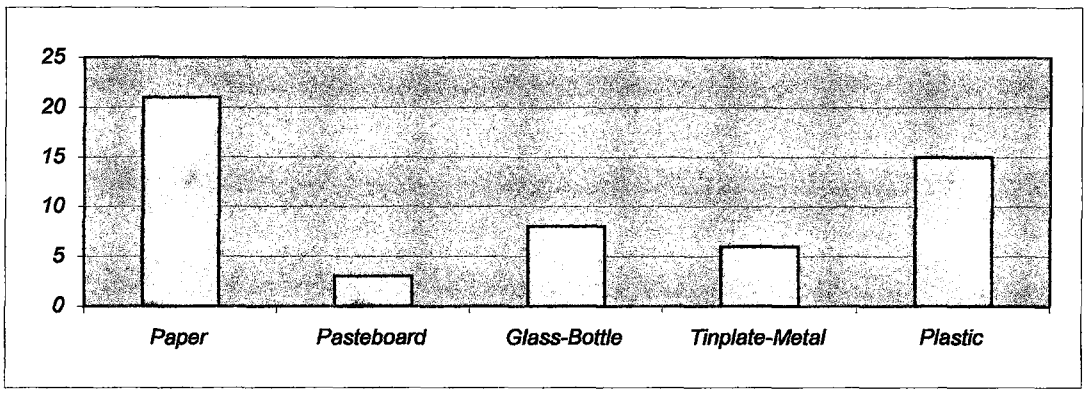


Figure 6.3 Middle Income Level, Ratio of Recycling Wastes (%)
(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu .1997)

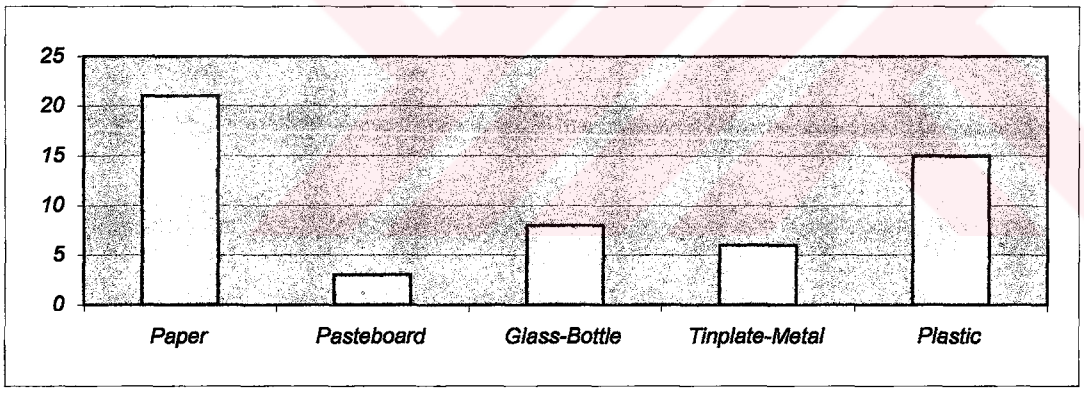


Figure 6.4 High Income Level, Ratio of Recycling Wastes (%)
(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu .1997)

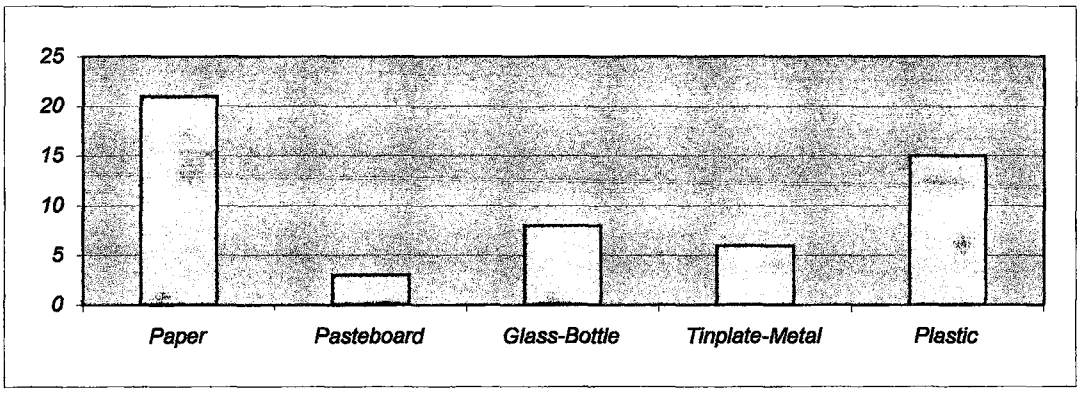


Figure 6.5 Industrial, Ratio of Recycling Wastes (%)
(Antalya Buyuksehir Belediyesi. Antalya Saha Arastirma Raporu.1997)

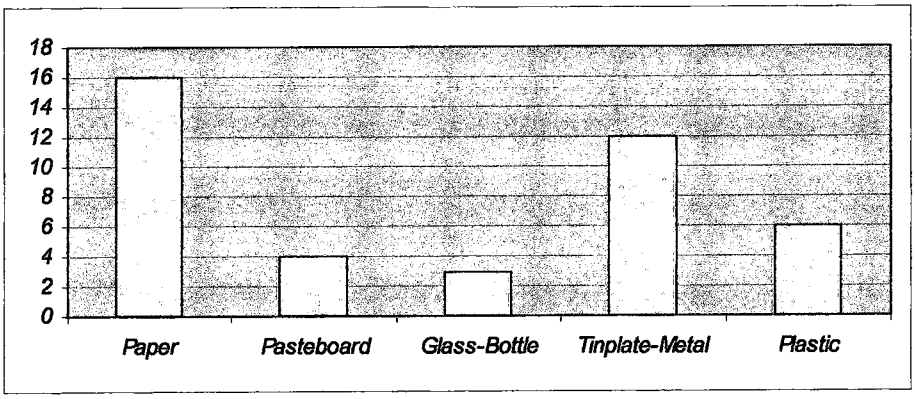
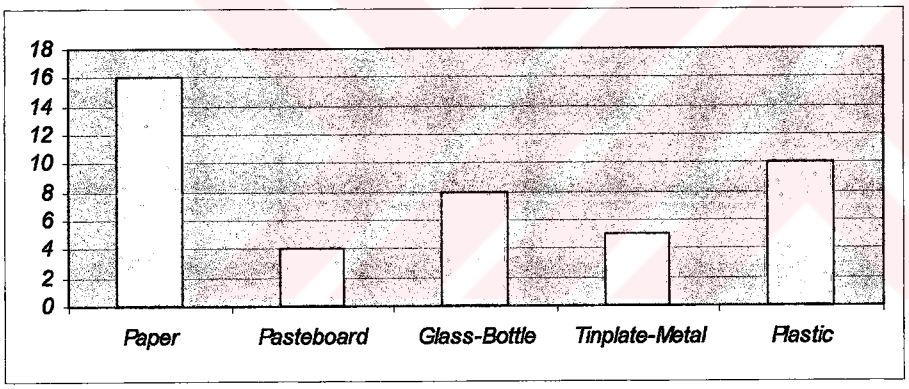


Figure 6.6 Commercial, Ratio of Recycling Wastes (%)
(Antalya Buyuksehir Belediyesi. Antalya Saha Arastirma Raporu.1997)



At the figure 6.2-6.6, for lower, middle, higher income level, industrial and commercial regions, recycling waste ratios are shown. Sieve analysis results are shown at appendix 2.

As a result of figure 6.2-6.6; Paper ratio is the highest at high income level, is high at industry and commercial regions, is low at middle and lower income level. Glass-Bottle ratio is high at high income level and industrial, commercial regions, is low at middle and lower income level. Tinplate-Metal ratio is high at industrial region and is low at other all regions. Plastic ratio is the highest at high income level,

is high at middle income level and commercial region, is low at lower income level and industrial region.

7. Chemical Analysis

Chemical analysis was done by Yıldız Teknik University in 1997. Amount of organic matter, water content and calorific value were evaluated. This analysis was done for <8 mm, 8-40 mm and >40 mm groups. After the recycling waste separated some examples have been taken from garbage faction and the analysis has started. These garbage examples were firstly dried and then the water content and organic matter were calculated. Calorific value was analized at last step. The calorific value determined at last show the drying matters without recycling matters.

7.1 Studies of Winter Period

In winter period studies, for lower, middle, high income level, commercial and industrial region, water content, organic matter and calorific values providing at the laboratory analysis are shown at table 7.1.

Table 7.1 Winter Period Average Analysis Results

(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu. 1997)

Parameter	Water Content (%)	Organic Matter (%)	Calorific Value (kj/kg)
Lower Income Level	71	67	4819
Middle Income Level	71	78	2855
Higher Income Level	72	86	3650
Commercial Region	67	77	3258

Table 7.1 Winter Period Average Analysis Results

(Antalya Buyuksehir Belediyesi.Antalya Saha Arastirma Raporu. 1997)

Parameter	Water Content (%)	Organic Matter (%)	Calorific Value (kj/kg)
Industry Region	30	64	11035
Average	**62**	**74**	**5123**

At figure 7.1 water content, at figure 7.2 organic matter and at figure 7.3 calorific values are shown for different regions.

Figure 7.1 Water Content (%)

(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu. 1997)

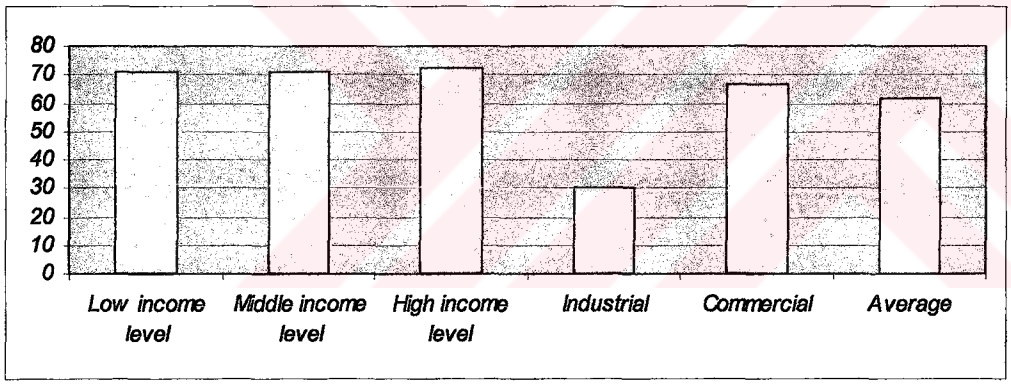


Figure 7.2 Organic Matter (%)

(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu. 1997)

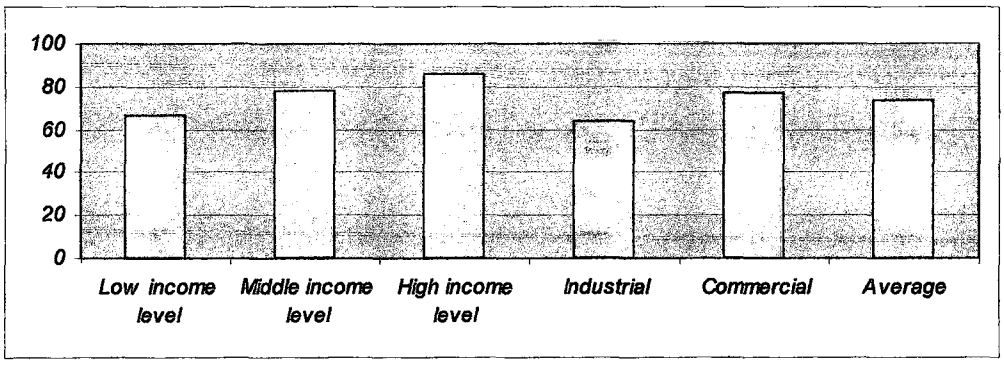
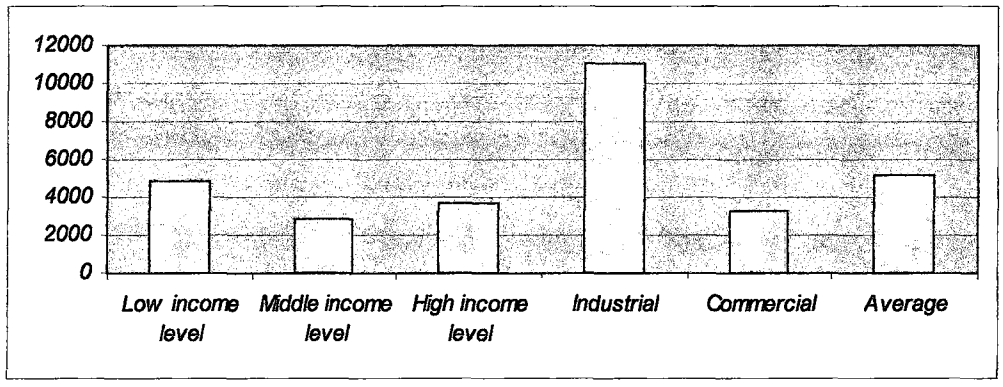


Figure 7.3 Calorific Value (kj/kg)

(Antalya Büyükşehir Belediyesi. Antalya Saha Araştırma Raporu. 1997)



CHAPTER TWO
LITERATURE SURVEY

1. Solid Waste Management

In the municipal areas of the region, the responsibility for solid waste management rests primarily with municipalities. Each municipality has a cleaning activities department within its organizational structure. Municipal solid waste management administration, refuse collection, street sweeping, transportation and disposal of the collected garbage are organized by these departments. The people involve in all stages municipal solid waste management are government employees. In small settlement units like villages where municipality hasn't been established, no organizational structure is present for collection, transportation and disposal of solid wastes. Therefore, the people live in these kind of small places are face to solve their own solid waste problems. The solid waste management is funded directly by the municipal board in the municipal areas. In recent years, residents in the municipal areas are charged approximately 4 to 5 US $ per year to contribute to the service. Among the various services provided by the municipality this activity has allowed priority and inadequate financial provision by means of resulting poor services (Ergun et all, 1998).

Generation of solid waste is a natural attribute of all human activities including agriculture in all communities. Management of solid wastes arising from municipal, industrial and agricultural sources cause important environmental and sanitary problems. In some countries problems are more accentuated and in other such as

developed countries less. However problems related to the solid waste collection, transport and disposal always persist (Qdais et all, 1997, Korfmacher, 1997).

The composition of municipal solid wastes depends on many economic, social and cultural factors. The standard of living of the community, food culture, using of coal, wood or fossil fuels for heating and cooking urbanization and education are some of these factors which affect the composition of municipal solid wastes (Curi, 1988, Qdais, 1997).

Municipal waste management in major cities developed highly efficient household waste collection systems with a combination of containers, vehicles, personnel and logistics that are individually suited to the local conditions such as population density, residential structure or traffic. Future developments will likely provide dedicated parallel collection systems for a wide range of separate waste streams according to their origin, physical properties, recyclability and treatment requirements. This will lead to an increasing challenge for container siting and collection logistics. In future many cities will foster separate collection systems for compostable organic wastes and packagings. As private contractors or collectors, hitherto only active in resource recovery and waste treatment, are venturing into the traditionally public services of household waste collection, municipal authorities are getting into closer contact with market economy. There is a trend towards dynamic waste fee assessment schemes which shall serve to facilitate an efficient collection and create incentives for waste minimization or resource recovery. It will be important to assess to what extent the low waste treatment fees reflect the scarcity of environmental resources and landfill space and if they will suffice to finance long-term preventive measures (Scharff & Vogel, 1993).

Solid waste management planning models and methods are used to analyse performance and costs of alternative waste management strategies. They may address one or more of the following aspects of solid waste management: waste generation, separation of waste components at their source, storage and collection of wastes,

transport of wastes from collection areas to intermediate processing systems, transport of waste to landfills, waste disposal at landfills and multiple simultaneous recycling, composting, and resource recovering (Wilson 1981, Rushbrook & Pugh 1987, Energy Systems Research Group 1989).

There are a number of methods which can solve the problem. A comprehensive review of mathematical models of solid waste management can be found in Liebman (1975). Yurteri & Siber (1985) presented a linear programming model to decide the location of transfer stations. Recently, Kırca & Erkip (1988) and Gottinger (1988) have proposed mathematical programming models to determine the number of transfer stations needed and their locations. These models could be used to determine the optimal allocation of trucks to the disposal sites. In such models, travelling cost could be minimized subject to the capacity constraints of the disposal sites. However, such models do not provide a satisfactory solution as they do not take into consideration the waiting times at the disposal sites, and assume the feasibility of the full utilization up to the capacity of the disposal sites. In other words, the uniform arrival of trucks during shift hours is assumed (Bhat, 1995).

2.Collection & Transportation

The solid waste management system incorporates numerous unit processes, including collection, recycling, composting, burial, and incineration. A number of design options for each unit process is considered. This includes collection options such as mixed waste collection, presorted and commingled recyclables collections, recyclables drop-off, co-collection, wet/dry collection and dedicated yardwaste collection, that cover the residental, multi-family and commercial sectors; several options for recovery of recyclable material; mixed waste and yardwaste composting; dry landfills; mono-landfill for ash disposal; anaerobic digestion; combustion and refuse derived fuel facilities; and truck and rail transfer stations. All feasible waste flow through these process options are captured and represented by a set of waste flow equations. These equations are then embedded into a mathematical optimization

model. This model is then solved to find management strategies that are efficient with respect to two main objectives: economics and environmental. The economic objective is estimated as the sum of the net cost incurred at all unit processes. The environmental objective is evaluated based on a life cycle inventory (LCI) analysis of all the waste items processed at each unit process (UNEP International Environmental Technology Centre. Collection and Transfer).

The most important level of a successful solid waste management is collection system which can be carried out effectively. Collection has the biggest portion in the cost of management and also carrying out the other management levels orderly depend on the organization of collection system. For these reasons; importance of collection system increases. For organizing the collection system, different methods of solid waste collection and also for reducing the cost of collection, different models have been improved and optimizations of collection have been done(Europan Recovery & Recycling Association, 1991).

Volume of vehicles which is used for collecting solid wastes is reduced because of traffic and also productivity of the system. At the same time; evaluation and disposal places of solid wastes are far away from city centers. For this reason; if solid wastes are transported to vehicles with bigger capacities and then transported to disposal unit; cost will be more economic. Operation of transport in the solid waste management does not threaten the environmental health and is more economic. For these reasons; this method has been approved. For a region; necessity of transfer station and determining the place of transfer station depend on the route of collection, distance of evaluation and disposal units and economic analysis(Europan Recovery & Recycling Association, 1991).

One of the important factors which affects the production of collection-transportation, is collection method. In the research which has done in Germany, in the event of collection of wastes in the garbage bags; in comparison with containers

with small volume; in the same time and with same number of worker; double collection production has been provided. Reason of this; anytime has been spent for unloading of garbages which collected in the bags. Time which is spent for unloading the containers with high volume, reduces naturally. Because; in this situtation, unloading of containers with high volume is in question in landfill. In solid waste technology; 60-70 % of total cost is cost of collection-transportation. For this reason; effective optimization can be done with taking into consideration these effects.

The most important factor in the total cost of solid waste disposal is the cost of collection-transportation. This cost changes with respect to disposal method. Rates of collection-transportation are shown below.

	Percentage of total cost
In the cities which have landfill	94 %
In the cities which have compost	87 %
In the cities which have incineration	62 %

Optimization of collection-transportation and choosing the place of establishment are effective on the total cost. 75 % of collection-transportation cost is the collection cost (Gök, 1989).

Solid waste collection is one of the most costly services provided by a city to its residents. Between 75-80 % of the solid waste management budget is spent on collection and transfer costs. Therefore, productivity of collection and transfer operations is of significant concern to the administrators. Collection and disposal operations begin when customers' waste is placed for pick-up and ends when the waste is discarded at a disposal or processing site. Rising waste disposal costs and high visibility of waste collection operations are forcing residents to demand efficient collection and disposal of solid waste. In every city, many trucks are used to collect and transport waste from different parts of cities to landfills, incinerations and transfer stations. The waste emptied at transfer stations is transported for final disposal using large vehicles such as barges and large capacity trucks. As a result of

increased regulations and public pressures, waste collection and disposal systems are in continuous change in almost all countries. In those places where land becomes limited and regulations increase, landfills are being closed. With a view to reducing the dependence on landfills for disposal, some cities are trying various alternatives including processing, exporting and prevention (Bhat, 1995).

The plethora of operational problems require city administrators to make day-to-day decisions relating to the allocation of trucks to disposal sites. If travel distances were only criterion to decide the allocation of trucks to disposal sites, then all that need to be done is to allocate each truck to the nearest feasible disposal site. One option to utilize vehicles most efficiently is to build a mathematical model to help city administrators to make effective long and short-term decisions relating to their municipal waste disposal system (Bhat, 1995).

In some cities, it is likely that allocating trucks to the nearest disposal sites may minimize the cost of travel, waiting and relay times. Such an approach, in other cities, can also lead to excessive waiting times at some disposal sites. The purpose of the simulation-optimization model presented in this paper is to present a methodology to develop the allocations of trucks belonging to different zones to disposal sites so as to minimize the total cost of travel, waiting and relay times. The simulation model estimates the waiting time of trucks arriving during each time slot of a shift at each disposal site for a given allocation. To find the optimal allocation of trucks operating at each zone to disposal sites, a heuristic approach is suggested. The costs which need minimizing include costs of travel and costs of waiting at disposal sites. Typically, average waiting time at a disposal site grows at increasing rates as more trucks are allocated to a site (Grassman, 1983). Therefore, marginal allocation methods (Rolfe, 1971) could be used to minimize the sum total of waiting costs at different sites. The marginal analysis method used for allocating trucks to disposal sites is as follows: (1) Start with the minimum distance allocation. Run the model and determine the expected waiting time at each disposal site for all time slots.

(2) For each zone, compute the new expected waiting time and travel time if that zone is allocated to the next nearest disposal site. There is no need to run the model again. Assume that the waiting time for each of the time slots for all disposal sites will continue to be the same even after a new allocation. Do this for all zones. If there is an improvement, change allocation of zone by new disposal site, otherwise continue old allocation. Do this for all zones. (3) Run the simulation model again and repeat whole algorithm until there is no change in allocation or until allocation "cycles", i.e. a similar alternative is found. (4) If an allocation cycles then choose the allocation with the lower cost (Bhat, 1995).

Even though large amounts of data are available in computer databaes, the amount of usable data is scarce in most sanitation departments. Each department involved in waste disposal system gathers its data according to its current management requirements. Consequently, it is necessary to collect new data from drivers of each of the collection trucks. The data requirements are presented in table 1. For the purpose of running this model, data relating to each day's schedule, depot to route, collection, route to disposal site travel, waiting time, dumping time, disposal site to route etc. was collected. Data collected are verified against check-in and check-out times at each disposal location. In addition, it is also necessary to estimate travel time from each zone to all disposal sites and all disposal sites to depots. This was used as a basis for simulation.

Table 1

Data requirements for the model presented

From truck operators

- Time required to travel from depot to the beginning of collection
- Collection times
- Time required to travel from the end of collection to depot

From zone supervisors

- Time required to travel from zones to different disposal sites
- Time required to travel from disposal sites to depot

From administrators

Number of zones

Number of depots

Number of disposal sites

Number of trucks used at each zone

Cost for 1 h of truck travel

Cost for 1 h of truck waiting

Cost of a relay from garages to disposal sites and return (Bhat, 1995).

Collection and transportation costs can represent as much as 80 % of all costs associated with solid waste removal. Solid waste collection vehicles are assigned to neighbourhoods without any serious demand analysis, route construction is left to the drivers and every vehicle is asked to collect solid wastes along its capacity is reached, at which time it is to go to the available disposal site to deposit its load and then return back to its route and continue with the collection. This approach is, of course, neither economical and nor practical. A systematic approach has been used to give due consideration on how to transport collected solid wastes from neighbourhoods to transfer sites, from transfer sites to disposal sites and on how to route the collection vehicles within each neighbourhood. Accordingly, the primary aims of the study were: (i) to develop a methodology for analysing solid waste collection and transportation alternatives; (ii) to provide the decision maker with an objective tool to evaluate alternatives; (iii) to encourage and show the advantages of methodical and serious data collection; (iv) to force the responsible personnel to behave methodically and logically and derive "reasonable" alternatives when necessary; (v) to obtain a minimum cost alternative (Or & Curi, 1992).

Innovative collection systems: In most industrialized countries, solid waste is collected from urban areas by compactor trucks which collect waste from each household. However, there are several reasons that such collection systems do not work in developing urban communities. First, road conditions often make truck access to individual households difficult. Second, the nature of the waste in poorer

areas denser and more corrosive due to a higher organic content makes compaction unfeasible and contributes to frequent equipment failure (Coffey, 1985). In part due to these two conditions, the costs of such a system are often prohibitive in developing communities where ability and willingness to pay for services are low. Third, weak local authorities and lack of precedent for paying fees for such services make it difficult to recover the costs of collection services. These difficulties have prompted the development of innovative collection systems better suited to developing urban areas. Four different types of systems are presented here: house to house collection, communal collection, block collection and no collection. They differ in terms of the equipment necessary (transport and storage), the effort required of households, and cost. (i) House to house collection: Several house to house collection systems ("primary collection") have been designed to be appropriate to developing urban areas. These programs are significantly different from traditional first-world collection systems with respect to financing, organization, and technology. In Bamako, Mali, a co-operative was formed by a group of university-educated women to collect waste (Robson, 1990). The goals of this program were to create employment, deliver basic health and hygiene education, and reduce rubbish in the community. Additionally, the program aims to convince individual households to pay for private garbage collection services. Although this approach to financing has not yet been successful, it does represent a potential alternative to paying for garbage collection through municipal fees in a city where only 10 % of the billed service charges are collected. (ii) Communal collection sites: Alternative methods of collection involve communal skips or collection sites. Sometimes these programs consist of several layers of collection networks. One program in Adjoufou II, a region of Abidjan in the Ivory Coast, used two-wheeled barrows to transport communal drums (which are placed less than 30 m from each house) to skips at collection points (Meyer, 1993). The skips are then periodically emptied by the private municipal collection company. Many of these programs utilize financial incentives to encourage recycling by paying different prices for different materials. (iii) Block collection: In this system, a collection vehicle travels a scheduled route, stopping periodically for residents to bring their refuse. Although it is less convenient

for residents, block collection eliminates the need for intermediate storage containers and thus may be less costly. There have been both positive and negative experience with block collection. This system was found to be suboptimal in Adjoufou II, Abidjan where weekly collections were made from main roads (Meyer, 1993). At first this free service was more popular than a community-run collection service for which a fee was charged. After a period of time, however, residents stopped carrying their rubbish to the trucks and refuse began to degrade the environment. (iv) Non-collection system: Finally, several areas have implemented collection systems which do not involve collection by contractors in the usual sense. Instead, residents receive incentives for bringing their refuse to central locations. This program involved 22,000 families in 52 communities and was credited with reducing litter, disease and infant mortality. The program cost the same as would a private collection service for these areas, and was subsidized by taxes from wealthier neighbourhoods (Korfmacher, 1996).

3. Waste Minimization

Economic incentive systems are currently being investigated by municipalities as a means of encouraging waste generators to reduce waste quantities requiring treatment and disposal. One option is to provide a diversion credit to businesses who provide products or services with reusable by-products as an alternative to products with disposable by-products. An important question, for both municipal staff and decision-makers alike, is what diversion credit level to offer for a particular application. In this short paper, we have provided a methodology for municipal engineers and planners to determine a reasonable diversion credit level for businesses offering the potential for by-product reuse (Baetz & Arey, 1993).

Recycling offers a substantial reduction in the cost of waste disposal. It saves energy and expensive raw materials, and also protects the environment. Growing population, rising incomes and changing consumption patterns complicate the waste management problem. In most of the developing countries the ability to manage the

waste effectively lags far behind its rate of growth. To increase the rate of recycling processes the following steps should be considered (Muttamara et. all, 1993).

Resource recovery from the waste stream is desirable because it cuts down on the costs of transporting and disposing of municipal waste. Money generated from the sale of recovered resources can offset collection costs. Additionally, the industries which revolve around sorting and using recovered resources create employment and income. In many developing communities, whether or not there is a formal system of waste collection, there is a highly developed network for resource recovery. This network may consist of door-to-door collectors and/or "scavengers" who separate re-usable materials at dumps and collection sites. By instituting or improving municipal solid waste collection systems, these informal collection networks may be negatively affected. Indeed, many municipalities see scavengers as a menace and try to prevent them from working at dump sites. However, experience in many countries has shown it to be beneficial for waste collection services to include existing collectors, rather than to launch new programs for resource recovery (Furedy, 1991).

Although waste minimization has become a primary concern for solid waste management in many countries, particularly in developed countries, since 1980, no efforts for waste minimization at source are carried out by local municipalities citizens or groups in the region. Even some unorganized recycling efforts are applied to paper, plastic and metal wastes during collection, transport or disposal by scavengers, the amount of recycled raw materials is generally very low and do not exceed 5 % of total raw material. During this investigation, an analysis of the existing practises revealed the following main issues and problems which need to be tacked in the region, at least in the investigated part of the rgion.

-Ineffective bye-laws,

-Rapid increase of population and urbanization,

-Increase of waste quantity,

-Inadequate resources,

-Managerial apothy,

-Public awarness,

-Planned and operated system,

-Trained staff.

Following the Earth Summit Conference in Rio de Janeiro in 1992, most of the participating countries prepared and published their national waste management strategies in accordance with sustainable development. These strategies demand that the present generations should deal with the waste they produces for not leaving any environmental problems to future generations. As one of the participating country Turkey has already set up its national waste management strategies including solid waste and hazardous waste management and published national bye-laws. But the applications are still to be very limited due to organizational and financial problems. It is hoped that modern issues for solid waste management will be realised in the near feature and new sanitary landfills will be operated in place of uncontrolled open dumps throughout the country (Ergun et all, 1998).

In Turkey, environmental studies has been steadily increasing since 1980's. Most of the studies in 1990's focus on the environmental conditions in various parts of the ecosystem and provide valuable suggestions. Çağlar (1991: 14) found in his study that air pollution (63.48 %) first and waste second problem among the most important environmental problems in Turkey. Keleş (1992) indicates that we can't be successful in environmental protection unless concerns for ethical responsibility are made dominant in peoples' behavior. Emphasizing the need for sustainability. Sönmez (1992: 62) argues that sustainable agriculture and soil protection practices are fundamental imperatives for protection, development and perpetuation of life on earth. Sözen, after examining the relationship between man and nature, (1992) suggests a relation oriented towards living in hormany with nature, instead of domination over it; less consumption, more rational use, less luxury but cleaner environment, more humble living and more nature and green, cleaner air and water, less variety but healthier nutrition. Aruoba (1992) approaches the issue in terms of economics and sustainability. İmamoğlu (1992) focuses on psychological approaches to ecosystem management policy as starting point. Ejder and Erdoğan (1997) move

beyond individual behavioral and socio-psychological level and argue that the question of environment can not be reduced down to consumer and awareness. It is a societal structural condition, thus all the other important factors, from production to consumption, have to be included in investigations. Most of research and discussions show that the only way to avoid environmental harm from waste is to prevent its generation. As it is stated in EPA (1994) prevention means changing the way activities are conducted and eliminating the source of the problem. It does not mean doing without, but doing differently. For example, preventing waste pollution from litter caused by disposable beverage containers does not mean doing without beverages; it just means using refillable bottles. Preventing pollution in a sensitive resource-related setting means thinking through all of the activities and services associated with the facility and planning them in a way that generates less waste. Waste prevention leads to thinking about materials in terms of reduce, reuse, recycle. The best way to prevent pollution is not to use materials that become waste problems. When such materials must be used, they should be reused. Materials that cannot be directly reused should be recycled (Ejder & Erdoğan, 1998).

CHAPTER THREE

OPTIMIZATION OF SOLID WASTE COLLECTION

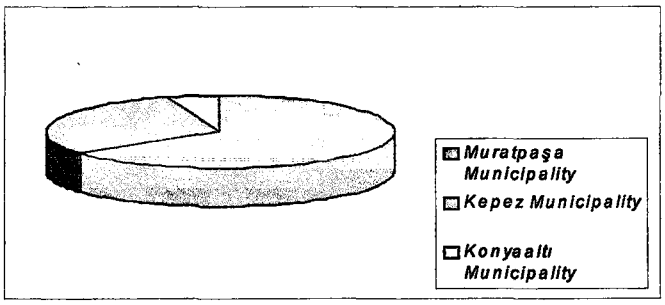
1. Basic Data of Sub-Municipalities of Antalya

Total amount of house solid wastes of Muratpaşa, Kepez and Konyaaltı Municipalities for 1999 was calculated that will be 352 tone/day and amount of industrial waste will be 9 tone/day. Distribution of house solid wastes amounts are shown at figure 1.1.

Amount of medical wastes was calculated that will be 6 tone/day, however, medical wastes have not been included in calculations because of these will be burnt at the incinerator presents in the Akdeniz University Campus.

Studies for existing Kepezüstü dumping area and also new dumping area planning to set in Varsak have been done taking into consideration the economy.

Figure 1.1 Distribution of House Solid Waste Amounts
(It has been determined for 1999)



Muratpaşa Municipality 65 %
Kepez Municipality 30 %
Konyaaltı Municipality 5 %

1.1 Density of Solid Waste

Density of uncompressing solid waste is 136.68 kg/m^3.
(361,000 kg / 2,641.28 m^3 = 136.68 kg/m^3)

Ash, stone, wood, porcelain etc. are assumed as uncompressing. In this way, weight of compressable solid wastes is;
361 tone – [(28.88 tone)+(5.054 tone)+(4.332 tone)] = 322.734 tone

Volume of compressable solid wastes before compressing is;
2,641.28 m^3 – [(60.17 m^3)+(21.06 m^3)+(10.07 m^3)] = 2,549.98 m^3

Compressing ratio of vehicle is 2.5

Volume of compressed solid wastes is;
(2,549.98 m^3) / (2.5) = 1,019.99 m^3

Density is;
(322,734 kg) / (1,019.99 m^3) = 316.41 kg / m^3

Density and volume of solid wastes with respect to solid waste groups are shown at table 1.1.

Table 1.1 Density and Volume of Waste Combination

(Density: TOPRAK, (1998). Katı Atık Toplama, Taşıma ve Bertaraf Sistemlerinin Eniyilenmesi ve Ekonomisi.)

(Volume: Amount of Solid Waste which has been calculated for Antalya in 1999)

PARAMETER	DENSITY (kg/m^3)	VOLUME (m^3)
<8 mm thin waste, ash, sawdust etc.	480	60.17
Organic Waste	290	476.77
Paper	85	747.48
Pasteboard	50	180.50
Glass-Bottle	195	103.67
Tinplate-Metal	160	103.79
Plastic	65	527.62
Wood	240	21.06
Textile	65	305.46
Stone, ceramic, porcelain	430	10.07
Other(full food boxes, battery etc.)	200	104.69
TOTAL		**2,641.28**

1.2 Muratpaşa Municipality

Table 1.2 Basic Data of Muratpaşa Municipality

NEIGHBOURHOOD	DAILY AVERAGE AMOUNT OF SOLID WASTE (m^3/gün)	DISTANCE OF VEHICLE GARAGE (km)	DISTANCE OF DUMPING AREA (km)	
			Kepezüstü	Varsak
Bayındır	46.63	4.49	11.50	20.90
Meltem	127.16	6.77	12.58	22.85
Soğuksu	63.58	4.64	11.63	20.90
Güvenlik	42.39	4.00	10.83	20.38
Yıldız	31.79	4.89	12.13	21.25

Table 1.2 Continued

NEIGHBOURHOOD	DAILY AVERAGE AMOUNT OF SOLID WASTE (m^3/gün)	DISTANCE OF VEHICLE GARAGE (km)	DISTANCE OF DUMPING AREA (km)	
			Kepezüstü	Varsak
Varlık	42.39	5.70	12.33	21.90
Bahçelievler	27.55	5.00	13.25	22.90
Memurevleri	23.31	4.05	11.68	21.55
Altındağ	25.43	4.26	12.23	22.18
Deniz	21.20	4.53	12.78	22.93
Sedir	29.68	3.26	11.03	19.58
Üçgen	29.68	3.59	11.98	20.83
Kızılsaray	23.31	3.56	12.60	21.53
Kışla	16.95	4.17	13.05	22.05
Elmalı	10.59	3.83	13.08	22.15
Kaleiçi	12.72	4.10	13.93	18.05
Haşim İşcan	25.43	4.65	14.43	17.90
Sinan	27.55	4.13	14.28	17.40
Gençlik	27.55	5.00	15.40	18.25
Yüksekalan	31.79	2.84	13.78	17.15
Tahılpazarı	38.15	3.00	12.78	18.15
Balbey	12.72	3.81	13.50	17.48
Çaybaşı	16.95	3.38	15.03	16.40
Zümrütova	27.55	7.50	19.53	17.00
Fener	61.46	9.33	21.60	17.60
Çağlayan	38.15	11.40	23.18	16.80
Zerdalilik	46.63	4.38	14.93	17.35
Demircikara	63.58	4.89	15.93	16.88
Yeşilbahçe	63.58	5.60	17.08	17.28
Şirinyalı	72.06	7.88	19.25	18.70

Table 1.2 Continued

NEIGHBOURHOOD	DAILY AVERAGE AMOUNT OF SOLID WASTE (m^3/gün)	DISTANCE OF VEHICLE GARAGE (km)	DISTANCE OF DUMPING AREA (km)	
			Kepezüstü	Varsak
Sanayi	55.11	2.69	11.85	18.83
Dutlubahçe	21.20	1.89	12.48	18.08
Muratpaşa	29.67	3.09	12.83	19.20
Konuksever	40.27	0.92	12.90	17.18
Etiler	33.91	1.76	14.08	18.25
Kızılarık	38.15	1.08	14.78	15.83
Yenigöl	8.47	6.80	19.68	11.13
Ermenek	25.43	17.43	29.43	14.25
Güzeloba	29.67	14.78	27.43	15.25
Yenigün	42.38	2.43	15.53	17.18
Yeşildere	42.39	2.03	15.45	14.83
Gebizli	12.72	2.75	16.25	15.68
Doğuyaka	10.59	3.73	17.05	13.83
Topçular	14.84	4.93	18.18	12.58
Kızıltoprak	42.39	4.59	16.78	15.78
Mehmetçik	16.95	5.18	18.10	14.83
Meydankavağı	19.07	5.03	18.13	16.33
Tarım	19.07	6.08	19.20	14.80
Yeşilova	21.20	6.30	19.63	12.83
Kırcami	14.84	6.68	20.40	16.05
Güzeloluk	16.95	8.85	22.35	14.95

Total amount of solid waste = 1682.78 m^3/day

= 230 tone/day

1.3 Kepez Municipality

Table 1.3 Basic Data of Kepez Municipality

NEIGHBOURHOOD	DAILY AVERAGE AMOUNT OF SOLID WASTE (m^3/gün)	DISTANCE OF VEHICLE GARAGE (km)	DISTANCE OF DUMPING AREA (km)	
			Kepezüstü	Varsak
Menderes	2.11	7.43	19.68	11.50
Orta	2.11	5.18	17.48	10.85
Sinan	4.23	6.23	19.15	11.00
Düden	4.23	5.75	17.18	13.40
Göksu	4.23	4.18	17.03	12.25
Beşkonaklar	2.11	4.10	16.40	14.25
Baraj	4.23	5.38	15.80	14.98
Habipler	6.34	4.20	13.80	16.95
Hüsnü Karakaş	6.34	3.73	14.20	16.38
Güneş	16.91	2.85	14.73	15.90
Düdenbaşı	25.37	2.35	14.40	15.10
Teomanpaşa	38.05	0.80	12.65	16.85
M.Akif Ersoy	14.79	1.63	13.25	17.20
Sütçüler	10.57	2.23	13.40	18.20
Gazi	4.23	3.50	14.78	19.45
Fevzi Çakmak	14.79	4.85	11.08	21.30
Kuzeyyaka	12.68	2.93	13.13	19.63
Gündoğdu	12.68	2.03	12.03	18.88
Yeni	21.14	1.30	12.88	18.48
Emek	21.14	0.53	12.68	17.90
Karşıyaka	29.59	1.45	11.78	18.75
Yeni Emek	27.48	2.50	10.85	19.55
Kütükçü	14.79	3.93	12.13	20.63

Table 1.3 Continued

NEIGHBOURHOOD	DAILY AVERAGE AMOUNT OF SOLID WASTE (m^3/gün)	DISTANCE OF VEHICLE GARAGE (km)	DISTANCE OF DUMPING AREA (km)	
			Kepezüstü	Varsak
Yavuz Selim	8.46	4.75	11.33	21.45
Kazım Karabekir	6.34	5.15	8.80	22.35
Çankaya	10.56	6.33	8.73	22.60
Esentepe	12.68	7.58	8.83	23.45
Erenköy	23.25	5.15	7.95	22.63
Kanal	25.37	5.55	7.95	22.30
Barış	19.02	3.85	9.60	21.15
Atatürk	19.02	3.05	9.90	19.85
Yeşiltepe	31.70	3.68	9.25	20.85
Özgürlük	25.37	3.43	9.78	20.30
Zafer	16.91	2.73	10.53	19.25
Yükseliş	27.48	2.50	11.05	18.65
Ulus	25.37	3.28	10.28	19.75
Çamlıbel	14.79	6.63	6.33	24.05
Göçerler	4.23	7.63	5.93	24.88
Fatih	10.56	8.18	5.10	25.45
Kepez	14.79	8.15	5.45	25.40
Santral	12.68	9.15	5.85	26.43
Ünsal	16.91	8.60	8.28	25.60
Şafak	25.37	7.48	9.68	25.40
Ahatlı	14.79	6.20	8.73	23.65
Yenidoğan	12.68	5.73	8.55	22.50
Fabrikalar	19.02	4.83	9.55	21.35
Kültür	31.70	6.28	10.73	22.80
Yeşilyurt	12.68	7.83	10.78	24.25

Table 1.3 Continued

NEIGHBOURHOOD	DAILY AVERAGE AMOUNT OF SOLID WASTE (m^3/gün)	DISTANCE OF VEHICLE GARAGE (km)	DISTANCE OF DUMPING AREA (km)	
			Kepezüstü	Varsak
Gülveren	14.79	7.20	11.35	23.95
Duraliler	4.23	10.53	13.38	26.80

Total amount of solid waste = 760.49 m^3/day

= 104 tone/day

NEIGHBOURHOOD	DAILY AVERAGE AMOUNT OF SOLID WASTE (m^3/gün)	DISTANCE OF VEHICLE GARAGE (km)	DISTANCE OF DUMPING AREA (km)	
			Kepezüstü	Varsak
Akdeniz Organize Industry Region	65.85	27.15	15.00	46.00

1.4 Konyaaltı Municipality

Table 1.4 Basic Data of Konyaaltı Municipality

NEIGBOURHOOD	DAILY AVERAGE AMOUNT OF SOLID WASTE (m^3/gün)	DISTANCE OF VEHICLE GARAGE (km)	DISTANCE OF DUMPING AREA (km)	
			Kepezüstü	Varsak
Sarısu	2.09	6.98	23.00	33.45
Liman	9.61	4.88	20.95	30.70
Hurma	4.18	4.25	20.25	30.95

Table 1.4 Continued

NEIGHBOURHOOD	DAILY AVERAGE AMOUNT OF SOLID WASTE (m^3/gün)	DISTANCE OF VEHICLE GARAGE (km)	DISTANCE OF DUMPING AREA (km)	
			Kepezüstü	Varsak
Zümrüt	2.09	2.65	18.40	30.30
Molla Yusuf	2.09	2.73	15.03	26.03
Siteler	10.46	2.75	13.68	24.63
Pınarbaşı	4.18	3.83	12.35	23.30
Toros	5.02	2.28	14.05	25.20
Akkuyu	6.27	1.65	14.75	25.98
Uncalı	4.18	0.88	15.93	26.73
Uluç	7.10	0.28	16.48	28.00
Öğretmenevi	5.44	1.30	16.10	26.40
Arapsuyu	12.54	3.03	14.38	24.55
Kuşkavağı	18.81	2.30	15.78	25.95
Altınkum	14.63	1.85	17.28	27.18
Gürsu	23.00	2.20	18.23	28.13

Total amount of solid waste = 131.69 m^3/day

= 18 tone/day

Distances are determined taking into consideration the centre of neigbourhoods.

2.Collection-Transportation Analysis

2.1 Collection and Transportation of Solid Wastes to Kepezüstü Dumping Area

Formulas used for calculations and results are shown below.

(TOPRAK, Hikmet (1998). Katı Atık Toplama, Taşıma ve Bertaraf Sistemlerinin Eniyilenmesi ve Ekonomisi. İzmir)

N_w : Number of weekly journey (journey/week)

V_w : Velocity of weekly solid waste production (m^3/week)

c : Averagely capacity of container (m^3/journey)

f : Container usage factor

t_w : Number of journey in a week (journey/week)

uc : Time for leaving empty container (hour/journey)

dbc : Time passing between containers (hour/journey)

a' and b' : Ampiric coefficients (hour/journey and km/journey)

x' : Distance between regions (km/journey)

D_w : Weekly period (day/week)

s : Time passing in the dumping area (hour/journey)

a and b : Ampiric coefficients (hour/journey and km/journey)

x : Distance of dumping area (km/journey)

w : Factor of come back time

H : Daily period of study (hour/day)

C_t : Number of container pouring out for a journey (number/journey)

v : Volume of vehicle (m^3/journey)

r : Compressing ratio

c : Volume of container (m^3/container)

P_{SKS} : Period of collecting for a journey (hour/journey)

n_p : Number of container in region for a journey (region/journey)

1. $C_t = [(v)(r)] / [(c)(f)]$
2. $P_{SKS} = (C_t)(uc) + (n_p-1)(dbc) = (C_t)(uc) + (n_p-1)[(a')+(b')(x')]$
3. $N_w = (V_w) / (c)(f)$
4. $D_w = \{(N_w)(P_{SKS}) + (t_w)[(s) + (a) + (b)(2x)]\} / [(1-w)(H)]$

In these calculations, values accepted are shown below.

f : 0.90

r : 2.50

x' : 0.05 km

a' : 0.06 hour/journey for < 40 km/hour

b' : 0.04 km journey for < 40 km/hour

uc : 0.04 hour/journey

s : 0.25 hour/journey

a : 0.022 hour/journey for 72 km/hour

b : 0.014 km/journey for 72 km/hour

w : 0.15

As a result of calculations, optimum daily period of study were determined for every regions. These are shown at table 2.1.

Table 2.1 Optimum Daily Period For Collection and Transportation of Solid Wastes to Kepezüstü Dumping Area

(These values have been calculated for every regions in 1999)

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Bahçelievler	13	750	48	4.834	192.85	6	7	13.25	6
Varlık	20	750	74	7.486	296.73	6	7	12.33	8
Deniz	13	750	48	4.834	148.40	5	5	12.78	6
Altındağ	10	750	37	3.712	178.01	7	7	12.23	5
Memurevleri	10	750	37	3.712	163.17	7	7	11.68	5
Yıldız	13	750	48	4.834	222.53	7	7	12.13	6
Güvenlik	20	750	74	7.486	296.73	6	7	10.83	8
Meltem (3 vehicles)	20	750	74 222	7.486	296.70 890.12	6	7	12.58	8
Sinan	13	750	48	4.834	192.85	6	7	14.28	6
H.İşcan	10	750	37	3.712	178.01	7	7	14.43	5
Elmalı, Kışla	13	750	48	4.834	192.78	6	7	13.06	6
Tahılpazarı	15	750	56	5.650	267.05	7	7	12.78	7

Table 2.1 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Balbey	6	750	23 46	2.284	89.04	6	3	13.50	7
Zerdalilik (2 vehicles)	10	750	37 74	3.712	163.21 326.41	7	7	14.93	5
Gençlik	13	750	48	4.834	192.85	6	7	15.40	6
Güzeloba	13	750	48	4.834	207.69	7	7	27.43	7
Çağlayan	15	750	56	5.650	267.05	7	7	23.18	8
Fener (2 vehicles)	13	750	48 96	4.834	215.11 430.22	7	7	21.60	7
Şirinyalı (2 vehicles)	15	750	56 112	5.650	252.21 504.42	7	7	19.25	8
Kızılsaray	10	750	37	3.712	163.17	7	7	12.60	5
Üçgen	6	750	23 46	2.284	207.76	14	7	11.98	7
Kaleiçi	6				89.04		7	13.93	8
Yeşilbahçe (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	17.08	7
Demircikara (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	15.93	7
Soğuksu (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	11.63	7
Bayındır (2 vehicles)	13	750	48 96	4.834	163.21 326.41	5	5	11.50	7
Yüksekalan	13	750	48	4.834	222.53	7	7	13.78	7
Etiler	13	750	48	4.834	237.37	7	7	14.08	7
Yeşildere	20	750	74	7.486	296.73	6	7	15.45	8

Table 2.1 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Kızılarık	15	750	56	5.650	267.05	7	7	14.78	8
Gebizli	6	750	23 46	2.284	89.04	6	3	16.25	7
Yenigün	20	750	74	7.486	296.66	6	7	15.53	8
Meydankavağı, Çaybaşı	15	750	56	5.650	252.14	7	7	16.58	8
Konuksever	20	750	74	7.486	281.89	6	7	12.90	8
Dutlubahçe	13	750	48	4.834	148.40	5	5	12.48	7
Ermenek	10	750	37	3.712	178.01	7	7	29.43	6
Zümrütova	13	750	48	4.834	192.85	6	7	19.53	6
Güzeloluk	10	750	37	3.712	118.65	5	5	22.35	6
Tarım and Kırcami	13	750	48	4.834	237.37	7	7	19.80	7
Yenigöl and Yeşilova	13	750	48	4.834	207.69	7	7	19.65	7
Topçular and Doğuyaka	10	750	37	3.712	178.01	7	7	17.61	6
Kızıltoprak	20	750	74	7.486	296.73	6	7	16.78	8
Mehmetçik	10	750	37	3.712	118.65	5	5	18.10	5
Sanayi (2 vehicles)	13	750	48 96	4.834	192.89 385.77	6	7	11.85	6
Muratpaşa	13	750	48	4.834	207.69	7	7	12.83	7
Sedir	13	750	48	4.834	207.76	7	7	11.03	7
Emek	10	750	37	3.712	147.98	6	7	12.68	5
Karşıyaka	13	750	48	4.834	207.13	6	7	11.78	6
Yeni	10	750	37	3.712	147.98	6	7	12.88	5

Table 2.1 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Yeni Emek	13	750	48	4.834	192.36	6	7	10.85	6
Yükseliş	13	750	48	4.834	192.36	6	7	11.05	6
Ulus	10	750	37	3.712	177.59	7	7	10.28	5
Özgürlük	10	750	37	3.712	177.59	7	7	9.78	5
Göksu,Sinan Orta,Mende.	6	220	72	7.282	88.76	6	7	18.35	8
Düden,Beşk. Baraj	5	220	60	6.058	73.99	6	7	16.49	7
Sütçüler,Kuzeyyaka,F.Ç	15	750	56	5.650	266.28	7	7	12.24	8
Gazi, H.Karakaş,Habipler	6	220	72	7.282	118.37	8	7	14.29	11
Barış and Kütükçü	13	750	48	4.834	236.67	7	7	10.86	7
Y.Selim and K.Karabekir	13	750	48	4.834	103.60	3	3	15.39	7
Gülveren, Duraliler	10	750	37	3.712	133.14	5	5	12.36	5
Yeşilyurt and Şafak	15	750	56	5.650	266.35	7	7	10.23	7
Zafer and Atatürk	15	750	56	5.650	251.51	7	7	10.21	7
Yeşiltepe	13	750	48	4.834	221.90	7	7	9.25	6
Fabrikalar	10	750	37	3.712	133.14	5	5	9.55	5
Kanal	10	750	37	3.712	177.59	7	7	7.95	5

Table 2.1 Continued

Kültür	13	750	48	4.834	221.90	7	7	10.73	6
Yenidoğan, Ahatlı	13	750	48	4.834	192.29	6	7	17.28	6
Teomanpaşa	15	750	56	5.650	266.35	7	7	12.65	7
Düdenbaşı	10	750	37	3.712	177.59	7	7	14.40	5
Güneş	10	750	37	3.712	118.37	5	5	14.73	5
M.A.Ersoy, Gündoğdu	13	750	48	4.834	192.29	6	7	12.64	6
Çanka,Esen-tepe,Göçerl.	13	750	48	4.834	192.29	6	7	7.33	5
Erenköy	10	750	37	3.712	162.75	7	7	7.95	5
Çamlıbel and Fatih	10	750	37	3.712	177.45	7	7	5.71	5
Ünsal	10	750	37	3.712	118.37	5	5	8.28	5
Santral and Kepez	13	750	48	4.834	192.29	6	7	5.65	5
Liman and Gürsu	13	800	45	4.528	228.27	7	7	19.59	7
Altınkum, Kuşkavağı	13	800	45	4.528	234.08	7	7	16.53	6
Arapsuyu, Pınarbaşı	10	800	35	3.508	117.04	5	5	13.36	5
Sarısu, Hurma.....	10	800	35	3.508	146.37	6	7	18.34	4
Uluç, Uncalı.....	13	800	45	4.528	196.07	6	7	15.26	5
Organize Industry Region	25	2 m^3	35	3.508	460.93	7	7	15.00	5

2.2 Collection and Transportation of Solid Wastes to Varsak Dumping Area

Formulas used for calculations and results are shown below.

(TOPRAK, (1998). Katı Atık Toplama, Taşıma ve Bertaraf Sistemlerinin Eniyilenmesi ve Ekonomisi. İzmir)

N_w : Number of weekly journey (journey/week)

V_w : Velocity of weekly solid waste production (m^3/week)

c : Averagely capacity of container (m^3/journey)

f : Container usage factor

t_w : Number of journey in a week (journey/week)

uc : Time for leaving empty container (hour/journey)

dbc : Time passing between containers (hour/journey)

a' and b' : Ampiric coefficients (hour/journey and km/journey)

x' : Distance between regions (km/journey)

D_w : Weekly period (day/week)

s : Time passing in the dumping area (hour/journey)

a and b : Ampiric coefficients (hour/journey and km/journey)

x : Distance of damping area (km/journey)

w : Factor of come back time

H : Daily period of study (hour/day)

C_t : Number of container pouring out for a journey (number/journey)

v : Volume of vehicle (m^3/journey)

r : Compressing ratio

c : Volume of container (m^3/container)

P_{SKS} : Period of collecting for a journey (hour/journey)

n_p : Number of container in region for a journey (region/journey)

1. $C_t = [(v)(r)] / [(c)(f)]$
2. $P_{SKS} = (C_t)(uc) + (n_p\text{-}1)(dbc) = (C_t)(uc) + (n_p\text{-}1)[(a')+(b')(x')]$

3. $N_w = (V_w) / (c)(f)$
4. $D_w = \{(N_w)(P_{SKS}) + (t_w)[(s) + (a) + (b)(2x)]\} / [(1-w)(H)]$

In these calculations, values accepted are shown below.

f : 0.90

r : 2.50

x' : 0.05 km

a' : 0.06 hour/journey for < 40 km/hour

b' : 0.04 km journey for < 40 km/hour

uc : 0.04 hour/journey

s : 0.25 hour/journey

a : 0.022 hour/journey for 72 km/hour

b : 0.014 km/journey for 72 km/hour

w : 0.15

As a result of calculations, optimum daily period of study were determined for every regions. These are shown at table 2.2.

Table 2.2 Optimum Daily Period For Collection and Transportation of Solid Wastes to Varsak Dumping Area

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Bahçelievler	13	750	48	4.834	192.85	6	7	22.90	6
Varlık (2 vehicles)	10	750	37 74	3.712	148.37 296.73	6	7	21.90	5
Deniz	13	750	48	4.834	148.40	5	5	22.93	7
Altındağ	10	750	37	3.712	178.01	7	7	22.18	6
Memurevleri	10	750	37	3.712	163.17	7	7	21.55	6
Yıldız	13	750	48	4.834	222.53	7	7	21.25	7

Tablo 2.2 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Güvenlik (2 vehicles)	10	750	37 74	3.712	148.37 296.73	6	7	20.38	5
Meltem (6 vehicles)	10	750	37 222	3.712	148.35 890.12	6	7	22.85	5
Sinan	13	750	48	4.834	192.85	6	7	17.40	6
H.İşcan	10	750	37	3.712	178.01	7	7	17.90	6
Elmalı, Kışla	13	750	48	4.834	192.78	6	7	22.10	6
Tahılpazarı	15	750	56	5.650	267.05	7	7	18.15	8
Balbey	6	750	23 46	2.284	89.04	6	3	17.48	8
Zerdalilik (2 vehicles)	10	750	37 74	3.712	163.21 326.41	7	7	17.35	6
Gençlik	13	750	48	4.834	192.85	6	7	18.25	6
Güzeloba	13	750	48	4.834	207.69	7	7	15.25	7
Çağlayan	15	750	56	5.650	267.05	7	7	16.80	8
Fener (2 vehicles)	13	750	48 96	4.834	215.11 430.22	7	7	17.60	7
Şirinyalı (2 vehicles)	15	750	56 112	5.650	252.21 504.42	7	7	18.70	8
Kızılsaray	10	750	37	3.712	163.17	7	7	21.53	6
Üçgen	6	750	23 46	2.284	207.76	14	7	20.83	8
Kaleiçi	6				89.04		7	18.05	8
Yeşilbahçe (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	17.28	7

Table 2.2 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Demircikara (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	16.88	7
Soğuksu (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	20.90	7
Bayındır (2 vehicles)	13	750	48 96	4.834	163.21 326.41	5	5	20.90	7
Yüksekalan	13	750	48	4.834	222.53	7	7	17.15	7
Etiler	13	750	48	4.834	237.37	7	7	18.25	7
Yeşildere	20	750	74	7.486	296.73	6	7	14.83	8
Kızılarık	15	750	56	5.650	267.05	7	7	15.83	8
Gebizli	6	750	23 46	2.284	89.04	6	3	15.68	7
Yenigün	20	750	74	7.486	296.66	6	7	17.18	8
Meydankavağı, Çaybaşı	15	750	56	5.650	252.14	7	7	16.36	8
Konuksever	20	750	74	7.486	281.89	6	7	17.18	8
Dutlubahçe	13	750	48	4.834	148.40	5	5	18.08	7
Ermenek	10	750	37	3.712	178.01	7	7	14.25	5
Zümrütova	13	750	48	4.834	192.85	6	7	17.00	6
Güzeloluk	10	750	37	3.712	118.65	5	5	14.95	5
Tarım and Kırcami	13	750	48	4.834	237.37	7	7	15.43	7
Yenigöl and Yeşilova	13	750	48	4.834	207.69	7	7	11.98	7
Topçular and Doğuyaka	10	750	37	3.712	178.01	7	7	13.20	5

Table 2.2 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Kızıltoprak	20	750	74	7.486	296.73	6	7	15.78	8
Mehmetçik	10	750	37	3.712	118.65	5	5	14.83	5
Sanayi (2 vehicles)	13	750	48 96	4.834	192.89 385.77	6	7	18.83	6
Muratpaşa	13	750	48	4.834	207.69	7	7	19.20	7
Sedir	13	750	48	4.834	207.76	7	7	19.58	7
Emek	10	750	37	3.712	147.98	6	7	17.90	5
Karşıyaka	13	750	48	4.834	207.13	6	7	18.75	6
Yeni	10	750	37	3.712	147.98	6	7	18.48	5
Yeni Emek	13	750	48	4.834	192.36	6	7	19.55	6
Yükseliş	13	750	48	4.834	192.36	6	7	18.65	6
Ulus	10	750	37	3.712	177.59	7	7	19.75	6
Özgürlük	10	750	37	3.712	177.59	7	7	20.30	6
Göksu,Sinan Orta,Mende.	6	220	72	7.282	88.76	6	7	11.88	8
Düden,Beşk. Baraj	5	220	60	6.058	73.99	6	7	14.19	7
Sütçüler,Kuzeyyaka,F.Ç	15	750	56	5.650	266.28	7	7	19.75	8
Gazi, H.Karakaş,Habipler	6	220	72	7.282	118.37	8	7	18.20	11
Barış and Kütükçü	13	750	48	4.834	236.67	7	7	20.89	7
Y.Selim and K.Karabekir	13	750	48	4.834	103.60	3	3	21.90	7

Table 2.2 Continued

REGION	v m^3	C Lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Gülveren, Duraliler	10	750	37	3.712	133.14	5	5	25.38	6
Yeşilyurt and Şafak	15	750	56	5.650	266.35	7	7	24.83	8
Zafer and Atatürk	15	750	56	5.650	251.51	7	7	19.55	8
Yeşiltepe	13	750	48	4.834	221.90	7	7	20.85	7
Kanal	10	750	37	3.712	177.59	7	7	22.30	6
Fabrikalar	10	750	37	3.712	133.14	5	5	21.35	6
Kültür	13	750	48	4.834	221.90	7	7	22.80	7
Yenidoğan, Ahatlı	13	750	48	4.834	192.29	6	7	23.08	6
Teomanpaşa	15	750	56	5.650	266.35	7	7	16.85	8
Düdenbaşı	10	750	37	3.712	177.59	7	7	15.10	5
Güneş	10	750	37	3.712	118.37	5	5	15.90	5
M.A.Ersoy, Gündoğdu	13	750	48	4.834	192.29	6	7	18.04	6
Çanka,Esen-tepe,Göçerl.	13	750	48	4.834	192.29	6	7	23.74	6
Erenköy	10	750	37	3.712	162.75	7	7	22.63	6
Çamlıbel and Fatih	10	750	37	3.712	177.45	7	7	24.75	6
Ünsal	10	750	37	3.712	118.37	5	5	25.60	6
Santral and Kepez	13	750	48	4.834	192.29	6	7	25.91	6

Table 2.2 Continued

REGION	v m^3	C Lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Liman and Gürsu	13	800	45	4.528	228.27	7	7	29.41	7
Altınkum, Kuşkavağı	13	800	45	4.528	234.08	7	7	26.56	7
Arapsuyu, Pınarbaşı	10	800	35	3.508	117.04	5	5	23.93	6
Sarısu, Hurma.....	10	800	35	3.508	146.37	6	7	29.04	5
Uluç, Uncalı.....	13	800	45	4.528	196.07	6	7	26.60	6
Organize Industry Region	25	2 m^3	35	3.508	460.93	7	7	46.00	6

2.3 Collection and Transportation Costs of Vehicles

Collection and transportation cost of vehicles was calculated taking into consideration the solid waste cost values of İzmir Maincity Municipality in 1997.

Fuel : (A lt/km)(2*X km/day)(0.5 $/lt) = ...$/day

A : For 5, 6, 10 m^3 vehicles = 0.6 lt / km

For 13, 15, 20 m^3 vehicles = 0.8 lt / km

For 25 m^3 vehicles = 0.9 lt / km

Wheel : (270 $*6 / 40,000 km)(2*X km/day) = ...$/day

Spare part : (Fuel)(20 %) = ...$/day

Worker's pay : (One driver) + (2 workers)

(480 $/month*3 persons) / (30 days /1 month) = 48 $/day

Amortization : (32,000 $) / (7 years)(365 days/year) = 12.5 $/day

Security : (Fuel)(100 %) = ...$/day

Costs of solid waste collection and transportation to Kepezüstü dumping area according to regions are shown at table 2.3.

Table 2.3 Costs of Solid Waste Collection and Transportation to Kepezüstü Dumping Area

REGION	COST ($ / week)	REGION	COST ($ / week)
Bahçelievler	519.03	Sinan	531.68
Varlık	592.58	Haşim İşcan	447.43
Deniz	366.66	Elmalı and Kışla	516.92
Altındağ	426.99	Tahılpazarı	556.26
Memurevleri	421.92	Balbey	277.48
Yıldız	505.28	Zerdalilik	903.60
Güvenlik	574.93	Gençlik	545.65
Meltem	1787.19	Güzeloba	735.58
Çağlayan	726.72	Etiler	571.44
Fener	1329.47	Yeşildere	631.11
Şirinyalı	1356.74	Kızılarık	623.06
Kızılsaray	430.39	Gebizli	299.26
Üçgen	619.47	Yenigün	632.17
Kaleiçi	568.83	Meydankav.,Çaybaşı	645.28
Yeşilbahçe	1216.60	Konuksever	599.45
Demircikara	1188.00	Dutlubahçe	394.04
Soğuksu	1082.17	Ermenek	627.71
Bayındır	771.58	Zümrütova	596.26
Yüksekalan	567.64	Güzeloluk	402.58

Table 2.3 Continued

REGION	COST ($ / week)	REGION	COST ($ / week)
Tarım and Kırcami	641.86	Mehmetçik	344.51
Yenigöl and Yeşilova	639.91	Sanayi	1003.79
Topçular, Doğuyaka	518.72	Muratpaşa	555.88
Kızıltoprak	647.74	Sedir	533.73

Total cost for Muratpaşa Municipality = 29,956 $ / week

=119,824 $ / month

=0.36 $ / person / month

REGION	COST ($ / week)	REGION	COST ($ / week)
Emek	431.49	Sütçüler,Kuzeyyaka...	590.97
Karşıyaka	502.04	Gazi,Habipler.....	698.81
Yeni	433.31	Barış,Kütükçü	532.48
Yeni Emek	489.78	Yavuz Selim.....	252.05
Yükseliş	492.15	Gülveren,Duraliler	306.31
Ulus	409.19	Yeşilyurt, Şafak	524.52
Özgürlük	404.58	Zafer,Atatürk	524.30
Göksu, Sinan, Orta.....	611.61	Yeşiltepe	470.72
Düden, Beşkonaklar, ...	549.21	Kanal	387.59
Fabrikalar	287.74	M.A.Ersoy,.....	512.39
Kültür	488.92	Çankaya,Esentepe.....	404.34
Yenidoğan and Ahatlı	462.44	Erenköy	387.82
Teomanpaşa	554.37	Çamlıbel,Fatih	366.81
Düdenbaşı	447.30	Ünsal	278.94
Güneş	321.50	Santral, Kepez	383.57

Total cost for Kepez Municipality = 13,507 $ / week

= 54,028 $ / month

= 0.35 $ / person / month

Table 2.3 Continued

REGION	COST ($ / week)	REGION	COST ($ / week)
Liman and Gürsu	639.29	Sarısu, Hurma,.....441.40	
Altınkum, Kuşkavağı	560.32	Uluç, Uncalı,.....502.23	
Arapsuyu, Pınarbaşı	312.80		

Total cost for Konyaaltı Municipality = 2,456 $ / week
= 9,824 $ / month
= 0.38 $ / person / month

TOTAL = 45,919 $ / week

Cost of collection and transportation to Kepezüstü dumping area for Akdeniz Organize Industry Region = 522 $ / week

Costs of solid waste collection and transportation to Varsak dumping area according to regions are shown at table 2.4.

Table 2.4 Costs of Solid Waste Collection and Transportation to Varsak Dumping Area

REGION	COST ($ / week)	REGION	COST ($ / week)
Bahçelievler	637.91	Sinan	570.17
Varlık	1032.66	Haşim İşcan	521.39
Deniz	485.91	Elmalı and Kışla	628.16
Altındağ	560.81	Tahılpazarı	664.67
Memurevleri	554.82	Balbey	327.00
Yıldız	659.81	Zerdalilik	1032.04
Güvenlik	1004.67	Gençlik	580.71
Meltem	3149.78	Güzeloba	585.69
Çağlayan	647.88	Etiler	622.72

Table 2.4 Continued

REGION	COST ($ / week)	REGION	COST ($ / week)
Fener	1230.68	Yeşildere	623.41
Şirinyalı	1342.95	Kızılarık	635.83
Kızılsaray	554.60	Gebizli	294.76
Üçgen	824.73	Yenigün	652.45
Kaleiçi	606.80	Meydankav.,Çaybaşı	642.52
Yeşilbahçe	1221.47	Konuksever	652.19
Demircikara	1211.13	Dutlubahçe	443.32
Soğuksu	1310.28	Ermenek	445.73
Bayındır	937.05	Zümrütova	565.42
Yüksekalan	567.64	Güzeloluk	323.75
Tarım and Kırcami	587.99	Mehmetçik	322.94
Yenigöl and Yeşilova	545.37	Sanayi	1175.66
Topçular, Doğuyaka	435.99	Muratpaşa	634.23
Kızıltoprak	635.17	Sedir	639.06

Total cost for Muratpaşa Municipality = 32,701 $ / week

=130,804 $ / month

=0.39 $ / person / month

REGION	COST ($ / week)	REGION	COST ($ / week)
Emek	479.62	Sütçüler,Kuzeyyaka...	683.77
Karşıyaka	587.79	Gazi,Habipler.....	735.06
Yeni	485.08	Barış,Kütükçü	656.06
Yeni Emek	596.78	Yavuz Selim.....	286.46
Yükseliş	585.48	Gülveren,Duraliler	422.24
Ulus	538.55	Yeşilyurt, Şafak	746.20
Özgürlük	543.65	Zafer,Atatürk	681.41
Göksu, Sinan, Orta.....	551.76	Yeşiltepe	655.73

Table 2.4 Continued

REGION	COST ($ / week)	REGION	COST ($ / week)
Düden, Beşkonaklar,	....527.96	Kanal	562.09
Fabrikalar	395.49	M.A.Ersoy,	.....578.12
Kültür	680.00	Çankaya,Esentepe	.....648.31
Yenidoğan and Ahatlı	640.16	Erenköy	565.37
Teomanpaşa	648.28	Çamlıbel,Fatih	584.42
Düdenbaşı	453.61	Ünsal	423.11
Güneş	329.26	Santral, Kepez	675.13

Total cost for Kepez Municipality = 16,947 $ / week
= 67,788 $ / month
= 0.44 $ / person / month

REGION	COST ($ / week)	REGION	COST ($ / week)
Liman and Gürsu	760.34	Sarısu, Hurma,	.....582.20
Altınkum, Kuşkavağı	726.08	Uluç, Uncalı,	.....683.94
Arapsuyu, Pınarbaşı	412.64		

Total cost for Konyaaltı Municipality = 3,165 $ / week
= 12,660 $ / month
= 0.49 $ / person / month

TOTAL = 52,813 $ / week

Cost of collection and transportation to Varsak dumping area for Akdeniz Organize Industry Region = 952 $ / week

2.4 Collection Routes

Collection routes must be determined for using equipment and work force effectively. Optimum route is found with experiment. There are not absolute rules for determining the route.

Existing and optimum collection routes for two neigbourhoods are shown in appendix 5.

Existing collection routes are not applied. For vehicles, there is not a determined period of study daily. Sometimes, vehicles do not pour out all containers because there is not a control system. And so these create problems at the collection operation.

CHAPTER FOUR

OPTIMIZATION OF SOLID WASTE TRANSPORTATION

1. Necessity of Transfer Station

Purposes of transfer station are to reduce study period of garbage collection vehicles, to obstruct traffic density in way of garbage area and to make more economic the collection-transfer operation.

For this reason, 4 transfer stations have been chosen in Antalya.

Distances between regions and transfer stations are shown at table 1.1.

Table 1.1 Distances Between Regions and Transfer Stations

REGION	DISTANCE (km)			
	T_1	T_2	T_3	T_4
Bahçelievler	9.20	8.71	10.63	10.78
Varlık	8.90	8.45	10.00	10.90
Deniz	8.60	9.55	10.15	10.95
Altındağ	8.40	9.00	9.88	10.80
Memurevleri	8.40	8.20	9.70	9.58
Yıldız	8.80	7.80	9.50	9.98
Güvenlik	8.20	7.85	8.20	8.75
Meltem	10.45	7.75	9.95	11.23
Sinan	8.70	11.58	11.20	5.88

Table 1.1 Continued

REGION	DISTANCE (km)			
	T_1	T_2	T_3	T_4
Haşim İşcan	8.90	11.38	11.30	6.18
Elmalı and Kışla	7.53	9.59	9.96	10.48
Tahılpazarı	6.93	9.89	9.85	6.30
Balbey	7.20	10.20	10.15	6.10
Zerdalilik	7.41	10.55	11.98	6.08
Gençlik	7.57	10.37	12.10	6.18
Güzeloba	14.95	18.25	19.82	4.55
Çağlayan	14.60	17.88	19.55	4.30
Fener	12.13	15.75	17.34	5.98
Şirinyalı	11.65	13.50	15.09	7.08
Kızılsaray	8.05	9.53	10.20	9.60
Üçgen	7.95	9.47	10.10	9.50
Kaleiçi	8.18	11.65	10.61	6.43
Yeşilbahçe	8.94	11.90	13.98	5.65
Demircikara	8.04	11.00	12.83	5.25
Soğuksu	9.05	7.05	9.00	9.28
Bayındır	9.55	6.18	8.88	9.28
Yüksekalan	6.36	11.45	10.98	6.23
Etiler	6.02	11.28	10.65	5.97
Yeşildere	5.38	12.40	12.65	3.60
Kızılarık	5.38	12.10	12.35	3.90
Gebizli	7.15	14.15	12.83	4.65
Yenigün	7.28	13.93	12.71	4.93
Meydankavağı and Çaybaşı	5.86	12.12	13.48	4.74
Konuksever	7.92	14.87	9.65	5.97
Dutlubahçe	8.07	14.72	9.51	6.12
Ermenek	20.35	23.85	26.80	2.63

Table 1.1 Continued

REGION	DISTANCE (km)			
	T_1	T_2	T_3	T_4
Zümrütova	12.35	17.38	18.30	4.42
Güzeloluk	12.24	17.23	18.36	4.30
Tarım and Kırcami	9.78	14.30	17.18	3.80
Yenigöl and Yeşilova	9.71	17.18	17.03	1.29
Topçular and Doğuyaka	7.18	13.85	14.99	1.58
Kızıltoprak	9.09	15.75	14.24	3.82
Mehmetçik	9.10	15.90	14.39	3.65
Sanayi	8.90	13.85	8.75	7.20
Muratpaşa	8.90	14.05	8.87	7.70
Sedir	9.02	13.70	8.65	7.93
Emek	5.42	15.47	9.20	6.55
Karşıyaka	5.58	15.33	9.07	6.69
Yeni	4.63	16.90	8.79	8.03
Yeni Emek	4.78	16.78	8.67	8.15
Yükseliş	7.09	13.53	7.35	8.47
Ulus	7.16	13.48	7.31	8.50
Özgürlük	7.19	13.46	7.26	8.55
Göksu, Sinan, Orta,.....5.62		21.47	13.86	4.23
Düden, Beşkonaklar, Baraj	5.47	21.39	13.75	4.31
Sütçüler, Kuzeyyaka,.....	2.21	19.91	9.61	11.13
Gazi, Hüsnü Karakaş,.....0.78		21.16	11.66	9.88
Barış and Kütükçü	5.15	15.80	7.76	9.63
Yavuz Selim, ...4.99		16.80	6.96	10.78
Gülveren and Duraliler	12.18	3.65	7.58	15.25
Yeşilyurt and Şafak	12.00	3.98	7.40	15.19
Zafer and Atatürk	6.45	14.53	7.11	9.55
Yeşiltepe	7.88	8.48	6.30	11.65

Table 1.1 Continued

REGION	DISTANCE (km)			
	T_1	T_2	T_3	T_4
Kanal	7.86	8.55	5.50	11.72
Fabrikalar	9.61	7.21	6.04	13.20
Kültür	9.72	7.15	6.10	13.35
Yenidoğan and Ahatlı	9.66	7.18	5.98	13.50
Teomanpaşa	4.56	12.05	10.83	3.65
Düdenbaşı	4.58	12.20	10.92	3.78
Güneş	3.49	13.25	10.85	4.73
M.Akif Ersoy, Gündoğdu	3.42	13.05	10.70	4.85
Çankaya, Esentepe,.....	6.14	11.45	4.23	13.03
Erenköy	7.18	9.50	3.38	19.62
Çamlıbel and Fatih	7.25	9.68	3.45	19.69
Ünsal	9.59	9.45	4.03	22.82
Santral and Kepez	9.56	9.55	3.76	22.85
Liman and Gürsu	14.78	6.35	14.27	15.45
Altınkum and Kuşkavağı	14.40	6.23	14.03	15.18
Arapsuyu and Pınarbaşı	14.28	6.19	13.88	14.98
Sarısu, Hurma, Zümrüt,.....	17.65	5.98	15.71	18.43
Uluç,Uncalı,Öğretmenevi,.	14.20	5.28	12.64	14.98

1.1 Collection and Transportation of Solid Wastes to Transfer Stations T_1, T_2 and T_3

Formulas used for calculations and results are shown below.

(TOPRAK, (1998). Katı Atık Toplama, Taşıma ve Bertaraf Sistemlerinin Eniyilenmesi ve Ekonomisi. İzmir)

N_w : Number of weekly journey (journey/week)

V_w : Velocity of weekly solid waste production (m^3/week)

c : Averagely capacity of container (m^3/journey)

f : Container usage factor

t_w : Number of journey in a week (journey/week)

uc : Time for leaving empty container (hour/journey)

dbc : Time passing between containers (hour/journey)

a' and b' : Ampiric coefficients (hour/journey and km/journey)

x' : Distance between regions (km/journey)

D_w : Weekly period (day/week)

s : Time passing in the damping area (hour/journey)

a and b : Ampiric coefficients (hour/journey and km/journey)

x : Distance of dumping area (km/journey)

w : Factor of come back time

H : Daily period of study (hour/day)

C_t : Number of container pouring out for a journey (number/journey)

v : Volume of vehicle (m^3/journey)

r : Compressing ratio

c : Volume of container (m^3/container)

P_{SKS} : Period of collecting for a journey (hour/journey)

n_p : Number of container in region for a journey (region/journey)

1. $C_t = [(v)(r)] / [(c)(f)]$
2. $P_{SKS} = (C_t)(uc) + (n_p-1)(dbc) = (C_t)(uc) + (n_p-1)[(a')+(b')(x')]$
3. $N_w = (V_w) / (c)(f)$
4. $D_w = \{(N_w)(P_{SKS}) + (t_w)[(s) + (a) + (b)(2x)]\} / [(1-w)(H)]$

In these calculations, values accepted are shown below.

f : 0.90

r : 2.50

x' : 0.05 km

a' : 0.06 hour/journey for < 40 km/hour

b' : 0.04 km journey for < 40 km/hour

uc : 0.04 hour/journey

s : 0.15 hour/journey

a : 0.022 hour/journey for 72 km/hour

b : 0.014 km/journey for 72 km/hour

w : 0.12

As a result of calculations, optimum daily period of study were determined for every regions. These are shown at table 1.2.

Table 1.2 Optimum Daily Period For Collection and Transportation of Solid Wastes to Transfer Stations T_1, T_2, T_3

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Bahçelievler	13	750	48	4.834	192.85	6	7	8.71	5
Varlık	20	750	74	7.486	296.73	6	7	8.45	8
Deniz	13	750	48	4.834	148.40	5	5	8.60	6
Altındağ	10	750	37	3.712	178.01	7	7	8.40	5
Memurevleri	10	750	37	3.712	163.17	7	7	8.20	5
Yıldız	13	750	48	4.834	222.53	7	7	7.80	6
Güvenlik	20	750	74	7.486	296.73	6	7	7.85	8
Meltem (3 vehicles)	20	750	74 222	7.486	296.70 890.12	6	7	7.75	8
Sinan	13	750	48	4.834	192.85	6	7	8.70	5
H.İşcan	10	750	37	3.712	178.01	7	7	8.90	5
Elmalı, Kışla	13	750	48	4.834	192.78	6	7	7.53	5
Tahılpazarı	15	750	56	5.650	267.05	7	7	6.93	7
Balbey	6	750	23 46	2.284	89.04	6	3	7.20	6
Gençlik	13	750	48	4.834	192.85	6	7	7.57	5

Table 1.2 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Zerdalilik (2 vehicles)	10	750	37 74	3.712	163.21 326.41	7	7	7.41	5
Güzeloba	13	750	48	4.834	207.69	7	7	14.95	6
Çağlayan	15	750	56	5.650	267.05	7	7	14.60	7
Fener (2 vehicles)	13	750	48 96	4.834	215.11 430.22	7	7	12.13	6
Şirinyalı (2 vehicles)	15	750	56 112	5.650	252.21 504.42	7	7	11.65	7
Kızılsaray	10	750	37	3.712	163.17	7	7	8.05	5
Üçgen	6	750	23 46	2.284	207.76	14	7	7.95	6
Kaleiçi	6				89.04		7	8.18	8
Yeşilbahçe (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	8.94	6
Demircikara (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	8.04	6
Soğuksu (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	7.05	6
Bayındır (2 vehicles)	13	750	48 96	4.834	163.21 326.41	5	5	6.18	6
Yüksekalan	13	750	48	4.834	222.53	7	7	6.36	6
Etiler	13	750	48	4.834	237.37	7	7	6.02	6
Yeşildere	20	750	74	7.486	296.73	6	7	5.38	8
Kızılarık	15	750	56	5.650	267.05	7	7	5.38	7
Gebizli	6	750	23 46	2.284	89.04	6	3	7.15	6

Table 1.2 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Yenigün	20	750	74	7.486	296.66	6	7	7.28	8
Meydankavağı, Çaybaşı	15	750	56	5.650	252.14	7	7	5.86	7
Konuksever	20	750	74	7.486	281.89	6	7	7.92	8
Dutlubahçe	13	750	48	4.834	148.40	5	5	8.07	6
Ermenek	10	750	37	3.712	178.01	7	7	20.35	5
Zümrütova	13	750	48	4.834	192.85	6	7	12.35	5
Güzeloluk	10	750	37	3.712	118.65	5	5	12.24	5
Tarım and Kırcami	13	750	48	4.834	237.37	7	7	9.78	6
Yenigöl and Yeşilova	13	750	48	4.834	207.69	7	7	9.71	6
Topçular and Doğuyaka	10	750	37	3.712	178.01	7	7	7.18	5
Kızıltoprak	20	750	74	7.486	296.73	6	7	9.09	8
Mehmetçik	10	750	37	3.712	118.65	5	5	9.10	5
Sanayi (2 vehicles)	13	750	48 96	4.834	192.89 385.77	6	7	8.75	5
Muratpaşa	13	750	48	4.834	207.69	7	7	8.87	6
Sedir	13	750	48	4.834	207.76	7	7	8.65	6
Emek	10	750	37	3.712	147.98	6	7	5.42	4
Karşıyaka	13	750	48	4.834	207.13	6	7	5.58	5
Yeni	10	750	37	3.712	147.98	6	7	4.63	4
Yeni Emek	13	750	48	4.834	192.36	6	7	4.78	5
Yükseliş	13	750	48	4.834	192.36	6	7	7.09	5

Table 1.2 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Ulus	10	750	37	3.712	177.59	7	7	7.16	5
Özgürlük	10	750	37	3.712	177.59	7	7	7.19	5
Göksu,Sinan Orta,Mende.	6	220	72	7.282	88.76	6	7	5.62	7
Düden,Beşk. Baraj	5	220	60	6.058	73.99	6	7	5.47	6
Sütçüler,Kuzeyyaka,F.Ç	15	750	56	5.650	266.28	7	7	2.21	7
Gazi, H.Karakaş,Habipler	6	220	72	7.282	118.37	8	7	0.78	10
Barış and Kütükçü	13	750	48	4.834	236.67	7	7	5.15	6
Y.Selim and K.Karabekir	13	750	48	4.834	103.60	3	3	4.99	6
Gülveren, Duraliler	10	750	37	3.712	133.14	5	5	3.65	5
Yeşilyurt and Şafak	15	750	56	5.650	266.35	7	7	3.98	7
Zafer and Atatürk	15	750	56	5.650	251.51	7	7	6.45	7
Yeşiltepe	13	750	48	4.834	221.90	7	7	6.30	6
Kanal	10	750	37	3.712	177.59	7	7	5.50	5
Fabrikalar	10	750	37	3.712	133.14	5	5	6.04	5
Kültür	13	750	48	4.834	221.90	7	7	6.10	6
Teomanpaşa	15	750	56	5.650	266.35	7	7	4.56	7

Table 1.2 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Yenidoğan, Ahatlı	13	750	48	4.834	192.29	6	7	5.98	5
Düdenbaşı	10	750	37	3.712	177.59	7	7	4.58	5
Güneş	10	750	37	3.712	118.37	5	5	3.49	5
M.A.Ersoy, Gündoğdu	13	750	48	4.834	192.29	6	7	3.42	5
Çanka,Esen-tepe,Göçerl.	13	750	48	4.834	192.29	6	7	4.23	5
Erenköy	10	750	37	3.712	162.75	7	7	3.38	5
Çamlıbel and Fatih	10	750	37	3.712	177.45	7	7	3.45	5
Ünsal	10	750	37	3.712	118.37	5	5	4.03	5
Santral and Kepez	13	750	48	4.834	192.29	6	7	3.76	5
Liman and Gürsu	13	800	45	4.528	228.27	7	7	6.35	6
Altınkum, Kuşkavağı	13	800	45	4.528	234.08	7	7	6.23	6
Arapsuyu, Pınarbaşı	10	800	35	3.508	117.04	5	5	6.19	4
Sarısu, Hurma.....	10	800	35	3.508	146.37	6	7	5.98	4
Uluç, Uncalı.....	13	800	45	4.528	196.07	6	7	5.28	5

1.2 Collection and Transportation of Solid Wastes to Transfer Stations T_1, T_2 and T_4

Formulas used for calculations and results are shown below.

(TOPRAK, (1998). Katı Atık Toplama, Taşıma ve Bertaraf Sistemlerinin Eniyilenmesi ve Ekonomisi. İzmir)

N_w : Number of weekly journey (journey/week)

V_w : Velocity of weekly solid waste production (m^3/week)

c : Averagely capacity of container (m^3/journey)

f : Container usage factor

t_w : Number of journey in a week (journey/week)

uc : Time for leaving empty container (hour/journey)

dbc : Time passing between containers (hour/journey)

a' and b' : Ampiric coefficients (hour/journey and km/journey)

x' : Distance between regions (km/journey)

D_w : Weekly period (day/week)

s : Time passing in the dumping area (hour/journey)

a and b : Ampiric coefficients (hour/journey and km/journey)

x : Distance of damping area (km/journey)

w : Factor of come back time

H : Daily period of study (hour/day)

C_t : Number of container pouring out for a journey (number/journey)

v : Volume of vehicle (m^3/journey)

r : Compressing ratio

c : Volume of container (m^3/container)

P_{SKS} : Period of collecting for a journey (hour/journey)

n_p : Number of container in region for a journey (region/journey)

1. $C_t = [(v)(r)] / [(c)(f)]$
2. $P_{SKS} = (C_t)(uc) + (n_p-1)(dbc) = (C_t)(uc) + (n_p-1)[(a')+(b')(x')]$

3. $N_w = (V_w) / (c)(f)$
4. $D_w = \{(N_w)(P_{SKS}) + (t_w)[(s) + (a) + (b)(2x)]\} / [(1-w)(H)]$

In these calculations, values accepted are shown below.

f : 0.90

r : 2.50

x' : 0.05 km

a' : 0.06 hour/journey for < 40 km/hour

b' : 0.04 km journey for < 40 km/hour

uc : 0.04 hour/journey

s : 0.15 hour/journey

a : 0.022 hour/journey for 72 km/hour

b : 0.014 km/journey for 72 km/hour

w : 0.12

As a result of calculations, optimum daily period of study were determined for every regions. These are shown at table 1.3.

Table 1.3 Optimum Daily Period For Collection and Transportation of Solid Wastes to Transfer Stations T_1, T_2, T_4

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Bahçelievler	13	750	48	4.834	192.85	6	7	8.71	5
Varlık	20	750	74	7.486	296.73	6	7	8.45	8
Deniz	13	750	48	4.834	148.40	5	5	8.60	6
Altındağ	10	750	37	3.712	178.01	7	7	8.40	5
Memurevleri	10	750	37	3.712	163.17	7	7	8.20	5
Yıldız	13	750	48	4.834	222.53	7	7	7.80	6
Güvenlik	20	750	74	7.486	296.73	6	7	7.85	8

Table 1.3 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Meltem (3 vehicles)	20	750	74 222	7.486	296.70 890.12	6	7	7.75	8
Sinan	13	750	48	4.834	192.85	6	7	5.88	5
H.İşcan	10	750	37	3.712	178.01	7	7	6.18	5
Elmalı, Kışla	13	750	48	4.834	192.78	6	7	7.53	5
Tahılpazarı	15	750	56	5.650	267.05	7	7	6.30	7
Balbey	6	750	23 46	2.284	89.04	6	3	6.10	6
Zerdalilik (2 vehicles)	10	750	37 74	3.712	163.21 326.41	7	7	6.08	5
Gençlik	13	750	48	4.834	192.85	6	7	6.18	5
Güzeloba	13	750	48	4.834	207.69	7	7	4.55	6
Çağlayan	15	750	56	5.650	267.05	7	7	4.30	7
Fener (2 vehicles)	13	750	48 96	4.834	215.11 430.22	7	7	5.98	6
Şirinyalı (2 vehicles)	15	750	56 112	5.650	252.21 504.42	7	7	7.08	7
Kızılsaray	10	750	37	3.712	163.17	7	7	8.05	5
Üçgen	6	750	23 46	2.284	207.76	14	7	7.95	6
Kaleiçi	6				89.04		7	6.43	8
Yeşilbahçe (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	5.65	6
Demircikara (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	5.25	6
Yüksekalan	13	750	48	4.834	222.53	7	7	6.23	6

Table 1.3 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Soğuksu (2 vehicles)	13	750	48 96	4.834	222.53 445.06	7	7	7.05	6
Bayındır (2 vehicles)	13	750	48 96	4.834	163.21 326.41	5	5	6.18	6
Etiler	13	750	48	4.834	237.37	7	7	5.97	6
Yeşildere	20	750	74	7.486	296.73	6	7	3.60	8
Kızılarık	15	750	56	5.650	267.05	7	7	3.90	7
Gebizli	6	750	23 46	2.284	89.04	6	3	4.65	6
Yenigün	20	750	74	7.486	296.66	6	7	4.93	8
Meydankavağı, Çaybaşı	15	750	56	5.650	252.14	7	7	4.74	7
Konuksever	20	750	74	7.486	281.89	6	7	5.97	8
Dutlubahçe	13	750	48	4.834	148.40	5	5	6.12	6
Ermenek	10	750	37	3.712	178.01	7	7	2.63	5
Zümrütova	13	750	48	4.834	192.85	6	7	4.42	5
Güzeloluk	10	750	37	3.712	118.65	5	5	4.30	5
Tarım and Kırcami	13	750	48	4.834	237.37	7	7	3.80	6
Yenigöl and Yeşilova	13	750	48	4.834	207.69	7	7	1.29	6
Topçular and Doğuyaka	10	750	37	3.712	178.01	7	7	1.58	5
Kızıltoprak	20	750	74	7.486	296.73	6	7	3.82	8
Mehmetçik	10	750	37	3.712	118.65	5	5	3.65	5
Muratpaşa	13	750	48	4.834	207.69	7	7	7.70	6

Table 1.3 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	X km	H hour/day
Sanayi (2 vehicles)	13	750	48 96	4.834	192.89 385.77	6	7	7.20	5
Sedir	13	750	48	4.834	207.76	7	7	7.93	6
Emek	10	750	37	3.712	147.98	6	7	5.42	4
Karşıyaka	13	750	48	4.834	207.13	6	7	5.58	5
Yeni	10	750	37	3.712	147.98	6	7	4.63	4
Yeni Emek	13	750	48	4.834	192.36	6	7	4.78	5
Yükseliş	13	750	48	4.834	192.36	6	7	7.09	5
Ulus	10	750	37	3.712	177.59	7	7	7.16	5
Özgürlük	10	750	37	3.712	177.59	7	7	7.19	5
Göksu,Sinan Orta,Mende.	6	220	72	7.282	88.76	6	7	4.23	7
Düden,Beşk. Baraj	5	220	60	6.058	73.99	6	7	4.31	6
Sütçüler,Kuzeyyaka,F.Ç	15	750	56	5.650	266.28	7	7	2.21	7
Gazi, H.Karakaş,Habipler	6	220	72	7.282	118.37	8	7	0.78	10
Barış and Kütükçü	13	750	48	4.834	236.67	7	7	5.15	6
Y.Selim and K.Karabekir	13	750	48	4.834	103.60	3	3	4.99	6
Gülveren, Duraliler	10	750	37	3.712	133.14	5	5	3.65	5
Yeşilyurt and Şafak	15	750	56	5.650	266.35	7	7	3.98	7

Table 1.3 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Zafer and Atatürk	15	750	56	5.650	251.51	7	7	6.45	7
Yeşiltepe	13	750	48	4.834	221.90	7	7	7.88	6
Kanal	10	750	37	3.712	177.59	7	7	7.86	5
Fabrikalar	10	750	37	3.712	133.14	5	5	7.21	5
Kültür	13	750	48	4.834	221.90	7	7	7.15	6
Yenidoğan, Ahatlı	13	750	48	4.834	192.29	6	7	7.18	5
Teomanpaşa	15	750	56	5.650	266.35	7	7	3.65	7
Düdenbaşı	10	750	37	3.712	177.59	7	7	3.78	5
Güneş	10	750	37	3.712	118.37	5	5	3.49	5
M.A.Ersoy, Gündoğdu	13	750	48	4.834	192.29	6	7	3.42	5
Çanka,Esen-tepe,Göçerl.	13	750	48	4.834	192.29	6	7	6.14	5
Erenköy	10	750	37	3.712	162.75	7	7	7.18	5
Çamlıbel and Fatih	10	750	37	3.712	177.45	7	7	7.25	5
Ünsal	10	750	37	3.712	118.37	5	5	9.45	5
Santral and Kepez	13	750	48	4.834	192.29	6	7	9.55	5
Liman and Gürsu	13	800	45	4.528	228.27	7	7	6.35	6
Altınkum, Kuşkavağı	13	800	45	4.528	234.08	7	7	6.23	6

Table 1.3 Continued

REGION	v m^3	c lt	C_t	P_{SKS}	V_w m^3/week	N_w	D_w	x km	H hour/day
Arapsuyu, Pınarbaşı	10	800	35	3.508	117.04	5	5	6.19	4
Sarısu, Hurma.....	10	800	35	3.508	146.37	6	7	5.98	4
Uluç, Uncalı.....	13	800	45	4.528	196.07	6	7	5.28	5

1.3 Collection and Transportation Costs of Vehicles

Collection and transportation cost of vehicles was calculated with respect to cost values which are determined at chapter three, in section 2.3.

Costs of solid waste collection and transportation to transfer stations from regions are shown at table 1.4.

Table 1.4 Costs of Solid Waste Collection and Transportation to T_1-T_2-T_3-T_4 Transfer Stations

REGION	COST ($ / week)			
	T_1	T_2	T_3	T_4
Bahçelievler	427.30	421.23	444.96	446.80
Varlık	550.40	545.13	564.19	575.14
Deniz	329.96	338.27	343.54	350.64
Altındağ	391.71	424.80	405.34	413.61
Memurevleri	391.59	389.80	403.63	402.52
Yıldız	464.51	452.04	473.03	478.81
Güvenlik	541.88	537.83	541.88	548.78

Table 1.4 Continued

REGION	COST ($ / week)			
	T_1	T_2	T_3	T_4
Meltem	1708.11	1608.35	1689.86	1737.30
Sinan	421.23	456.56	452.07	386.44
Haşim İşcan	396.34	419.21	418.48	371.28
Elmalı and Kışla	406.73	432.04	436.79	443.11
Tahılpazarı	484.36	520.86	520.49	476.69
Balbey	209.69	233.42	233.06	200.93
Zerdalilik	764.89	822.87	849.18	740.36
Gençlik	407.26	441.79	463.15	390.13
Güzeloba	539.98	580.86	600.16	412.22
Çağlayan	578.89	619.41	639.85	451.87
Fener	1011.95	1101.32	1140.13	860.24
Şirinyalı	1085.12	1130.62	1169.91	972.05
Kızılsaray	388.47	431.28	408.09	402.74
Üçgen	502.79	530.89	542.53	531.46
Kaleiçi	547.65	547.65	538.16	499.58
Yeşilbahçe	931.92	1004.91	1056.00	851.00
Demircikara	910.02	983.01	1028.03	841.28
Soğuksu	934.96	885.68	933.74	940.43
Bayındır	677.47	662.76	665.43	672.57
Yüksekalan	434.40	497.06	491.28	432.88
Etiler	430.29	494.86	487.40	429.64
Yeşildere	507.00	593.80	596.64	485.10
Kızılarık	465.00	548.23	551.15	446.76
Gebizli	209.20	282.59	272.24	189.49
Yenigün	530.39	612.31	597.30	501.60
Meydankavağı and Çaybaşı	471.20	548.42	564.96	457.42
Konuksever	538.23	623.70	559.41	513.98

Table 1.4 Continued

REGION	COST ($ / week)			
	T_1	T_2	T_3	T_4
Dutlubahçe	325.29	383.90	338.07	308.26
Ermenek	501.93	534.29	603.38	338.43
Zümrütova	466.04	527.99	581.24	368.51
Güzeloluk	305.75	338.84	346.30	253.36
Tarım and Kırcami	476.37	532.18	567.55	403.03
Yenigöl and Yeşilova	475.53	567.52	565.53	371.91
Topçular and Doğuyaka	380.52	441.83	452.29	328.70
Kızıltoprak	552.83	635.17	616.51	487.94
Mehmetçik	284.99	330.08	320.02	248.98
Sanayi	847.21	968.99	843.52	805.56
Muratpaşa	465.60	529.19	465.31	450.83
Sedir	467.30	524.65	462.47	453.67
Emek	322.31	415.32	357.29	332.82
Karşıyaka	383.47	503.74	426.48	397.05
Yeni	315.23	428.46	353.45	346.57
Yeni Emek	372.79	520.54	420.90	414.33
Yükseliş	401.45	480.58	404.60	418.54
Ulus	380.31	438.80	381.77	392.69
Özgürlük	380.55	438.56	381.28	393.17
Göksu, Sinan, Orta, Menderes	451.49	640.51	569.97	438.74
Düden, Beşkonaklar, Baraj	405.81	594.35	524.01	395.29
Sütçüler, Kuzeyyaka,.....	425.76	643.74	516.74	535.30
Gazi, Hüsnü Karakaş, Habipler	532.00	762.56	632.64	616.30
Barış and Kütükçü	419.90	551.24	452.25	475.22
Yavuz Selim,.....	179.12	241.57	189.60	209.71
Gülveren and Duraliler	305.03	248.79	274.64	325.23
Yeşilyurt and Şafak	546.00	447.36	489.58	585.68

Table 1.4 Continued

REGION	COST ($ / week)			
	T_1	T_2	T_3	T_4
Zafer and Atatürk	478.23	577.58	486.13	516.39
Yeşiltepe	453.74	461.32	434.33	500.45
Kanal	386.86	393.17	365.02	422.54
Fabrikalar	288.11	272.27	264.45	311.77
Kültür	476.79	444.94	431.90	521.37
Yenidoğan and Ahatlı	433.00	402.50	387.78	480.32
Teomanpaşa	454.64	547.09	531.80	443.35
Düdenbaşı	356.53	426.91	415.02	349.25
Güneş	247.39	311.79	295.93	255.64
M.Akif Ersoy and Gündoğdu	356.23	474.80	445.88	373.84
Çankaya, Esentepe, Göçerler	389.62	455.08	366.22	474.53
Erenköy	380.70	402.06	345.54	495.51
Çamlıbel and Fatih	381.12	403.44	345.95	495.87
Ünsal	287.52	286.71	250.95	374.73
Santral and Kepez	431.94	431.68	360.44	637.27
Liman and Gürsu	538.20	434.62	531.96	546.62
Altınkum and Kuşkavağı	534.08	433.28	529.28	543.68
Arapsuyu and Pınarbaşı	318.88	235.52	316.32	323.52
Sarısu, Hurma, Zümrüt,.....	435.20	327.40	417.40	442.40
Uluç, Uncalı, Öğretmenevi,.....	489.37	379.22	470.07	498.75

1.4 Numbers of Vehicles

Numbers of garbage vehicles change according to different alternatives done for collection-transportation operation.

Program which is done as an example is shown below.

Capacity of transfer station T_1 is 480 tone/week

Capacity of transfer station T_2 is 570 tone/week

Capacity of transfer station T_3 is 250 tone/week

Capacity of transfer station T_4 is 1200 tone/week

For T_1;

Region	**Capacity of Vehicle**	**Day/week**	**Hour/day**	**Shift**
Üçgen	6 m^3	7	7	05.00-12.00
Yeşildere	20 m^3	7	8	05.00-13.00
Altındağ	10 m^3	7	5	05.00-10.00
Kızılsaray	10 m^3	7	5	20.00-01.00
Deniz	13 m^3	5	6	05.00-11.00
Elmalı and Kışla	13 m^3	7	6	05.00-11.00
Gazi.....	6 m^3	7	11	05.00-11.00 20.00-01.00
Sütçüler.....	15 m^3	7	8	05.00-13.00
Zafer.....	15 m^3	7	7	20.00-03.00
Emek	10 m^3	7	5	20.00-01.00
Yeni	10 m^3	7	5	20.00-01.00
Ulus	10 m^3	7	5	20.00-01.00
Özgürlük	10 m^3	7	5	05.00-10.00
Güneş	10 m^3	5	5	20.00-01.00
Karşıyaka	13 m^3	7	6	20.00-02.00
Yeni Emek	13 m^3	7	6	20.00-02.00
Yükseliş	13 m^3	7	6	20.00-02.00
Barış and Kütükçü	13 m^3	7	7	20.00-03.00
Yavuz Selim.....	13 m^3	3	7	05.00-12.00
M.Akif Ersoy.....	13 m^3	7	6	05.00-11.00

For T_2;

Region	Capacity of Vehicle	Day/week	Hour/day	Shift
Varlık	20 m^3	7	8	20.00-04.00
Güvenlik	20 m^3	7	8	20.00-04.00
Meltem 1	20 m^3	7	8	05.00-13.00
Meltem 2	20 m^3	7	8	20.00-04.00
Meltem 3	20 m^3	7	8	20.00-04.00
Memurevleri	10 m^3	7	5	05.00-10.00
Bahçelievler	13 m^3	7	6	20.00-02.00
Yıldız	13 m^3	7	6	05.00-11.00
Soğuksu 1	13 m^3	7	7	05.00-12.00
Soğuksu 2	13 m^3	7	7	05.00-12.00
Bayındır 1	13 m^3	7	5	05.00-10.00
Bayındır 2	13 m^3	7	5	20.00-01.00
Yeşilyurt.....	15 m^3	7	7	05.00-12.00
Gülveren.....	10 m^3	5	5	20.00-01.00
Liman	13 m^3	7	7	05.00-12.00
Altınkum	13 m^3	7	6	05.00-11.00
Uluç	13 m^3	7	5	20.00-01.00
Arapsuyu	10 m^3	5	5	05.00-10.00
Sarısu	10 m^3	7	4	20.00-00.00

For T_3;

Region	Capacity of Vehicle	Day/week	Hour/day	Shift
Fabrikalar	10 m^3	5	5	05.00-10.00
Kanal	10 m^3	7	5	05.00-10.00
Erenköy	10 m^3	7	5	05.00-10.00
Çamlıbel.....	10 m^3	7	5	05.00-10.00

T_3 Continued

Region	Capacity of Vehicle	Day/week	Hour/day	Shift
Ünsal	10 m^3	5	5	05.00-10.00
Yeşiltepe	13 m^3	7	6	05.00-11.00
Kültür	13 m^3	7	6	05.00-11.00
Yenidoğan.....	13 m^3	7	6	05.00-11.00
Santral.....	13 m^3	7	5	05.00-10.00
Çankaya.....	13 m^3	7	5	05.00-10.00

For T_4;

Region	Capacity of Vehicle	Day/week	Hour/day	Shift
Balbey	6 m^3	3	7	20.00-03.00
Gebizli	6 m^3	3	7	20.00-03.00
Kaleiçi	6 m^3	7	8	05.00-13.00
Yenigün	20 m^3	7	8	05.00-13.00
Konuksever	20 m^3	7	8	05.00-13.00
Kızıltoprak	20 m^3	7	8	20.00-04.00
Haşim İşcan	10 m^3	7	5	20.00-01.00
Güzeloluk	10 m^3	5	6	05.00-11.00
Zerdalilik 1	10 m^3	7	5	05.00-10.00
Zerdalilik 2	10 m^3	7	5	20.00-01.00
Ermenek	10 m^3	7	6	20.00-02.00
Topçular.....	10 m^3	7	6	20.00-02.00
Mehmetçik	10 m^3	5	5	20.00-01.00
Tahılpazarı	15 m^3	7	7	20.00-03.00
Çağlayan	15 m^3	7	8	05.00-13.00
Şirinyalı 1	15 m^3	7	8	20.00-04.00
Şirinyalı 2	15 m^3	7	8	05.00-13.00

T_4 Continued

Region	Capacity of Vehicle	Day/week	Hour/day	Shift
Kızılarık	15 m^3	7	8	05.00-13.00
Meydankavağı.....	15 m^3	7	8	20.00-04.00
Sinan	13 m^3	7	6	20.00-02.00
Gençlik	13 m^3	7	6	05.00-11.00
Güzeloba	13 m^3	7	7	20.00-03.00
Zümrütova	13 m^3	7	6	05.00-11.00
Fener 1	13 m^3	7	7	05.00-12.00
Fener 2	13 m^3	7	7	20.00-03.00
Yeşilbahçe 1	13 m^3	7	7	05.00-12.00
Yeşilbahçe 2	13 m^3	7	7	20.00-03.00
Demircikara 1	13 m^3	7	7	05.00-12.00
Demircikara 2	13 m^3	7	7	20.00-03.00
Yüksekalan	13 m^3	7	7	20.00-03.00
Etiler	13 m^3	7	7	20.00-03.00
Tarım.....	13 m^3	7	7	20.00-03.00
Dutlubahçe	13 m^3	5	7	05.00-12.00
Yenigöl.....	13 m^3	7	7	20.00-03.00
Sanayi 1	13 m^3	7	6	05.00-11.00
Sanayi 2	13 m^3	7	6	20.00-02.00
Muratpaşa	13 m^3	7	7	20.00-03.00
Sedir	13 m^3	7	7	20.00-03.00
Teomanpaşa	15 m^3	7	7	20.00-03.00
Düden.....	5 m^3	7	7	20.00-03.00
Göksu.....	6 m^3	7	8	20.00-04.00
Düdenbaşı	10 m^3	7	5	20.00-01.00

As a result;

Number of vehicles for Muratpaşa Municipality,

2 vehicles with 6 m^3 capacity

5 vehicles with 20 m^3 capacity

6 vehicles with 10 m^3 capacity

14 vehicles with 13 m^3 capacity

3 vehicles with 15 m^3 capacity

TOTAL = 30 vehicles

Number of vehicles for Kepez Municipality,

2 vehicles with 6 m^3 capacity

1 vehicles with 5 m^3 capacity

2 vehicles with 15 m^3 capacity

6 vehicles with 10 m^3 capacity

7 vehicles with 13 m^3 capacity

TOTAL = 18 vehicles

Number of vehicles for Konyaaltı Municipality,

2 vehicles with 13 m^3 capacity

1 vehicles with 10 m^3 capacity

TOTAL = 3 vehicles

Capacities of transfer stations according to shift are shown below.

From Muratpaşa Municipality to transfer station T_1 : 05.00-13.00 = 20.00 tone/day

20.00-01.00 = 3.19 tone/day

From Kepez Municipality to transfer station T_1 : 05.00-13.00 = 15.61 tone/day

20.00-03.00 = 33.81 tone/day

Total 05.00-13.00 = 35.61 tone/day [one journey]

20.00-03.00 = 37.00 tone/day [one journey]

From Muratpaşa Municipality to transfer station T_2 : 05.00-13.00 = 25.21 tone/day
20.00-04.00 = 30.13 tone/day
From Kepez Municipality to transfer station T_2 : 05.00-12.00 = 5.20 tone/day
20.00-01.00 = 2.60 tone/day
From Konyaaltı Municipality to transfer station T_2 : 05.00-12.00 = 11.31 tone/day
20.00-01.00 = 6.69 tone/day
Total 05.00-13.00 = 41.72 tone/day [one journey]
20.00-04.00 = 39.42 tone/day [one journey]

From Kepez Municipality to transfer station T_3 : 05.00-11.00 = 34.97 tone/day
Total 05.00-11.00 = 34.97 tone/day [one journey]

From Muratpaşa Municipality to transfer station T_4 : 05.00-13.00 = 60.99 tone/day
20.00-04.00 = 90.58 tone/day
From Kepez Municipality to transfer station T_4 : 20.00-04.00 = 11.85 tone/day
Total 05.00-13.00 = 60.99 tone/day [two journies]
20.00-04.00 = 102.43 tone/day [three journies]

2. Example of One Alternative For Optimization of Transportation System With Simplex Method

Transportation cost of tır was determined according to solid waste cost analysis whichz is done by İzmir Maincity Municipality in 1997.

Cost of transportation with tır;

Fuel : (1.1 lt/km)(2*X km/day)(0.5 $/lt) = ...$/day
Wheel : (300 $*18 / 30,000 km)(2*X km/day) =.....$/day
Spare part : (Fuel)(30 %) =.....$/day
Workers' pay : (one driver) + (one worker)
(480 $/month*2)(30 day/month) = 32 $/day
Amortization : (87,000 $/ 7 years)(365 day/year) = 34 $/day

Security : (Fuel)(50 %) = ...$/day

Distance between transfer stations and dumping areas are shown below.

DUMPING AREAS	TRANSFER STATİONS			
	T_1	T_2	T_3	T_4 (km)
Varsak	18.35	26.50	28.00	11.08
Kepezüstü	14.35	15.43	4.00	18.58

From 81 regions to 4 transfer stations, from 4 transfer stations and organize industry region to Varsak (compost) and Kepezüstü (landfill) (table 2.14).

Density of compressing solid waste is 316.41 kg/m^3.

In tansfer stations, 120 m^3 tır is used.

Capacity of T_1 = 480 tone/week

= 68.57 tone/day

= 216.71 m^3/day

Number of journey the tır used

for T_1 transfer station = (216.71 m^3/day)/(120 m^3/journey)

= 2 journey/day

Capacity of T_2 = 570 tone/week

= 81.43 tone/day

= 257.35 m^3/day

Number of journey the tır used

for T_2 transfer station = (257.35 m^3/day)/(120 m^3/journey)

= 2 journey/day

Capacity of T_3 = 250 tone/week

= 35.71 tone/day

= 112.87 m^3/day

Number of journey the tır used

for T_3 transfer station = (112.87 m^3/day)/(120 m^3/journey)

= 1 journey/day

Capacity of T_4 = 1200 tone/week

= 171.43 tone/day

= 541.79 m^3/day

Number of journey the tır used

for T_4 transfer station = (541.79 m^3/day)/(120 m^3/journey)

= 5 journey/day

Cost of collection from regions and transportation to T_1 is 7,214 $/week.

Cost of collection from regions and transportation to T_2 is 8,009 $/week.

Cost of collection from regions and transportation to T_3 is 3,553 $/week.

Cost of collection from regions and transportation to T_4 is 17,405 $/week.

TOTAL = 36,180 $/week

Costs of transportation from transfer stations to disposal units are shown below.

Cost of transportation from T_1 transfer station to Kepezüstü landfill area is totally 133.83 $ and (133.83 $)/(68.57 tone/day) = 1.95 $/tone

Cost of transportation from T_1 transfer station to Varsak compost area is totally 149.67 $ and (149.67 $)/(68.57 tone/day) = 2.18 $/tone.

Cost of transportation from T_2 transfer station to Kepezüstü landfill area is totally 138.11 $ and (138.11 $)/(81.43 tone/day) = 1.70 $/tone

Cost of transportation from T_2 transfer station to Varsak compost area is totally 181.94 $ and (181.94 $)/(81.43 tone/day) = 2.23 $/tone

Cost of transportation from T_3 transfer station to Kepezüstü landfill area is totally 84.92 $ and (84.92 $)/(35.71 tone/day) = 2.38 $/tone

Cost of transportation from T_3 transfer station to Varsak compost area is totally 132.44 $ and (132.44 $)/(35.71 tone/day) = 3.71 $/tone

Cost of transportation from T_4 transfer station to Kepezüstü landfill area is totally 187.36 $ and (187.36 $)/(85.71 tone/day) = 2.19 $/tone

Cost of transportation from T_2 transfer station to Varsak compost area is totally 142.81 $ and (142.81 $)/(85.71 tone/day) = 1.67 $/tone

DISPOSAL UNIT	Y_1[Varsak(compost)]	Y_2[Kepezüstü(landfill)]
CAPACİTY	1950 tone/week	650 tone/week
COST ($/year)	(6.67)(1950)(52) ($/tone)(tone/week)(week/year) = 676,338	(2.3)(650)(52) ($/tone)(tone/week)(week/year) = 77,740
WEEKLY CONSTANT COST	676,338 / 52 = 13.00 $/week	77,740 / 52 = 1.50 $/week

Decision variable;

X_{ij} =Amount of solid waste which will be carried to j disposal unit from i region.

Mass balance;

$$\sum_{j=1}^{2} X_{1j} = 480 \qquad \sum_{j=1}^{2} X_{3j} = 250$$

$$\sum_{j=1}^{2} X_{2j} = 570 \qquad \sum_{j=1}^{2} X_{4j} = 1200$$

Capacity restriction;

$$\sum_{i=1}^{4} X_{i1} =< 1950 \qquad \sum_{i=1}^{4} X_{i2} =< 650$$

Objective function;

$$\text{Min } Z = 2.18*(X_{11})+1.95*(X_{12})+2.23*(X_{21})+1.70*(X_{22})+ 3.71*(X_{31})+2.38*(X_{32})+ 1.67*(X_{41})+2.19*(X_{42})+15.11*(X_{org.1})+8.29*(X_{org.2})$$

After forming the functions; problem was solved with simplex method and results at table 2.14 were provided.

Total cost of transportation and removed (Z);

$$Z = 13.00*(Y_1)+1.50*(Y_2)+2.18*(X_{11})+1.95*(X_{12})+2.23*(X_{21})+1.70*(X_{22})+ 3.71*(X_{31})+2.38*(X_{32})+1.67*(X_{41})+2.19*(X_{42})+15.11*(X_{org.1})+8.29*(X_{org.2})$$

$Z = 31{,}790$ \$/week

Total Cost = (36,180 \$/week) + (31,790 \$/week)
= 67,970 \$/week

Providing incomes;

For Varsak compost unit

Compost : (769 tone/week)*(15 \$/tone) = 11,535 \$/week

Plastic : (173 tone/week)*(95 \$/tone) = 16,435 \$/week

Paper : (321 tone/week)*(25 \$/tone) = 8,025 \$/week

Tinplate-Metal : (84 tone/week)*(7 \$/tone) = 588 \$/week

TOTAL = 36,583 \$/week

Total Cost = (67,970 \$/week) – (36,583 \$/week)
= 31,387 \$/week

Table 2.1 From 81 Regions and Organize Industry to Kepezüstü and Varsak Landfill Area

(Results of Simplex Method)

Y_1 (Varsak Landfill Capacity) = 550 tone/week

Y_2 (Kepezüstü Landfill Capacity) = 2050 tone/week

Total Cost = 56,341 $/week = 225,364 $/month

= 0.44 $/person/month

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2
1		26.36	24		60.83
2		40.56	25		60.83
3		20.28	26		44.60
4		24.33	27		30.42
5		22.30	28		32.45
6		30.42	29	40.56	
7		40.56	30		36.50
8		121.66	31	12.17	
9		26.36	32		40.55
10		24.33	33	34.47	
11		26.36	34		38.50
12		36.50	35		20.28
13		12.17	36	24.33	
14		44.60	37	26.36	
15		26.36	38	16.22	
16	28.39		39	32.45	
17	36.50		40	28.39	
18	58.80		41	24.33	
19	68.94		42	40.56	
20		22.30	43	16.22	
21		28.39	44		52.72
22		12.17	45		28.39
23		60.83	46		28.39

Table 2.1 Continued

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2
47	20.22	65	18.20
48	28.30	66	30.33
49	20.22	67	26.29
50	26.29	68	36.40
51	26.29	69	24.27
52	24.27	70	16.18
53	24.27	71	26.29
54	12.14	72	26.29
55	10.12	73	22.25
56	36.39	74	24.26
57	16.18	75	16.18
58	32.35	76	26.29
59	14.16	77	31.20
60	18.20	78	32.00
61	36.40	79	16.00
62	34.38	80	20.00
63	30.33	81	26.80
64	24.27	Org.Ind.Region	63.00
		TOTAL	510.95 2016.05

Table 2.2 From 81 Regions to 4 Transfer Stations, from 4 Transfer Stations and Organize Industry Region to Kepezüstü and Varsak Landfill Area

(Results of Simplex Method)

T_1 (Capacity of the first transfer station) = 480 tone/week

T_2 (Capacity of the second transfer station) = 570 tone/week

T_3 (Capacity of the third transfer station) = 250 tone/week

T_4 (Capacity of the fourth transfer station) = 1200 tone/week

Cost = 36,180 $/week

Table 2.2 Continued

NUMBER OF REGIONS	REMOVAL UNITS				NUMBER OF REGIONS	REMOVAL UNITS			
	T_1	T_2	T_3	T_4		T_1	T_2	T_3	T_4
1		26.36			32				40.55
2		40.56			33				34.47
3	20.28				34				38.50
4	24.33				35				20.28
5		22.30			36				24.33
6		30.42			37				26.36
7		40.56			38				16.22
8		121.66			39				32.45
9				26.36	40				28.39
10				24.33	41				24.33
11	26.36				42				40.56
12				36.50	43				16.22
13				12.17	44				52.72
14				44.60	45				28.39
15				26.36	46				28.39
16				28.39	47	20.22			
17				36.50	48	28.30			
18				58.80	49	20.22			
19				68.94	50	26.29			
20	22.30				51	26.29			
21	28.39				52	24.27			
22				12.17	53	24.27			
23				60.83	54				12.14
24				60.83	55				10.12
25		60.83			56	36.39			
26		44.60			57	16.18			
27				30.42	58	32.35			
28				32.45	59	14.16			
29				40.56	60		18.20		
30				36.50	61		36.40		
31				12.17	62	34.38			

Table 2.2 Continued

NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	T_4	NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	T_4
63			30.33		73			22.25	
64			24.27		74			24.26	
65			18.20		75			16.18	
66			30.33		76			26.29	
67			26.29		77		31.20		
68				36.40	78		32.00		
69				24.27	79		16.00		
70	16.18				80		20.00		
71	26.29				81		26.80		
72			26.29						
					TOTAL	467.45	567.89	244.69	1183.97

Y_1 (Varsak Landfill Capacity) = 1220 tone/week Cost = 12,829 $/week

Y_2 (Kepezüstü Landfill Capacity) = 1380 tone/week

NUMBER OF TRANSFER STATION	REMOVAL UNITS Y_1	Y_2	TOTAL
T_1		480	
T_2		570	
T_3		250	
T_4	1200		
Org. Ind. Region		63	
TOTAL	1200 tone/week	1363 tone/week	2563 tone/week

TOTAL COST = 49,009 $/week = 196,036 $/month

= 0.38 $/person/month

Table 2.3 From 81 Regions and Organize Industry to Kepezüstü Landfill Area

(Results of Simplex Method)

Y_1 (Varsak Landfill Capacity) = 0

Y_2 (Kepezüstü Landfill Capacity) = 2600 tone/week

Total Cost = 61,989 $/week = 247,956 $/month

= 0.48 $/person/month

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2
1	26.36	24	60.83
2	40.56	25	60.83
3	20.28	26	44.60
4	24.33	27	30.42
5	22.30	28	32.45
6	30.42	29	40.56
7	40.56	30	36.50
8	121.66	31	12.17
9	26.36	32	40.55
10	24.33	33	34.47
11	26.36	34	38.50
12	36.50	35	20.28
13	12.17	36	24.33
14	44.60	37	26.36
15	26.36	38	16.22
16	28.39	39	32.45
17	36.50	40	28.39
18	58.80	41	24.33
19	68.94	42	40.56
20	22.30	43	16.22
21	28.39	44	52.72
22	12.17	45	28.39
23	60.83	46	28.39

Table 2.3 Continued

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2
47	20.22	65	18.20
48	28.30	66	30.33
49	20.22	67	26.29
50	26.29	68	36.40
51	26.29	69	24.27
52	24.27	70	16.18
53	24.27	71	26.29
54	12.14	72	26.29
55	10.12	73	22.25
56	36.39	74	24.26
57	16.18	75	16.18
58	32.35	76	26.29
59	14.16	77	31.20
60	18.20	78	32.00
61	36.40	79	16.00
62	34.38	80	20.00
63	30.33	81	26.80
64	24.27	Org.Ind.Region	63.00
		TOTAL	2527.00

Table 2.4 From 81 Regions to 3 Transfer Stations, from 3 Transfer Stations and Organize Industry Region to Kepezüstü Landfill Area

(Results of Simplex Method)

T_1 (Capacity of the first transfer station) = 1550 tone/week

T_2 (Capacity of the second transfer station) = 580 tone/week

T_3 (Capacity of the third transfer station) = 370 tone/week

Cost = 37,860 $/week

Table 2.4 Continued

NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3
1		26.36		32	40.55		
2		40.56		33	34.47		
3	20.28			34	38.50		
4	24.33			35	20.28		
5		22.30		36	24.33		
6		30.42		37	26.36		
7		40.56		38	16.22		
8		121.66		39	32.45		
9	26.36			40	28.39		
10	24.33			41	24.33		
11	26.36			42	40.56		
12	36.50			43	16.22		
13	12.17			44			52.72
14	44.60			45			28.39
15	26.36			46			28.39
16	28.39			47	20.22		
17	36.50			48	28.30		
18	58.80			49	20.22		
19	68.94			50	26.29		
20	22.30			51	26.29		
21	28.39			52	24.27		
22	12.17			53	24.27		
23	60.83			54	12.14		
24	60.83			55	10.12		
25		60.83		56	36.39		
26		44.60		57	16.18		
27	30.42			58	32.35		
28	32.45			59	14.16		
29	40.56			60		18.20	
30	36.50			61		36.40	
31	12.17			62	34.38		

Table 2.4 Continued

NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3
63			30.33	73			22.25
64			24.27	74			24.26
65			18.20	75			16.18
66			30.33	76			26.29
67			26.29	77		31.20	
68	36.40			78		32.00	
69	24.27			79		16.00	
70	16.18			80		20.00	
71	26.29			81		26.80	
72			26.29				
				TOTAL	1541.92	567.89	354.19

Y_1 (Varsak Landfill Capacity) = 0 tone/week Cost = 21,165 $/week

Y_2 (Kepezüstü Landfill Capacity) = 2600 tone/week

NUMBER OF TRANSFER STATION	REMOVAL UNITS Y_1	Y_2	TOTAL
T_1		1550	
T_2		580	
T_3		370	
Org. Ind. Region		63	
TOTAL		2563 tone/week	2563 tone/week

TOTAL COST = 59,025 $/week = 236,100 $/month

= 0.46 $/person/month

Table 2.5 From 81 Regions and Organize Industry to Varsak Landfill Area
(Results of Simplex Method)

Y_1 (Varsak Landfill Capacity) = 2600 tone/week

Y_2 (Kepezüstü Landfill Capacity) = 0

Total Cost = 69,313 $/week = 277,252 $/month

= 0.54 $/person/month

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2
1	26.36	24	60.83
2	40.56	25	60.83
3	20.28	26	44.60
4	24.33	27	30.42
5	22.30	28	32.45
6	30.42	29	40.56
7	40.56	30	36.50
8	121.66	31	12.17
9	26.36	32	40.55
10	24.33	33	34.47
11	26.36	34	38.50
12	36.50	35	20.28
13	12.17	36	24.33
14	44.60	37	26.36
15	26.36	38	16.22
16	28.39	39	32.45
17	36.50	40	28.39
18	58.80	41	24.33
19	68.94	42	40.56
20	22.30	43	16.22
21	28.39	44	52.72
22	12.17	45	28.39
23	60.83	46	28.39

Table 2.5 Continued

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2
47	20.22	65	18.20
48	28.30	66	30.33
49	20.22	67	26.29
50	26.29	68	36.40
51	26.29	69	24.27
52	24.27	70	16.18
53	24.27	71	26.29
54	12.14	72	26.29
55	10.12	73	22.25
56	36.39	74	24.26
57	16.18	75	16.18
58	32.35	76	26.29
59	14.16	77	31.20
60	18.20	78	32.00
61	36.40	79	16.00
62	34.38	80	20.00
63	30.33	81	26.80
64	24.27	Org.Ind.Region	63.00
		TOTAL	2527 tone/week

Table 2.6 From 81 Regions to 3 Transfer Stations, from 3 Transfer Stations and Organize Industry Region to Varsak Landfill Area

(Results of Simplex Method)

T_1 (Capacity of the first transfer station) = 600 tone/week

T_2 (Capacity of the second transfer station) = 700 tone/week

T_4 (Capacity of the fourth transfer station) = 1200 tone/week

Cost = 36,458 $/week

Table 2.6 Continued

NUMBER OF REGIONS	REMOVAL UNITS T_1 T_2 T_4	NUMBER OF REGIONS	REMOVAL UNITS T_1 T_2 T_4
1	26.36	31	12.17
2	40.56	32	40.55
3	20.28	33	34.47
4	24.33	34	38.50
5	22.30	35	20.28
6	30.42	36	24.33
7	40.56	37	26.36
8	121.66	38	16.22
9	26.36	39	32.45
10	24.33	40	28.39
11	26.36	41	24.33
12	36.50	42	40.56
13	12.17	43	16.22
14	44.60	44	52.72
15	26.36	45	28.39
16	28.39	46	28.39
17	36.50	47	20.22
18	58.80	48	28.30
19	68.94	49	20.22
20	22.30	50	26.29
21	28.39	51	26.29
22	12.17	52	24.27
23	60.83	53	24.27
24	60.83	54	12.14
25	60.83	55	10.12
26	44.60	56	36.39
27	30.42	57	16.18
28	32.45	58	32.35
29	40.56	59	14.16
30	36.50	60	18.20

Table 2.6 Continued

NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_4	NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_4
61		36.40		72	26.29		
62	34.38			73	22.25		
63	30.33			74	24.26		
64	24.27			75		16.18	
65		18.20		76		26.29	
66		30.33		77		31.20	
67		26.29		78		32.00	
68			36.40	79		16.00	
69			24.27	80		20.00	
70	16.18			81		26.80	
71	26.29						
				TOTAL	594.85	685.18	1183.97

Y_1 (Varsak Landfill Capacity) = 2600 tone/week Cost = 21,192 $/week

Y_2 (Kepezüstü Landfill Capacity) = 0

NUMBER OF TRANSFER STATION	REMOVAL UNITS Y_1	Y_2	TOTAL
T_1	600		
T_2	700		
T_4	1200		
Org. Ind. Region	63		
TOTAL	2563 tone/week		2563 tone/week

TOTAL COST = 57,650 $/week = 230,600 $/month

= 0.45 $/person/month

Table 2.7 From 81 Regions and Organize Industry to Varsak Compost Area
(Results of Simplex Method)

Y_1 (Varsak Landfill Capacity) = 2600 tone/week

Y_2 (Kepezüstü Landfill Capacity) = 0

Total Cost = 98,849 $/week

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2
1	26.36	24	60.83
2	40.56	25	60.83
3	20.28	26	44.60
4	24.33	27	30.42
5	22.30	28	32.45
6	30.42	29	40.56
7	40.56	30	36.50
8	121.66	31	12.17
9	26.36	32	40.55
10	24.33	33	34.47
11	26.36	34	38.50
12	36.50	35	20.28
13	12.17	36	24.33
14	44.60	37	26.36
15	26.36	38	16.22
16	28.39	39	32.45
17	36.50	40	28.39
18	58.80	41	24.33
19	68.94	42	40.56
20	22.30	43	16.22
21	28.39	44	52.72
22	12.17	45	28.39
23	60.83	46	28.39

Table 2.7 Continued

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week) Y_2
47	20.22	65	18.20
48	28.30	66	30.33
49	20.22	67	26.29
50	26.29	68	36.40
51	26.29	69	24.27
52	24.27	70	16.18
53	24.27	71	26.29
54	12.14	72	26.29
55	10.12	73	22.25
56	36.39	74	24.26
57	16.18	75	16.18
58	32.35	76	26.29
59	14.16	77	31.20
60	18.20	78	32.00
61	36.40	79	16.00
62	34.38	80	20.00
63	30.33	81	26.80
64	24.27	Org.Ind.Region	63.00
		TOTAL	2527 tone/week

Amount of income providing;

Compost = 15,165 $/week

Plastic = 21,660 $/week

Paper = 10,575 $/week

Tinplate-Metal = 770 $/week

TOTAL = 48,170 $/week

TOTAL COST = 50,679 $/week = 202,716 $/month

= 0.40 $/person/month

Table 2.8 From 81 Regions to 3 Transfer Stations, from 3 Transfer Stations and Organize Industry Region to Varsak Compost Area

(Results of Simplex Method)

T_1 (Capacity of the first transfer station) = 600 tone/week

T_2 (Capacity of the second transfer station) = 700 tone/week

T_4 (Capacity of the fourth transfer station) = 1200 tone/week

Cost = 36,458 $/week

NUMBER OF REGIONS	REMOVAL UNITS T_1 T_2 T_4	NUMBER OF REGIONS	REMOVAL UNITS T_1 T_2 T_4
1	26.36	23	60.83
2	40.56	24	60.83
3	20.28	25	60.83
4	24.33	26	44.60
5	22.30	27	30.42
6	30.42	28	32.45
7	40.56	29	40.56
8	121.66	30	36.50
9	26.36	31	12.17
10	24.33	32	40.55
11	26.36	33	34.47
12	36.50	34	38.50
13	12.17	35	20.28
14	44.60	36	24.33
15	26.36	37	26.36
16	28.39	38	16.22
17	36.50	39	32.45
18	58.80	40	28.39
19	68.94	41	24.33
20	22.30	42	40.56
21	28.39	43	16.22
22	12.17	44	52.72

Table 2.8 Continued

NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_4	NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_4
45			28.39	64	24.27		
46			28.39	65		18.20	
47	20.22			66		30.33	
48	28.30			67		26.29	
49	20.22			68			36.40
50	26.29			69			24.27
51	26.29			70	16.18		
52	24.27			71	26.29		
53	24.27			72	26.29		
54			12.14	73	22.25		
55			10.12	74	24.26		
56	36.39			75		16.18	
57	16.18			76		26.29	
58	32.35			77		31.20	
59	14.16			78		32.00	
60		18.20		79		16.00	
61		36.40		80		20.00	
62	34.38			81		26.80	
63	30.33						
				TOTAL	594.85	685.18	1183.97

Y_1 (Varsak Landfill Capacity) = 2600 tone/week Cost = 50,728 $/week

Y_2 (Kepezüstü Landfill Capacity) = 0

NUMBER OF TRANSFER STATION	REMOVAL UNITS Y_1	Y_2	TOTAL
T_1	600		
T_2	700		
T_4	1200		
Org. Ind. Region	63		
TOTAL	2563 tone/week		2563 tone/week

TOTAL COST = 87,186 $/week

Amount of income providing;

Compost = 15,375 $/week

Plastic = 21,945 $/week

Paper = 10,725 $/week

Tinplate-Metal = 784 $/week

TOTAL = 48,829 $/week

TOTAL COST = 38,357 $/week = 153,428 $/month

= 0.30 $/person/month

Table 2.9 From 81 Regions to 4 Transfer Stations, from 4 Transfer Stations and Organize Industry Region to Varsak Compost Area

(Results of Simplex Method)

T_1 (Capacity of the first transfer station) = 480 tone/week

T_2 (Capacity of the second transfer station) = 570 tone/week

T_3 (Capacity of the third transfer station) = 250 tone/week

T_4 (Capacity of the fourth transfer station) = 1200 tone/week

Cost = 36,180 $/week

NUMBER OF REGIONS	REMOVAL UNITS				NUMBER OF REGIONS	REMOVAL UNITS			
	T_1	T_2	T_3	T_4		T_1	T_2	T_3	T_4
1		26.36			11	26.36			
2		40.56			12				36.50
3	20.28				13				12.17
4	24.33				14				44.60
5		22.30			15				26.36
6		30.42			16				28.39
7		40.56			17				36.50
8		121.66			18				58.80
9				26.36	19				68.94
10				24.33	20	22.30			

Table 2.9 Continued

NUMBER OF REGIONS	REMOVAL UNITS				NUMBER OF REGIONS	REMOVAL UNITS			
	T_1	T_2	T_3	T_4		T_1	T_2	T_3	T_4
21	28.39				52	24.27			
22				12.17	53	24.27			
23				60.83	54				12.14
24				60.83	55				10.12
25		60.83			56	36.39			
26		44.60			57	16.18			
27				30.42	58	32.35			
28				32.45	59	14.16			
29				40.56	60		18.20		
30				36.50	61		36.40		
31				12.17	62	34.38			
32				40.55	63			30.33	
33				34.47	64			24.27	
34				38.50	65			18.20	
35				20.28	66			30.33	
36				24.33	67			26.29	
37				26.36	68				36.40
38				16.22	69				24.27
39				32.45	70	16.18			
40				28.39	71	26.29			
41				24.33	72			26.29	
42				40.56	73			22.25	
43				16.22	74			24.26	
44				52.72	75			16.18	
45				28.39	76			26.29	
46				28.39	77		31.20		
47	20.22				78		32.00		
48	28.30				79		16.00		
49	20.22				80		20.00		
50	26.29				81		26.00		
51	26.29				TOTAL	467.45	567.89	244.69	1183.97

Table 2.9 Continued

Y_1 (Varsak Landfill Capacity) = 2600 tone/week Cost = 51,285 $/week

Y_2 (Kepezüstü Landfill Capacity) = 0

NUMBER OF TRANSFER STATION	REMOVAL UNITS Y_1	Y_2	TOTAL
T_1	480		
T_2	570		
T_3	250		
T_4	1200		
Org. Ind. Region	63		
TOTAL	2563 tone/week		2563 tone/week

TOTAL COST = 87,465 $/week

Amount of income providing;

Compost = 15,375 $/week

Plastic = 475 $/week

Paper = 113 $/week

Tinplate-Metal = 84 $/week

TOTAL = 48,829 $/week

TOTAL COST = 38,636 $/week = 154,544 $/month

= 0.30 $/person/month

Table 2.10 From 81 Regions and Organize Industry to Kepezüstü and Varsak Landfill Area

(Results of Simplex Method)

Y_1 (Varsak Landfill Capacity) = 1950 tone/week

Y_2 (Kepezüstü Landfill Capacity) = 650 tone/week

Total Cost = 60,554 $/week = 242,216 $/month = 0.47 $/person/month

Table 2.10 Continued

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2
1	26.36		31	12.17	
2		40.56	32		40.55
3	20.28		33	34.47	
4	24.33		34		38.50
5	22.30		35	20.28	
6	30.42		36	24.33	
7		40.56	37	26.36	
8		121.66	38	16.22	
9	26.36		39	32.45	
10	24.33		40	28.39	
11	26.36		41	24.33	
12		36.50	42	40.56	
13	12.17		43	16.22	
14	44.60		44	52.72	
15	26.36		45	28.39	
16	28.39		46	28.39	
17	36.50		47	20.22	
18	58.80		48	28.30	
19	68.94		49	20.22	
20	22.30		50	26.29	
21	28.39		51	26.29	
22	12.17		52	24.27	
23	60.83		53	24.27	
24	60.83		54	12.14	
25	60.83		55	10.12	
26	44.60		56	36.39	
27	30.42		57	16.18	
28	32.45		58	32.35	
29	40.56		59	14.16	
30	36.50		60	18.20	

Table 2.10 Continued

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2
61		36.40	72		26.29
62		34.38	73	22.25	
63		30.33	74		24.26
64		24.27	75	16.18	
65		18.20	76		26.29
66	18.48	11.85	77	31.20	
67	26.29		78	32.00	
68		36.40	79	16.00	
69	24.27		80	20.00	
70	16.18		81	26.80	
71	26.29		Org.Ind.Region		63.00
			TOTAL	1877.00	650.00

Table 2.11 From 81 Regions to 4 Transfer Stations, from 4 Transfer Stations and Organize Industry Region to Kepezüstü and Varsak Landfill Area

(Results of Simplex Method)

T_1 (Capacity of the first transfer station) = 480 tone/week

T_2 (Capacity of the second transfer station) = 570 tone/week

T_3 (Capacity of the third transfer station) = 250 tone/week

T_4 (Capacity of the fourth transfer station) = 1200 tone/week

Cost = 36,180 $/week

NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	T_4	NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	T_4
1		26.36			7		40.56		
2		40.56			8		121.66		
3	20.28				9				26.36
4	24.33				10				24.33
5		22.30			11	26.36			
6		30.42			12				36.50

Table 2.11 Continued

NUMBER OF REGIONS	REMOVAL UNITS				NUMBER OF REGIONS	REMOVAL UNITS			
	T_1	T_2	T_3	T_4		T_1	T_2	T_3	T_4
13				12.17	44				52.72
14				44.60	45				28.39
15				26.36	46				28.39
16				28.39	47	20.22			
17				36.50	48	28.30			
18				58.80	49	20.22			
19				68.94	50	26.29			
20	22.30				51	26.29			
21	28.39				52	24.27			
22				12.17	53	24.27			
23				60.83	54				12.14
24				60.83	55				10.12
25		60.83			56	36.39			
26		44.60			57	16.18			
27				30.42	58	32.35			
28				32.45	59	14.16			
29				40.56	60		18.20		
30				36.50	61		36.40		
31				12.17	62	34.38			
32				40.55	63			30.33	
33				34.47	64			24.27	
34				38.50	65			18.20	
35				20.28	66			30.33	
36				24.33	67			26.29	
37				26.36	68				36.40
38				16.22	69				24.27
39				32.45	70	16.18			
40				28.39	71	26.29			
41				24.33	72			26.29	
42				40.56	73			22.25	
43				16.22	74			24.26	

NUMBER OF REGIONS	REMOVAL UNITS T_1 T_2 T_3 T_4	NUMBER OF REGIONS	REMOVAL UNITS T_1 T_2 T_3 T_4
75	16.18	79	16.00
76	26.29	80	20.00
77	31.20	81	26.00
78	32.00		
		TOPLAM	467.45 567.89 244.69 1183.97

Y_1(Varsak Landfill Capacity) = 1950 tone/week Cost = 15,196 $/week

Y_2(Kepezüstü Landfill Capacity) = 650 tone/week

NUMBER OF TRANSFER STATION	REMOVAL UNITS Y_1	Y_2	TOTAL
T_1	463	17	
T_2		570	
T_3	250		
T_4	1200		
Org.Ind.Region		63	
TOTAL	1913 tone/week	650 tone/week	2563 tone/week

TOTAL COST = 51,376 $/week = 205,504 $/month

= 0.40 $/person/month

Table 2.12 From 81 Regions to 4 Transfer Stations, from 4 Transfer Stations and Organize Industry Region to Kepezüstü and Varsak Landfill Area

(Results of Simplex Method)

T_1 (Capacity of the first transfer station) = 550 tone/week

T_2 (Capacity of the second transfer station) = 700 tone/week

T_3 (Capacity of the third transfer station) = 550 tone/week

T_4 (Capacity of the fourth transfer station) = 700 tone/week

Cost = 37,557 $/week

Table 2.12 Continued

NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	T_4	NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	T_4
1		26.36			32				40.55
2		40.56			33				34.47
3	12.14	8.14			34				38.50
4	24.33				35	20.28			
5		22.30			36				24.33
6	30.42				37				26.36
7		40.56			38			16.22	
8		121.66			39				32.45
9	26.36				40				28.39
10			24.33		41				24.33
11	26.36				42				40.56
12				36.50	43			16.22	
13			12.17		44			52.72	
14		44.60			45			28.39	
15	26.36				46			28.39	
16		22.60	5.79		47	20.22			
17				36.50	48	28.30			
18		58.80			49	20.22			
19				68.94	50	26.29			
20			22.30		51	26.29			
21		28.39			52	24.27			
22			12.17		53	24.27			
23				60.83	54			12.14	
24				60.83	55			10.12	
25		60.83			56	36.39			
26		44.60			57			16.18	
27	29.87			0.55	58	32.35			
28				32.45	59	14.16			
29				40.56	60		18.20		
30				36.50	61		36.40		
31			12.17		62	34.38			

Table 2.12 Continued

NUMBER OF REGIONS	REMOVAL UNITS				NUMBER OF REGIONS	REMOVAL UNITS			
	T_1	T_2	T_3	T_4		T_1	T_2	T_3	T_4
63			30.33		73			22.25	
64			24.27		74			24.26	
65			18.20		75			16.18	
66			30.33		76			26.29	
67			26.29		77		31.20		
68				36.40	78		32.00		
69	24.27				79		16.00		
70	16.18				80		20.00		
71	26.29				81		26.80		
72			26.29						
					TOTAL	550.00	700.00	514.00	700.00

Y_1 (Varsak Landfill Capacity) = 1950 tone/week Cost = 14,562 $/week

Y_2 (Kepezüstü Landfill Capacity) = 650 tone/week

NUMBER OF TRANSFER STATION	REMOVAL UNITS		
	Y_1	Y_2	TOTAL
T_1	550		
T_2	663	37	700
T_3		550	
T_4	700		
Org. Ind. Region		63	
TOTAL	1913 tone/week	650 tone/week	2563 tone/week

TOTAL COST = 52,119 $/week = 208,476 $/month

= 0.41 $/person/month

Table 2.13 From 81 Regions and Organize Industry to Kepezüstü Landfill and Varsak Compost Area

(Results of Simplex Method)

Y_1 (Varsak Compost Capacity) = 1950 tone/week

Y_2 (Kepezüstü Landfill Capacity) = 650 tone/week

Total Cost = 77,149 $/week

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2
1	26.36		24	60.83	
2		40.56	25	60.83	
3	20.28		26	44.60	
4	24.33		27	30.42	
5	22.30		28	32.45	
6	30.42		29	40.56	
7		40.56	30	36.50	
8		121.66	31	12.17	
9	26.36		32		40.55
10	24.33		33	34.47	
11	26.36		34		38.50
12		36.50	35	20.28	
13	12.17		36	24.33	
14	44.60		37	26.36	
15	26.36		38	16.22	
16	28.39		39	32.45	
17	36.50		40	28.39	
18	58.80		41	24.33	
19	68.94		42	40.56	
20	22.30		43	16.22	
21	28.39		44	52.72	
22	12.17		45	28.39	
23	60.83		46	28.39	

Table 2.13 Continued

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2
47	20.22		65		18.20
48	28.30		66	18.48	11.85
49	20.22		67	26.29	
50	26.29		68		36.40
51	26.29		69	24.27	
52	24.27		70	16.18	
53	24.27		71	26.29	
54	12.14		72		26.29
55	10.12		73	22.25	
56	36.39		74		24.26
57	16.18		75	16.18	
58	32.35		76		26.29
59	14.16		77	31.20	
60	18.20		78	32.00	
61		36.40	79	16.00	
62		34.38	80	20.00	
63		30.33	81	26.80	
64		24.27	Org.Ind.Region		63.00
			TOTAL	1877.00	650.00

Amount of income providing;

Compost = 11,370 $/week

Plastic = 16,245 $/week

Paper = 7,925 $/week

Tinplate-Metal = 581 $/week

TOTAL = 36,121 $/week

TOTAL COST = 41,028 $/week = 164,112 $/week

= 0.32 $/person/month

Table 2.14 From 81 Regions to 4 Transfer Stations, from 4 Transfer Stations and Organize Industry Region to Kepezüstü Landfill and Varsak Compost Area

(Results of Simplex Method)

T_1 (Capacity of the first transfer station) = 480 tone/week

T_2 (Capacity of the second transfer station) = 570 tone/week

T_3 (Capacity of the third transfer station) = 250 tone/week

T_4 (Capacity of the fourth transfer station) = 1200 tone/week

Cost = 36,180 $/week

NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	T_4	NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	T_4
1		26.36			23				60.83
2		40.56			24				60.83
3	20.28				25		60.83		
4	24.33				26		44.60		
5		22.30			27				30.42
6		30.42			28				32.45
7		40.56			29				40.56
8		121.66			30				36.50
9				26.36	31				12.17
10				24.33	32				40.55
11	26.36				33				34.47
12				36.50	34				38.50
13				12.17	35				20.28
14				44.60	36				24.33
15				26.36	37				26.36
16				28.39	38				16.22
17				36.50	39				32.45
18				58.80	40				28.39
19				68.94	41				24.33
20	22.30				42				40.56
21	28.39				43				16.22
22				12.17	44				52.72

Table 2.14 Continued

NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	T_4	NUMBER OF REGIONS	REMOVAL UNITS T_1	T_2	T_3	T_4
45				28.39	64			24.27	
46				28.39	65			18.20	
47	20.22				66			30.33	
48	28.30				67			26.29	
49	20.22				68				36.40
50	26.29				69				24.27
51	26.29				70	16.18			
52	24.27				71	26.29			
53	24.27				72			26.29	
54				12.14	73			22.25	
55				10.12	74			24.26	
56	36.39				75			16.18	
57	16.18				76			26.29	
58	32.35				77		31.20		
59	14.16				78		32.00		
60		18.20			79		16.00		
61		36.40			80		20.00		
62	34.38				81		26.80		
63			30.33						
					TOTAL	467.45	567.89	244.69	1183.97

Y_1 (Varsak Compost Capacity) = 1950 tone/week Cost = 31,790 $/week

Y_2 (Kepezüstü Landfill Capacity) = 650 tone/week

NUMBER OF TRANSFERSTATION	REMOVAL UNITS Y_1	Y_2	TOTAL
T_1	463	17	480
T_2		570	
T_3	250		
T_4	1200		
Org. Ind. Region		63	
TOTAL	1913 tone/week	650 tone/week	2563 tone/week

TOTAL COST = 67,970 $/week

Amount of income providing;

Compost = 11,535 $/week

Plastic = 16,435 $/week

Paper = 8,025 $/week

Tinplate-Metal = 588 $/week

TOTAL = 36,583 $/week

TOTAL COST = 31,387 $/week = 125,548 $/month

= 0.25 $/person/month

Table 2.15 From 81 Regions and Organize Industry to Kepezüstü Landfill and Varsak Compost Area

(Results of Simplex Method)

Y_1 (Varsak Compost Capacity) = 1300 tone/week

Y_2 (Kepezüstü Landfill Capacity) = 1300 tone/week

Total Cost = 63,441 $/week

NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2	NUMBER OF REGIONS	REMOVAL UNITS Y_1 (tone/week)	Y_2
1	26.36		11	26.36	
2		40.56	12		36.50
3		20.28	13	12.17	
4		24.33	14	44.60	
5	22.30		15	26.36	
6		30.42	16	28.39	
7		40.56	17	36.50	
8		121.66	18	58.80	
9	26.36		19	68.94	
10		24.33	20	22.30	

NUMBER OF REGIONS	REMOVAL UNITS Y_1(tone/week) Y_2		NUMBER OF REGIONS	REMOVAL UNITS Y_1(tone/week) Y_2	
21	28.39		52		24.27
22	12.17		53		24.27
23	60.83		54	12.14	
24	60.83		55	10.12	
25		60.83	56		36.39
26		44.60	57	16.18	
27	30.42		58		32.35
28		32.45	59		14.16
29	40.56		60		18.20
30		36.50	61		36.40
31	12.17		62		34.38
32		40.55	63		30.33
33	34.47		64		24.27
34		38.50	65		18.20
35	20.28		66		30.33
36	24.33		67		26.29
37	26.36		68		36.40
38	16.22		69		24.27
39	32.45		70	16.18	
40	28.39		71	26.29	
41	24.33		72		26.29
42	40.56		73		22.25
43	16.22		74		24.26
44	52.72		75		16.18
45	28.39		76		26.29
46	28.39		77	31.20	
47	20.22		78		32.00
48		28.30	79	16.00	
49	20.22		80	20.00	
50	3.56	22.73	81	26.80	
51	26.29		Org.Ind.Region		63.00
			TOTAL	1263.12	1263.88

Amount of income providing;

Compost = 7,575 $/week

Plastic = 10,830 $/week

Paper = 5,275 $/week

Tinplate-Metal = 385 $/week

TOTAL = 24,065 $/week

TOTAL COST = 39,376 $/week = 157,504 $/week

= 0.31 $/person/month

Table 2.16 From 81 Regions to 4 Transfer Stations, from 4 Transfer Stations and Organize Industry Region to Kepezüstü Landfill and Varsak Compost Area

(Results of Simplex Method)

T_1 (Capacity of the first transfer station) = 480 tone/week

T_2 (Capacity of the second transfer station) = 570 tone/week

T_3 (Capacity of the third transfer station) = 250 tone/week

T_4 (Capacity of the fourth transfer station) = 1200 tone/week

Cost = 36,180 $/week

NUMBER OF REGIONS	REMOVAL UNITS				NUMBER OF REGIONS	REMOVAL UNITS			
	T_1	T_2	T_3	T_4		T_1	T_2	T_3	T_4
1		26.36			13				12.17
2		40.56			14				44.60
3	20.28				15				26.36
4	24.33				16				28.39
5		22.30			17				36.50
6		30.42			18				58.80
7		40.56			19				68.94
8		121.66			20	22.30			
9				26.36	21	28.39			
10				24.33	22				12.17
11	26.36				23				60.83
12				36.50	24				60.83

Table 2.16 Continued

NUMBER OF REGIONS	REMOVAL UNITS				NUMBER OF REGIONS	REMOVAL UNITS			
	T_1	T_2	T_3	T_4		T_1	T_2	T_3	T_4
25		60.83			55				10.12
26		44.60			56	36.39			
27				30.42	57	16.18			
28				32.45	58	32.35			
29				40.56	59	14.16			
30				36.50	60		18.20		
31				12.17	61		36.40		
32				40.55	62	34.38			
33				34.47	63			30.33	
34				38.50	64			24.27	
35				20.28	65			18.20	
36				24.33	66			30.33	
37				26.36	67			26.29	
38				16.22	68				36.40
39				32.45	69				24.27
40				28.39	70	16.18			
41				24.33	71	26.29			
42				40.56	72			26.29	
43				16.22	73			22.25	
44				52.72	74			24.26	
45				28.39	75			16.18	
46				28.39	76			26.29	
47	20.22				77		31.20		
48	28.30				78		32.00		
49	20.22				79		16.00		
50	26.29				80		20.00		
51	26.29				81		26.80		
52	24.27								
53	24.27				TOTAL	467.45	567.89	244.69	1183.97
54				12.14					

Table 2.16 Continued

Y_1 (Varsak Compost Capacity) = 1300 tone/week Cost = 20,268 $/week

Y_2 (Kepezüstü Landfill Capacity) = 1300 tone/week

NUMBER OF TRANSFER STATION	REMOVAL UNITS Y_1	Y_2	TOTAL
T_1		480	
T_2		570	
T_3	63	187	250
T_4	1200		
Org. Ind. Region		63	
TOTAL	1263 tone/week	1300 tone/week	2563 tone/week

TOTAL COST = 56,448 $/week

Amount of income providing;

Compost = 7,695 $/week

Plastic = 11,020 $/week

Paper = 5,350 $/week

Tinplate-Metal = 392 $/week

TOTAL = 24,457 $/week

TOTAL COST = 31,991 $/week = 127,964 $/month

= 0.25 $/person/month

Table 2.17 From 81 Regions to 2 Transfer Stations, from 2 Transfer Stations and Organize Industry Region to Kepezüstü Landfill and Varsak Compost Area

(Results of Simplex Method)

T_2 (Capacity of the second transfer station) = 950 tone/week

T_4 (Capacity of the fourth transfer station) = 1550 tone/week

Cost = 37,202 $/week

Table 2.17 Continued

NUMBER OF REGIONS	REMOVAL UNITS T_2	T_4	NUMBER OF REGIONS	REMOVAL UNITS T_2	T_4
1	26.36		31		12.17
2	40.56		32		40.55
3	20.28		33		34.47
4	24.33		34		38.50
5	22.30		35		20.28
6	30.42		36		24.33
7	40.56		37		26.36
8	121.66		38		16.22
9		26.36	39		32.45
10		24.33	40		28.39
11	26.36		41		24.33
12		36.50	42		40.56
13		12.17	43		16.22
14		44.60	44		52.72
15		26.36	45		28.39
16		28.39	46		28.39
17		36.50	47		20.22
18		58.80	48		28.30
19		68.94	49		20.22
20	22.30		50		26.29
21	28.39		51		26.29
22		12.17	52		24.27
23		60.83	53		24.27
24		60.83	54		12.14
25	60.83		55		10.12
26	44.60		56		36.39
27		30.42	57		16.18
28		32.45	58		32.35
29		40.56	59		14.16
30		36.50	60	18.20	

Table 2.17 Continued

NUMBER OF REGIONS	REMOVAL UNITS T_2	REMOVAL UNITS T_4	NUMBER OF REGIONS	REMOVAL UNITS T_2	REMOVAL UNITS T_4
61	36.40		72	26.29	
62		34.38	73	22.25	
63	30.33		74	24.26	
64	24.27		75	16.18	
65	18.20		76	26.29	
66	30.33		77	31.20	
67	26.29		78	32.00	
68		36.40	79	16.00	
69		24.27	80	20.00	
70		16.18	81	26.80	
71		26.29			
			TOTAL	934.24	1529.76

Y_1 (Varsak Compost Capacity) = 1950 tone/week Cost = 32,014 $/week

Y_2 (Kepezüstü Landfill Capacity) = 650 tone/week

NUMBER OF TRANSFER STATION	REMOVAL UNITS Y_1	Y_2	TOTAL
T_2	300	650	950
T_4	1550		
Org. Ind. Region	63		
TOTAL	1913 tone/week	650 tone/week	2563 tone/week

TOTAL COST = 69,216 $/week

Amount of income providing;

Compost = 11,535 $/week

Plastic = 16,435 $/week

Paper = 8,025 $/week

Tinplate-Metal = 588 $/week

TOTAL = 36,583 $/week

TOTAL COST = 32,633 $/week = 130,532 $/month

= 0.25 $/person/month

Simplex method was used in the calculations. In the states which is considered to use of transfer stations; at only table 2.12, firstly, capacities of transfer stations have been calculated. In other tables; capacities of transfer stations have been determined for minimum cost.

In the same way; in the table 2.1 and 2.2, capacities of removed units have been determined for minimum cost.

In the table 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, evaluation has been done for only one removed unit.

In the table 2.10, 2.11, 2.12, 2.13, 2.14, 2.17, capacity of Varsak removed unit is 75 % and Kepezüstü removed unit is 25 % of total amount. In the table 2.15 and 2.16, capacity of Varsak removed unit is 50 % and Kepezüstü removed unit is 50 % of total amount.

In the state that there are 2 removed units, Organize Industry Region has not been calculated with simplex method, its amount has been accepted that is sent away straight to Kepezüstü removed unit. These tables are 2.11, 2.12, 2.13, 2.14 and 2.16.

Cost calculations have been done according to solid waste cost analysis report which is prepared in 1997 by İzmir Maincity Municipality. These values in the report have been adapted to data of Antalya.

Cost of compost and landfill system are shown below.

Cost of compost system;

Personnel : 10 workers
3 civil servant

Vehicles : 3 work machines
1 truck
1 pickup
1 minibus

Diesel fuel : 4440 lt/month

Electric : 8695 kwh/month

Water : 225 m^3/month

Mineral oil : 90 kg/month

Expences;

Personnel : 10*480 $/month = 4800 $/month
3*400 $/month = 1200 $/month
Total = 6000 $/month

Diesel fuel : 1954 $/month

Electric : 696 $/month

Water : 180 $/month

Mineral oil : 90 $/month

Repair : (fuel *25 %) = 489 $/month

Spare part : (fuel*25 %) = 489 $/month

Repair of building,

way, expence of telephone and etc.: 600 $/month

Equipment : 7500 $/month

TOTAL :17,998 $/month

Cost of prossesing one tone solid waste = (17,998 $/month) / (2700 tone/month)
= 6.67 $/tone

Values have been adapted according to 90 tone/day solid waste

Cost of landfill system;

Personnel : 8 workers
2 civil servant

Vehicles : 2 bulldozers
1 excavator
1 work machine
2 trucks
1 pickup
1 minibus
1 fuel vehicle
2 water motors
2 pumps
1 generator

Diesel fuel : 15,000 lt/month

Electric : 670 kwh/month

Water : 46 m^3/month

Mineral oil : 163 kg/month

Expences;

Personnel : 8*480 $/month = 3840 $/month
2*400 $/month = 800 $/month
Total = 4640 $/month

Diesel fuel : 6600 $/month

Electric : 94 $/month

Water : 37 $/month

Mineral oil : 163 $/month

Repair : (fuel *25 %) = 1650 $/month

Spare part : (fuel*25 %) = 1650 $/month

Repair of building,
way, expence of telephone and etc.: 1650 $/month

Amortization : 1326 $/month

Methane establishment

amortization : 732 $/month

TOTAL :18,542 $/month

Cost of prossesing one tone solid waste = (18,542 $/month) / (8130 tone/month)

= 2.30 $/tone

Values have been adapted according to 271 tone/day solid waste

Besides; income which will be provided with selling of fertilizer and recycling waste separated in separation system which will be present compost system has included to calculations.

Separated ratio of recycling wastes has been accepted 95 %.

Rates of fertilizer produced and recycling wastes separated are shown at table 2.18.

Table 2.18 Rates of Fertilizer Produced and Recycling Wastes Separated

	PERCENT OF FOUND IN GARBAGE	PERCENT OF SEPARATION	SELLING INCOME
Fertilizer	40.0 %		15 $/tone
Plastic	9.5 %	95 %	95 $/tone
Paper	17.6 %	95 %	25 $/tone
Tinplate-Metal	4.6 %	95 %	7 $/tone

It has been accepted that there is not sale of recycling wastes in landfill.

Table 2.19 All Methods of Solid Waste Collection-Transportation and Disposal Units

Method of Solid Waste Collection Transportation	Capacities of Transfer Stations	Cost of Transportation To Transfer Stations	Disposal System
From 81 regions and org. İnd. region to 2 landfills	----	----	Varsak (landfill) Kepez (landfill)
From 81 regions to 4 transfer stations, from 4 transfer stations and org. ind. region to 2 landfills	T_1=480 tone/week T_2=570 tone/week T_3=250 tone/week T_4=1200 tone/week	36,180 $/week	Varsak (landfill) Kepez (landfill)
From 81 regions and org. ind. region to landfill	----	----	Kepez (landfill)
From 81 regions to 3 transfer stations, from 3 transfer stations and org. ind. region to landfill	T_1=1550 tone/week T_2=580 tone/week T_3=370 tone/week	37,860 $/week	Kepez (landfill)
From 81 regions and org. ind. region to landfill	----	----	Varsak (landfill)
From 81 regions to 3 transfer stations, from 3 transfer stations and org. ind. region to landfill	T_1=600 tone/week T_2=700 tone/week T_4=1200 tone/week	36,458 $/week	Varsak (landfill)
From 81 regions and org. ind. region to compost	----	----	Varsak (compost)
From 81 regions to 3 transfer stations, from 3 transfer stations and org. ind. region to Compost	T_1=600 tone/week T_2=700 tone/week T_4=1200 tone/week	36,458 $/week	Varsak (compost)

Table 2.19 Continued

Capacities Of Disposal Units	Cost of Transportation to Disposal Units	Cost	Providing Income	Total Cost
550 tone/week 2050 tone/week	56,341 $/week	56,341 $/week	----	225,364 $/month
1220 tone/week 1380 tone/week	12,829 $/week	49,009 $/week	----	196,036 $/month
2600 tone/week	61,989 $/week	61,989 $/week	----	247,956 $/month
2600 tone/week	21,165 $/week	59,025 $/week	----	236,100 $/month
2600 tone/week	69,313 $/week	69,313 $/week	----	277,252 $/month
2600 tone/week	21,192 $/week	57,650 $/week	----	230,600 $/month
2600 tone/week	98,849 $/week	98,849 $/week	48,170 $/week	202,716 $/month
2600 tone/week	50,728 $/week	87,186 $/week	48,829 $/week	153,428 $/month

Table 2.19 Continued

Method of Solid Waste Collection Transportation	Capacities of Transfer Stations	Cost of Transportation To Transfer Stations	Disposal System
From 81 regions to 4 transfer stations, from 4 transfer stations and org. ind. region to compost	T_1=480 tone/week T_2=570 tone/week T_3=250 tone/week T_4=1200 tone/week	36,180 $/week	Varsak (compost)
From 81 regions and org. ind. region to 2 landfills	----	----	Varsak (landfill) Kepez (landfill)
From 81 regions to 4 transfer stations, from 4 transfer stations and org. ind. region to 2 landfills	T_1=480 tone/week T_2=570 tone/week T_3=250 tone/week T_4=1200 tone/week	36,180 $/week	Varsak (landfill) Kepez (landfill)
From 81 regions to 4 transfer stations, from 4 transfer stations and org. ind. region to 2 landfills	T_1=550 tone/week T_2=700 tone/week T_3=550 tone/week T_4=700 tone/week	37,557 $/week	Varsak (landfill) Kepez (landfill)
From 81 regions and org. ind. region to compost and landfill	----	----	Varsak (compost) Kepez (landfill)
From 81 regions to 4 transfer stations, from 4 transfer stations and org. ind. region to compost and landfill	T_1=480 tone/week T_2=570 tone/week T_3=250 tone/week T_4=1200 tone/week	36,180 $/week	Varsak (compost) Kepez (landfill)

Table 2.19 Continued

Capacities Of Disposal Units	Cost of Transportation to Disposal Units	Cost	Providing Income	Total Cost
2600 tone/week	51,285 $/week	87,465 $/week	48,829 $/week	154,544 $/month
1950 tone/week 650 tone/week	60,554 $/week	60,554 $/week	----	242,216 $/month
1950 tone/week 650 tone/week	15,196 $/week	51,376 $/week	----	205,504 $/month
1950 tone/week 650 tone/week	14,562 $/week	52,119 $/week	----	208,476 $/month
1950 tone/week 650 tone/week	77,149 $/week	77,149 $/week	36,121 $/week	164,112 $/month
1950 tone/week 650 tone/week	31,790 $/week	67,970 $/week	36,583 $/week	125,548 $/month

Table 2.19 Continued

Method of Solid Waste Collection Transportation	Capacities of Transfer Stations	Cost of Transportation To Transfer Stations	Disposal System
From 81 regions and org. İnd. region to compost and landfill	----	----	Varsak (compost) Kepez (landfill)
From 81 regions to 4 transfer stations, from 4 transfer stations and org. İnd. region to compost and landfill	T_1=480 tone/week T_2=570 tone/week T_3=250 tone/week T_4=1200 tone/week	36,180 $/week	Varsak (compost) Kepez (landfill)
From 81 regions to 2 transfer stations, from 2 transfer stations and org. İnd. region to compost and landfill	T_2=950 tone/week T_4=1550 tone/week	37,202 $/week	Varsak (compost) Kepez (landfill)

Table 2.19 Continued

Capacities Of Disposal Units	Cost of Transportation to Disposal Units	Cost	Providing Income	Total Cost
1300 tone/week 1300 tone/week	63,441 $/week	63,441 $/week	24,065 $/week	157,504 $/month
1300 tone/week 1300 tone/week	20,268 $/week	56,448 $/week	24,457 $/week	127,964 $/month

Table 2.19 Continued

Capacities Of Disposal Units	Cost of Transportation To Disposal Units	Cost	Providing Income	Total Cost
1950 tone/week 650 tone/week	32,014 $/week	69,216 $/week	36,583 $/week	130,532 $/month

CHAPTER FIVE
EXPERIMENTAL STUDIES

1. Optimization of Transportation System with Simplex Method

Solid waste is a residual product from human activities. Solid wastes include agricultural manures and crop residues, mining slag, commercial and institutional garbage, litter such as beverage cans and bottles, and dewatered sludges from wastewater treatment plants. The problems associated with solid wastes are equally varied. Garbage and other refuse accumulations can cause health and safety problems, mining wastes can result in drainage of acid waters to streams, and improper manure disposal often contributes nonpoint source nutrient inputs to surface and groundwaters.

Although most forms of solid waste have inherent environmental dangers, municipal solid wastes are frequently of most concern. These wastes include garbage and refuse from homes, commercial, and industrial establishments, street sweepings, and sludges. After collection municipal solid wastes may be disposed of by incineration, landfill, and recycling. Incineration is a relatively expensive disposal alternative that can result in air pollution. Sanitary landfills involve the disposal of waste on large land surfaces. The solid waste is spread in layers on low-lying areas, with layers of earth separating layers of waste. After subsidence, landfill areas may be used for parks or other recreational activities.

Recycling is in many ways the most attractive means of solid waste disposal, it treats the waste as a resource from which economic value can be derived. Various recycling options are available, many of which have long been in common use.

Newspapers and other paper material are recycled in paper production, metals such as copper, aluminum, and lead are salvaged and recycled, and the organic portions of solid wastes are sometimes composted and used as a soil conditioner. The production of energy from solid waste combustion can be economically attractive when traditional energy resources are scarce. The primary difficulty with recycling is the need to sort or separate the various components of municipal solid wastes prior to recycling. Some sorting can be done at the source as, for example, when homeowners compost leaves and other organic wastes and save newspapers, bottles, and cans for subsequent return to recycling centers. In high-density urban areas, solid waste sorting requires a centralized facility within which the various components of the waste can be separated. It has proved very difficult to design large-scale sorting facilities that are economical and reliable.

The great variety of solid waste management problems suggests the need for many different types of models. Models are used to evaluate the environmental impacts of solid waste disposal alternatives. Examples are manure disposal, acid mine drainage, waste incineration, leaching of chemicals from landfills and sludge disposal areas. In addition, models have been developed to aid in the development of cost-effective plans for collection and disposal of municipal solid wastes.

Mathematical modelling can provide practical support to decision makers in determining and evaluating policies related to municipal solid waste collection and transportation.

Convenience of problem for system has to be determined before beginning the system analysis for any problem. This problems must have four features:

-This is able to be definited clearly and it's purposes are able to be indicated.

-This is able to be expressed with mathematics models.

-This must have adequate data for characterizing the effects of solutions of different alternatives.

-This has to include only one the best alternative.

In this research; purpose is to remove the solid waste of Antalya with minimum cost. For thirth criter; amount of solid waste production, capacities of removed units and costs of transportation and removed are definite.

2. Results and Comparison

In this study, collection, transportation and disposal unit systems have been evaluated taking into consideration the economy. Simplex method have been used for determining the optimum collection, transportation and disposal system.

4 transfer stations and 2 disposal units have been chosen for determining optimum collection-transportation and disposal system. Optimum collection transportation and disposal system have been studied making different assumption. The effects of changing transfer station and disposal site capacities have also been investigated using this model and the principal solutions generated have been presented and discussed.

Kepezüstü dumping area which is considered to stop it's activity has been evaluated as only landfill; for Varsak dumping area planned to set both landfill and compost systems have been evaluated. Different assumptions are shown at tables 2.1-2.17.

In the first alternative; Varsak and Kepezüstü dumping areas have been accepted as if sanitary landfill. Capacities of these landfills have been determined for minimum cost. Cost per one person for a month is 0.44 $. (Table 2.1)

In the second alternative; Varsak and Kepezüstü dumping areas have been accepted as if landfill. And also four transfer stations have been chosen. Capacities of transfer stations and landfills have been determined for minimum cost. In this situation; cost per one person for a month is 0.38 $. (Table 2.2)

In the state which has been accepted the Kepezüstü dumping area as if landfill; cost per one person for a month is 0.48 $ (Table 2.3). However, for only Varsak landfill area, cost is 0.54 $ (Table 2.5).

When the three transfer stations and only one landfill area (Kepezüstü) have been used; cost per one person for a month is 0.46 $ (Table 2.4). Capacities of transfer stations have been determined for minimum cost. However, for Varsak landfill area, cost is 0.45 $ (Table 2.6).

In the state which has been accepted the Varsak dumping area as if compost system; cost per one person for a month is 0.40 $ (Table 2.7). However, when the three transfer stations have been used, cost is 0.30 $ (Table 2.8). When the four transfer stations have been used, cost is 0.30 $ (Table 2.9).

When the Varsak and Kepezüstü dumping areas have been accepted as if landfill, and capacity of Varsak landfill area is 75 % of total capacity and capacity of Kepezüstü landfill area is 25 % of total capacity; cost per one person for a month is 0.47 $ (Table 2.10). However, when the four transfer stations have been used, cost is 0.40 $ (Table 2.11). Capacities of transfer stations have been determined for minimum cost. In the state that the capacities of transfer stations have been calculated firstly, cost is 0.41 $ (Table 2.12).

In the state that Varsak compost and Kepezüstü landfill and capacity of Varsak 75 % and Kepezüstü 25 % of total capacity have been accepted, cost per one person for a month is 0.32 $ (Table 2.13). When the four transfer stations have been used and capacities of transfer stations have been determined for minimum cost, cost is 0.25 $ (Table 2.14).

When the capacity of Varsak compost equal to capacity of Kepezüstü landfill area; cost per one person for a month is 0.31 $ (Table 2.15). When the four transfer stations have been used; cost is 0.25 $ (Table 2.16).

In the state that capacity of Varsak compost establishment is 75 % of total capacity and capacity of Kepezüstü landfill area is 25 % of total capacity, and two transfer stations have been used, cost per one person for a month is 0.25 $ (Table 2.17).

As a result; system which has minimum cost presents at table 2.16. But, if existing Kepezüstü dumping area will be closed, then method which presents at table 2.8 will be optimum system.

At this time; for only Muratpaşa Municipality, cost which paid to private company is at about 31,000 $/week. This cost more than the cost determined at table 2.3. At the table 2.3, cost of collection-transportation for Muratpaşa Municipality is 29,956 $/week.

Varsak dumping area planning to set is considered to operate as landfill. In this state; method at table 2.6 will be optimum.

CHAPTER SIX
CONCLUSIONS

1. Conclusions and Suggestions

In this study prepared for Antalya, basicly, optimization of collection and transportation have been researched. Existing problems occured during operation of collection and transportation are;

1-The definite route is not followed

2-There is not a definite work period

3-Vehicles come back to dumping area without pouring out the all containers

For every street, time of removing solid wastes from houses was determined by municipality. This application was considered for reducing the waiting period of solid wastes in containers and preventing to occur of odour problem. However, this time is not observed during operation of collection done by private firm.

For solution of these problems, operation of collection and transportation that is route and work period of vehicles has to be planned and vehicles must observe this plan.

Operation of collection and transportation was evaluated in two sections. First section is collection and transportation from regions straight to removed units and second section is collection and transportation from regions to transfer stations and transportation from transfer stations to removed units. In the states used transfer stations, cost is more economic. However, place problem for transfer stations will be

in the future because of Antalya develops continously. In transfer stations, tır which has capacity of 120 m^3 was used.

Two removed units is in question. Capacity of these removed units was accepted as 2600 tone / week. Kepezüstü dumping area present was considered as if only landfill and Varsak dumping area planned to set was considered as if both landfill and compost.

Optimization of collection and transportation was done for Muratpaşa, Kepez and Konyaaltı Municipalities connected with Antalya Main-City Municipality. House and industrial wastes will be transported to these disposal units. Medical wastes will be sent to the incinerator in Akdeniz University.

1.1 Kepezüstü Dumping Area

Kepezüstü dumping area still used is considered to close. This area has been hired for 49 years from Forest General Directorship. However, this area has been used without taking environmental measures and so sources of groundwater are polluted. Ground of this area is permeable. There is not gas collection and control network. Windway is straight to city centre from dumping area. Besides, solid wastes of vicinity municipalities and medical wastes are accepted to Kepezüstü dumping area without checking. And random pouring out of solid waste is done to the dumping area. For this reason; danger of fire occurs frequently especially in summer.

All these negativenesses are required to close of this area and this dumping area must be reformed.

1.2 Varsak Dumping Area

Landfill system is considered to apply in Varsak. However, calculations were also done for compost system. This area is appropriate because of windway and distance

from city. There is also a treatment plant which has begun activity in the beginning of 1999.

Wastewater which is poured out by sewage trucks are treated at this treatment plant. In the treatment plant, there are two lagoons (70 m-35 m) and aeration tank. Wastewater is sent in order first lagoon, second lagoon and aeration tank. Sludge which formed in the lagoons is sent to thickener unit and then beltfilter. Aeration tank is worked as if intermittent reactor. 20 hours aeration, 3 hours precipitating and 1 hour discharge operations are applied. Water treated is discharged to forest. Leakage water of landfill will be sent to this treatment plant.

For this area, environmental measures have to be taken. Besides, control of accepting solid waste of vicinity municipalities has to be also done. Charge per tone is able to take applying the monetary sanctions for storing. Medical wastes have to be sent to the incinerator in Akdeniz University and it has not to been accepted to the landfill.

1.3 Waste Collection Separately

Firstly waste collection separately system in it's source has to be considered before operation of collection-transportation and removed for solution of solid waste problem. Amount of solid waste which will be brought to removed unit will reduce with applying this system.

This application has been begin at Kültür and Oyak Blocks by Muratpaşa Municipality, but, application does not continue. Bag of a wrapping paper resistant to oil was considered to use because of disappearing of plastic bag continues for years.

At the same time, reusing of recycling wastes is important because of economy.

If we are able to reduce the forming of waste, then both we protect the environmental sources and we form the less waste. For this reason, there are three parts of solid waste economy.

a-Protection and to reduce of waste forming

b-To evaluate and to reuse of wastes

c-To dispose of solid wastes with healthy and environmentalist technology

Problem of solid waste has to be taken into consideration for Antalya city. Taking into consideration the solid waste problem will be useful because of environment and also economy.

The coastal zone east and westwards of Antalya City shows a rapid development in population and urbanization in the recent years. This trend have very negative effects on the environment. One of the urgent problems is the solid waste management along the coastal zone. Transport and final disposal of solid waste is becoming a serious problem especially in the summer months.

As a coastal province Antalya has two economic sides: The first is tourism which mainly takes place along the narrow coastal zone and the other is agriculture practised on the hinterland and along the coastal zone outside of the tourism centers. Solid waste management strategies for the province must take these conditions. For the towns and villages along the coastal zone, regional solutions should be strived. The sanitary landfill of Antalya city should be accomplished by the earliest term.

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APPENDIX 1

RESULTS OF WEIGHT

Amount of Waste Weighted in Antalya Kepezüstü Dumping Area (tone)

SOURCE OF WASTE	31.03.1997	01.04.1997	02.04.1997	03.04.1997
Muratpaşa	190.50	211.69	196.32	240.66
Kepez	3.25	102.68	167.04	144.42
Konyaaltı	25.62	18.28	14.35	10.59
Beldibi	21.23	21.56	17.82	6.50
Göynük	5.73	9.81	6.95	9.29
Belek	14.82	7.58	18.85	15.33
Akdeniz Org. Ind. Region	---	6.00	14.38	11.69
Varsak	---	---	3.42	2.77
Döşemealtı	---	---	6.33	---
Hal	5.65	5.41	10.24	22.74
Otogar	1.40	1.20	1.40	1.00
Çamyuva	9.39	---	13.13	6.66
Çalkaya	---	4.37	2.29	3.56
Aksu	2.37	2.37	2.60	2.00
Abdurrahmanlar	---	---	---	---
Kemer	16.62	21.85	27.28	19.66
Wastes of airport	---	---	---	5.45
Wastes of hospital	3.57	4.87	6.04	3.54
Others	---	---	1.70	0.71
TOTAL	296.60	412.80	510.10	506.60

Amount of Waste Weighted in Antalya Kepezüstü Dumping Area (tone)

(Continued)

SOURCE OF WASTE	04.04.1997	05.04.1997	06.04.1997	Average (t/day)
Muratpaşa	211.31	204.32	237.48	213.18
Kepez	81.47	78.86	89.20	95.27
Konyaaltı	27.86	15.72	---	16.06
Beldibi	15.97	5.21	4.02	13.19
Göynük	11.95	9.12	15.15	9.71
Belek	20.21	24.56	15.49	16.69
Akdeniz Org. Ind. Region	12.28	5.60	4.39	7.76
Varsak	1.04	---	---	1.03
Döşemealtı	7.50	---	---	1.98
Hal	6.98	10.66	---	8.81
Otogar	1.11	1.15	1.10	1.19
Çamyuva	10.98	12.14	10.88	9.03
Çalkaya	---	---	3.29	1.93
Aksu	---	---	---	1.33
Abdurrahmanlar	---	3.34	---	0.48
Kemer	18.62	25.79	14.13	20.56
Wastes of airport	5.54	---	---	1.57
Wastes of hospital	3.65	4.37	2.37	4.06
Others	---	---	---	0.34
TOTAL	436.50	400.80	397.50	422.99

APPENDIX 2

SIEVE ANALYSIS OF SOLID WASTE

PROJECT OF ANTALYA SOLİD WASTE MANAGEMENT

SİEVE ANALYSIS OF WINTER TERM

Date of illustration : 31.03.1997 01.04.1997

İllustration area : Muratpaşa / Kızıltoprak neighbourhood Kepez / Dokuma

Structure of illustration area: Low income level Mıddle income level

PARAMETER	Weight (Kg)	(%)	Weight (Kg)	(%)
<8 mm. Thin waste, ash, sawdust	**35.00**	**11.8**	**16.00**	**4.9**
8-40 mm. Mixed organic waste	75.00	25.4	88.00	26.9
>40 mm. Thick organic waste	90.00	30.5	109.00	33.3
Total-Organic Waste	**165.00**	**55.8**	**197.00**	**60.2**
Paper	24.99	8.5	27.58	8.4
Paperboard	5.7	1.9	6.67	2.0
Glass-Bottle	20.48	6.9	13.65	4.2
Tinplate-Metal	9.48	3.2	7.67	2.3
Plastic	16.96	5.7	25.72	7.9
Total-Valuable Waste	**77.61**	**26.2**	**81.29**	**24.8**
Wood	2.00	0.7	1.5	0.5
Textile	5.50	1.9	8.0	2.4
Stone, ceramic, porcelain	2.50	0.8	2.5	0.8
Others (Full food boxes, battery, shoes etc.)	8.00	2.8	21.0	6.5
Total-Other	**18.00**	**6.2**	**33.00**	**10.2**
TOTAL	**295.61**	**100.0**	**327.29**	**100.0**

PROJECT OF ANTALYA SOLİD WASTE MANAGEMENT

SİEVE ANALYSIS OF WINTER TERM

Date of illustration : 02.04.1997 03.04.1997

İllustration area : Muratpaşa / Oyak Blocks Kepez / Akdeniz Industry Region

Structure of illustration area: High income level Industry

PARAMETER	Weight (Kg)	(%)	Weight (Kg)	(%)
<8 mm. Thin waste, ash, sawdust	**7.00**	**2.9**	**32.00**	**11.4**
8-40 mm. Mixed organic waste	28.00	11.7	35.00	12.5
>40 mm. Thick organic waste	36.00	15.1	55.00	19.6
Total-Organic Waste	**64.00**	**26.8**	**90.00**	**32.1**
Paper	51.90	21.8	44.09	15.8
Paperboard	6.59	2.8	11.03	4.0
Glass-Bottle	23.10	9.7	7.71	2.7
Tinplate-Metal	12.47	5.3	34.21	12.2
Plastic	25.59	10.7	16.80	6.0
Total-Valuable Waste	**119.65**	**50.3**	**113.84**	**40.7**
Wood	2.5	1.0	16.00	5.7
Textile	12.0	5.0	15.00	5.4
Stone, ceramic, porcelain	3.0	1.3	10.00	3.6
Others (Full food boxes, battery, shoes etc.)	30.00	12.6	3.00	1.1
Total-Other	**47.5**	**19.9**	**44.00**	**15.8**
TOTAL	**238.15**	**100.0**	**279.84**	**100.0**

PROJECT OF ANTALYA SOLİD WASTE MANAGEMENT

SİEVE ANALYSIS OF WINTER TERM

Date of illustration : 04.04.1997 05.04.1997

İllustration area : Muratpaşa / Konyaaltı Street Konyaaltı / Liman-Free Zone

Structure of illustration area: High income level Commercial

PARAMETER	Weight (Kg)	(%)	Weight (Kg)	(%)
<8 mm. Thin waste, ash, sawdust	**7.00**	**2.5**	**48.00**	**15.1**
8-40 mm. Mixed organic waste	35.00	12.5	51.00	16.1
>40 mm. Thick organic waste	45.00	16.1	52.00	16.4
Total-Organic Waste	**80.00**	**28.6**	**103.00**	**32.5**
Paper	57.54	20.6	39.72	12.5
Paperboard	12.00	4.2	8.84	2.8
Glass-Bottle	17.64	6.3	26.77	8.4
Tinplate-Metal	17.22	6.2	17.28	5.4
Plastic	49.61	17.7	23.68	7.5
Total-Valuable Waste	**154.00**	**55.0**	**116.29**	**36.6**
Wood	3.00	1.1	2.00	0.6
Textile	8.00	2.8	44.0	13.9
Stone, ceramic, porcelain	6.00	2.1	0	----
Others (Full food boxes, battery, shoes etc.)	22.00	7.9	4.00	1.3
Total-Other	**39.00**	**13.9**	**50.00**	**15.8**
TOTAL	**280.00**	**100.0**	**317.29**	**100.0**

PROJECT OF ANTALYA SOLİD WASTE MANAGEMENT

SİEVE ANALYSIS OF WINTER TERM

Date of illustration : 06.04.1997

İllustration area : Muratpaşa / Lara

Structure of illustration area: Commercial-Touristic

Weight

PARAMETER	(Kg)	(%)
<8 mm. Thin waste, ash, sawdust	**12.00**	**5.1**
8-40 mm. Mixed organic waste	19.00	8.0
>40 mm. Thick organic waste	38.00	16.1
Total-Organic Waste	**57.00**	**24.1**
Paper	48.37	20.5
Paperboard	9.6	4.0
Glass-Bottle	15.06	6.4
Tinplate-Metal	9.88	4.2
Plastic	31.36	13.3
Total-Valuable Waste	**114.27**	**48.4**
Wood	1.5	0.7
Textile	16.00	6.8
Stone, ceramic, porcelain	----	----
Others (Full food boxes, battery, shoes etc.)	35.50	14.9
Total-Other	**53.00**	**22.4**
TOTAL	**236.27**	**100.0**

APPENDIX 3

WINTER PERIOD LABORATORY ANALYSIS

WINTER PERIOD LABORATORY ANALYSIS

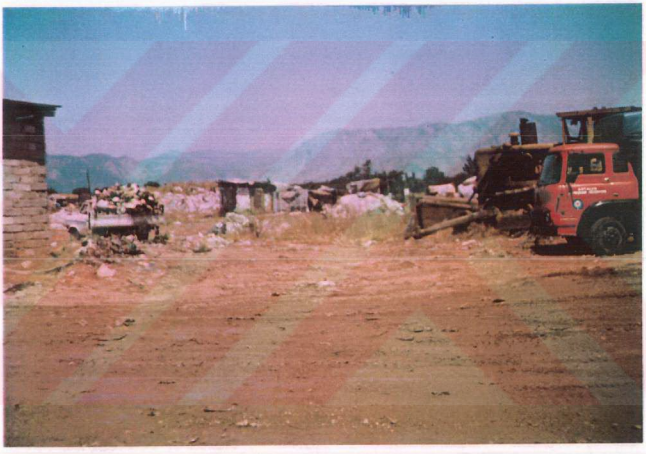
ILLUSTRATION AREA	STRUCTURE OF ILLUSTRATION AREA	DATE OF ILLUSTRATION	SIEVE INTERVAL (mm)
Muratpaşa Kızıltoprak	Lower Income Level	31.03.1997	<8 8-40 >40
Kepez Dokuma	Middle Income Level	01.04.1997	<8 8-40 >40
Muratpaşa Oyak Blocks	High Income Level	02.04.1997	<8 8-40 >40
Kepez Akdeniz Industry Region	Industry Region	03.04.1997	<8 8-40 >40
Muratpaşa Bahçelievler	High Income Level	04.04.1997	<8 8-40 >40
Konyaaltı Harbour-Free Zone	Commercial	05.04.1997	<8 8-40 >40
Muratpaşa Lara	Commercial Touristic	06.04.1997	<8 8-40 >40

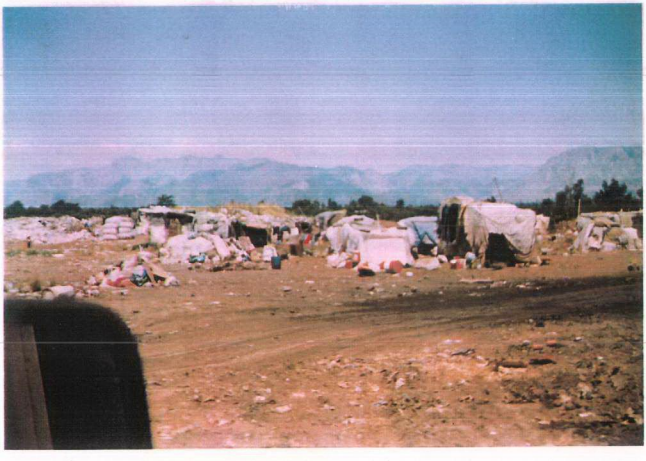
WINTER PERIOD LABORATORY ANALYSIS

ILLUSTRATION AREA	WATER CONTENT (%)	ORGANIC MATTER (%)	CALORIFIC VALUE (Kcal / kg)
Muratpaşa	71.6	63.4	3,215
Kızıltoprak	94.7	87.3	4,250
	46.8	50.2	2,640
Kepez	65.1	75.3	3,790
Dokuma	76.2	85.5	4,210
	72.4	77.2	3,885
Muratpaşa	59.4	75.8	3,810
Oyak Blocks	76.6	79.5	3,980
	81.4	84.6	4,210
Kepez	26.3	45.8	2,430
Akdeniz Industry	29.9	62.2	3,200
Region	34.5	83.9	4,310
Muratpaşa	69.6	87.3	4,315
Bahçelievler	82.4	93.8	4,520
	61.2	93.2	4,450
Konyaaltı	62.6	57.5	2,865
Harbour-Free	62.7	71.0	3,495
Zone	70.6	82.8	4,205
Muratpaşa	65.7	76.7	3,880
Lara	63.7	88.0	4,350
	74.7	87.9	4,350

APPENDIX 4

PHOTOGRAPHIES OF KEPEZÜSTÜ GARBAGE AREA





APPENDIX 5

SOLID WASTE COLLECTION ROUTES

Existing Route of Deniz Neighbourhood

In the existing solid waste collection plan, vehicle collects solid wastes of Altındağ neighbourhood firstly and at second journey, solid wastes of Deniz neighbourhood are collected. Deniz neighbourhood has at about 34 containers. Operation of solid waste collection is done everyday.

Distance between garage and Deniz neighbourhood is 4.53 km
Way traveled during operation of collection is 4.30 km
Distance between Kepezüstü garbage area and Deniz neighbourhood is 12.78 km
TOTAL = 21.61 km / day

DENİZ

N

1/2000

TEOMANPAŞA STREET

128 Str.

124 Str.

123 Str.

122 Str.

121 Str.

ANAFARTALAR STREET

127 Str.

123 Str.

122 Str.

121 Str.

126 Str.

KONYAALTI STREET

133 Str.

132 Str.

Existing Route of Özgürlük Neighbourhood

In the existing solid waste collection plan, vehicle collects solid wastes of Yükseliş, Ulus and Özgürlük neighbourhood together. Özgürlük neighbourhood has at about 34 containers.

Operation of solid waste collection is done everyday.

Distance between garage and Özgürlük neighbourhood is 3.43 km

Way traveled during operation of collection is 7.58 km

Distance between Kepezüstü garbage area and Özgürlük neighbourhood is 9.78 km

TOTAL = 20.79 km / day

N

1/3000

ÖZGÜRLÜK

MİTHAT PAŞA STREET

2659 Str.

YAHYA KEMAL STREET

2661 Str.

2668 Str.

2658 Str.

2663 Str.

2666 Str.

2664 Str.

2662 Str.

MEHMET AKİF STREET

2655 Str.

TEVFİK FİKRET STREET

RASİH KAPLAN STREET

2653 Str.

2660 Str.

2658 Str.

2656 Str.

2654 Str.

2652 Str.

2651 Str.

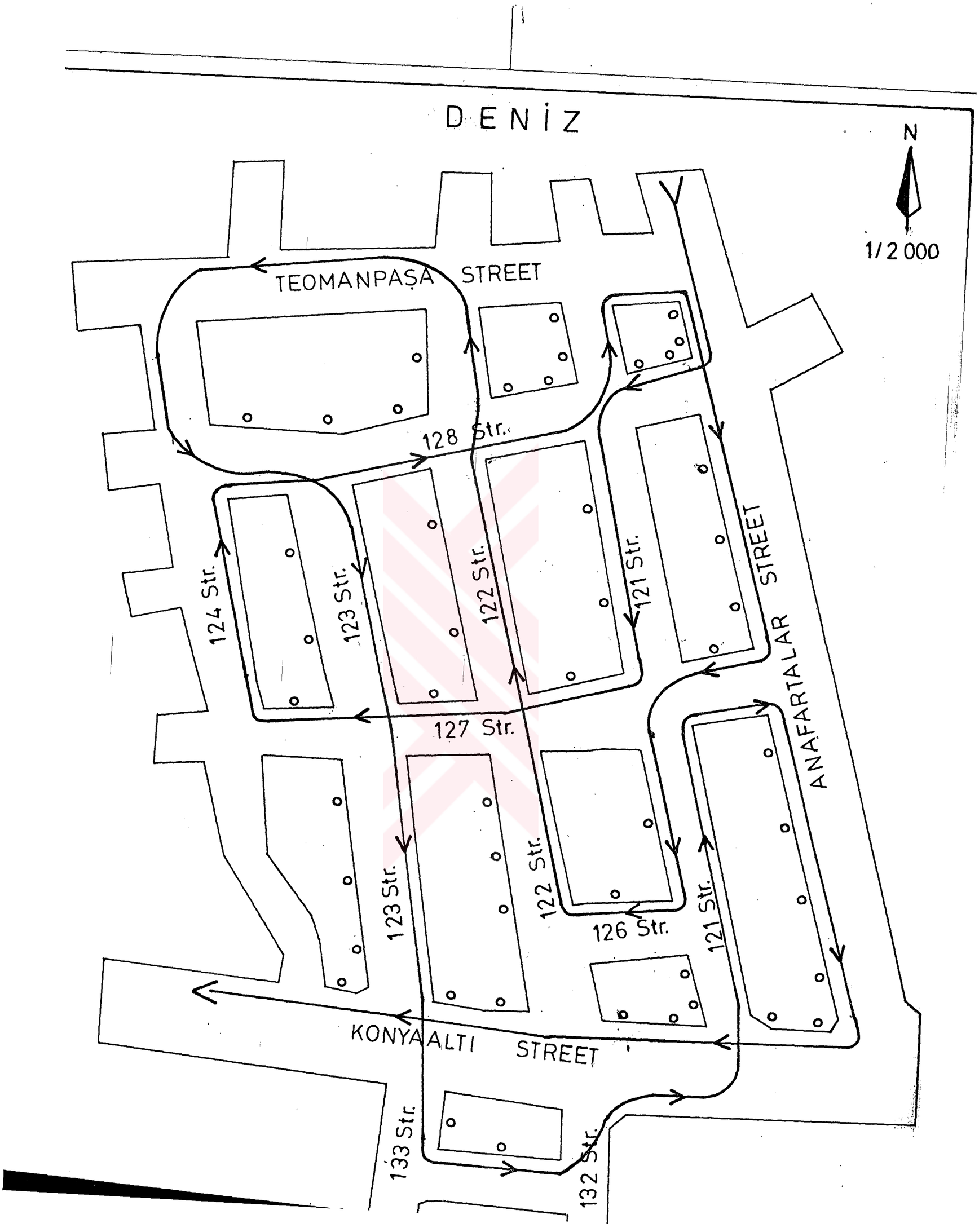
NAMIK KEMAL STREET

Optimum Route of Deniz Neighbourhood

In the optimum solid waste collection plan, Operation of solid waste collection is done 5 days in a week. Deniz neighbourhood has 48 containers.

Distance between garage and Deniz neighbourhood is 4.53 km
Way traveled during operation of collection is 3.90 km
Distance between Kepezüstü garbage area and Deniz neighbourhood is 12.78 km
TOTAL = 21.21 km / day

Distance between garage and Deniz neighbourhood is 4.53 km
Way traveled during operation of collection is 3.90 km
Distance between Varsak garbage area and Deniz neighbourhood is 22.93 km
TOTAL = 31.36 km / day


DENİZ
N
1/2 000
TEOMANPAŞA STREET
128 Str.
124 Str.
123 Str.
122 Str.
121 Str.
ANAFARTALAR STREET
127 Str.
126 Str.
KONYAALTI STREET
133 Str.
132 Str.

Optimum Route of Özgürlük Neighbourhood

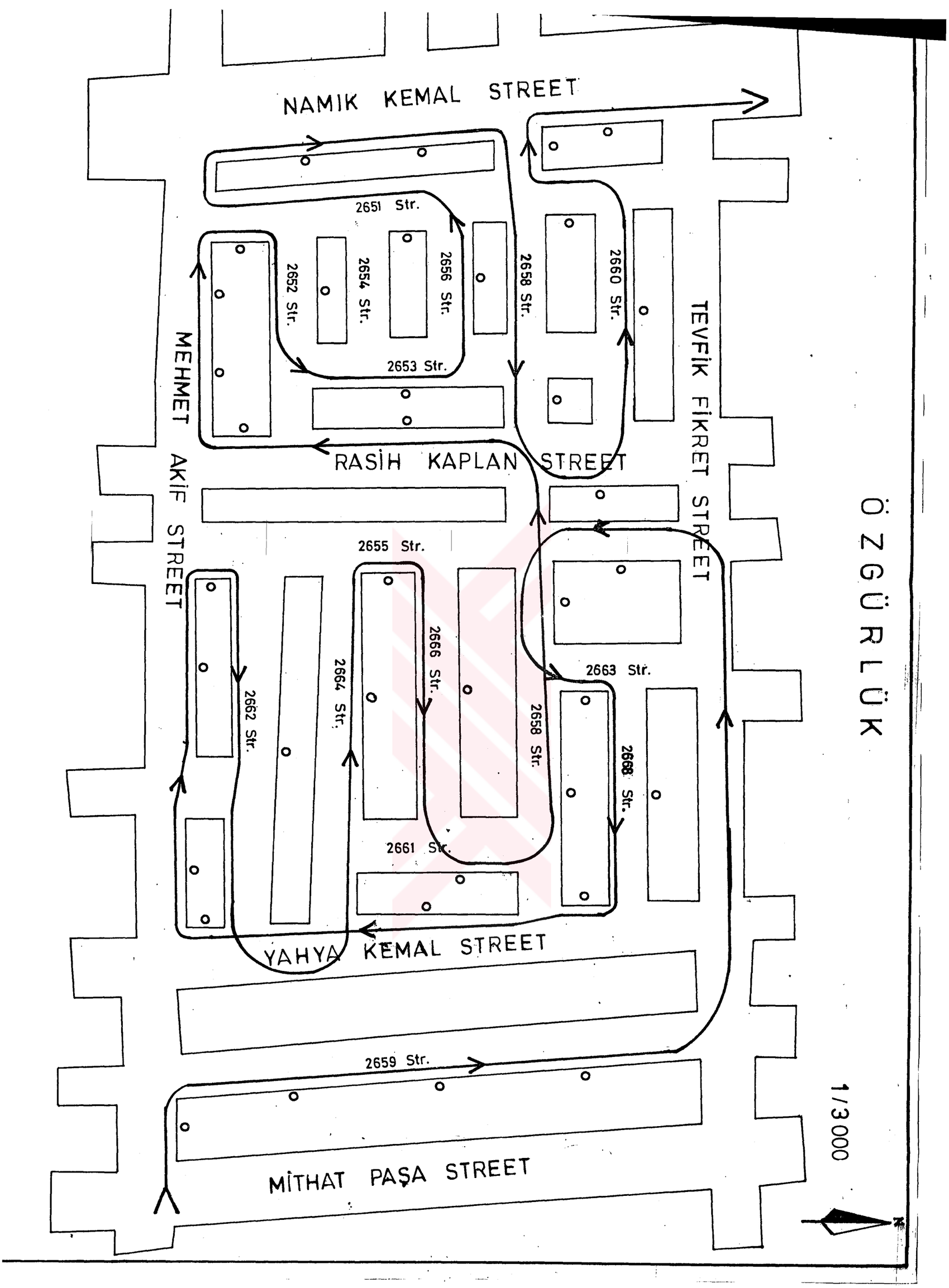
In the optimum solid waste collection plan, Operation of solid waste collection is done 7 days in a week. Özgürlük neighbourhood has 37 containers.

Distance between garage and Özgürlük neighbourhood is 3.43 km
Way traveled during operation of collection is 6.30 km
Distance between Kepezüstü garbage area and Özgürlük neighbourhood is 9.78 km

TOTAL = 19.51 km / day

Distance between garage and Özgürlük neighbourhood is 3.43 km
Way traveled during operation of collection is 6.30 km
Distance between Kepezüstü garbage area and Özgürlük neighbourhood is 20.30 km

TOTAL = 30.03 km / day


NAMIK KEMAL STREET
2651 Str.
2652 Str.
2654 Str.
2656 Str.
2658 Str.
2660 Str.
2653 Str.
MEHMET AKİF STREET
TEVFİK FİKRET STREET
RASİH KAPLAN STREET
2655 Str.
2662 Str.
2664 Str.
2666 Str.
2663 Str.
2658 Str.
2661 Str.
YAHYA KEMAL STREET
2659 Str.
MİTHAT PAŞA STREET
ÖZGÜRLÜK
1/3000
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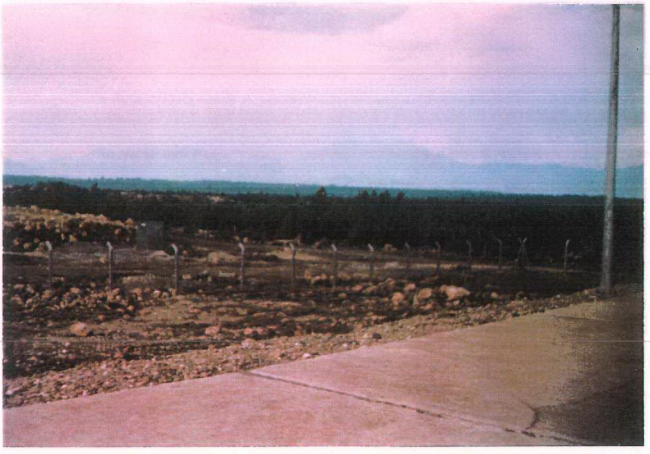
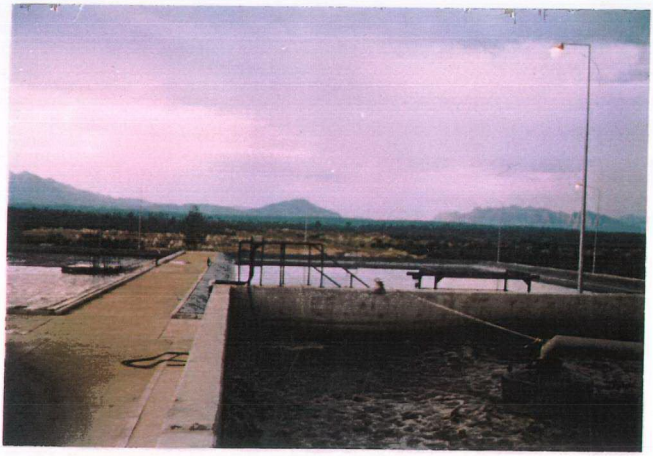
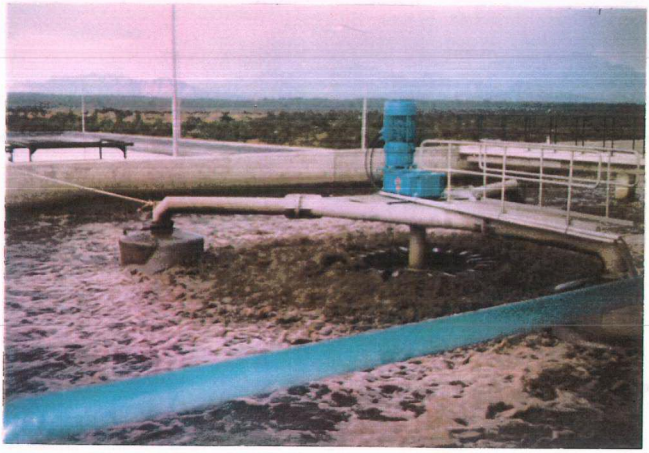
APPENDIX 6

PHOTOGRAPHIES OF VARSAK GARBAGE AREA







APPENDIX 7

NEIGHBOURHOOD AND ROAD MAP