JAPAN INTERNATIONAL COOPERATION AGENCY

THE SOFIA GREATER MUNICIPALITY, THE REPUBLIC OF BULGARIA

THE STUDY ON THE SOLID WASTE MANAGEMENT FOR THE TERRITORY OF THE SOFIA GREATER MUNICIPALITY

MAIN REPOPT VOLUME II-CASE STUDY ON FEASIBILITY OF THE PRIORITY PROJECT

July 1994

Yachiyo Engineering Co., Ltd.
Tokyo, Japan

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ABBREVIATIONS

Alt.	alternative
B/C	Benefit over Cost ratio
BKC	Abbreviation of Bulgarian word meaning "Urbanization and Public Utilities Services"
cap.	capita
CAW	Citizens' Awareness Survey
CHIPP	Collection and Haulage Improvement Priority Project
cu m	cubic meters
EC	European Community
ETC8	European Technical Committee, document 8 on "Geotechnics of Landfill and Contaminated Land"
EIA	Environment Impact Assessment
EPL	Environmental Protection Law
F/S	Feasibility Study
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
Ha., ha	Hectare
HCS	Hauled Container System
HEI	Hygiene Epidemiologic Inspectorate
km	kilometer
l	liter
Lv	Leva (Bulgarian currency)
M/P	Master Plan
MIA	Ministry of Internal Affairs
MOA	Ministry of Agriculture
MOH	Ministry of Health
MOE	Ministry of Environment
MOL	Ministry of Labor and Social Welfare
MRD	Ministry of Regional Development and Construction
MUN	Municipalities
NPV	Net Present Value
O & M	Operation and Maintenance
PCW	Precompressed waste blocks
pcu	passenger car unit
PDS	Pound Sterling
PLC	Public Limited Company: New public company proposed for operation of SWM
RC	Reinforced Concrete
RDF	Refuse Derived Fuel
REI	Regional Environment Inspectorate
SCS	Stationary Container System
SG	State Gazette
SGM	Sofia Greater Municipality
SHW	Solid Household Waste
sq m	square meters
SWM	Solid Waste Management
t/d	ton per day
UPUD	Urbanization and Public Utilities Department, SGM
Veh	vehicle
VOC	Vehicle Operating Cost

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INTRODUCTION

CASE STUDY ON THE FEASIBILITY OF THE PRIORITY PROJECT

INTRODUCTION: CASE STUDY ON THE FEASIBILITY OF THE PRIORITY PROJECT

The feasibility study on the priority projects selected from the master plan was based on the precondition that Katina may be used as a disposal site. However an agreement could not be reached regarding the use of Katina, thus the results of the feasibility study implemented for the priority projects inclusive of Katina sanitary landfill have been compiled in this report as a case study. The sequence of events leading to the present situation are described hereafter.

During the final discussions held with the Bulgarian side concerning the Master Plan, in October 1993, various view-points and considerations concerning Katina disposal site, an essential element of the priority project, were raised.

During these discussions, the Bulgarian side proposed the early introduction of an incineration plant in parallel with the construction of the disposal site, to effectively reduce waste volume and stabilize its content and thereby lighten the burden imposed on the environment at the disposal site. The feasibility of this proposal was studied further. The study concluded that early introduction of the incineration plant would impose an excessive financial burden on the SGM and the residents during this period of transition from a planned economy to a market economy. Once the economy revives and the financial basis is more stable then investing in such a large scale project may be appropriate. The result of this study is reported on in Annex 1 of the Main Report.

With regard to final disposal sites, and with the aim of closing down Dolny Bogrov disposal site by mid 1993 due to environmental problems generated there, SGM developed a plan to extend the Suhudol disposal site. Unfortunately, the rampant inflation made it impossible to secure financing to construct the Suhudol site extension and accordingly closure of Dolny Bogrov was not possible and SGM is continuing to use that site.

Bearing this in mind, the need to construct a sanitary land-fill site at an early stage made it imperative to search for candidate sites where land acquisition poses no serious problem. Katina was a candidate site which met this require-ment and accordingly Katina was selected with the approval of the Deputy Mayor.

After reaching this joint decision with the Bulgarian side, the Study Team commenced the feasibility study from November 1993. Since then, over a considerable period of time, opinions were exchanged with the authorities concerned over the construction of Katina disposal site, notably the Ministry of Defense and at the Novi Iskar District. As a result of this exchange, flight safety at the nearby military airfield and environmental protection in the vicinity of the proposed Katina disposal site were repeatedly studied from various aspects, and countermeasures were proposed.

However, during the final phase of the preparation of the final report in March 1994, it became evident that in addition to the opposition to construction of a disposal site at Katina by the surrounding residents, attaining the agreement of the Ministry of Defense on construction was necessary. Discussions with the Ministry of Defense in relation to this matter had been continuing since 1970, when the nearby military airfield authorities expressed fear that a disposal site in Katina may hamper its flight operations, and it is now clear that a long period of time may be required to resolve this issue. Therefore, starting operation at Katina disposal site by the beginning of 1997 as set out in the priority project implementation schedule seems exceedingly difficult at present.

Under this condition where clarification of the final disposal site location has not been resolved, it is naturally not possible to prepare a feasibility study (F/S) for the priority projects. However, since the F/S had already been developed to its final stage, it is strongly desirable that the Bulgarian side, in one form or another, benefit from the results. Therefore the study has been compiled in this report as a case study for a F/S of a series of SWM priority projects based on the precondition that Katina site shall be the final disposal site.

Given that it is not possible to open Katina disposal site in the near future as aforementioned, that no other land can be allocated as an alternative site, and that in addition the agreement of local residents surrounding other candidate disposal sites has yet to be sought, it is necessary to resort to temporary measures to resolve this difficulty. There is no alternative but to continue using Dolny Bogrov site in addition to the extension of Suhudol disposal site. However, due to the many environmental problems generated by Dolny Bogrov site such as pollution of groundwater and scattering of waste, resulting in the petition by surrounding

residents, the municipality agreed to close down this site. Therefore continued use of this site must be conditional on enforcement of stringent environmental improvement and protection measures. A countermeasure plan for using this site has been included in Annex 2 of the Main Report for reference.

CHAPTER 1

PRECONDITIONS OF THE CASE STUDY

CHAPTER 1 PRECONDITIONS OF THE CASE STUDY

1.1 Master Plan and Priority Project

According to the Master Plan, all the projects of the first phase (1995-2000) are considered priority projects necessary to achieve the Master Plan which has a target date of 2010 for full implementation. Accordingly these priority projects are:

a. Improvement of solid waste collection
   - Purchase of vehicles and containers
   - Re-arrangement of collection zones
   - Consider plastic bag discharge in city center (or new container system)

b. Construction of Katina disposal site, Stage I
   - EIA and detail design of Katina Disposal site, Stage I, including Amenity center
   - Construction of Katina disposal site, Stage 1, and infrastructure
   - Purchase of heavy equipment

c. Pilot project for recycling

d. Establishment of new tariff values

e. Preparation of groundwork for privatization

f. Establishment of public limited company for SWM
   - Establishment of public limited company (PLC) for SWM
   - Preparation of infrastructure for PLC headquarters, depots and central workshop

Novi Iskar bypass road is a general infrastructure project, which will mainly serve the Sofia incoming and outgoing northern traffic in addition to waste vehicle traffic bound for Katina disposal site. It is considered that this access road shall be financed by local funding and constructed by the year 1997.

Pre-treated leachate will be discharged into the city sewerage system under agreement with the sewerage authority.

1.2 Solid Waste Amount and Composition

The forecast solid waste amount and composition to be handled in the priority project is explained in Chapter 4 of Volume I, and shown in Table 1-2-1.

Table 1-2-1 Forecast Solid Waste Amount
(unit: t/d)

Year	Domestic/ commercial	Street/ park	Non Hazardous Industrial	Total
1993	1005	24	74	1103
1994	1007	25	74	1106
1995	1010	25	74	1109
1996	1058	25	77	1160
1997	1106	25	109	1240
1998	1154	25	111	1290
1999	1202	25	114	1341
2000	1250	25	116	1391

The forecast solid waste composition is also explained in Chapter 4 of Volume I, and is shown in Figure 1-2-1 and Table 1-2-2. The density of solid waste is assumed to remain the same as the 1993 value of 0.23 t/m^3.

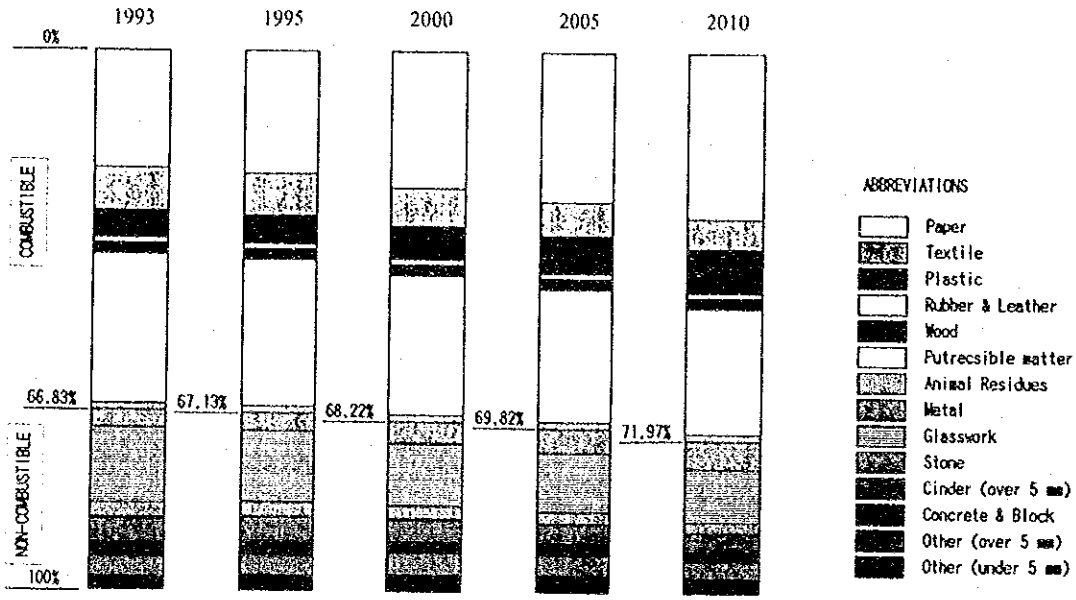


Figure 1-2-1 Forecast Solid Waste Composition

Table 1-2-2 Forecast Solid Waste Composition

Dry Base Composition	Original Solid Waste			Waste After Separation of Reusable Material		
	1993	1995	2000	1993	1995	2000
Combustible(%)						
Paper	17.97	19.03	21.89	17.97	19.03	20.99
Textile	5.88	5.62	5.04	5.88	5.62	5.36
Plastic	6.61	6.99	8.03	6.61	6.99	8.55
Rubber & Leather	1.25	1.25	1.24	1.25	1.25	1.32
Wood	1.97	1.97	1.95	1.97	1.97	2.07
Putrescible matter	18.70	18.26	17.21	18.7	18.26	18.33
Animal Residues	1.15	1.15	1.14	1.15	1.15	1.21
Sub total	53.54	54.27	56.49	53.54	54.27	57.83
Non-Combustible(%)						
Metal	4.97	5.25	6.03	4.97	5.25	6.42
Glasswork	22.85	21.86	19.58	22.85	21.86	16.68
Stone	3.33	3.19	2.85	3.33	3.19	3.04
Cinder(over 5mm)	6.27	6.00	5.37	6.27	6.00	5.72
Concrete & block	2.68	2.56	2.30	2.68	2.56	2.44
Other(over 5mm)	3.69	3.70	3.98	3.69	3.70	4.24
Other(Under 5mm)	2.68	3.16	3.40	2.68	3.16	3.62
Sub total	46.46	45.73	43.51	46.46	45.73	42.17
Total (%)	100.00	100.00	100.00	100.00	100.00	100.00
Three components (%)						
Moisture	42.12	41.91	41.37	42.12	41.91	42.11
Organic	27.37	28.01	29.37	27.37	28.01	30.04
Ash	30.51	30.08	28.91	30.51	30.08	27.85
Lower Calorific Value (Kcal/kg)						
Q = 45 V - 6 W	979	1,009	1,090	979	1,009	1,099
Karigo formula	1,109	1,147	1,250	1,109	1,147	1,268
Calculation	1,224	1,264	1,373	1,224	1,264	1,398

1.3 Target Year and Schedule

Since the master plan also includes staged development, target year for each sub-component of the Priority Project shall be set considering life time of equipment and facilities and based on the following policy.

a. Complete renewal of collection vehicle fleet shall be completed by year 2000. Rearrangement of collection zones shall be implemented at the time of PLC establishment.
b. Katina disposal site shall open at the beginning of 1997. Capacity for stage I shall be more than 6 years to cover at least the period from 1997 to 2002 to insure necessary period for expansion. Heavy equipment shall fulfill requirement of 2000.
c. Establishment of PLC based on requirement of year 2000 shall be as soon as possible.
d. Schedule of pilot project for recycling shall be set considering preparation period and preparation work by PLC.
e. New tariff value and system shall be revised every year based on present system until establishment of new system. New system shall cover required cost of SWM in year 2000.

PLC is assumed to be established by January 1995, considering that one year for preparation and adaptation of infrastructure is required. This assumption is made under the following conditions.

a. Decision on PLC will be made by January 1994.
b. Local fund will be provided for adaptation of existing infrastructure to the requirements of the new organization.
c. Existing equipment shall be used at time of establishment.

Before establishment of PLC, the following work is deemed necessary to ensure smooth transmission from the existing system to the proposed new organization.

a. Decision making
b. Preparatory work for new organization including preparation of necessary regulation and staffing.
c. Preparation of necessary budget for operation of the company and the funds for Priority Project.
d. Adaptation of infrastructure including head office, central workshop and depot(s).

1.4 Solid Waste Flow Chart

Figures 1-4-1 and 1-4-2 show the forecast solid waste flows in the years 1995 and 2000. These forecasts are based on the following considerations.

a. Recycled amount of domestic/commercial waste will continue unchanged until 1996. Pilot project for separate collection of reusable material (paper and glass) will start in 1997. SGM will expand the area step by step. Recycled waste amount is planned to be 5% of domestic/commercial waste in the year 2000.

b. Street/park waste and non-hazardous industrial waste will continue to be received at the municipal disposal site in the future.

c. Solid waste illegally dumped at present will also be received at the municipal disposal site (after 1997 at Katina disposal site).

d. Collection service will be provided for all of domestic/commercial waste and 30% of non-hazardous industrial waste in the future, in the same manner as at present. Street/park waste and 70% of non-hazardous industrial waste will be transported by other agencies and generators.

e. Amenity center(s) to receive domestic hazardous waste, reusable material etc, will be opened in 1997. Domestic hazardous waste will be disposed of at Kremikovtsi disposal site and reusable material will be recycled. However, these waste amounts are considered to be small.

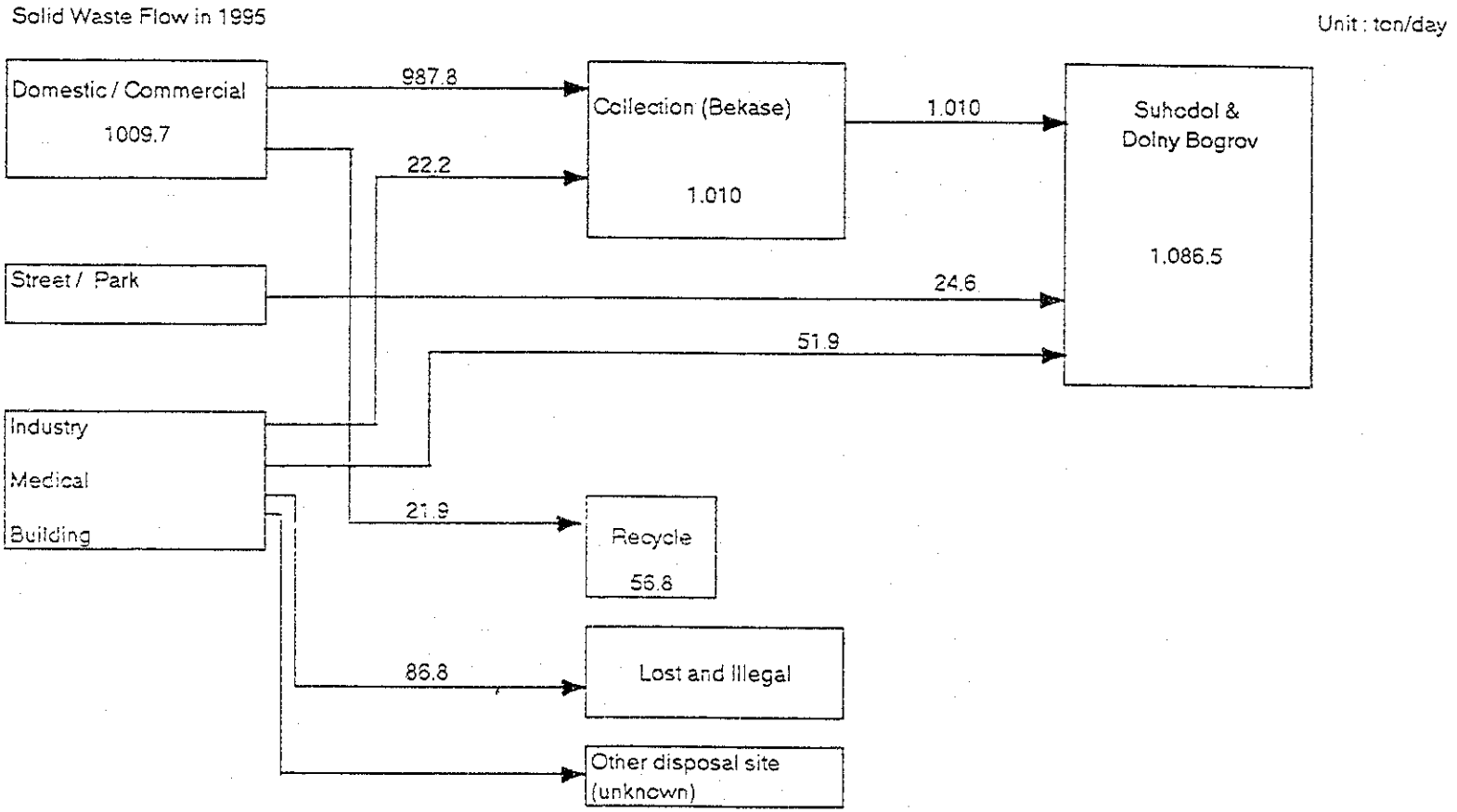


Figure 1-4-1 Solid Waste Flow in 1995

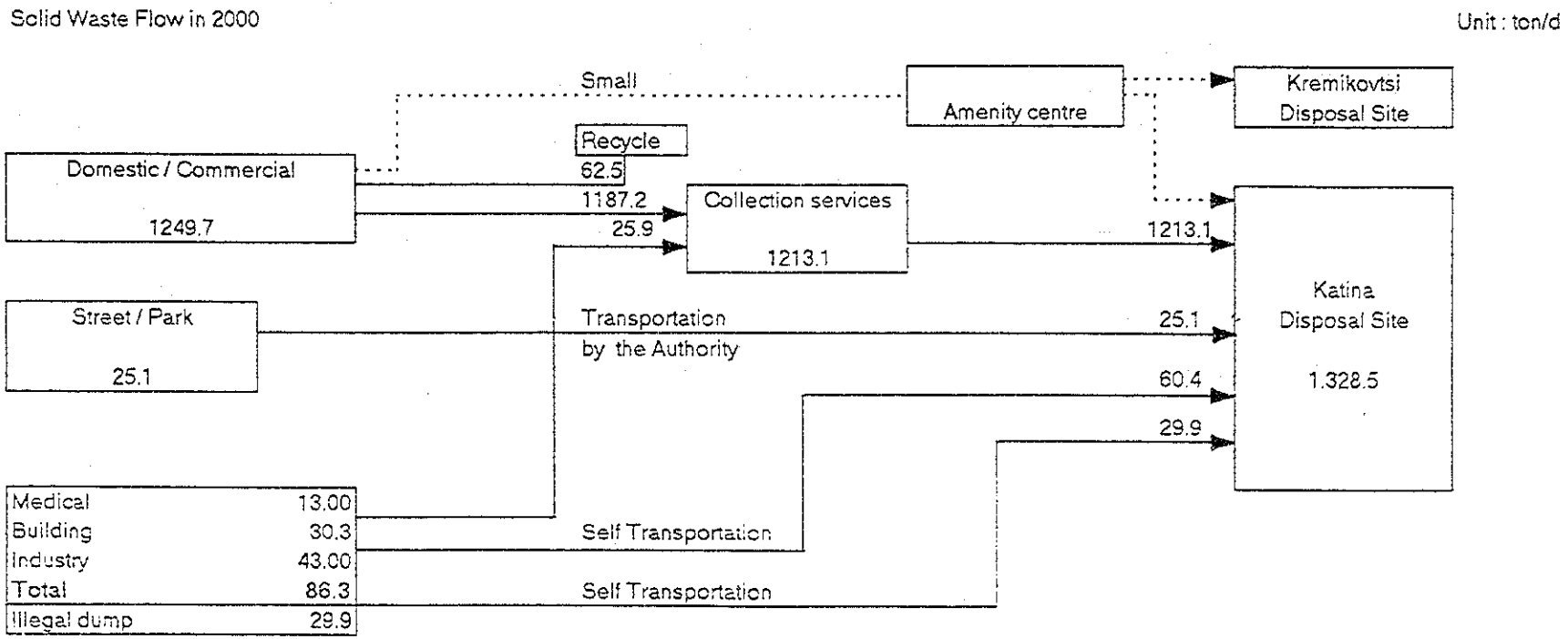


Figure 1-4-2 Solid Waste Flow in 2000

CHAPTER 2

DESCRIPTION OF PRIORITY PROJECT

CHAPTER 2 DESCRIPTION OF PRIORITY PROJECT

2.1 Collection and Haulage

2.1.1 Objectives

In 1993 the BKC and Chistota figures show that roughly US$ 16.0 was spent for every ton of waste collected. Cost for disposal in the same year was less than US$ 1.0. The collection and haulage activity accounted for over 90% of the total SWM costs in that year.

Bearing this in mind, the collection and haulage improvement priority project (CHIPP) shall have three objectives:
- Rearrangement of collection zones
- Introduction of a collection system that will rationalize the use of vehicle fleet in a more cost efficient manner.
- Development of a plan for vehicle replacement to upgrade the service which is at present dependent upon an aged and multi-type fleet.

2.1.2 Technical System

1) Waste Amount to be Collected and Hauled

Type and amount of waste to be collected shall be as follows:
- All domestic waste (excluding recycled amount)
- All commercial waste (excluding recycled amount)
- 30% of non-hazardous industrial waste

Both types of commercial and non-hazardous industrial wastes shall be collected and hauled on a direct contract basis between the dischargers and PLC. Collection frequency shall be decided according to the contract and in principle Kison containers shall be used. Table 2-1-1 shows the waste types and their respective amounts to be considered in the plan.

Table 2-1-1 Waste Amount to be Collected
(unit: ton/day)

Year	1995	2000
Domestic/Commercial	988	1,187
Non-hazardous industrial	22	26
Total	1,010	1,213

2) Collection Zones

SGM is divided into 24 districts with each served by an independent BKC with its own vehicle fleet and manpower at present. This seems to be an inefficient way to best utilize the equipment.

The 24 districts (each an independent collection zone) shall be modified into eight zones (Figure 2-1-1). Zonal borders are fixed according to major roads. Zones I to V comprise the urban area where the majority of the population is concentrated. Zone I (Central area) is located within the Inner Ring Road, and zones II to V fall within the Outer Ring Road.

The present land use features of the city show that there is mainly one commercial center, which is situated in Zone I. Most of the governmental and public buildings are also located here. Housing outside Zone I, and extending to the Outer Ring Road (Zones II to V) is mainly in the form of residential blocks with scattered commercial activity.

The Outer Ring Road forms a natural boundary the city's urbanized area, and the remaining Zones VI to VIII outside the Ring Road are considered suburban zones. Residences in these zones are mainly semi-detached or detached dwellings. Many of these residential areas developed from small villages, and hence the predominance of narrow roads and one unit dwellings. Populations of the collection zones at present and up to year 2000 are shown in the following Table 2-1-2.

Table 2-1-2 Population by Collection Zone

Collection Zone	Resd. Built-up area (Ha)	Populations 1992	1995	2000	Share of Tot. (%) 2000
CENTER I	430.6	109,166	109,174	109,699	9%
NORTH II	1,163.4	183,684	186,960	196,669	15%
EAST III	1,122.1	175,974	178,081	184,054	14%
SOUTH IV	1,734.6	311,976	321,482	348,065	27%
WEST V	1,312.2	262,415	265,973	286,381	22%
SUB VI	2,531.7	61,143	62,692	66,930	5%
SUB VII	1,695.9	45,507	47,309	52,583	4%
SUB VIII	1,208.6	32,830	33,329	35,620	3%
TOTAL	11,199.1	1,182,695	1,205,000	1,280,000	100%

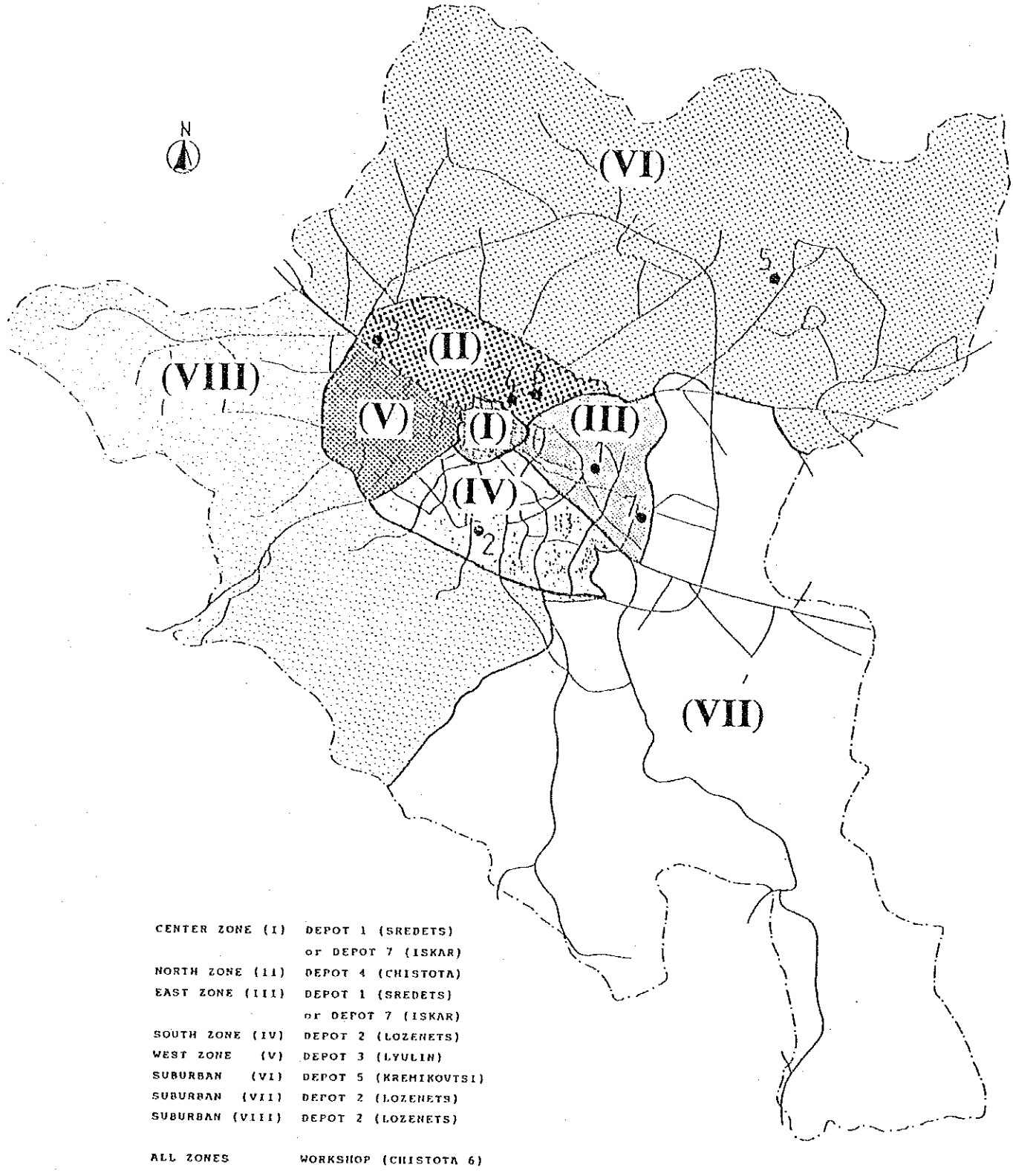


Figure 2-1-1 New Collection Zones and Selected Depot Facilities

Each of the eight collection zones shall have its own vehicle fleet and equipment, although all the zones will be under the responsibility of the PLC (as outlined in the institutional development plan of this study). Equipment requirements, inclusive of standby vehicles will therefore be calculated for each zone independently.

3) Collection System Components

The components comprising the collection and haulage system, namely discharge method, container types to be adopted, collection frequencies, vehicle types, and workshops and depots shall be described hereafter.

At present SGM citizens are free to discharge their waste at any time. Central districts are served by Meva communal containers (0.11 m^3) while in urban districts both Meva and Ra (1.1 m^3) containers are utilized. Suburban areas are served mainly by Meva and Kison (4 m^3)containers.

Door-to-door collection service is provided in the centrally located districts and at suburban districts, while communal container stations are predominant in urban districts.

The collection system shall adopt three unified systems for the zones, after grouping them into: (1) Central Zone I, (2) Urban Zones II to V, and (3) Suburban Zones VI to VIII. The systems are shown in Table 2-1-3.

Table 2-1-3 Collection System

Item	Central Zone I	Urban Zones II-V	Suburban Zones VI-VIII
1) Communal Container Type	Meva (pl. bag)	Ra	Meva
2) Collection Point	Door-to -Door	Communal Station	Door-to -Door
3) Collection Frequency	Daily (exc. Sunday)	3 times/ week	1-2 times/ week
4) Discharge Time	Fixed Time	---	---

(1) Discharge

Communal containers placed at stations or in front of buildings are an open invitation to citizens to discharge waste at any time. However in the case of areas with low frequency collection services, waste piling up in the containers for two or three days is not desirable from view points of public health and street environment. Citizens living in these areas will be encouraged to discharge waste on the collection day or one day before it. Signs shall be placed at communal stations clearly identifying collection days.

Citizens residing and working in Central Zone I, where daily collection service is planned, on the other hand shall have to discharge waste at fixed time (possibly from 8 PM to 8 AM of the following day). Containers full of waste and emitting odors or attracting scavengers shall not be allowed during daytime in this vital commercial and scenic area of the city.

Presently citizens discharge waste directly into unlined communal containers and this practice is not expected to change soon. Therefore watering and disinfecting communal containers periodically is necessary. Containers should be placed in enclosures when possible, and be capped at all times.

(2) Container Type

The present Meva and Ra metallic containers shall continue to be used, however mixed usage in one collection zone shall not be adopted. Ra is suitable for block housing and communal station service. Utilization of smaller containers here would mean placing long rows of containers in front of densely populated blocks and producing very unpleasant aesthetics. Collection vehicles would also spend longer time on routes with the smaller containers.

Meva takes up lesser space, and is more suitable for detached and semi-detached housing. These smaller containers are recommended for the central area and suburbs. One disadvantage of using Meva is that trip time on the collection route increases, when compared to larger containers. It is therefore more advisable to consider smaller collection vehicles in commercially active areas where Meva is employed. Prolonged time in waste collection during daytime hours when such areas are bustling with activity, and when daytime population may double nighttime population is not desirable.

However Meva containers take up space and their use in the central area may raise objections from business and commercial concerns. An alternative to Meva in the central area, would be to have citizens discharge waste in plastic bags. Table 2-1-4 compares the advantages and disadvantages of using Meva and plastic bags.

As a conclusion of the table, in Zone I where the city's commercial and business activities are concentrated adoption of plastic bag discharge may provide a better atmosphere.

However to be successful, plastic bag discharge requires strict and enthusiastic citizens cooperation in observing discharge times and collection operations punctuality in removing the discharged waste. This may not be easy to achieve immediately, as witnessed by the poor conditions in an area of Oborishte District, where plastic bag discharge with fixed discharge time has been in operation for a long time with only modest success. It is therefore recommended to continue use of Meva size containers up to 2000. At the same time plastic bag discharge in the area of Oborishte District (which is located within the Central Zone I) shall continue as a pilot project, to be expanded in the future as suitable.

To eliminate disadvantages of using Meva containers, they may be located in building backyards or entrances and kept properly maintained. These should be considered during planning of pick-up points and collection routes. This will help maintain the central area's streets in a better condition.

Kison containers shall be utilized at large commercial and business dischargers. In urban and central areas Kison should be used only when it is possible to keep them on the premises of the discharger, due to the large space they occupy. For locations where collection vehicle access may be hampered by poor street infrastructure or mountainous roads they shall also be used. The priority project shall consider that approximately 10% of total domestic waste and 95% of the commercial waste shall be discharged into Kison type containers. This closely corresponds with the present conditions.

(3) Collection Frequency

Collection frequency influences the amount of time spent on the collection route, and consequently the number of trips that can be done per shift by a vehicle.

Table 2-1-4 Meva Containers and Plastic Bag Use

Item	Plastic Bag	Meva Container
1) Dischargers	- Plastic bag purchase may be costly	- No cost burden
	- Not suitable for heavy waste, such as coal	- No problem
	- One trip to pick-up point and no return to home	- Empty household container at pick-up point and return it
	- Strict fixed discharge time must be observed	- Fixed discharge time unnecessary
2) Collection Operation	- Faster to load into collection vehicle	- More time required for emptying container into vehicle
	- Necessary to clean up scattered waste often caused by torn bags	- Scattered waste around containers may not be so serious if container number sufficient
	- Collection time must be strictly maintained	- Collection time need not be so strict
	- More freedom in changing vehicle type	- Specialized collection vehicle necessary
	- Increase of plastic element in waste may cause treatment and disposal problems	- No effect upon plastic content in waste
3) Public Street Atmosphere	- Street atmosphere may be improved	- Stationary containers occupy space, and emit bad odor. Create pedestrian and car parking problems
	- Stray animals may tear bags and scatter waste causing dirty streets, attracting insects and rodents	- No stray animal problem if containers are properly covered
	- Rain and snow may aggrevate scattered waste	- No weather problem
	- Waste does not linger on the street	- Containers encourage waste discharge with disregard to collection time and frequency

Table 2-1-5 shows an exercise whereby time in collection route is estimated. In that exercise smaller vehicles for Central Zone I are assumed. Average traveling time between the stations and time required for loading at the stations are assumed based on time and motion study carried out.

Container number at each station differs according to adopted collection frequency. Typical features of each area have been used to estimate container number per station.

In case of Zone I, container number/station was estimated as follows:

Waste generated from Ave. Bldg./day
= 8 Fl x 4 apt/fl x 2.6 cap/apt x 0.9 kg/cap
= 75 Kg
Waste amount collected/collection time
= 75 Kg x 7 days/weekly collection times
= 75 x 7/6 (six days/week)
= 90 kg
Required Meva containers/station
= 90/(0.11 x 230 t/cu.m x 0.8)
= 4.4 (4 - 6 containers)

For urban zones, where block housing is predominant, container number/station was estimated as follows:

Population in Ave. Block Bldg./day
=(10-12)Fl x 4 apt/fl x 4 Wings x2.6 cap/apt
= 450 - 500 capita
Waste generated is roughly 450 Kg
Waste amount collected/collection time
= 450 Kg x 7/3 (three days/week)
= 1050 kg
Required Ra containers/station
= 1050/(1.1 x 230 t/cu.m x 0.8)
= ave. 5 containers

In case of 3 times/week collection, container number per station shall increase and due increased waste amount at the stations, number of stations to be served will decrease.

In Zone I, due to small capacity vehicles use, differences in time spent on collection route by collection frequency are not significant. However in suburban zones daily collection cannot be completed within a working shift, and it is necessary to decrease collection frequency to twice per week. This assumes vehicle and container types are maintained.

Table 2-1-5 Time Required in Collection Route

Area	Veh. Cap. (t)	Cont. Type (R/M)	Cont. No.	Time bet. Stat. (min)	Loading Time/ Cont. (min)	Coll. Freq.	Cont. per Sta.	Sta. No.	Time in C/R (hr)
Central	**2.2**	**M**	**109**	**1.5**	**0.4**	**6d/wk**	**6**	**18**	**1.2**
(Zone 1)	2.2	M	109	1.5	0.4	3d/wk	9	12	1.0
	2.2	M	109	1.5	0.4	2d/wk	13	8	0.9
Urban	5.4	R	27	10	1.5	6d/wk	3	9	2.0
(Zones	**5.4**	**R**	**27**	**10**	**1.5**	**3d/wk**	**5**	**5**	**1.4**
2-5)	5.4	R	27	10	1.5	2d/wk	8	3	1.1
Suburban	5.4	M	267	1.5	0.4	6d/wk	1	267	8.4
(Zones	**5.4**	**M**	**267**	**1.5**	**0.4**	**2d/wk**	**2**	**133**	**5.1**
6-8)	5.4	M	267	1.5	0.4	1d/wk	4	67	3.4

For urban zones, three times a week collection will cut the time spent on the collection route by 30%.

The priority project shall adopt a lower collection frequency of three times/week in the urban zones and two times/week in the suburban zones. This shall ensure that two trips/vehicle-shift are accomplished in the urban zones and at least a full one trip vehicle load can be achieved in suburban zones where Meva containers are proposed. Daily collection frequency shall be adopted at the central zone but with smaller vehicles two trips/vehicle-shift are possible.

Although the lesser frequency of collection will lead to more frequent vehicle utilization and more cost efficiency, frequency reduction means a decrease in service level. However dischargers need not be effected provided a sufficient container number is allocated at the stations to accommodate two to three days of discharged waste. On the other hand increasing the number of containers at stations may not be a pleasant sight. Therefore it is better to consider having containers enclosed in fences and places behind buildings so as not to be too much of an eyesore. Introduction of fixed discharge time when the waste can be brought down one day before, or at the same day of collection is also recommended to avoid keeping waste in the containers for over two days.

(4) Vehicle Fleet

Phase I shall start from 1995 and extend to the year 2000. During the initial years of 1995 and 1996 waste collection and haulage shall be implemented by the existing fleet. Vehicle fleet renewal plan shall commence in earnest from 1996 and is planned to be completed by the year 2000. Vehicle types to be procured under the renewal plan are:

- $16m^3$ drum capacity compactor vehicles (compacted density $400kg/m^3$)
- $7m^3$ drum capacity compactor vehicles (compacted density $360kg/m^3$)
- $4m^3$ hauled container vehicles

(5) Workshops and Depots

To avoid incurring heavy expenses SGM plans to utilize existing BKC and Chistota depots as possible.

In discussions with the SGM Counterpart Team, 6 depots considered to have sufficient area (approx. 1 ha) and conveniently located to serve the proposed 8 new collection zones were selected. Five are envisioned to serve the collection zones, and one depot shall be used as a central work shop. Depot locations are shown in Figure 2-1-1, and existing facilities are summarized in Table 2-1-6.

Table 2-1-6 Proposed Depot and Work Shop Facilities

Dep BKC -ot	Collec- tion Zones served	Tot. Area (Ha)	Available Facilities Area							
			Off- ice (m2)	Work- shop (m2)	Shed (m2)	Ware- house (m2)	Trnsf. stat. (m2)	Other (m2)	Well (no.)	Pet. sta. (no)
1 SREDETZ	1,3	0.51	285	144	400	45	0	0	0	0
2 LOZENETZ	4,7,8	1.65	270	467	250	1,890	0	0	1	0
3 LYULIN	5	1.70	612	936	0	810	110	0	0	0
4 CHISTOTA 25/1	2	1.20	265	175	0	22	0	1,140	1	0
5 KREMIKOVTSI	6	1.42	600	820	900	720	50	0	1	0
WK CHISTOTA 25/2	ALL	0.83	1,817	1,088	90	275	0	0	0	1
TOTAL		7.31	3,849	3,630	1,640	3,862	160	1,140	3	1
6 ISKAR	1,3	0.77	255	33	0	106	0	0	1	0

Should SREDETZ depot prove to be too small for the required facilities, ISKAR depot may be proposed as an alternative. It is therefore included in the table.

4) Recycling System

To reduce solid waste amount, a pilot project for recycling of paper and glass as described in section 2.3 is planned. However collection and haulage of recyclable items shall be dealt with independently by that pilot project.

5) Privatization of Collection and Haulage System

The initial idea of privatization for the collection and haulage system simultaneously with the creation of the new organization had to be dropped due to the fact that no experience and financial capability are existing within the nascent private sector at the time being.

Know-how and practical experience has only been built up, during the past in the 24 BKC and Chistota companies in the SGM region. For this particular reason privatization has been included only during Phase II of the master plan.

Nevertheless after formation of the PLC and its operation specific activities like collection and haulage for special areas, mainly the outskirts beyond the Ring Road could be prepared for tendering on competitive basis as soon as the economic situation has stabilized and respectively improved.

6) Schedule of Collection and Haulage Improvement

Figure 2-1-2 shows the collection and haulage improvement schedule. The basic features of the schedule are as follows:

- During 1995 and 1996 the existing fleet will play the major role in collection and transport of waste.
- New collection zones will come into operation at the start of 1995, with the introduction of the new solid waste management organization.
- New collection system in each collection zone will commence at the same time.
- Collected waste shall be transported to the existing disposal sites up to the year 1997, when the waste shall be directed to Katina disposal site.
- Large investment costs will be required mid 1996 when the vehicle renewal plan comes into implementation. This plan is scheduled to be completed by the year 2000.

ITEMS	1994				1995				1996				1997				1998				1999				2000			
	1	4	7	10	1	4	7	10	1	4	7	10	1	4	7	10	1	4	7	10	1	4	7	10	1	4	7	10
JICA FINAL REPORT			X																									
1. FULL DEPENDENCE ON EXISTING FLEET																												
2. STRENGTHEN EXISTING FLEET			O		O																							
3. NEW COLLECTION AND HAULAGE PLAN																												
- Establish New Collection Zones																												
* Preparation																												
* Start time					X																							
- Implement Plan																												
* Set Discharge Time					X																							
* Ra and Meva plans					X																							
- Vehicle Renewal Plan											X		X		X		X		X		X		X		X		X	
- Container procurement			O		O						X		X				X				X							
4. TRANSPORT DESTINATION																												
- Dolny Bogrov & Suhodol DS operation																												
- Shift to Katina DS													X															
- Katina DS operation																												

O: Local Funding
X: Priority Project Component

Figure 2-1-2 CHIPP Implementation Schedule

2.1.3 Equipment and Manpower Requirements

1) Communal Containers

As described earlier communal containers presently in use shall continue to be employed. Container types by collection zones shall be as follows:

- Central Zone I: Meva containers
- Urban Zones II to V: Ra containers
- Suburban Zones VI to VIII: Meva containers

Kison shall serve all the collection zones. In 1995, when collection and haulage will be dependent upon the existing fleet, commercial and non-hazardous industrial waste will be hauled by Kison as well as dump trucks. However as new vehicles are introduced, and contracts are established with commercial and non-hazardous industrial waste generators haulage of their waste will gradually be taken over by haul

container type vehicles, using Kison. By year 2000, dump trucks are planned to be phased out of the main activity, remaining as standby vehicles for transport of specific waste types (eg. bulky waste, etc.). Therefore a steady increase in required number of Kison containers is planned.

Container requirements are calculated by taking into consideration trip frequency in each zone and ensuring that a sufficient number is available to accommodate 2, 3 or 4 days generated waste, for daily (excluding Sundays), thrice and twice weekly collection respectively. Required container numbers during 1995 to 2000 are shown in Table 2-1-7.

Table 2-1-7 Container Requirements

Year	Number of Container Type			Remarks
	Meva	Ra	Kison	
1995	33,760	8,410	100	
1996	35,070	8,730	120	
1997	36,430	9,050	300	Dump truck service
1998	37,840	9,390	310	discontinued
1999	39,310	9,740	310	
2000	40,830	10,100	340	

2) Collection and Haulage Vehicles

(1) Calculation Process

Required vehicles by type and number for 1995 and 2000 shall be estimated after calculation of waste amount to be collected from each zone according to the following process:

a. Determine amount to be collected by compactor and non-compactor type vehicles
b. Determine vehicle types to be used
c. Calculate trip number
d. Determine number of trips per shift
e. Calculate required vehicle number with standby

After calculation of the requirements for 1995 and 2000, and based on assumptions concerning extent of use of existing fleet's vehicles in the years in between, the vehicle requirements for those years shall also be calculated.

(2) Shares of Compactor and Non-compactor Vehicles

In order to determine required trip number by vehicle type, the first step called for estimating amount of waste to be transported by compactor vehicles and that by non-compactors.

At present (winter survey results) shares of each type are:

Table 2-1-8 Collection Share by Vehicle Type

Waste Type	Compactor	Non-Compactors
Domestic	89%	11%
Commercial	3%	97%
Non-hazardous Industrial	13%	87%
Total	87%	13%

Source: JICA Winter survey results

These results served as the basis for planning, and taking into consideration the land use and geographical characteristics in each of the 24 districts, a breakdown of compactor and non-compactor haul shares by district was estimated.

The forecast breakdown by compactor and non-compactor vehicle types is shown in Table 2-1-9.

Table 2-1-9 Waste Amount by Collection System
(unit: ton/day)

Year	1995	2000
A) WASTE COLLECTION BY VEHICLE TYPE		
Compactor	959	1,152
Others	219	262
B) WASTE TYPE COLLECTED BY COMPACTORS		
Domestic	952	1,144
Commercial	7	18
N-H Ind.	0	0
C) WASTE TYPE COLLECTED BY NON-COMPACTORS		
Domestic	62	74
Commercial	131	158
N-H Ind.	26	30

Note: Collection activity 313 days annually

For example, in most districts domestic waste is forecast to continue to be hauled by compactor vehicles, with the exception of hilly areas in Vitosha district, villages in Lyulin, Ovcha Kupel and Novi Iskar. On the other hand nearly 100% of commercial waste is planned to be hauled by non-compactor vehicles with the exception of some centrally located districts where it is inevitable that small shops and offices would use Meva for their waste discharge, and therefore a share for compactor vehicles was also considered.

(3) Determination of Vehicle Type

As explained in the previous section of this chapter, it is considered that at the start of Phase I, SGM will continue to rely on its existing fleet in principle for waste collection and transport. New vehicle procurement will commence in 1996. Therefore in 1995 the existing fleet will be used.

That fleet is multi-typed, aged and many breakdowns are expected. Considering these conditions it is necessary to allocate most suitable vehicle types for each zone, in order to avoid poor utilization of available limited vehicles.

a. Vehicle Age

Vehicle types for each zone were selected on the basis of age and cost efficiency. Vehicles were assumed to have a usable life of 10 years.

Figure 2-1-3 shows a graphic presentation of the vehicles by age and type.

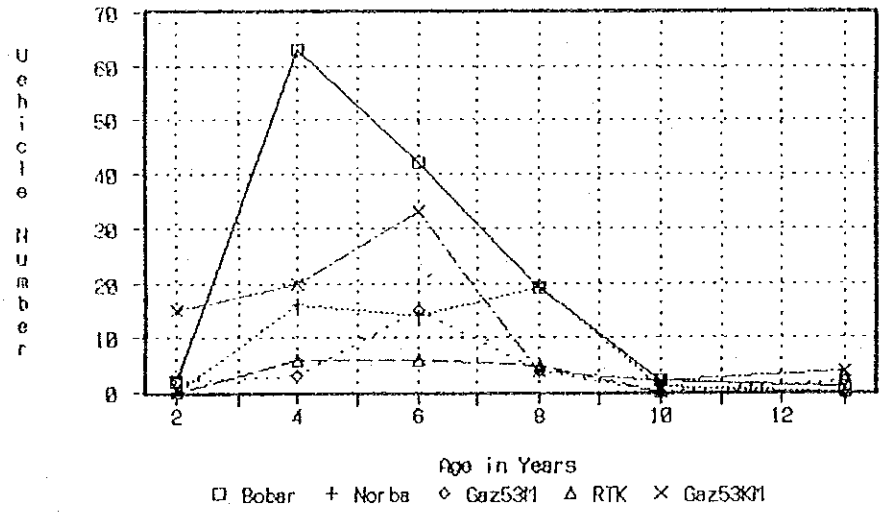


Figure 2-1-3 Vehicle Age

The mainstay of the fleet, Bobar compactors with average haul capacity of 4.6 ton in 1993 surveys, had an average age of 5.4 years in 1993. These vehicles will continue to play an important role during Phase I. The larger Norba compactors (average 5 ton) are older (6.4 years) and in poor condition.

In the case of non-compactor vehicles, Gaz 53KM (hauled container type) will be used in the plan along with Zil and Gaz dump trucks. However existing dump trucks are aged and are planned to be phased out mid way through Phase I.

b. Cost Efficiency

Vehicle operating costs are effected by disposal site location, time spent on collection route, haulage capacities, and communal container type. Applying these factors, the selection procedure used is illustrated in Figure 2-1-4, for 1995.

Bobar vehicles are determined to be most suitable in zones II to V, and VII. Smaller capacity vehicle RTK (average haul 3.8 t) was found more suitable in zones VI and VIII, and the smallest compactors (GAZ 53M) shall be employed in zone I.

Under existing performance conditions and with present average loadings of 5 ton, Norba vehicles were found to be the least suitable in all the zones when compared with other vehicle types. However due to limited vehicle availability and age restrictions these vehicles will continue to be employed, but in small numbers.

In the year 2000, as described earlier the three vehicle types in service shall be:
- Compactor (L): average haul 5.4 t
- Compactor (S): average haul 2.2 t
- Gaz 53KM (or equivalent haul container vehicle): average haul 1 t.

(4) Trip Number per Shift

It is assumed that each vehicle will work one shift per day, for six days a week. Total time required to complete one trip, inclusive of time spent to arrive to collection route from depot (or disposal site in case of second trip), time spent on collection route, time spent to go from collection route to disposal site, and time spent to go back to depot from disposal site was calculated for each of the 152 sub-districts.

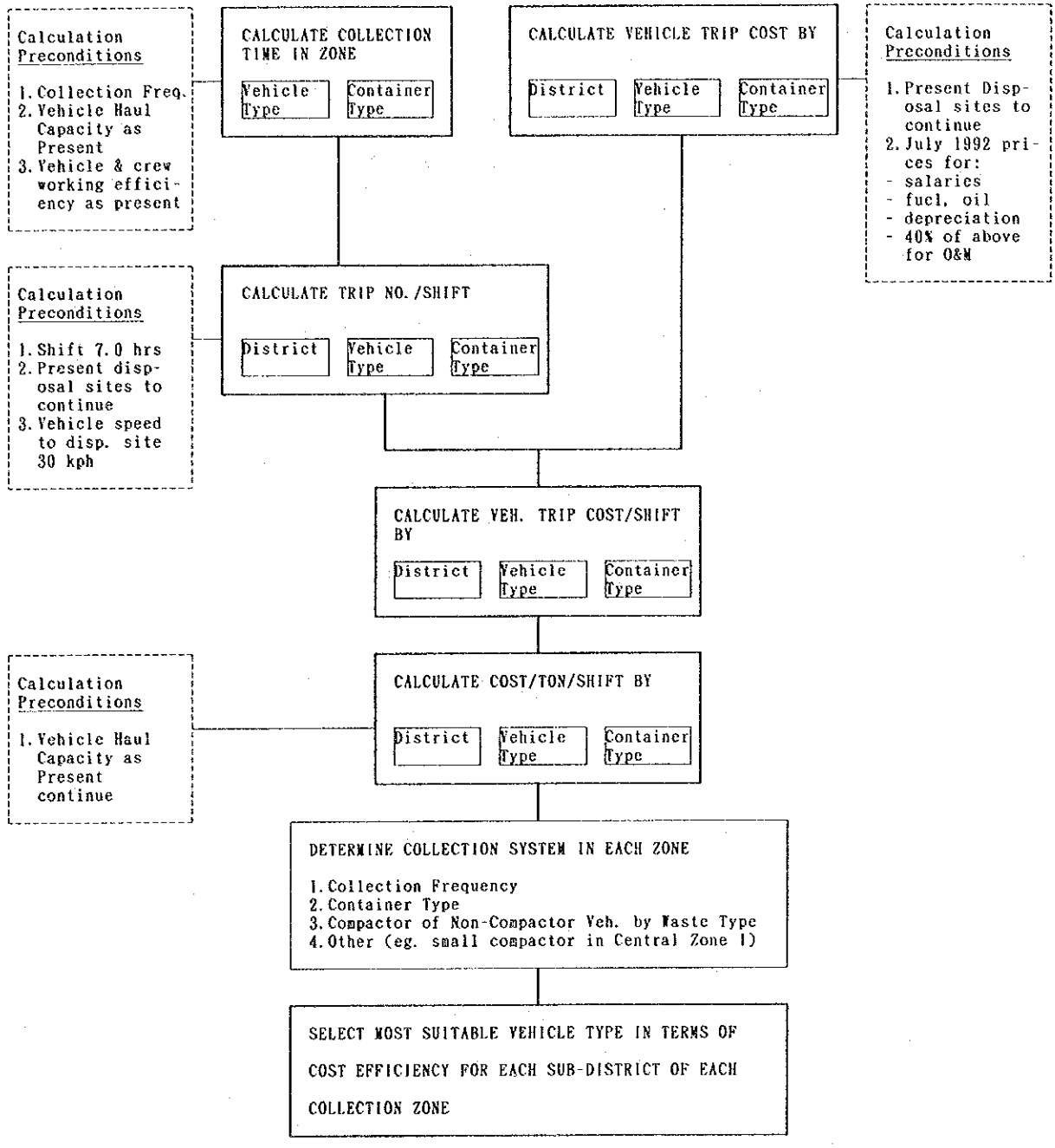


Figure 2-1-4 Flow for 1995 Vehicle Requirements Calculation

Distances from each sub-district to depot, and to disposal site were measured off maps and several were confirmed by actual vehicle runs. In selection of distances care was taken to use major roads and arteries. In trial runs during hours of 10:00 to 13:00 speeds were measured and an average speed of 30 Kph was adopted.

Calculation of time required were done for the 152 sub-districts, however Table 2-1-10 below shows the weighted average distances for the eight collection zones (weighted with respect to waste amount collected from each sub-district).

Average distances to the selected depot locations ranges between 4-6 kilometers for the urban zones, but is slightly longer at 6.7 Km for zone I. Due to the nature of that zone, no existing depots are located there with sufficient capacity to accommodate the fleet.

Distances from collection areas to Katina are on average 22 Km, although for southern zones IV, VII and VIII distances range from 25 to 35 km. However zone VIII, with the longest distance has the smallest population (3% in 2000) and therefore does not pose a serious problem in terms of raising costs.

Applying time spent on collection route (Table 2-1-5) and trip distances, trip times were calculated for each sub-district, as shown in Table 2-1-10 by weighted averages.

Table 2-1-10 Ave. Trip Distances and Trip Time

Zone	Distance from C/Z t		Distance from	Compactor		Gaz 53KM	
	Depot (Km)	Katina (Km)	Katina to Depot (Km)	1 trip /day (Hr)	2 trips /day (Hr)	3 trips /day (Hr)	4 trips /day (Hr)
CENTER I	6.7	19.3	25.0	3.2	6.1	5.2	6.8
NORTH II	4.6	17.0	20.0	3.1	6.0	4.6	6.1
EAST III	5.2	23.0	36.6	3.9	7.2	5.9	7.6
SOUTH IV	5.7	24.2	25.5	3.6	6.9	5.8	7.7
WEST V	4.9	20.0	18.7	3.2	6.3	5.0	6.6
SUB VI	11.9	11.2	20.0	6.9	13.1	3.7	4.7
SUB VII	12.7	25.4	25.5	7.6	14.7	6.3	8.2
SUB VIII	13.5	34.0	25.5	7.9	15.6	7.3	9.7

Assuming an 8 hour shift, in zones I to V compactors can operate 2 trips/shift. On the other hand, combination of large compactors and Meva in suburban zones (thereby increasing time on collection route) and lengthy distances to depots and Katina will allow for only one trip/shift in these zones. In case of hauled container (HC), it is possible to operate 4 trips/shift in zones I, II, V and VI, and a lesser number of 3 in zones III, IV and VII. Two to 3 trips may be operated in zone VIII, and for calculation purposes the smaller figure was used.

(5) Vehicle Requirements in 1995 and 2000

a. Year 1995

In this year waste collection and haulage will depend upon existing fleet and no new vehicles will be introduced. Table 2-1-11 shows required compactor vehicles by type and number.

Table 2-1-11 1995 Compactor Vehicle and Trip Requirements

Zone	Waste coll. (t/d)	Norba 5 t		Bobar 4.6 t		RTK 3.8 t		Gaz53M 2.2 t		Haul Cap. (t)	Cap. Surplus
		Trip	Veh	Trip	Veh	Trip	Veh	Trip	Veh		
CENTER I	88	0	0	6	5	0	0	32	16	98	112%
NORTH II	148	2	3	35	18	0	0	0	0	171	115%
EAST III	142	2	3	34	17	0	0	0	0	166	117%
SOUTH IV	216	2	4	52	26	0	0	0	0	249	115%
WEST V	196	2	4	47	23	0	0	0	0	226	116%
SUB VI	75	2	2	7	6	10	9	0	0	80	108%
SUB VII	57	1	1	12	11	0	0	0	0	60	106%
SUB VIII	37	1	1	0	0	9	8	0	0	39	105%
Total	959	12	18	193	106	19	17	32	16	1090	114%
Share by Vec. type of tot. haul cap.		5%		75%		6%		6%		--	--

Assumed vehicle haulage performances are less than the specifications of the vehicles but accurately reflect the present average haulage conditions. Modest haul figures are more realistic as the existing fleet is aged and their maximum haulage capacity utilization is difficult.

In principal trip number per compactor vehicle in zones I to V is assumed to be 2 (as calculated in the previous section). In zones VI to VIII vehicle trips/shift will fall to about 1.1. However because vehicle fleet is aged and breakdowns or poor vehicle haulage efficiency may be expected additional trips were introduced, such as those by Bobar in Zone I, and Norba in zones II to VIII. This is interpreted in the 14% increased haul capacity over waste amount to be collected.

Of the total waste to be collected, 81% will be by compactors, and the remainder by dump trucks and hauled container type trucks (Gaz 53KM). About 94% of commercial waste and all non-hazardous industrial waste shall be transported by non-compactor vehicles. Direct contracts shall be entered with generators of these waste types, and in places where dump trucks shall be operated generators shall be requested to discharge their waste in plastic bag or other containers so that direct loading onto dump trucks may be possible. Table 2-1-12 shows the non-compactor vehicles to be used.

Table 2-1-12 Non-Compactor Vehicle and Trip Requirements in 1995

Zone	Waste coll. (t/d)	Gaz53KM		Zil		GazTrc		Haul Cap. (t)	Cap. Surplus	Total Haul Cap. (t)	Total Cap. Surplus
		Trip 1 t	Veh	Trip 3 t	Veh	Trip 2 t	Veh				
CENTER I	28	2	4	3	1	10	3	31	111%	129	112%
NORTH II	27	3	4	5	2	7	2	32	117%	203	116%
EAST III	24	3	4	6	2	3	1	27	115%	193	117%
SOUTH IV	49	3	4	11	5	14	6	64	130%	313	118%
WEST V	49	3	4	14	5	6	2	57	115%	283	116%
SUB VI	20	3	4	7	3	0	0	24	121%	104	110%
SUB VII	11	3	4	0	0	6	2	15	133%	75	111%
SUB VIII	11	2	4	4	2	0	0	14	128%	53	110%
Total	219	22	32	50	20	46	16	264	120%	1354	115%
Share by Vec. type of tot. haul cap.		2%		13%		8%		--		--	--

The number of Gaz 53KM vehicles has been increased above the requirement again because of the poor vehicle conditions. An average 1.73 trips per vehicle shift is estimated. Table 2-1-12 also shows that in total a 15% surplus over the waste amount to be collected has been provided.

The total vehicle number required per day in 1995 was 225 vehicles. This includes stand-by vehicles. Concerning the size of existing fleet, there are various figures and lower figures were used. At 324 vehicles at present, the required 225 vehicles can be met, with ample room for breakdowns, etc.

b. Year 2000

Under the priority project the vehicle fleet will be completely renewed by the year 2000. The fleet will have two types of compactors, with 5.4t and 2.2t capacities, and a 1t hauled container vehicle type.

The vehicle requirements are as shown in Table 2-1-13. Vehicle number shown include an additional compactor vehicle and haul container type vehicle for each collection zone. Haul capacity will exceed waste amount to be collected by 6%.

Table 2-1-13 Vehicle and Trip Requirements in 2000

Zone	Waste Coll.		Reqd. Veh. by Type				Total Haul Cap.	Cap. Surplus
	SCS (t/d)	HCS (t/d)	SCS		HCS			
			Trip	Veh	Trip	Veh	(t)	(%)
CENTER I	104	33	47	25	42	12	145	106%
NORTH II	178	33	33	18	42	11	220	105%
EAST III	171	28	32	17	36	13	209	105%
SOUTH IV	260	59	48	25	75	26	334	105%
WEST V	235	59	44	23	76	20	314	107%
SUB VI	90	24	17	18	31	9	123	107%
SUB VII	69	14	13	14	18	7	88	107%
SUB VIII	45	13	8	9	17	9	60	103%
Total	1153	263	242	149	337	107	1493	106%

Comparing 1995 and 2000 vehicle requirements;

	1995	2000
Waste collected (t/d)	1178	1416
Compactor vehicles	157	149
HC type vehicles	32	107
Dump trucks	36	--

Introduction of larger compactors will make it possible to reduce the overall number of compactors. Dump trucks will be replaced gradually by HC vehicles.

3) Equipment Procurement Schedule during 1995 to 2000

(1) New Vehicles

SGM has entered into a partnership with a German manufacturer, Faun, to assemble collection vehicles in Bulgaria (Figure 2-1-5). The major features of the agreement are as follows;

- By the end of 1994, 10 vehicles shall be assembled for use in SGM
- Thereafter 15 vehicles are to be produced annually
- Vehicles will have a drum capacity of $16m^3$, and a compaction factor of 1:5
- The loading and hydraulic devices will be German made while chassis and drum will be produced in Bulgaria
- Cost per vehicle is calculated at Lv. 2.5 million

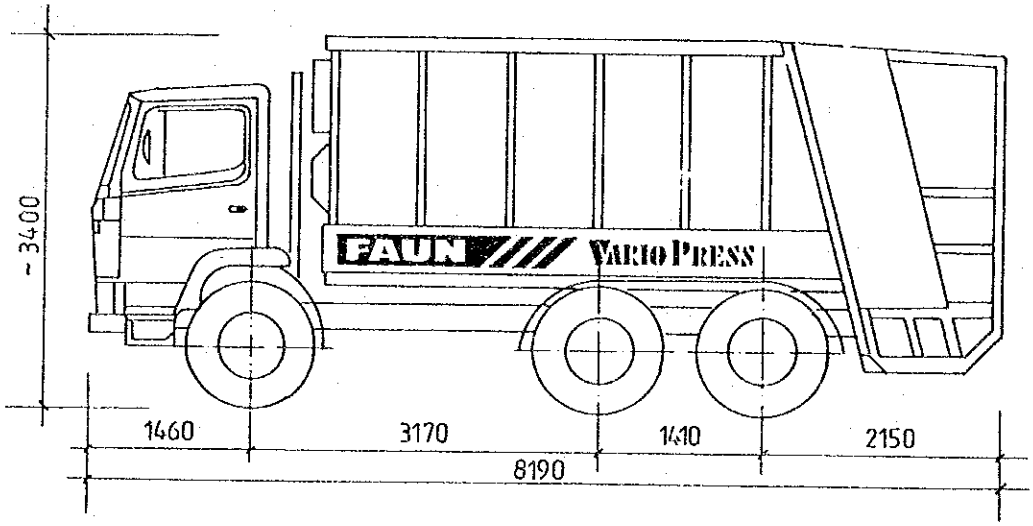


Figure 2-1-5 New SGM Collection Vehicle

Therefore this type of vehicle shall form the bulk of the compactor vehicles to be purchased under the CHIPP vehicle renewal plan. Smaller compactor vehicles of $7m^3$ drums (such as GAZ 53M) shall be purchased for the Central Zone I.

Hauled container system (HCS) and dump trucks shall also be used in the collection system. GAZ 53KM or equivalent haul container vehicle shall be purchased.

(2) Procurement of Collection Vehicles and Containers

The vehicle procurement schedule has been prepared based on the following assumptions;

- Vehicle fleet will be completely renewed by year 2000
- Trip frequency per shift will improve gradually from 1995 to 1997, thereafter it will remain constant
- Existing compactor vehicles:
  * RTK vehicles which are small in number and aged shall be withdrawn at the end of 1995
  * Norba vehicles, which are costly to operate and mostly in poor conditions shall be operated up to end of 1996
  * Gaz 53M small compactors will continue to serve Central Zone I until the end of 1997
  * Bobar vehicles will be gradually replaced, reaching zero by the end of 1999. The use of these vehicles will be extended to that late period because they are comparatively more cost effective, of appropriate capacity, and are in a large enough number.
- Non-compactor vehicles
  * Gaz and Zil trucks shall cease to be operated by the end of 1996. Reasons for their early withdrawal are their old age, and application of communal container system throughout SGM.
  * Starting 1997 only haul container type vehicles shall be used.
  * The largest number of new haul container vehicles shall be introduced in 1997. This is due to the scrapping of 24 dump trucks which will be replaced by the smaller hauling capacity Gaz 53KM.

Table 2-1-14 shows vehicle and container procurement schedule from 1995 to 2000. In 1996 total vehicle number will fall due to introduction of large sized compactors. The following year will see an increase in total vehicle number because of procurement of a large number of HC type vehicles.

Although SGM originally planned to assemble 10 Faun (large sized) capacity vehicles by the end of 1994, and 15 vehicles annually thereafter, these plans seem to have been delayed. The Study Team has been informed that decision on the Bulgarian side on where the vehicles will be produced and which Bulgarian company will jointly produce them with Faun has not yet been reached. As of January 1994, only one vehicle had been assembled. The procurement schedule therefore assumes there will be a delay in production and it will start in earnest by 1995. Usable vehicle life is taken at 8 years.

Table 2-1-14 Equipment Procurement Schedule

	1995	1996	1997	1998	1999	2000
I. REQUIRED VEHICLES	225	216	243	244	250	256
(1) Existing Fleet Vehicles						
- RTK	17	0	0	0	0	0
- Bobur	106	95	70	50	20	0
- Norba	18	5	0	0	0	0
- GAZ 53M	16	16	6	0	0	0
- GAZ Truck	16	8	0	0	0	0
- Zil Truck	20	16	0	0	0	0
- GAZ 53KM (Old)	32	20	10	0	0	0
(2) Vehicles Introduced under CHIPP						
- Faun L	0	25	53	75	103	125
- Faun S	0	0	10	20	24	24
- GAZ 53KM (New)	0	31	94	99	103	107
II. VEHICLE PROCUREMENT SCHEDULE						
- Faun L	0	25	28	22	28	22
- Faun S	0	0	10	10	4	0
- GAZ 53KM (New)	0	31	63	5	4	4
III. CONTAINER PROCUREMENT SCHEDULE						
(1) Required Containers						
- Meva	33760	35068	36427	37839	39306	40829
- Ra	8412	8725	9050	9387	9736	10099
- Kison	102	120	310	311	311	336
(2) Procurement Schedule						
- Meva	16880	1308	1359	18292	1467	18403
- Ra	4206	313	325	4543	349	4569
- Kison	51	18	207	35	0	76
III. INVESTMENT COSTS (US$ 1000000)						
(1) Vehicles Required						
- Faun L: (US$ 95000)	0.00	2.38	2.66	2.09	2.66	2.09
- Faun S: (US$ 70000)	0.00	0.00	0.70	0.70	0.28	0.00
- Gaz (New): (US$ 15000)	0.00	0.47	0.95	0.08	0.06	0.06
Sub-total	0.00	2.84	4.31	2.87	3.00	2.15
(2) Containers Required						
- Meva: (Lv 1200)	0.75	0.06	0.06	0.81	0.07	0.82
- Ra: (Lv 3500)	0.55	0.04	0.04	0.59	0.05	0.59
- Kison: (Lv 15000)	0.03	0.01	0.12	0.02	0.00	0.04
Sub-total	1.32	0.11	0.22	1.42	0.11	1.45
Total	1.32	2.95	4.52	4.29	3.11	3.60

Introduction of large compactor vehicles is fairly distributed over time, while for small compactor vehicles it will be necessary to introduce most of the vehicles over a two year period. These vehicles shall serve the Central area replacing Gaz 53M compactors which are already in small number and aging.

For containers, it is assumed that in 1995, half the required amount will be available, and it will be necessary to procure the other half. Containers are assumed to be used for 5 years. The total investment costs are fairly spread among the period of 1996 to 2000, between US$ 3 to 4.5 million.

4) Manpower Requirements

Drivers have been assigned for the total number of vehicles required inclusive of standby vehicles. A crew of four have been assigned to all compactor vehicles and trucks. The total manpower requirements are therefore as shown in Table 2-1-15.

Table 2-1-15 Manpower Requirements

Year	1995	1996	1997	1998	1999	2000
Drivers	225	216	243	244	250	256
Crew	772	660	556	580	588	596
Total	997	876	799	824	838	852

2.1.4 Application of Priority Project

SGM has been divided into eight collection zones in order to implement more efficient vehicle utilization. Based on trip frequency assumed by collection zone and required trip number calculated by sub-district, collection schedules were prepared for Zone I and Zone IV. Figure 2-1-6 shows the waste generated from both zones daily by sub-district in 2000.

1) Central Zone I

At present SGM is served by only one commercial and business central area and no new sub-centers appear to be rapidly developing in other areas of the city. The available development and future land use maps show that this area will continue to serve the city in its present capacity without competition.

Figure 2-1-6 Daily Waste Generated in Zones I and IV

The collection and transport plan, recognizing the importance of this area, has adopted daily collection service and smaller compactor vehicles. Figure 2-1-7 shows that about 60% of the roads there have widths less than 8 meters, with 54% of the total with widths less than 6 meters. If the road space occupied by the on-street parked vehicles is considered, it becomes apparent that large compactor vehicles will have difficulty in maneuvering in this zone.

Table 2-1-16 shows an alternative for collection schedule for Central Zone I, for the year 2000, by sub-district.

Table 2-1-16 Collection Schedule in Zone I (Daily)

Sub-Dist.	Compactor Veh Schedule						HC Type Veh Schedule					
	Mon	Tue	Wed	Thr	Fri	Sat	Mon	Tue	Wed	Thr	Fri	Sat
1	1	1	1	1	1	0	0	1	0	1	0	1
2	10	10	10	10	10	9	6	6	6	6	6	6
3	5	5	5	5	5	4	3	3	3	3	3	3
4	2	2	2	2	2	2	0	4	0	0	3	0
7	2	1	1	1	1	1	1	0	0	1	0	0
8	2	1	1	1	1	1	0	1	0	0	0	0
9	2	2	2	1	2	1	0	1	0	0	1	0
16	1	2	1	1	1	2	0	4	0	3	0	3
17	2	2	2	2	2	3	5	0	5	0	5	0
18	2	1	2	1	2	1	0	0	5	0	0	5
19	0	1	1	1	1	0	2	0	0	3	0	0
22	0	1	0	1	0	1	0	1	0	1	0	1
27	0	1	1	1	1	1	0	2	0	2	0	2
28	3	3	2	3	3	2	4	4	4	5	4	4
29	3	3	3	3	2	3	4	4	4	4	5	4
30	5	5	5	5	5	5	8	7	8	7	8	7
32	2	1	2	2	1	2	2	0	1	0	1	0
33	1	1	1	1	1	1	0	1	0	1	0	2
51	0	0	0	0	0	0	0	0	0	0	0	0
52	3	3	4	4	4	4	3	3	3	4	3	3
53	1	1	2	2	2	2	3	0	3	0	3	0
54	0	0	0	0	0	1	0	0	0	0	0	1
Total	47	47	48	48	47	46	41	42	42	41	42	42

It now takes about 6 to 6.5 hours for a Norba compactor to complete one trip in that area, according to time and motion surveys. Total waste collected by vehicles surveyed were about 3.5 tons from Meva containers. Therefore a smaller

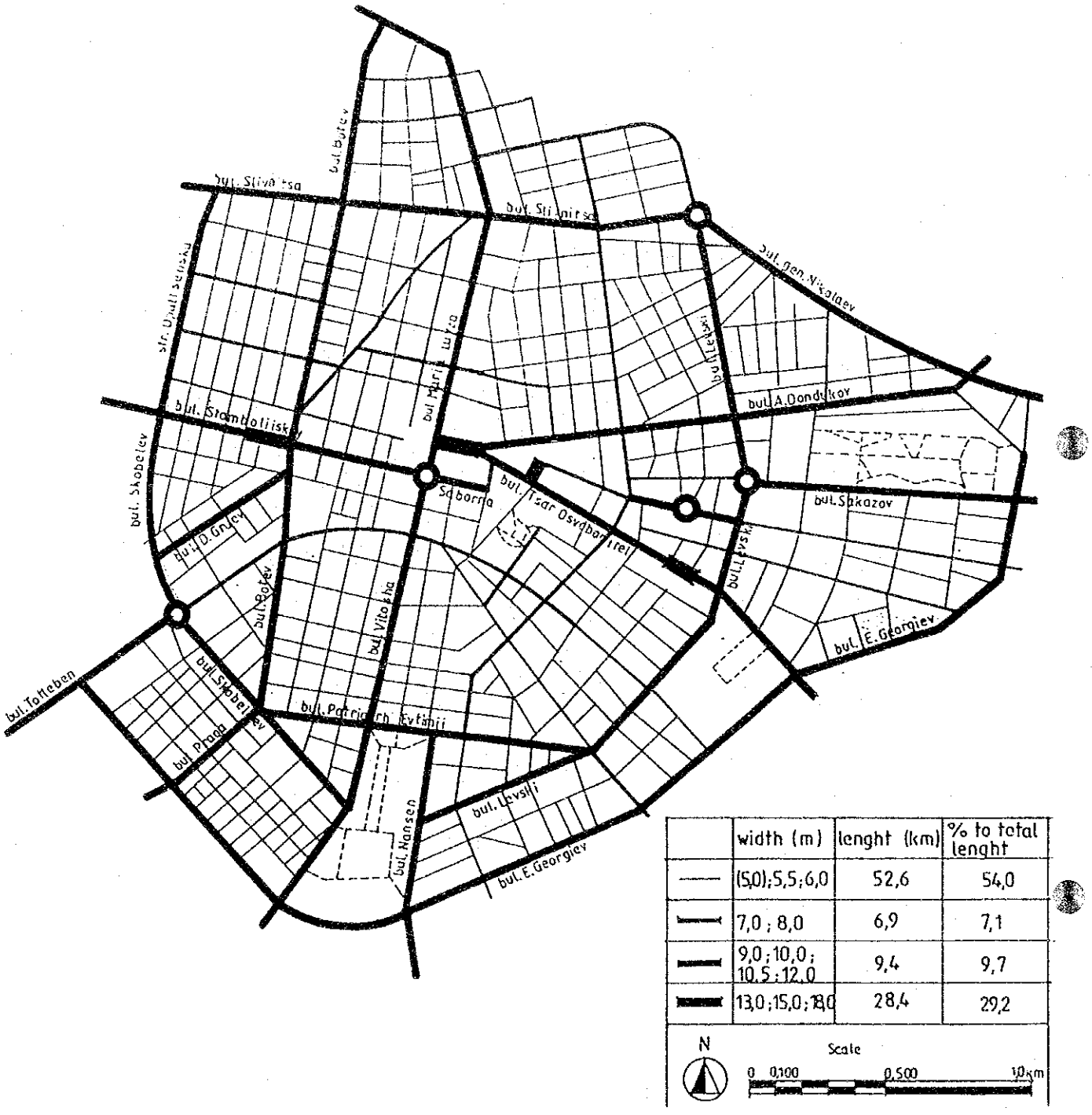


Figure 2-1-7 Distribution of Roads by Width

sized compactor is adopted to decrease time spent on collection route and increase waste collected per vehicle (through 2 trips/vehicle).

2) Zone IV South

Table 2-1-17 shows a collection schedule in Zone IV in 2000.

Table 2-1-17 Collection Schedule in Zone IV (3times/wk)

Sub-Dist.	Compactor Veh Schedule						HC Type Veh Schedule					
	Mon	Tue	Wed	Thr	Fri	Sat	Mon	Tue	Wed	Thr	Fri	Sat
10	2	0	2	0	2	0	0	1	0	1	0	1
12	0	4	0	4	0	4	2	0	2	0	2	0
13	2	0	2	0	2	0	0	2	0	0	2	0
15	9	0	9	0	9	0	5	0	5	0	5	0
46	0	4	0	4	0	4	5	5	5	5	5	5
47	5	0	5	0	5	0	6	6	6	6	5	5
48	11	0	11	0	11	0	15	15	15	15	14	15
49	0	0	0	0	0	0	0	2	0	0	2	0
50	0	0	0	0	0	0	1	0	0	1	0	0
55	0	0	0	0	0	0	0	0	0	0	0	1
56	0	2	0	2	0	2	2	2	2	2	2	2
57	4	0	4	0	4	0	4	4	4	4	4	4
58	4	0	4	0	4	0	5	4	4	5	4	4
59	0	0	0	0	0	0	0	1	0	0	1	0
78	0	2	0	2	0	2	1	1	1	1	1	1
79	0	9	0	9	0	9	5	6	5	6	5	6
80	5	0	5	0	5	0	3	3	3	3	3	3
81	7	0	7	0	7	0	4	4	4	5	4	5
82	0	6	0	6	0	6	3	4	3	4	3	4
84	0	0	0	0	0	0	0	0	0	0	0	1
85	0	3	0	3	0	3	2	2	2	3	2	3
86	0	3	0	3	0	3	2	2	2	3	2	3
87	0	6	0	6	0	6	4	4	4	4	4	4
88	0	0	0	0	0	0	0	1	0	0	0	0
89	0	0	0	0	0	0	0	0	0	1	0	0
90	0	7	0	7	0	7	6	6	6	6	6	6
91	0	1	0	1	0	1	0	0	2	0	0	2
Total	48	48	48	48	48	48	75	75	75	75	76	75

In this zone collection will be three times per week, and large size compactor vehicles making two trips per vehicle shift are adopted.

2.2 Disposal

2.2.1 The Selected Site

Katina Sanitary Landfill Site, as selected in the Master Plan, is located in the North West of the Sofia Basin as shown in Figure 2-2-1. Present conditions of the site are shown in Figure 2-2-2.

The former Katina quarry site was allocated to SGM for its solid waste deposit in the early 1970s. The intention was that the Mine workings be more sensibly and economically reinstated using municipal landfill rather than by expensive and 'unproductive' civil works by the Ministry of Energy Mining Organization. It is understood that the site is the property of the Municipality.

Since its allocation for solid waste, the site inner section (that is now proposed for landfilling) has been left in a 'derelict' and 'untouched state'; although there has been a gradual and natural establishment of sparse vegetation within the quarry.

2.2.2 Site Condition - Derelict and Abandoned

Apparently all intentions to properly reinstate the site and make it safe, were abandoned. Normally open cast mine closure safety measures would have been instituted, lignite seams would have to been sealed, slopes stabilized, contamination cleared, flooded areas made safe, fencing set up, landscaping and top soiling undertaken, and the whole of the area would have been returned to productive use.

None of these were however instituted. In expectation of its filling with waste, the site was left 'abandoned' with steep grades and precipitous falls. The central quarry hole was left flooded with groundwater. Silts and industrial residues contaminate the pond silts. Typically, lead is present in the site silt in alarming proportions.

Since their original exposure and disturbance, the underground coal seams in the quarry appear to have been burning. Over the last 25 years or so these fires have slowly consumed the coal and have, and still are, now undermining the very foundations and slopes of the quarry pit. Hot burnt coal-gas vents emit fumes from the underground fires at around 25 different spots over at least 4 principal faces. Venting flues from the remote strata have deposited black soot and

Figure 2-2-1 Katina Landfill Site

N

Scale 0 2 10km

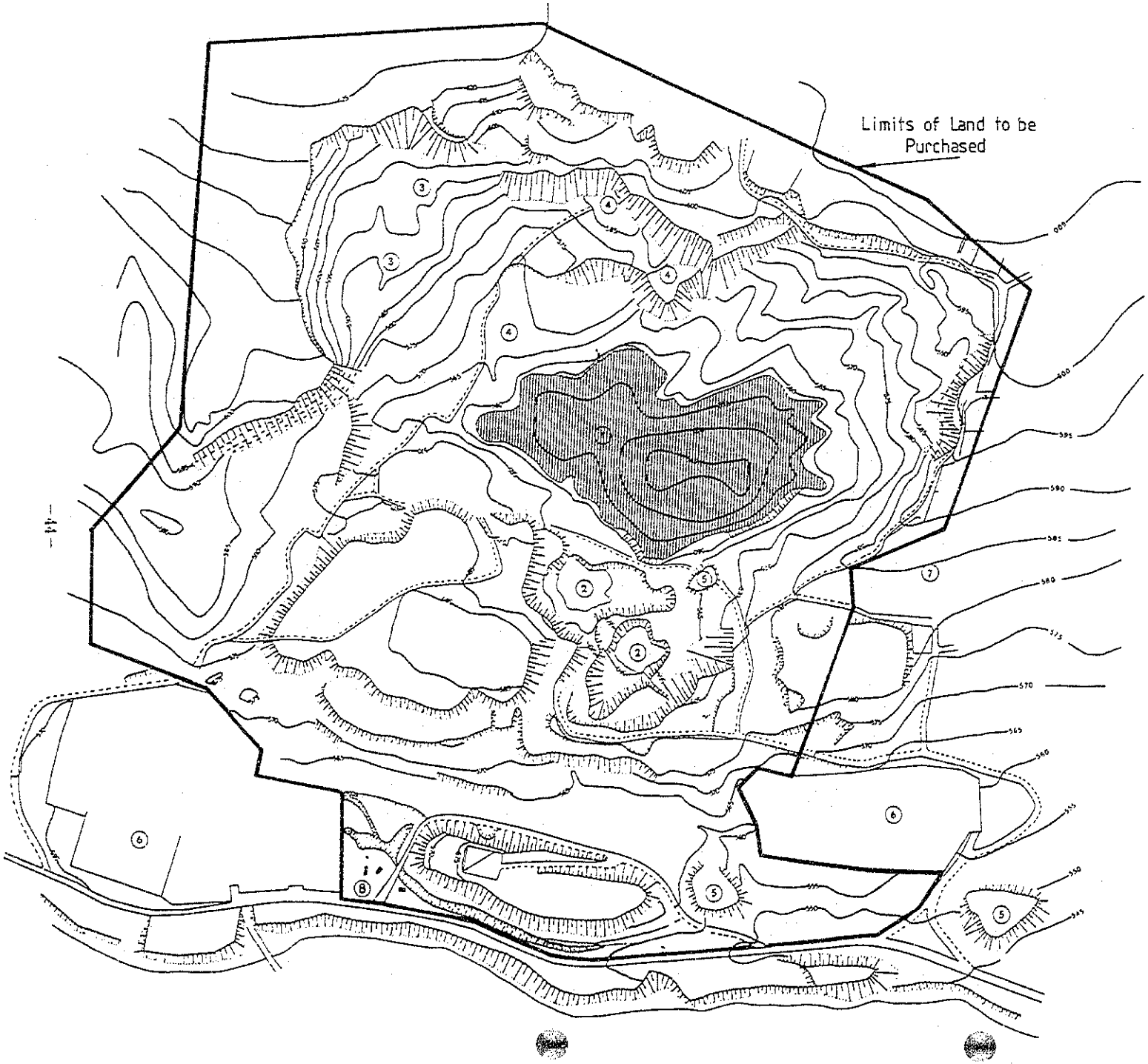


Figure 2-2-2

Plan of Existing Site

Legend

① Lake	⑤ Working Waste Piles
② Pond	⑥ Industrial area
③ Springs	⑦ Holiday Home Area
④ Coals	⑧ Existing Buildings

N

Scale 0 50m 250m

coal-tar like deposits in bands across the North Quarry face. The surface area around the hot gas outlets are contaminated with crystallized sulphur.

Due to the lack of the original topsoil (and such as the old mine fumes and smoke), natural vegetation has been slow in establishing itself in the coal ash and on the clay faces. Wild life is comparatively scarce although 'lake No 2' does support some algal species, frogs and a small fish population. This aquatic life is despite modestly high dissolved sulphate levels and lowish radiation levels in the waters (due to locally natural groundwater flushing of Radium and Uranium deposits).

2.2.3 Site Environs

A local land use survey has been prepared and is presented in Figure 2-2-3.

For presentation purposes this information was plotted on the 1:25,000 (1972) series of maps of the area with the base data information up-dated to accord with aerial photographs, the study's own survey work and latest information obtained from the larger more recent (1992) series of 1:5,000 maps.

The location and land use plans (Figures 2-2-1 and 2-2-3) show features of relevance to the proposals; in particular:-

a. The setting of the site and local land usage, especially the residential housing, holiday homes, and etc.

b. An area plotted on the map showing the limits of lands within which is a Military Airfield. It is understood, from the Air Force that the airstrip itself is some 4.5 km of the proposed landfill site.

c. The local natural watercourses of the Katinska Stream and the River Iskar.

d. The position in Novi Iskar, of the existing main intercepting Sewer which is due to be connected to Sofia City sewage system before the end of 1995.

e. The alignment of the Novi Iskar Bypass Roadway is to be funded jointly by the Ministry of Transport and SGM. The Budget is reported to be available and construction of the Bypass is scheduled for completion in 1996.

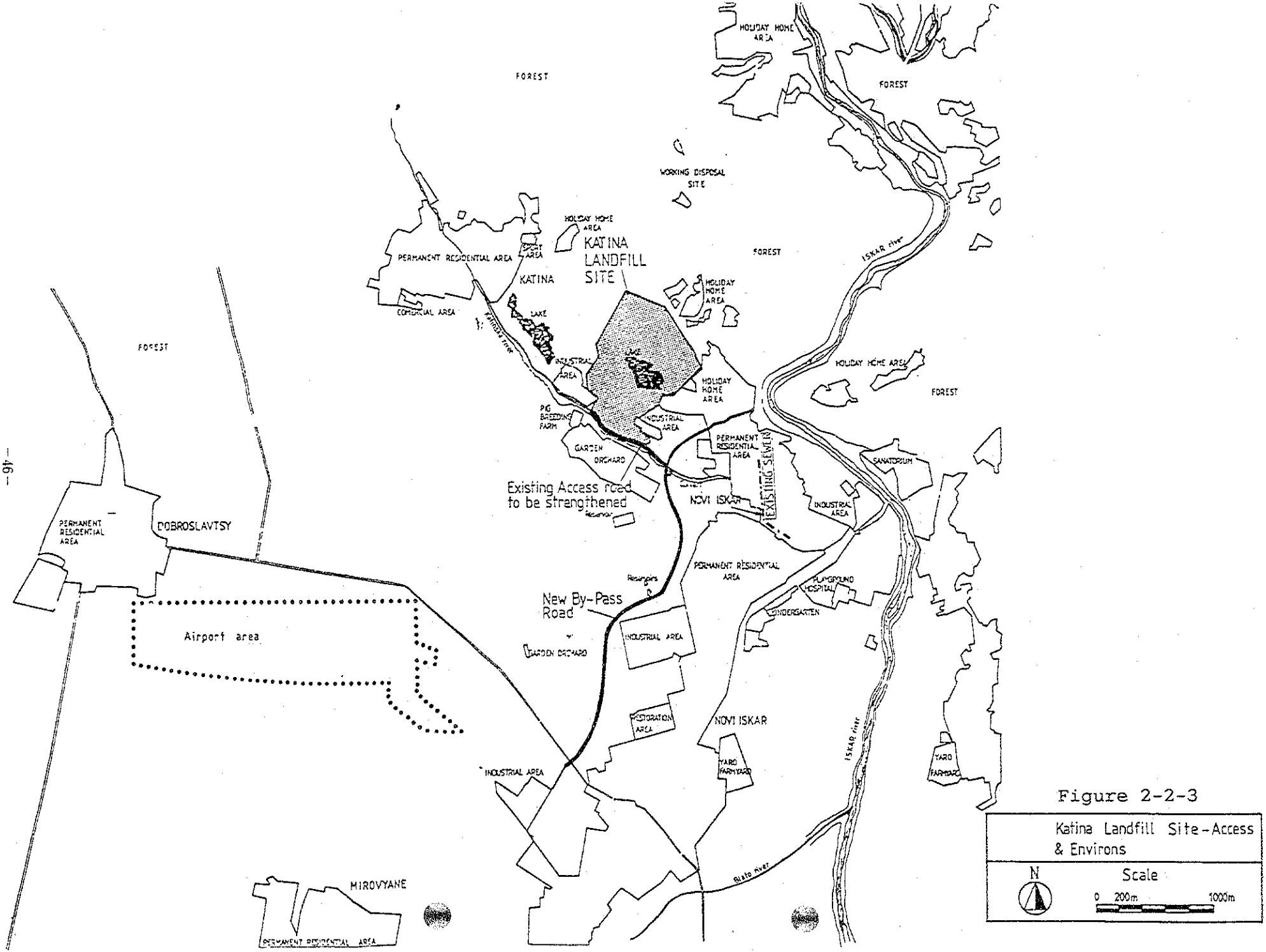


Figure 2-2-3

Katina Landfill Site - Access & Environs

2.2.4 Site Topographic Survey

A topographic survey was commissioned under this Study and a set of 4 detailed maps (@ 1:1,000) was prepared for the preliminary designs and geotechnical survey. It is from these that the small scale land plan of Figure 2-2-2 was prepared to show the extent of the site and its principal features.

Referring to this figure, main features of note are:

- limits of the permanent lands necessary to accommodate the proposed works;
- extent of the inner lake (to be drained and filled in). Although this lake contains some 440,000 m^3 of natural groundwater and although water sample analyses confirm that the constituents are within the normal ranges to be expected.
- groundwater springs to be intercepted by the landfill drainage system;
- ponded areas which will be removed/replaced;

2.2.5 Site Geotechnical and Hydrogeological Survey

Regional geological and hydrogeological conditions of the area are described in Volume I and Supporting Report I. In the area of Katina site, general geological characteristics are those of pliocene coal seams lying in and below deposits of clay and sand lenses and founded upon gravels, sands and a sandstone lower base. Aquifers flow slowly between the lenses and the coal strata and are confined by the relatively impervious clay deposits.

In order to supplement the general data and to gather particular geological, hydrogeological, and geotechnic data necessary for the preliminary designs, a desk study and on-site investigation was commissioned during July 1993. The targets of the investigation were those set out in ETC8: to establish base data to enable planning, development and managerial proposals for the site to be formulated with confidence.

The site work supplemented a very useful data bank of existing data available from other geological work in the area. It comprised an additional 10 exploratory boreholes, 15 trial pits, 21 sets of analyses on undisturbed soil samples and 8 on disturbed samples, 6 roengeno-structural mineralogical scans and 14 sets of groundwater analysis.

From the survey work, it is evident that the lakes within the coal pits are manometrically standing on a combined general aquifer gradient. A plan showing the local isohyets of the groundwaters intercepted (on 27th July 1993) was built up and is shown in Figure 2-2-4. In general waters from the Western Lake flows (at right angles to the isohyets) towards the Katinska Stream and to the adjacent and parallel geological fault. The inner quarry lake levels reflect the head on the aquifer from the groundwater flowing to the fault and the 'Katinska' area.

The relative lake levels (10.53 m level difference over 650 m distance) are indicative of a high hydraulic gradient (slope 0.016) and confirm the poor interconnection slow flowing nature and high permeability of the aquifers.

Groundwaters are generally fed from surface charging of the North-Western aquifers from the slopes of the Sofia Basin. Discharge is to the Iskar basin both as surface and groundwater as they leave the Sofia basin flowing North and out of the Sofia Region.

As part of a system of peak flood mitigation measures a surface water intake to the Westerly (external) lake bleeds off approximately 50% of the normal flows of the Katinska into the lake. This has the effect to reduce the natural impurities of the aquifers as (evidenced in the other lake) and to maintain an improved and higher water level (it rose by 2.70 m) thus enhancing the local 'amenity' of the area.

Within the inner quarry, natural groundwater quality was found to vary markedly from point to point over the area (ie the lakes and boreholes) investigated. This variation confirms the slow groundwater transfer rates through the intercepted strata. The general characteristics are those of mineralized waters, high in Sulphates and Calcium salts. Dissolved solid variations observed range from 11600 mg/l in the large quarry lake to 229 mg/l in waters abstracted from an adjacent borehole. Radioactive background levels were measurable as total β-activity in the 1,150 mBq/l range with uranium levels at 0.01 mg/l and radium 297 undetected.

General pollution of the surface aquifers downstream is marked as Novi Iskar town is currently without a proper sewage scheme and relies on soakaways and the like. Serving as the Sofia ground and surface water 'outlet' these waters generally drain the area downstream of Sofia and accordingly carry a considerable burden (eg. from such as Kremikovski

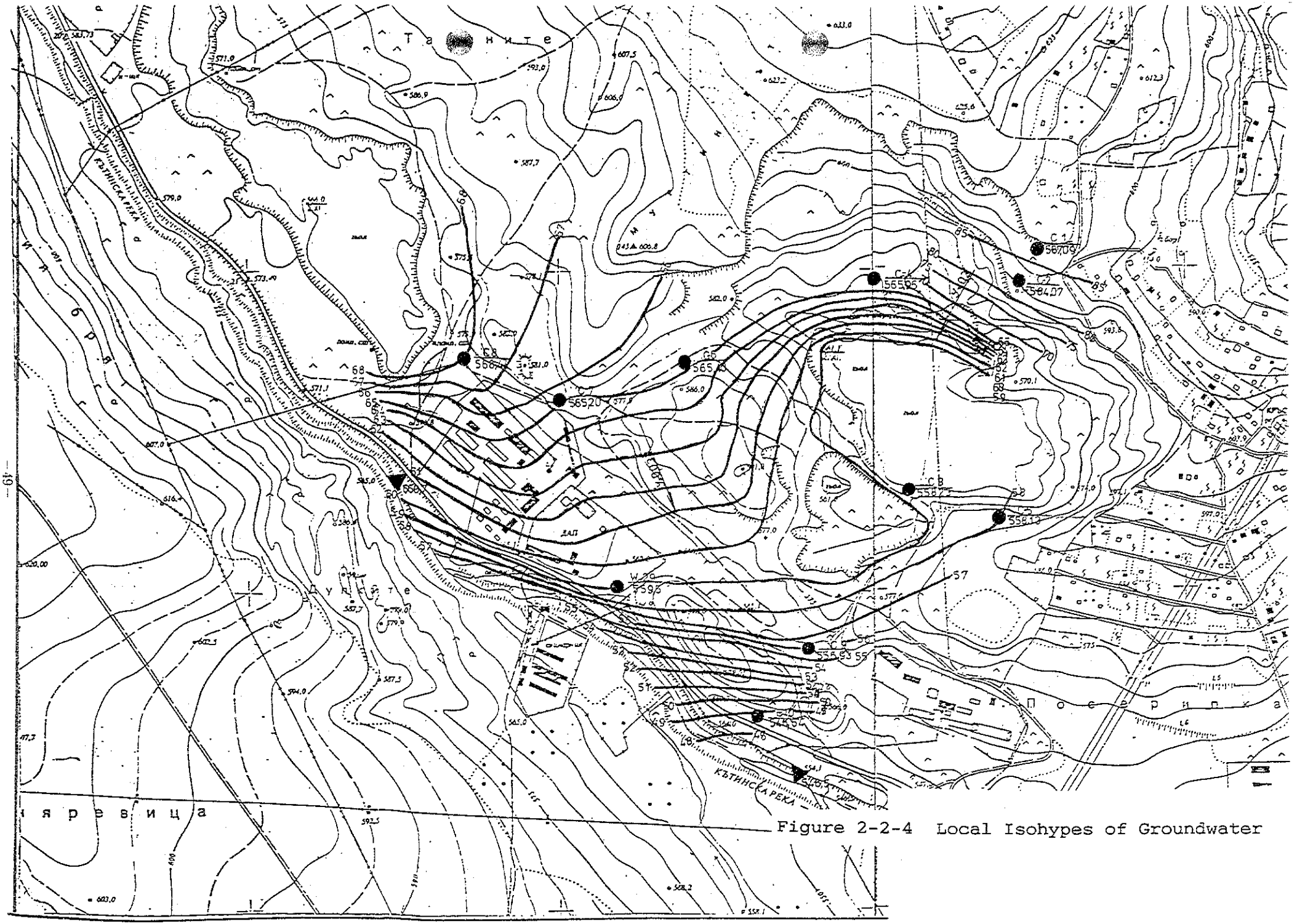


Figure 2-2-4 Local Isohypes of Groundwater

area and Dolny Bogrov dump site). It is for this reason that no potable domestic water sources, surface or underground are brought to the region. Novi Iskar is fed with piped water from Sofia 'Rila' Water main. (A new sewerage system is under construction and the Town is due to be 'connected' in 1996).

Due to a fear of possible contamination of drinking potable water drawn from water wells that may be in the Katina and Novi Iskar area, particular and special effort was made to professionally investigate contamination risks. The nearest existing potable water supply well is some 1.5 km distant and well above the area on the slopes of the Stara Planina Mountain. There is no possibility of any hydraulic connection to this source. It is understood that many hand dug garden watering wells have been installed in Katina and Novi Iskar but these are generally unused as drinking water sources and due to lack of municipal sewerage must be generally classified as unfit for potable use. They are in areas where public supplies are provided and are used. There are no known aquifers in the lower Katina area capable of sustaining a public supply and the Iskar Valley flows at Novi Iskar are in any case, too polluted to exploit.

It should be noted that, should Katina quarry groundwater be diverted to a potable source the drinking waters would be tainted and possibly undrinkable due to the high level of natural salts present.

Laboratory and site permeability tests on several clay samples show the clay to be impermeable and resistant in the laboratory to leachate attack.

2.2.6 Site Appraisal

The main 'external' (mostly environmental issues) for which provision is made for in the plan are:

A. The proximity of the site to nearby dwellings and holiday homes;
B. the site's 'Sanitary Protection Zone';
C. the proximity of the site to the Military Airfield;
D. the operational waste truck traffic to and from the site;
E. mitigation of the very presence in the Novi Iskar and Katina area of this solid waste landfill site. (ie: effects of the site on the 'Cultural Patrimony' of area)

These aspects are respectively reviewed:

A. Proximity to Dwellings and Home

Land areas immediately adjacent to the northern and eastern perimeter of the site have been effectively developed as an unofficial holiday-home area. It is understood that no official permission for this was issued.

Although no formal up-to date mapping of this area was located, the opportunity of the helicopter survey was taken to obtain a set of aerial photographs. These photographs, together with on-the-spot appraisals, have enabled a general appraisal of an 'area of influence of the site' to be made.

The plots are variously occupied by groups of huts and housing varying in quality from simple garden sheds to some quite elaborate two story chalet-bungalow homes. Some plots appear to be developed as semi-commercial market gardens, some as orchards and some solely for holiday homes. Access to and through the area is by poor quality surface tracks formed in the clay soil, which by the nature of the area makes it difficult to traverse in extreme weather. At least part of the area is served with electricity.

It was estimated that around 75 properties, including some 50 holiday homes would be involved to varying degrees, (assumes payment made in respect of plots with at least 20% of their land area within 100 m of the outer site limits). In view of the nature and location of these properties, it was agreed with the counterpart staff that a budgetary allowance of some US$2,500,000 be allocated for this purpose.

B. Sanitary Protection Zone Around The Site

As reviewed above, the Site is at present a liability to its owners, to the general public and in particular to the residents of the holiday homes. Some properties directly overlook the quarry and lie within the 'quarry smoke' area.

In respect of the sanitary health protection zoning, it is recommended that the Ministry of Health:

a) Replace the existing Regulation No 7 of 1992 'protective zone' (due to the unreinstated mine) by a new one relating to the proposed change in responsibility for the site: ie; from an abandoned and dangerous old and active mine site to that appropriate for a Controlled Landfill.

b) Until the mine is filled with waste, impose a 1 Km zone around the site within which no further dwelling homes should be developed without special permission from the Ministry of Health on a case-by-case basis and until such time as the site is formally 'closed'.

C. Military Airport Proximity

Unfortunately, and as mentioned above, the presence of a solid waste landfill site is one of the recognized possible attractants to birds. No solid waste site design planning should proceed without proper consideration of its possible interrelation with local airfields and the risk that the site be used as either a roosting or a feeding ground for the flocks of birds which can congregate because of such sites.

As a military airport lies within some 4.5 km of the site, proposals are budgeted in order to control birds at Katina and prevent any build up of the habitual 'resident/visiting' flocks about which airport authorities frequently worry. Although no evidence of persistent flocks were noted at Dolny Bogrov or Suhudol, proposals for bird control are outlined.

D. Waste truck traffic intensity

In view of the anticipated high waste collection vehicle arrival rates, it is considered essential that the Novi Iskar By-Pass road be constructed and opened before the commencement of site filling. This is to:

- Ensure the highway construction can stand the traffic
- Relieve Novi Iskar residents of the burden of the traffic noise, vibration, exhaust fumes, etc.

E. Other Measures - In Mitigation of Proposals

In view of the reported past and present local opposition to the landfill site it is clear that SGM may wish to formulate some form of local social compensation.

It has been reported that at one time proposals were made to construct a Golf Course in the area of the site. Accordingly, it is recommended that consideration be given to establishment of such a golf, possibly to be locally owned by the public, but commercially run). It is suggested that the local Mayors of Katina and Novi Iskar be appointed as Directors.

The proposal is to:
- Construct a clubhouse and social club and the first 9 holes of the golf course by 1997;
- complete the remaining 9 holes upon completion of the landfill covering around 2010.

The optional extra budget costs of this proposal of US$ 200,000 would enable a 1st step and simple initial local course to be established by local companies. Thereafter the enterprise could be self developing and self financing.

2.2.7 Katina Site Capacity

As designed, the site capacity is estimated as being sufficient to accommodate some 8,200,000 m^3 of Municipal solid waste. The priority project envisages Katina as being 'on-stream' in January 1997.

The capacity is based on:

- The topographic survey undertaken;
- the proposed preliminary design;
- the assumption that, apart from the final soil covering, all cover material is taken from the inner quarry walls;
- filling to inner quarry pit up to the presumed original ground level profile as indicated by the surrounding terrain: This filled 'profile' is set out in Figure 2-2-5.

It is assumed that due to the current 'value' of controlled landfill sites, all inert waste (eg. pre-separated glass), building and similar waste will not be accommodated at this site. SGM has 4 inert waste sites elsewhere.

2.2.8 Other Available Capacity (Suhudol and Dolny Bogrov)

SUHUDOL: SGM intends to extend the existing Suhudol site by some 220,000 m^3. This work was due for completion in mid 1993. Projected costs for this extension is believed to be in the region of 30,000,000 Leva.

DOLNY BOGROV: To alleviate the pollution of the Sofia plain Aquifer and the regional irrigation waters, it has been SGM's intention that Dolny Bogrov be closed 'as soon as possible'.

The masterplan recommendation concurs. The original assumption of this study was that the site would close in December 1993.

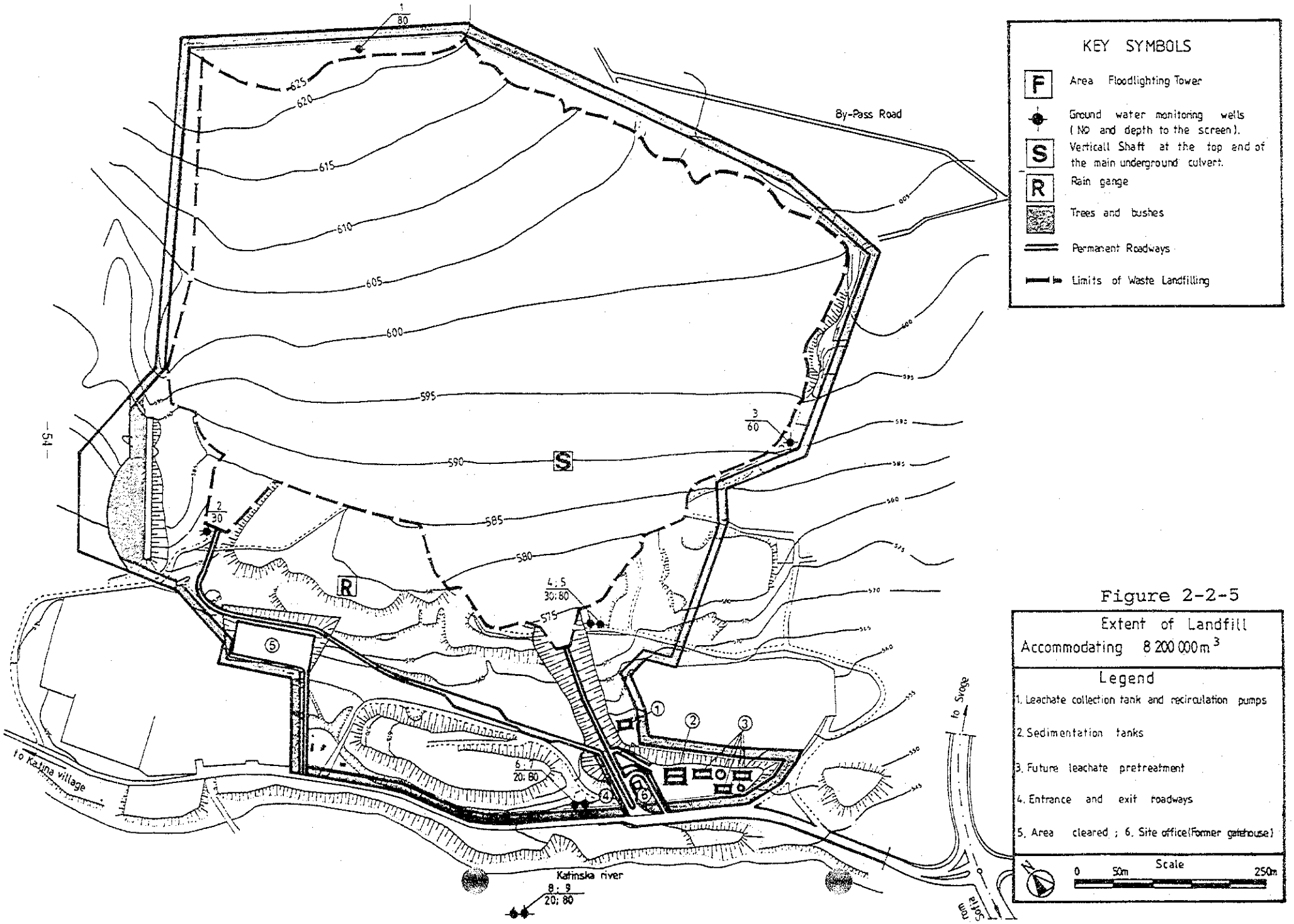

KEY SYMBOLS
F Area Floodlighting Tower
Ground water monitoring wells (NO and depth to the screen).
S Verticall Shaft at the top end of the main underground culvert.
R Rain gange
Trees and bushes
Permanent Roadways
Limits of Waste Landfilling
By-Pass Road
to Katina village
Katinska river
to Svoge
Extent of Landfill
Accommodating 8 200 000 m3
Legend
1. Leachate collection tank and recirculation pumps
2. Sedimentation tanks
3. Future leachate pretreatment
4. Entrance and exit roadways
5. Area cleared ; 6. Site office(Former gatehouse)
Scale
0 50m 250m

Figure 2-2-5

2.2.9 Waste for Disposal

Following the finalization of demographic data and waste generation amounts and for the purposes of appraising the capacitive landfill disposal requirement, the waste produced has been analyzed in relation to the year-by-year tonnages of the main waste types which are to be handled at the disposal sites from 1994 to 2010 and beyond.

As Annual tonnages they are summarized in Table 2-2-1:

Table 2-2-1 Solid Waste Amount to be Disposed

(unit: t/d)

Waste type	1993	1995	2000	2005	2010
Domestic/commercial	1,005	1,010	1,188	723	754
Street	24	25	25	26	26
Non-hazardous industrial	74	74	116	121	125
Ash	-	-	-	77	77
Total	1,103	1,109	1,329	947	982

Note: Treated amount at Incineration Plant after 2005 is 186,150 t/year

2.2.10 Mass Waste Balance

The waste amount in tons was converted into volume using the densities in place for the various types of waste as described hereafter.

- Domestic/commercial waste : 0.70 t/m^3
- Street waste : 1.00 t/m^3
- Non-hazardous indust. waste: 0.85 t/m^3
- Ash : 1.00 t/m^3

The accumulated waste amount to be disposed of from 1994 up to 2010 is shown in Figure 2-2-6.

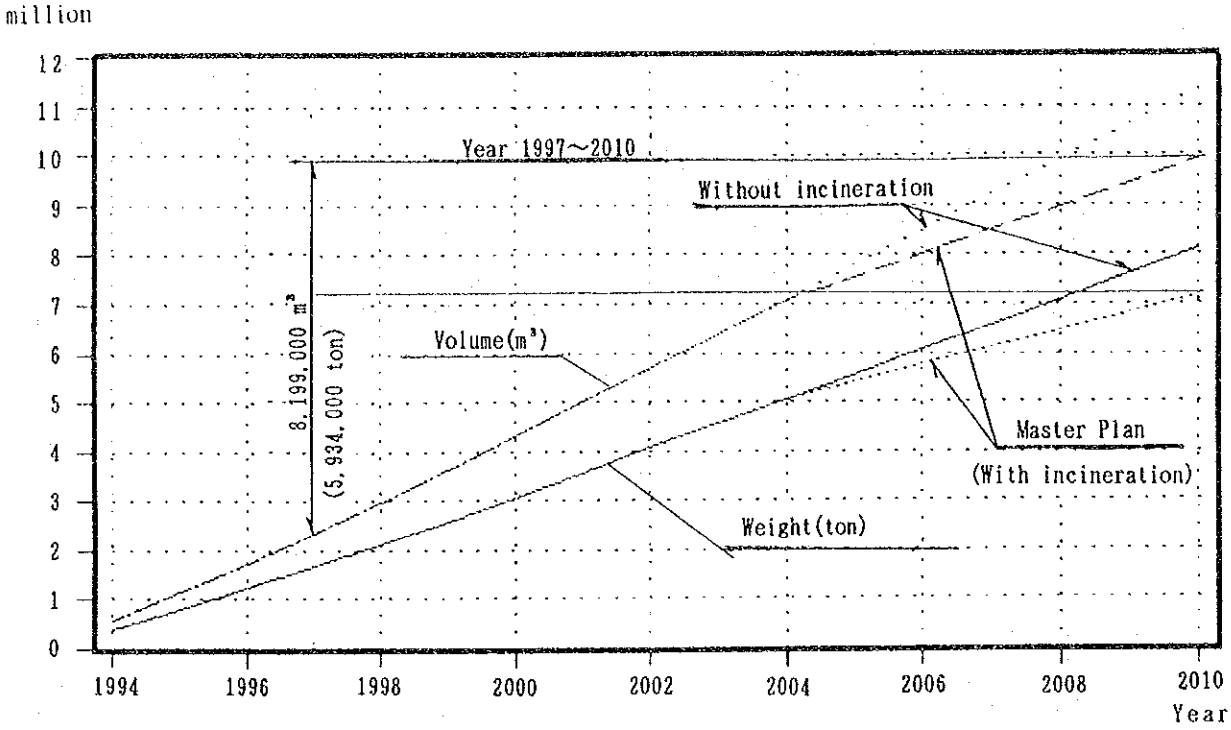


Figure 2-2-6 Annual Disposal Waste Amount

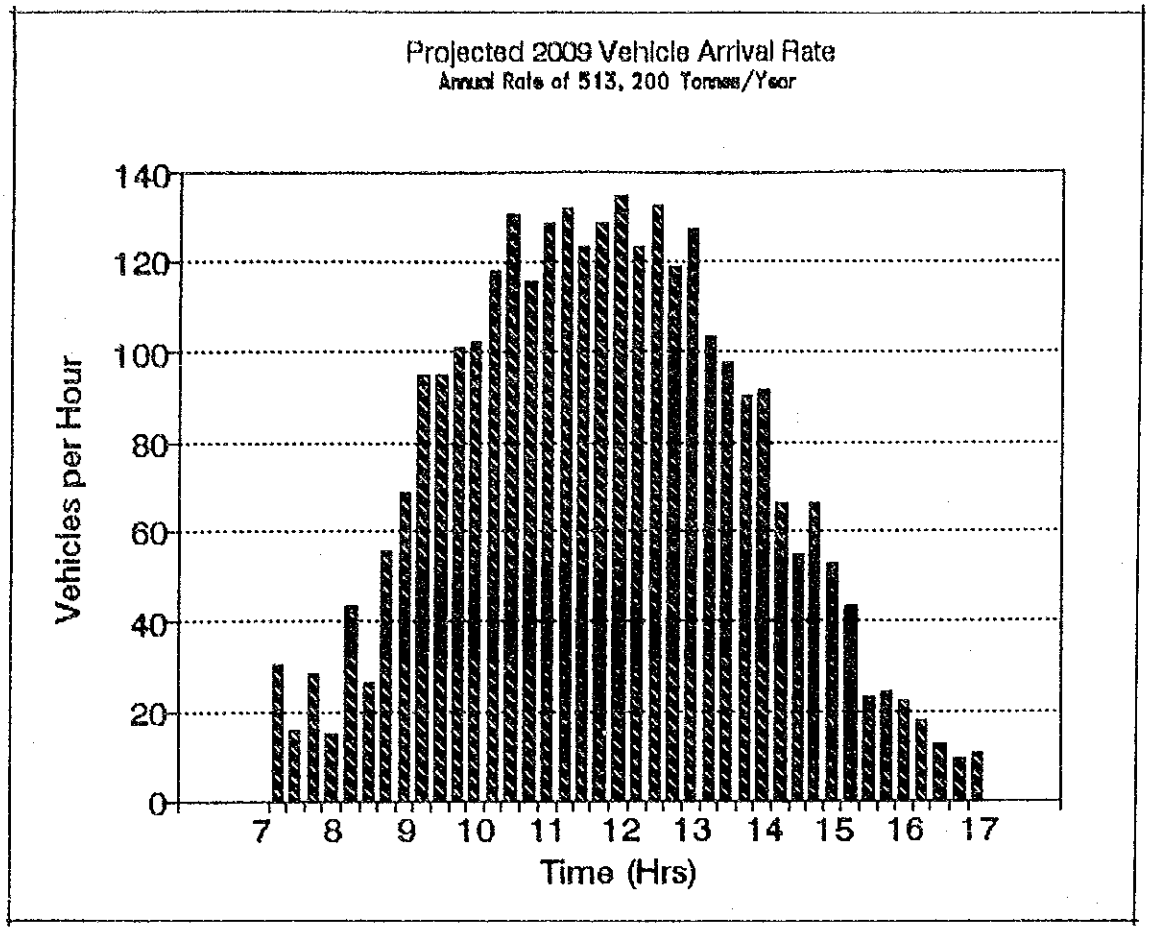
2.2.11 Waste Delivery Rate

The present disposal sites' combined vehicle arrival times were analyzed in order to obtain an estimate of the likely Katina Site approach traffic and the rate of waste arrival and handling inside the site. The same rates were applied for the new landfill site and the results are plotted in Figure 2-2-7.

The figure assumes:

- Measured over the one week period, a 1993 arrival rate peaking to some 100 vehicles per hour;
- based on a 'worst case' scenario, projections of the same situation projected to the Year 2009: Assumes Katina full at that time (no incineration). The rate is some 130 vehicles per hour; and
- assume that little or no improvement will be made in the vehicle utilization efficiency.

These rates are used in order to Gauge the basis upon which the absolute peak traffic rate (entrance, working faces and exit) arrangements should be made.



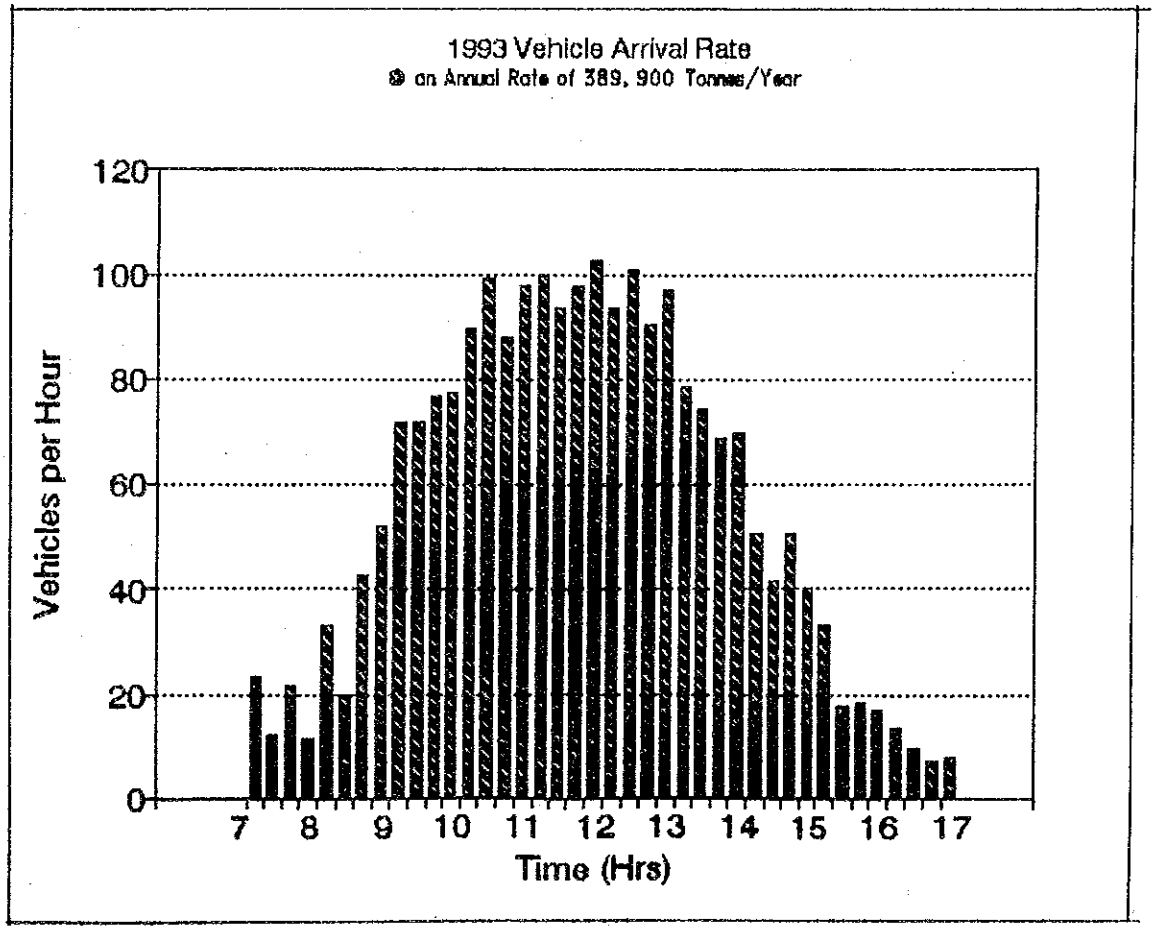


Figure 2-2-7 Collection Vehicle Arrival Rate

2.2.12 Katina Site Design

It is on the basis of the foregoing and the general Master-plan Criteria (particularly the principals embodied within ETC8-R2) that the preliminary design of the site has been developed.

The design and site arrangements are presented in the following drawings and described hereinafter:

- Figure 2-2-8 Administration Area
- Figure 2-2-9 Entrance and Exit Facilities
- Figure 2-2-10 Perimeter screen
- Figure 2-2-11 Typical cell
- Figure 2-2-12 Cross section

(1) Nature of the Work

The design involves principally earth moving. Around 1,000,000 cu m of earth has to be moved to fill the lake, construct the culvert (and entrance road) and prepare the working landfill cellular areas.

(2) Extent of Design

The facilities and features shown on the drawings and/or included are those required to met the environmental requirements, and the Master Plan requirements.

Respective facilities developed relate to the results of site features and characteristics surveyed on site. The arrangement of the works are tailored to accord with a scheme to suit local conditions for optimum completion for landfilling using established methods, and to facilitate fill placement.

The design has been checked to ensure that it is 'operable'.

The extent of the design is to:
- enable feasibility of the more detailed arrangements to be confirmed with confidence that they can form the basis of a good and competent final design;
- facilitate understanding of the proposals and the arrangements;
- facilitate subsequent finalization of the cost estimates;
- enable the principal features of the preliminary design to be presented;
- enable the Bulgarian EIA procedures to be instigated

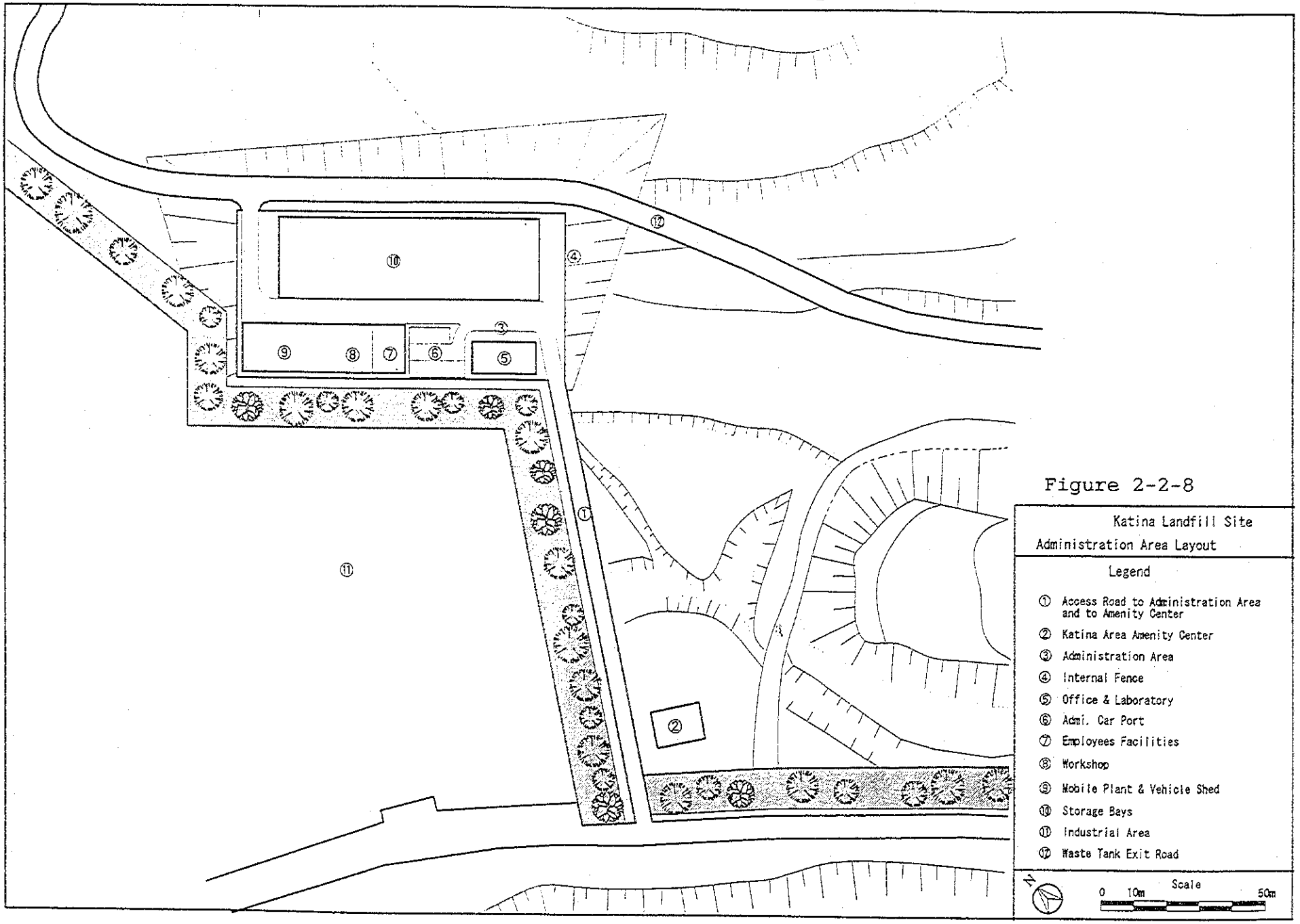


Figure 2-2-8

Katina Landfill Site

Administration Area Layout

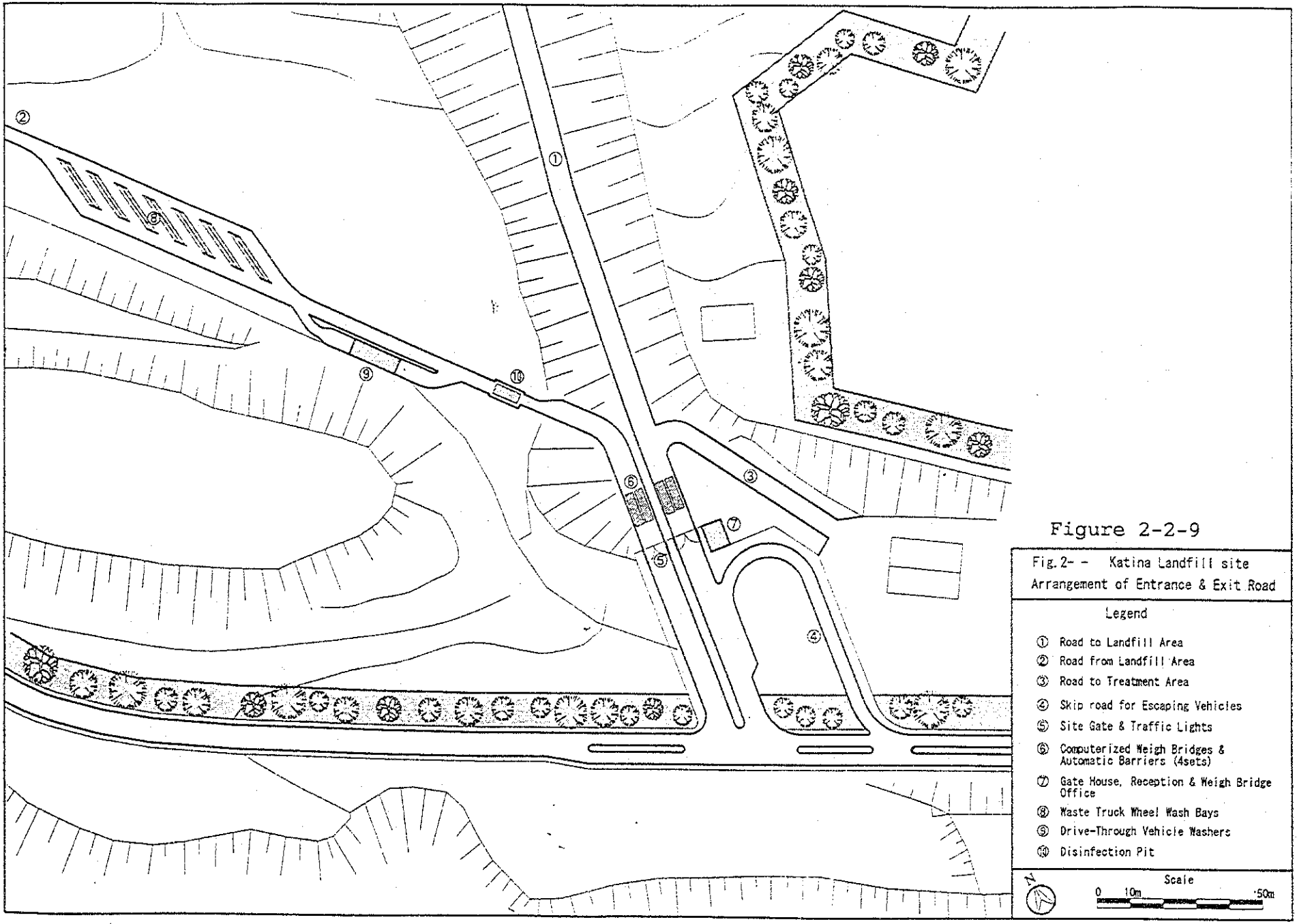


Figure 2-2-9
Fig. 2- - Katina Landfill site
Arrangement of Entrance & Exit Road
Legend
① Road to Landfill Area
② Road from Landfill Area
③ Road to Treatment Area
④ Skip road for Escaping Vehicles
⑤ Site Gate & Traffic Lights
⑥ Computerized Weigh Bridges & Automatic Barriers (4sets)
⑦ Gate House, Reception & Weigh Bridge Office
⑧ Waste Truck Wheel Wash Bays
⑨ Drive-Through Vehicle Washers
⑩ Disinfection Pit
N
Scale
0 10m 50m

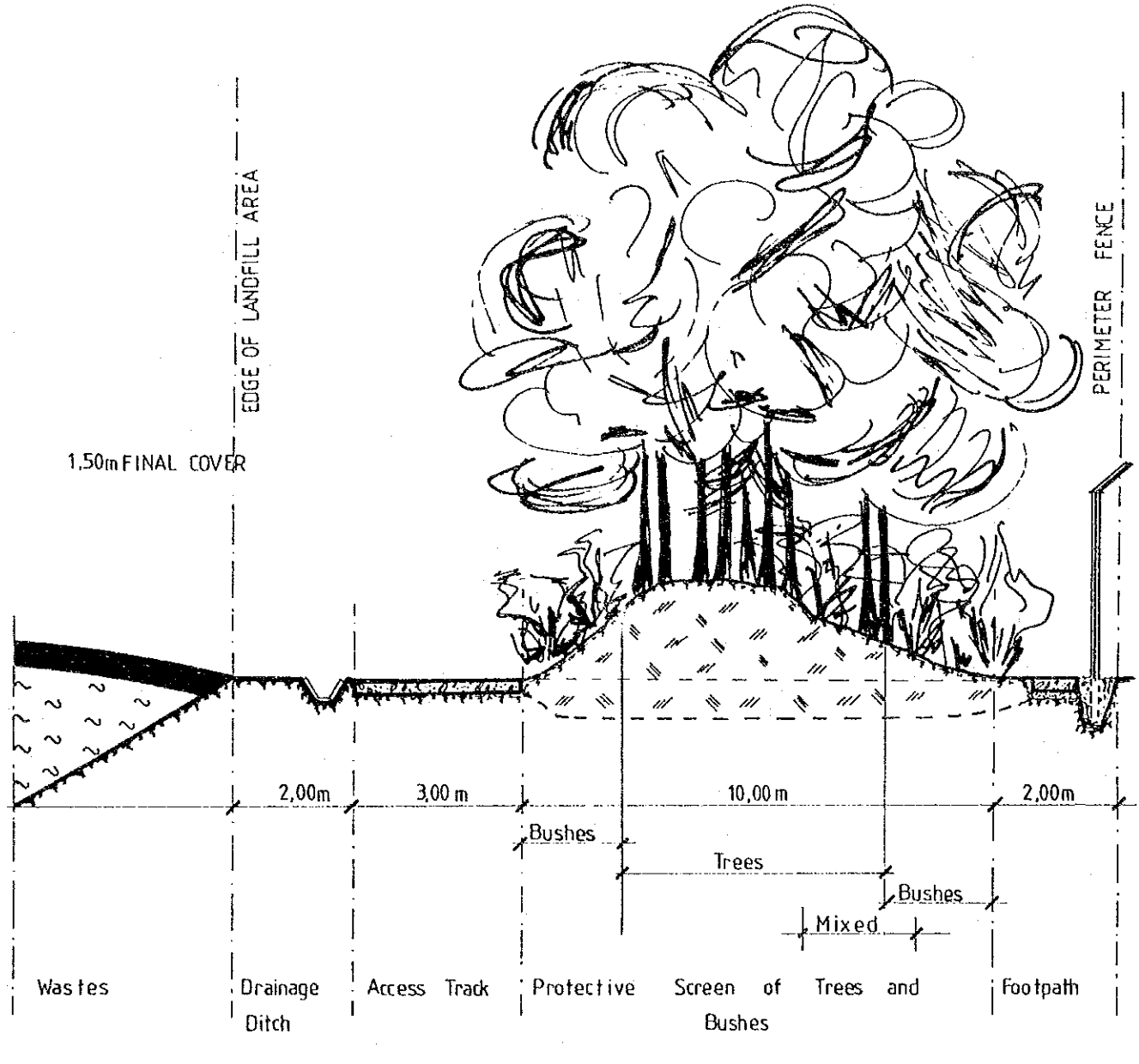


Figure 2-2-10 Perimeter of Screen

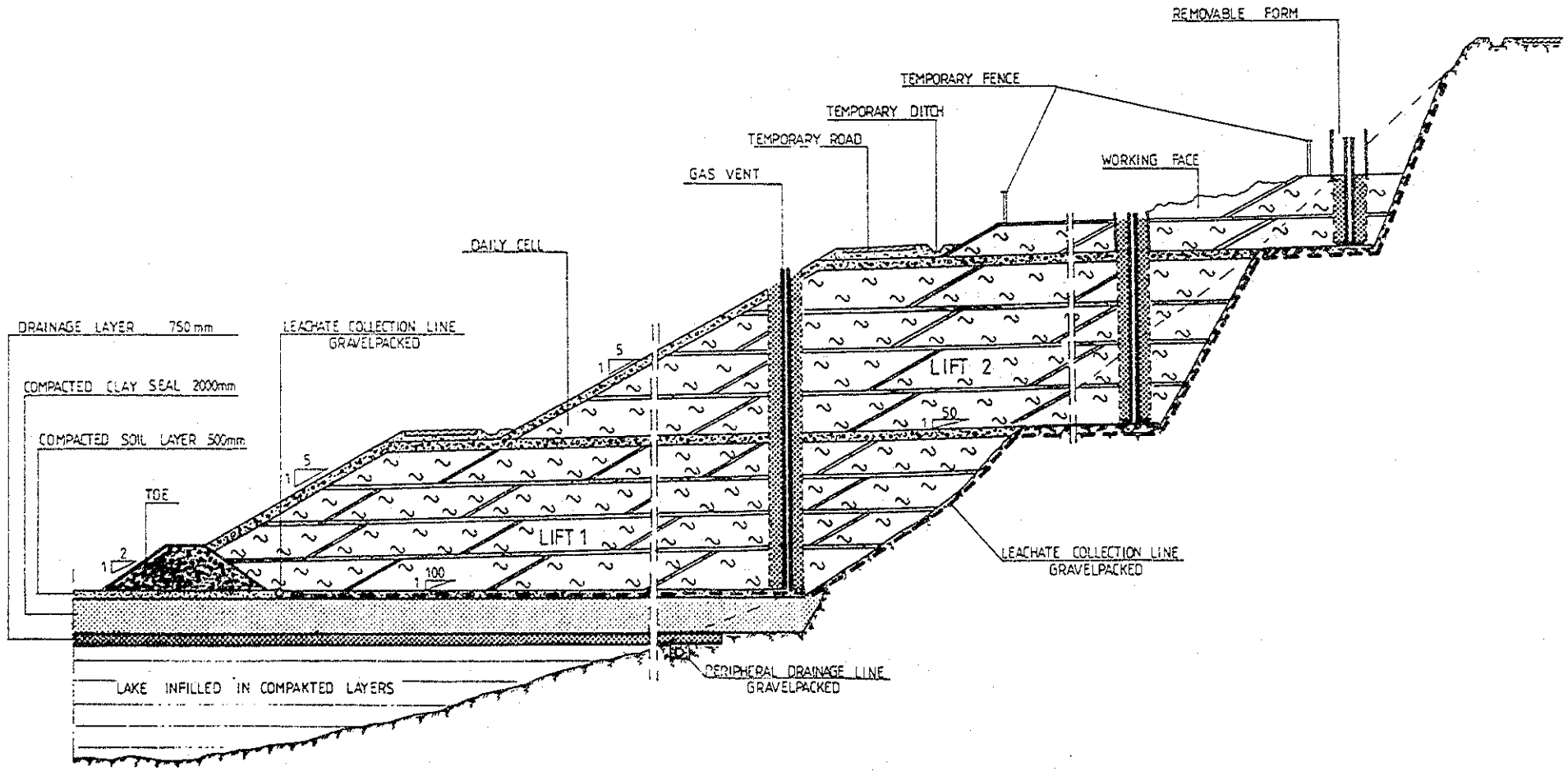


Figure 2-2-11 Typical Cell

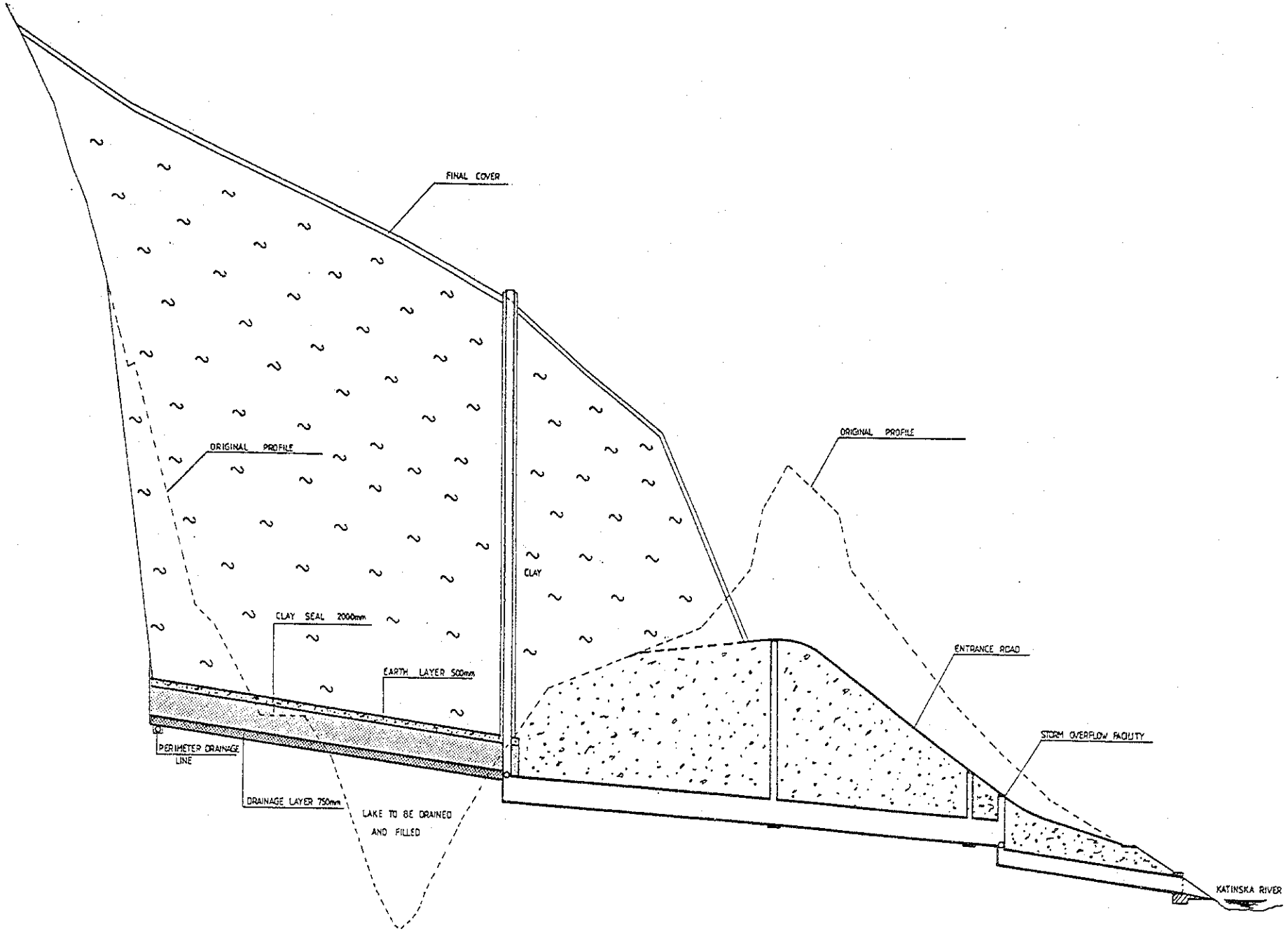


Figure 2-2-12 Sectional Elevation Across the Site

(3) Management Facilities

The administration facilities proposed at the site have been developed on the assumption that either the manager or the assistant manager shall be a Geotechnical Engineer and in full time professional charge of all landfilling and soils cover material earthmoving operations. The associated facilities are considered necessary to ensure that it is possible to optimize safe and economic landfilling operations at this old coal quarry. Employment of a Geotechnical engineer on site is a necessary prerequisite of the recommendation that the site is suitable for receipt of municipal waste.

(4) Principal Facilities

- Common site vehicular Entrance and Exit;
- separate Administrative Entrance and Exit;
- Weighbridging, Site Reception, and common Gate House;
- main administration area accommodating Manager's office, site stores, sheds, Workshop and etc.;
- permanent Internal Site Roadways into and out of the main filling areas: Thereafter internal access via temporary removable concrete road segments;
- an initial pre-prepared filling area above and adjacent to the existing lake area (to be drained and filled);
- a main site drainage culvert to the Katinska Stream, separate piped drainage of leachate, vehicle wash bays and toilets;
- security fencing around the entire site with a screen of trees and bushes, separate internal fencing to the Admin area and temporary fencing around the landfill Zones;
- new diversion track within the Holiday Home Area;
- vehicle wash bays on the exit road (hose points);
- exit vehicle wheel disinfection pit;
- surface water mud settlement tanks;
- leachate collection, allocated space for leachate pre-treatment and pumped re-circulation sump;
- improvement of the Katina to Novi Iskar highway;
- piped drainage of sewerage, surplus leachate to the Sofia Sewers, groundwater and surface water drainage systems;
- fill area floodlighting, internal street lights, fire hydrants, etc;
- amenity center facilities;
- potable and non-potable water supplies, radio links, and power supply.

(5) Site Environs

- An environmental 'buffer' strip and 'security' zone around the site;
- a perimeter Site Screen comprising a security fence, footpath, 10m tree and bush 'forestry' strip, and vehicle access track as required. 'Forestry' strip to be elevated (generally by 2m and where appropriate), to enhance visual screening, improve wind boundary behavior and generally enhance the scenic impact of the site;
- at the South-Western Corner (windward corner), an enlargement of the afforested screen has been included specifically to minimize 'wind surface funnel effect' thought to be drawing accelerated wind gusts into the S-W Quarry entrance;

(6) Site Access Facilities

- Entrance and exit facilities arranged to pass a peak design vehicle arrival rate of 140 per hour. Entrance gates set back from the highway with road space to accommodate an 'of-street' queue of some 10 to 14 vehicles 'at the gate'. External 'holding' park and 'escape' path for visiting trucks.
- Reconstructed and enlarged road access between the new Novi Iskar by-pass roundabout and the main site entrance: By enlargement and reinforcement of the existing roadway. (It is understood that the proposed Novi Iskar by-pass will be completed prior to 1997 by Ministry of Transport);

(7) General Site Features and Facilities

- An internally fenced administration area where the site offices, garages, and site stores are located;
- new inner site access roadway and a gravity drainage path to be provided by excavating a cutting through the Southern Quarry wall;
- separate in-out vehicular access with duplicate computerized weighbridging facilities, traffic lights and automatic road barriers;
- a system of temporary and movable precast road segments arranged within the site for circular internal anticlockwise waste-traffic flow (up to 140 vehicles/hour). Also for a separate road system for earth moving and cover material traffic. (Plant to excavate, haul and grade up to some 450 cu m of clay cover per working day);

- a pre-prepared central earth platform to facilitate multiple faced municipal waste landfilling in two cells; complete with perimeter surface water drains, under drains, temporary and permanent access roadways;
- drainage system to protect landfill from surface water run-off, to divert surrounding surface water inflows, to intercept spring waters, to intercept internal rainwater, to intercept rising groundwater and to discharge all waters for settlement, pre-treatment or overflow: Piped discharges to the proposed new Novi Iskar Sewers and the Katinska Stream Culvert;
- provision to recirculate leachate and other waste waters (vehicle wash water).

(8) Quarry Coal Seams and Gas Migration Inhibition Facilities

- Isolation barrier sealing facilities provided to isolate and seal off all identifiable coal faces from the landfill. Isolation to prevent gas migration, leachate ingress and to stop transfer of oxygen and/or other gasses/fluids into the coal (or other permeable strata encountered);
- coal found to be burning to be cut into, stripped of all ash and extinguished by sealing with calcium chloride solution prior to isolation.
- during construction, all such known seams to be located, exposed and inspected by professional mining and geotechnical engineers. Coal faces to be cut back and sealed below or behind at least 3 m of selected clay sealer.
- all records, equipment and mobile plant facilities to remain on-site under the Manager's control and any subsequent similar or other strata to be likewise treated.

(9) Spring Diversion Facilities

- Existing groundwater springs (two identified) to be cut back, piped to the main underground drainage/interception system, and sealed below and/or behind a 3m clay layer.

(10) Groundwater Interception Facilities

- Groundwater standing in the inner quarry lake to be initially drawn down by the Construction Contractor and/or pumped out into the new main gravity culvert to the South of the Site (440,000 m^3 at a rate of 100l/sec during the contractors daylight working hours); Contract to require the interception of all suspended matter/sediments etc;
- following drainage, the lake basin is to be cleaned, filled with compacted material from the excavations (into

the coal etc), and the fill topped a 700mm drainage blanket and pipe system installed for the diversion of inflowing groundwater springs into the main culvert. Permanent discharge is expected to be some 7 to 9 l/sec.

(11) Surface Water Facilities

- The site is to be constructed with a main drainage culvert (2m deep x 1m broad) from its center to the Katinska Stream (Figure 2-2-12);
- this culvert designed to carry flood flows of up to that from a 1:100 year storm;
- site to be constructed with an upper level storm water run-off ditch to discharge to the external lake (extending existing system);
- further storm water ditches to collect internal run off and discharge to the new entrance road ditches and/or to the culvert as appropriate;
- facilities to adjust and extend these ditches as the filling of the quarry progresses;
- surface water and culvert flows intercepted by a set of ponds/tanks to settle out suspended matter/mud from the site traffic: Internally these to be excavated in the clay and moved as necessary. Externally two final concrete tanks to be constructed.

(12) Leachate Collection, Recirculation and Handling Facilities

- Gravity leachate collection system installed below the base of all landfill cells within a 500 mm thick protective earth layer. Collection pipes in 300 mm dia slotted pipe system manufactured from corrosion resistant pressure pipework with a flexible jointing system. Pipes with a 200 mm drainage material surround. Figure 2-2-11 illustrates;
- whereas the leachate capacity of the system must be at least the legal minimum of 10% of precipitation (ie 1.19 l/sec), additional capacity will be provided, to enable higher rates (up to 4 l/sec) to be eventually coped with. Pretreatment assumed avoidable in the meantime as the Municipal Sewage works Manager confirms he has the capacity to deal with 'Suhudol leachate-type discharges;
- each cell drainage to be independently run to collection points for individual cell leachate quantity and quality monitoring; Final combined discharges piped to an external storage/collection sump of 300 m^3 capacity. Sump constructed with space for further enlargement at later date, if necessary;

- pumped recirculation to be provided to return the leachate to the landfill cells. HDPE pipes (100mm dia) to be initially laid to the pre-prepared cells with spare stock for extension and route modification as the landfill develops. Facilities for dosing caustic soda (or lime) for pH adjustment of recirculated liquor;
- 10 l/sec duty standby pumping capacity;
- leachate recirculation to be augmented with supplies from the groundwater and vehicle wash bays. Facility therefore to blend the leachate with other site waters for diluted recirculation and/or discharge as appropriate;

(13) Landfill Gas Facilities

- Facilities for controlled collection of landfill gas and open ventilation during the first three years' operation. Thereafter, once behavior of the landfill has been established and understood, possible future continuation/modification of the gas release system; initial facilities not to preclude gas collection, scrubbing and reuse;
- stock of crushed rock, vertical PC pipe vents and small bore flexible gas collection tubing to be provided. Vertical vent equipment for 3 risers for each of the 3 initial cells. Horizontal tubes for inclusion below the cover material at depths approximating 10, 20, 30 m etc;
- arrangement shown in Figure 2-2-11.

(14) Wastewater Discharge Facility Summary

The site wastewater discharge facilities are summarized:

- Surface waters from the North Western reaches of the Site to the external Lake (No. 1): In an expansion of the existing open earth channel;
- Surface waters from the main site area (and all groundwater not recirculated). From the sedimentation tanks outlet, in a 300 mm pipe, to discharge into the inlet to the Novi Iskar Surface Water Culvert. (This also carries the Katinska waters to the River Iskar);
- Site storm Water. From the main site drainage culvert (at the inlet to the sedimentation tanks) a 1200 mm discharge pipe to the Katinska Stream bed;
- Sewage and domestic foul flows. Discharges from the admin. area and from the main gatehouse to the new external sewers in 150 mm dia. sewer lines;
- leachate excess (neither recirculated or tankered out) discharges from the site of the pre-treatment facilities to the sewer;