Japan International Cooperation Agency (JICA)
The Ministry of Public Works and Regional Planning
The Municipality of Bucharest
Romania

The Study on the Solid Waste Management System
for Bucharest Municipality in Romania

Final Report

Volume 5

Appendices to the Feasibility Study on the Development of the 3 Sanitary Landfill Sites in Balaceanca, Cretuleasca and Glina

December 1995

EX Corporation
Yachiyo Engineering Co., Ltd.

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CHAPTER 1 SITE CONDITIONS USED FOR FACILITY DESIGN

1.1 Natural Conditions of Each site

1) Glina

a. Location

Glina site is outside the boundary of the Bucharest city. It is located 9 km to the southeast from the center of the city. See Fig.1. 1-1. The site location is very important factor for SWM, the location is acceptable distance without transfer station.

b. Topography

The site is a huge swampy land and is surrounded by terrace except the northern part. The swampy land is about 56 m hight from the Black Sea level, while the terrace is about 73 m. The site area is about 100 ha, 60 % of the area has been used so far. The topographic condition is economical to construct the disposal site, because the site can be ensured the big capacity by short embankment. The final level of the site will be recreated at 73 m as same as terrace level. In near future, the municipality will be get wide and flat land.

c. Geology

The terrace and the base of swampy land is consist of the Quartunary deposit layers, and the swampy land had been covered by several meters of Alluvium deposit layer. The layers of Quaternary is almost occupied by clay and silt layer, but thin fine sand with gravel layer also exist from 59m to 50 m level. Alluvium deposit layers on the swampy land have high moisture content and soft, however the results of compression shows that the layers can keep the stability of final figure of embankment. The details of geological conditions are described as " Geological Survey Report ".

d. Hydrogeology

According to the "Geological Survey Report ", first ground water level is conformed by every boreholles, it is about 57m at the terrace and it is about 55m at the swampy land. The grand water forms gentle curve from terrace to swampy land, is called as " free grand water ", the level has changed time to time by the meteorological condition. The water has possibility contamination from leachate especially in Glina village where

located at lower reaches of the water, because this aquifer has high permeability coefficient (1 x 10-3 cm/s order level). If local people use the same aquifer by shallow well for drinking water , we recommend digging deep well to get drinking water. Detail information is described as " Geological Survey Report ".

c. Surface water

Topography of Glina site is formed by river erosion. The area is not suitable for agriculture area , because the site is swampy land. Surface water come from not only rainfall water but also the seepage from the edge of the terrace. The half area is covered with thin water, and effluent water flow out to the drain ditch that is located northern part of the area . The ditch joins another agricultural drain ditch at the about 1km northern part. See Fig.1.1-2. We should design the leachate collection system and pump station to send leachate to the sewage water treatment facility to protect the surface water contamination.

2) Balaceanca

a. Location

Balaceanca new final disposal site is also outside the boundary of the Bucharest city. It is located 12 km to the southeast from the center of the city and near the existing Glina site and the sewage waste water treatment facility. See Fig.1.1-1. The distance is also acceptable.

b. Topography

The site topography condition is almost same as Glina site, and has same background of topographical history. The land is about 50 m from the Black Sea level, while terrace is 65 m. The site area is about 50 ha. The site will be recreated at 65 m high.

c. Geology

Geological condition of this site is also almost same as Glina site. At the terrace and base of swampy land, the clay and silt layers are distributed mainly that is origin from Quartunary. And shallow zone of low land is distributed of several meters Alluvium deposit. The Alluvium layers is consists of clay and silt that have high moisture contents and soft, however the layers have enough shearing strength to keep the

stability of final figure of embankment. The details of geological conditions are descried as " Geological Survey Report".

d. Hydrogeology

Ground water level is conformed about 50 m level at the terrace, and about 48 m at the low land, this site also that the ground water forms gentle curve from terrace to swampy land. The water at the terrace is existed in fine sand with gravel layer forms first aquifer layer for " free ground water". Therefore, we decide to install the artificial liner to protect the ground water contamination from leachate.

e. Surface water

The site is same conditions of Glina site, natural drainage of rainfall water is bad and also there is seepage water from the edge of terrace. Therefore, the land become swampy and is not suitable for agriculture. We will prepare the leachate collection system and pump station to send leachate to the sewage water treatment facility to protect the surface water contamination.

3) Cretuleasca

a. Location

Cretuleasca new final disposal site is out side of ring. road. It is located 12 km to the northeast from the center of Bucharest and near the river. The distance from the city center to the site is acceptable without transfer station. See Fig.1.1-1.

b. Topography

The site has shallow vary made by the rainfall drainage water erosion from the back ground area, the water do not existing without rainy season and snow melting season. The site has about 6 m different height between top of the terrace and bottom of the vary. This topographic condition is not suitable for landfill site, because much excavation earth work is needed to ensure the capacity of the site. However, there is not so many suitable site in near area of Bucharest, especially within 20 km from the center of the city. Therefore, in near future this kind of site will be major in this city, and also much excavated soil will be very useful for another two sites as embankment material and covering material. We recognize that this development is indispensable project in our total project component. We should consider and design the stability of embankment to store the solid waste, because the site is located near the river.

c. Geology

The site area is consist of Quaternary deposit layers and river side and bottom of vary had covered by Alluvium deposit. The both deposit is almost occupied by fine particle-size soil. These soil have a low moisture contents. In this site, earth excavation work is major work. Excavated soil is used by embankment material to another sites, and the soil is suitable for earth work. Thin sand with gravel layer is also distributed from 81m to 76m level in Quaternary deposit, but the layer is under the bottom of planed final disposal site. Detail geological condition is described as "Geological Survey Report".

d. Hydrogeology

Grand water level is conformed at 81m level, the water forms gentle curve from terrace to the river. At the site, first aquifer is 81m level in Quaternary Deposit consists of sand with gravel. This layer has high permeability (1x10-3 cm/s order) and may conduct flow of grand water. However, clay layer distribute at the bottom of the planned site.

The layer has low permeability, therefore the site does not need to install the artificial liner, according to the Japanese Standard.

e. Surface water

There is a vary in this site that is created by surface water erosion. The site has huge back ground area, and many surface water come together in this vary when it is rain and water from snow melting. Therefore, we should design surface water drainage system to protect the site. The drainage system will be installed under the bottom. And, the site is located near the river, we will not able to effluent leachate to the river directory. We consider the treatment method of leachate economically, however it is difficult to treat by only biological method in winter season. Therefore , we decided to send leachate to sewage pipeline near the site.

1.2 Other Conditions

1) Glina

Other conditions of Glina site are as following;

- village	Glina, Popesiti;
- population	Glina 8,000, Popesiti 22,000;
- water use	shallow well and
- road and traffic condition	ling road.

Note; Both village has been received a public hazard from existing Glina disposal site, smoke, odor and surface water contamination. There is traffic congestion at the entrance of the access road that is connected ring road, because not only collection viecles but also many cars that visit market near the site are together on ling load. Therefore, collection viecles should be decreased by construction of another disposal sites.

2) Balaceanca

Other conditions of Balaceanca new site are as following;

- village	Cernica, Balaceanca;
- population	Cernica 8,731; Balaceanca 2,129;
- water use	shallow well and
- road and traffic condition	ling road

Note; There is a road through the center of Glina village, but it is difficult to use as the access road. Because, pavement of road is not good and also the road is main street of the village, local people may not agree to use the road for access to the site. Therefore, we recommend to construct 2.5 km new access road from ling road to the site directory.

3) Cretuleasca

Other conditions of Cleturcasca new site are as following;

- village	Stefanestii de Jos, Cletuleasca;
- population	Stefanestii de Jos 3,740, Cleturcasca 326;
- Water use	shallow well and
- road and traffic condition	ling road

Note; The location of the new site is near ling road, therefore we will construct new access road from the road to the site directory. The new road is for from residential area, it is good to protect the environment of the area by the vehicle.

Fig.1.1-1 Sites Location Map

S = 1:100,000

CHAPTER 2 CALCULATION FOR FACILITIES DESIGN

2.1 Climatic Condition and Leachate Quality & Quantity

Climatic condition and leachate quality & quantity are described in Appendices Report of Master Plan.

2.2 Storage Pond and Pump Station Capacity

There is a closed relationship between leachate storage pond capacity and pump station capacity. If, we designed the pump capacity that can be sent annual average leachate quantity, the storage pond capacity needs about 1,000 m3/ha. The pond capacity is too big for site area, therefore we design the pump capacity is 1.5 times for the annual average leachate quantity. In this case, the pond capacity decrease about half. The detail calculations of each site is discussed as below.

1) Glina

a. Storage Pond Capacity

Glina site area is 99.2 ha, assumed annual average leachate quantity will reach 650 m3/day (6.3 m3/day/ha x 99.2 ha = 624.96 m3/day). If, the pump capacity will be adopted 650 m3/day, the storage pond capacity will be needed about 98,000 m3. See Fig. 1.2-1. Therefore, we adopted 1.5 times pump capacity. In this case, the storage pond capacity is about 50,000 m3.
The conclusion is following;

- storage pond capacity 60,000 m3 (safety coefficient = 1.2) and
- pump capacity 900 m3/day (0.625 m3/min.).

b. Specification of Pump Capacity

1. Diameter of pipeline
D = 125 mm
V = 0.625 / (60 x 0.125 x 0.125 x 3.14 / 4) = 0.85 m/s
2. Head loss from A to B (D = 125 mm, l1 = 680 m)
h1l = (3 x 6.8 x 0.21 + 0.025 x 680 / 0.125 + 0.16 +1.0) x (0.85 x 0.85 / 19.6) = 5.3 m

3. Head loss from B to C (D = 125 mm, l2 = 830 m)

h2l = (3 x 3 .8 x 0.21 + 0.025 x 830 / 0.125 + 1.0) x (0.85 x 0.85 / 19.6) = 6.4 m

Head of B point : Hn = 55.4 m + 6.4 m = 61.2m < 62 m

4. All head of pump

Ht = (62.0 - 49.0) + 5.3 = 18.3 --- 19.0 m

5. Trial calculation of power

P = (0.163 x 1.0 x 19.0 x 0.625) / o.65 x 1.15 = 3.5 kW

6. Conclusion

Water pump D 65 x 0.625 m3/min. x 19 m x 3.7 kW or

Waste water pump D 100 x 0.625 m3/min. x 19 m x 5.5 kW

2) Balaccanca

a. Storage Pond Capacity

Balaccanca landfill site area is 35.4 ha, assumed annual average leachate quantity will reach 223 m3/day (6.3 m3/day/ha x 35.4 ha = 223.02 ha). If, annual average quantity will be sent to treatment facility, the storage pond capacity will become big as same as the case of Glina site, therefore the pump capacity is adopted 1.5 times annual average quantity. The designed capacity of each facilities are following;

storage pond capacity 20,250 m3 (safety coefficient = 1.1)

pump capacity 320 m3/day (0.22 m3/min.)

b. Specification of Pump Capacity

- Conditions

Q = 0.221 m3/min. = 0.00369 m3/s

Diameter of pipeline = 75mm

- Head Loss A~B~C

hl = (3 x 36.7 x 0.21 + 0.025 x 3,670/0.075 + 1.0) x 0.84 x 0.84 / 19.6 = 44.9 m

- All head of pump

H = (55.4 - 47.1) + 44.9 = 53.2 about 54 m

P = (0.163 x 1.0 x 54 x 0.221) / 0.5 x 1.15 = 4.47 kw

- Specification of Pump Capacity

D=50mm x 0.221 m3/min x 53m x 5.5kw

3) Cretuleasca

a. Storage Pond Capacity

According to the leachate quantity calculation, maximum storage quantity will reach 512 m3/ha, when 9m3/ha/day quantity will be pump upped and sent to the sewage waste water treatment facility. The area is about 22.5 ha, therefore pond capacity is needed at least 11,500 m3. Designed pond has 2.7m depth and 5,770 m2 area. The capacity is 15,500 m3.

The Pond Capacity	15,500 m3 (Safety Coefficient = 1.3)
Pump Capacity	200 m3/day

b. Specification of Pump Capacity

- Condition

Diameter of pipeline 65mm

Q = 0.141 m3/min. = 0.00235 m3/s

- Head Loss from B to C

hl = 3 x 45 x 0.21 + 0.025 x 4500/0.065 + 1.0) x 0.72 x 0.72 / 19.6 = 46.6 m

B' = 82 + 46.6 = 128.6 about 129 m

- Head Loss from B to C

hl = (3 x 0.6 x 0.21 + 0.025 x 60 / 0.065 + 1.0) x 0.72 x 0.72 / 19.6 = 0.65 m

- All head of pump loss

All head = (129 - 79) + 0.65 = 50.65 m about 51m

P = (0.163 x 1.0 x51 x0.141) / 0.5 = 2.7 kw

- Specification of pump capacity

Diameter 40mm x 0.141 m3/ min. x 51 m x 3.7 kw

CHAPTER 3 URGENT IMPROVEMENT PLAN OF GLINA SITE

Site condition of Glina site does not reach first basic sanitary level, therefore many contamination has happened. Local people and site workers should be endured the current worst condition. The site improvement is the most important and urgent matter for Bucharest municipality. We propose the minimum improve plan as urgent improvement plan of Glina site to the municipality. The contents of the plan are following;

1. soil cover for existing south-western open dump area to protect odor and smoke from garbage and

2. new access road to the bottom of the site to adopt cell-final disposal method.

The plan is shown in Fig.3.1-1 and approximate improvement cost is described as bellow.

(Soil cover work)

Work quantity

Slope area	76.5m x (520m + 570m) / 2 = 41,692m2 ---- 41,700m2
Cover soil	41,700 m2 x 0.5m = 20,850m3
Cut	43m x 8m x 0.5m x (520m +570m) / 2 = 93,740 m3
Embankment	Same as above
Total	20,850m3 + 93,740m3 x 2 = 208,330 m3

Cost

Bulldozer (Spread & Compaction)

208,330m3 / (60 m3 x 8 hours) = 434 days

1 day cost 18,000 lei / 2,000 lei x 8 hours = 72 $/day

72 $/day x 434 days = 31,248 $

Excavator (Soil excavation)

20,850m3 / (80 m3 x 8 hours) = 33 days

1 day cost 30,000lei / 2,000lei = 150 $/day

150 $/day x 33 day = 4,950 $

Truck (Soil Transportation)

20,850 m3 / (25m3 x 8 hours) = 104 days

1 day cost 8,000lei / 2,000lei x 8 hours = 32 $/day

32 $/day x 104 days = 3,328 $

Total cost 39,526 $

(Access Road Construction Work)

Work quantity

Cover soil 30m x 200m x 0.5m = 3,000 m3

Cut 7.5 m x 15m / 2 x 200 m = 11,250 m3

Embankment Same as above

(Pavement 10 m x 350 m = 3,500 m2)

Total 25,500 m3

Cost

Bulldozer (Spread & Compaction)

22,500 m3 / (60 m3 x 8 hours) = 47 days

72 $/day x 47 days = 3,384 $

Excavator (Soil Cover)

3,000 m3 (80 m3 x 8 hours) = 5 days

150 $/day x 5 days = 750 $

Truck (Soil Transportation)

3,000 m3 / (25 m3 x 8 hours) = 15 days

32 $/day x 15 days = 480 $

(Pavement)

(3,500 m2 x 0.5 x 10 $ = 17,500 $)

Total Cost 4,611 $ (22,111 $)

Ground Total Cost 44,137 $ (61,637 $)

Include TVA 44,137 x 1.18 = 52,081 $

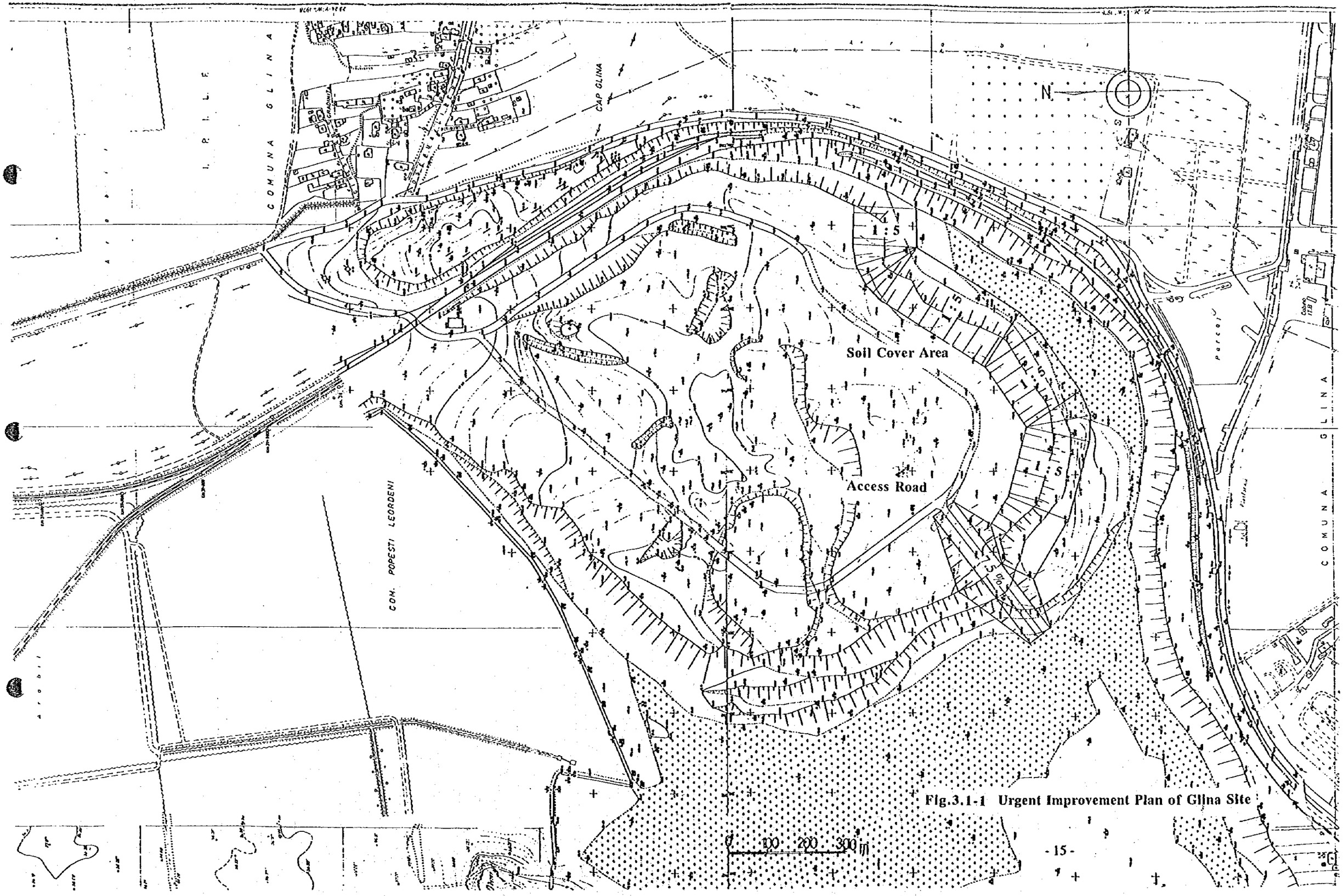


Fig.3.1-1 Urgent Improvement Plan of Glina Site

CHAPTER 4 COST ESTIMATION

4.1 Construction Cost of Glina and New sites

Glina site improvement construction cost is estimated in Tables 4.1-1 and 4.1-2. Construction cost of Balaceanca site is shown in Tables 4.1-3 ~ 4.1-5. The cost of Cretulcasca is shown in Table 4.1-6. And total construction cost is summarized in Table 4.1-7.

Table 4.1-1 Glina site Improvement Construction Cost (1st)

Work	Item	Form, Size	Unit	Quantity	Unit Cost ($/Unit)	Cost
1.Civil Work						
(1) Embankment (1st)	Material		m3	153,300	4.09	626,997
	Embankment		m3	153,300	0.45	68,985
	Adjustment		m2	34,558	0.64	22,117
Subtotal						**718,099**
Embankment (2nd)	Material		m3	155,400	4.09	635,586
	Embankment		m3	155,400	0.45	69,930
	Adjustment		m2	35,032	0.64	22,420
Subtotal						**727,936**
(2) Leachate Collection System	Excavation		m3	2,070	0.45	
	Pipe	D=400mm	m	650	24	
		D=200mm	m	2,760	10.75	Detail is
	Geotexitile	t=20mm	m2	2,898	2.0	shown in
	Removal surplus soil		m3	2,070	0.6	Basis Document
	Others					
Subtotal						**110,133**
(3) Rainfall Drainage System	U type concrete ditch	450 x 450	m	1,400	51.3	71,820
		300 x 300	m	2,200	38.5	84,700
	Manhole	450 x450	m	2	93	186
Subtotal						**156,706**
(4) Gate, Net	Net fence	H=1.8m	m	4,520	24.8	112,096
	Net fence	H=1.8m	m	620	33.0	20,460
	Gate	W=6m		1	2,600	2,600
		W=4m		1	1,420	1,420
		W=2m		1		240
Subtotal						**136,816**

(5) Gas exhaust equipment			Place	17	152	2,584
Subtotal						**2,584**
(6) Road Construction Work	Management Road	W=6m (pav.=4m)	m	1,080	121	130,680
	Onsite Road	W=8m	m	3,600	167	601,200
Subtotal						**731,880**
(7) Drainage Ditch Improvement work	Ditch	3,000 x 1200	m	700	328	229,600
	Excavation		m3	1,470	0.45	662
	Embankment		m3	875	0.45	394
	Adjustment		m2	777	0.6	466
	Embankment material		m3	875	4.1	3588
Subtotal						**234,710**
(8) Temporary Work				1		104,680
Subtotal						**104,680**
(9) Leachate storage pond	Excavation		m3	32,000	0.45	14,400
	Embankment		m3	2,025	0.45	911
	Adjustment work		m2	4,217	0.5	2,109
	Liner		m2	22,928	3.0	68,784
	Embankment Material		m3	2,025	4.09	8,282
	Removal of surplus soil		m3	32,000	0.6	19,200
Subtotal						**113,686**
(10) Leachate pump station	Water tank	Concrete	m3	477	See basis document	70,021
	Intake pump					502
	Pump		unit	1	1,500	1,500
	Hume pipe	500mm	m	100	55.8	1,786
Subtotal						**73,809**
(11) Electric Work	Pump station		m	600	30	18,000
Subtotal						**18,000**
(12) Building Construction	Leachate Pump Station		m2	286	210	60,060
Subtotal						**60,060**
(13) Pipeline		125 mm	m	1,510	40.1	60,551
Subtotal						**60,551**

(14) Transportation				1		5,200
Subtotal						**5,200**
(15) Site Plant Work						7,600
Subtotal						**7,600**
Total Direct Cost						**3,262,450**
Indirect Cost				Total Direct Cost about 20 %		**647,550**
Total Cost						**3,910,000**

*** Cost Estimation**

(Condition)

1. Added 5% of physical contingency & 10 % price contingency

   3,910,000 x 1.15 = 4,496,000 ($)

2. And added 18% TVA

   4,496,000 x 1.18 = 5,305,280 ($)

3. Final Total Cost

   5,305,280 ($)

Table 4.1-2 Glina Site Improvement Construction Cost (3rd 2000)

Work	Item	Form, Size	Unit	Quantity	Unit Cost	Cost
1. Civil Work						
Embankment	Material		m3	92,160	4.09	376,934
	Embankment		m3	92,160	0.45	41,472
	Adjustment		m2	34,329	0.64	21,970
Subtotal						**440,376**
2. Indirect Cost					Subtotal x about 20%	87,624
Total Cost						**528,000**

*** Cost Estimation**

1. Added 5% physical contingency and 10% price contingency

   528,000 x 1.15 = 607,000 ($)

2. And Added TVA

   607,000 x 1.18 = 716,260 ($)

3. Final Cost

716,260 ($)

Table 4.1-3 Balaceanca Site Construction Cost (1st)

Work	Item	Form, Size	Unit	Quantity	Unit Cost	Cost
I.Civil Work						
(1) Embankment	Material		m3	123,500	4.09	505,115
	Embankment	15t class Bulldozer	m3	123,500	0.45	55,575
	Adjustment		m2	36,286	0.64	23,223
	Subtotal					**583,913**
(2) Leachate Collection System	Pipe installment work	D=400mm	m	667	55.8	37,777
		D=200mm	m	2,848	25.7	73,194
	Drainage Pit		unit	1		1,340
	Subtotal					**112,311**
(3) Rainfall Drainage System	U type concrete ditch	300 x 300	m	2,920	38.5	112,420
	Subtotal					**112,420**
(4) Gate, Net	Net fence (Site)	H=1.8m	m	2,615	24.8	64,852
	Net fence (Sheet fixed)		m	440	33.0	14,520
	Gate	W=6m	Unit	1	2,600	2,600
		W=4m	Unit	4	1,420	5,680
		W=2m	Unit	1	240	240
	Subtotal					**87,892**
(5) Gas exhaust equipment			Place	24	152	3,648
	Subtotal					**3,648**
(6) Road Construction Work	Management Road	W=6m	m	2,710	121	327,910
	Access Road	W=8m	m	5,060	271	1,371,260
	Insite Road	W=8m	m	2,410	167	402,470
	Subtotal					**2,101,640**
(7) Ground water Drainage		D=200mm	m	730	20.0	14,600
	Subtotal					**14,600**
(8) Track scale	Foundation	30t Capacity		1		35,240
	Subtotal					**35,240**

(9) Artificial Liner	Rubber sheet	t=2mm	m2	359,261	3.0	1,077,783
	Geotextile	t=20mm	m2	359,261	2.0	718,522
	Sand mat	t=50cm	m3	137,500	0.45	61,875
	Sand mat material		m3	137,500	4.09	562,375
	Sheet fixed	concrete	m3	3,850	4.2	16,170
	Subtotal					**2,436,725**
(10) Temporary Work				1		5,320
	Subtotal					**5,320**
(11) Leachate storage pond	Excavation		m3	30,000	0.45	13,500
	Adjustment work		m2	4,972	0.5	2,486
	Liner		m2	10,516	3.0	31,548
	Removal of surplus soil		m3	30,000	0.6	18,000
	Subtotal					**65,534**
(12) Leachate pump station	Water tank	Concrete	m3	240	112.28	26,947
	Intake Pit			1		502
	Humu Pipe		m	43.2	55.8	2,411
	Pump			1	1,500	1,500
	Subtotal					**31,360**
(13) Electric Work				1	25,000	25,000
	Subtotal					**25,000**
(14) Building Work	Control Office		m2	240	225	54,000
	Leachate pump station		m2	176.5	210	37,065
	Subtotal					**91,065**
(15) Pipeline		125 mm	m	3,670	40.1	147,167
	Subtotal					**147,167**
(16) Site Plant Work						10,640
	Subtotal					**10,640**
Total Direct Cost						**5,870,325**
Indirect Cost					Direct Cost x about 20%	**1,169,675**
Total Direct Cost						**7,040,000**

*** Cost Estimation**

(Condition)

1. Add 5 % physical contingency and 10 % price contingency

   7,040,000 x 1.15 = 8,096,000 ($)

2. Added TVA

   8,096,000 x 1.18 = 9,553,280 ($)

3. Final Total Cost

   9,553,280 ($)

Table 4.1-4 Balachanca Site Construction Cost (2nd 2001)

Work	Item	Form, Size	Unit	Quantity	Unit Cost	Cost
Earth Work						
	Material		m3	78,240	4.09	320,002
	Embankment		m3	78,240	0.45	35,280
	Adjustment		m2	29,144	0.64	18,652
Subtotal						**373,862**
Indirect cost					Subtotal x 20 %	74,138
Total Cost						**448,000**

* Cost Estimation

1. Added 5% physical contingency and 10% price contingency

   448,000 x 1.15 = 515,000 ($)

2. Added TVA

   515,000 x 1.18 = 607,700 ($)

3. Final Cost

   607,700 ($)

Table 4.1-5 Balaceanca Site Construction Cost (3rd 2004)

Work	Item	Form, Size	Unit	Quantity	Unit Cost	Cost
Earth Work						
	Material		m3	79,200	4.09	323,928
	Embankment		m3	79,200	0.45	35,640
	Adjustment		m3	29,502	0.64	18,881
Subtotal						**378,449**
Indirect Cost					Subtotal x 20%	75,551
Total						**454,000**

*** Cost Estimation**

1. Added 5% physical contingency and 10% price contingency

454,000 x 1.15 = 522,000 ($)

2,Added TVA

522,000 x 1.18 = 615,960 ($)

3. Final Cost

615,960 ($)

Table 4.1-6 Cretuleasca Site Construction Cost (1st)

Work	Item	Form, Size	Unit	Quantity	Unit Cost	Cost
1.Civil Work						
(1) Embankment	Material		m3	59,400	0	0
	Embankment		m3	59,400	0.45	26,730
	Adjustment	Cut Face	m2	22,136	0.51	11,289
		Embankment Face	m2	26,532	0.64	16,980
	Excavation		m3	901,600	0.45	405,720
	Subtotal					**460,719**
(2) Leachate Collection System	Drainage Pit			1	1,340	1,340
	Pipe	D=300mm	m	858	55.8	47,816
		D=200mm	m	1,725	25.7	44,333
	Subtotal					**93,549**
(3) Rainfall Drainage System	U type concrete ditch	600 x 600	m	300	73.3	21,990
		300 x 300	m	2,110	38.5	81,235
	Humu pipe	600mm	m	640	75.2	48,128
	Inflow pit			1		10,947
	Subtotal					**162,300**

(4) Gate, Net Fence	Net fence	H=1.8m (arround the site)	m	2,450	24.8	60,760
		H=1.8m (Include fixed foundation)	m	349	33.0	11,517
	Gate	W=6m	Place	1	2,600	2,600
		W=4m	Place	4	1,420	5,680
		W=2m	Place	1	240	240
	Subtotal					**80,797**
(5) Gas exhaust equipment	On main pipe		Place	8	152	1,216
	On branch pipe		place	15	152	2,280
	Subtotal					**3,496**
(6) Road Construction Work	Management Road	W=6m	m	2,440	121	295,240
	Access Road	W=8m	m	620	271	168,020
	Insite Road	W=8m	m	1,205	167	201,235
	Subtotal					**664,495**
(7) Track scale		30t Capacity		1		35,240
	Subtotal					**35,240**
(8) Liner	Sheet	2mm	m2	230,938	3.0	692,814
	Geotextile	20mm	m2	230,938	2.0	461,876
	Sand mat		m3	84,844	0.45	36,180
	Sand mat material		m3	84,844	0	0
	Sheet Fixed	Concrete	m3	5,940	4.2	24,948
	Subtotal					**1,217,818**
(9) Temporary Work	Electricity			1		1,000
	Subtotal					**1,000**
(10) Leachate storage pond	Excavation		m3	26,447	0.45	11,915
	Adjustment work		m2	2,110	0.5	1,055
	Liner		m2	7,955	3.0	23,865
	Subtotal					**36,835**
(11) Leachate pump station	Water tank	Concrete	m3	240	112.28	26,947
	Hume pipe		m3	36	55.8	2,009
	Pump			1	1,500	1,500
	Intake pit			1		502
	Subtotal					**30,958**
(12) Electric Work				1		25,000
	Subtotal					**25,000**

(13) Building Work	Control Office		m2	240	225	54,000
	Pump Station		m2	176.5	210	37,065
	Subtotal					**91,065**
(14) Pipeline			m	4,560	40.1	182,856
	Subtotal					**182,856**
(15) Transportation				1	10,400	10,400
	Subtotal					**10,400**
(16) Site Plant Work						15,200
	Subtotal					**15,200**
Total Direct Cost						**3,111,729**
Indirect Cost					Direct Cost x about 20%	**618,271**
Total Cost						**3,730,000**

*** Cost Estimation**

(Condition)

1. Added 5 % physical contingency and 10 % price contingency

   3,730,000 x 1.15 = 4,289,000 ($)

2. Added TVA

   4,289,000 x 1.18 = 5,061,020 ($)

3. Final Cost

   5,061,020 ($)

Table 4.1-7 Cost Summary of Site Construction

Site	Direct Cost	Include Overhead	Include Contingency	Include TVA
Glina	3,262,950	3,910,000	4,496,000	5,305,280
Balaceanca	5,870,325	7,040,000	8,096,000	9,553,280
Cleturcasca	3,111,729	3,730,000	4,289,000	5,061,020
Total	-	-	16,881,000	**19,919,580**

2) Estimated Annual Disposal Cost (1996 - 1998)

Annual disposal cost from 1996 to 1998 is estimated as bellow.

Table 4.1-8 Estimated Annual Disposal Cost Unit: US $/year

Year	Investment Cost		Operation Cost (See Table 1.3-9)	Total
	Construction	Purchase of bulldozers		
1996	0	35,000	215,723	250,723
1997	0	35,000	219,996	254,996
1998	0	35,000	226,410	261,400
Total	0	105,000	662,129	767,129

Table 4.1-9 Estimated Annual Operation Cost

Year	Salary			Fuel of Bulldozers			Total Disposal Operation Cost
	Annual salary ($/year/ person)	Number of employ	Total salary	Unit Fuel cost ($/ton)	Disposal amount (ton/year)	Annual fuel cost	
1996	2,000	50	100,000	0.23	503,144	115,723	215,723
1997	2,000	50	100,000	0.23	521,723	119,966	219,996
1998	2,000	50	100,000	0.23	549,610	126,410	226,410

4.2 Engineering Services Cost

Engineering services cost for the project is estimated in tables 4.2-1 ~ 4.2-4. The services needs about 2 years, half year is for detail design and one and half years is for supervision.

Table 4.2-1 Approximate Cost of Engineering Services

(Detail Design)

	Item	Rank	Unit Cost ($/Month)	Quantity (Month)	Cost ($)
International	Engineering Cost	1st	30,000	1.5	45,000
		2nd	25,000	6.0	150,000
		3rd	20,000	10.0	200,000
	Daily Allowance	-	3,000	17.5	52,500
	Travel Expenses	-	5,000	5 times	25,000
	Office	-	2,000	6 month	12,000
	Car	-	20,000	1	20,000
	Subtotal	-	-	-	504,500
Local	Engineering Cost	1st	2,000	2.0	4,000
		2nd	1,500	16.0	24,000
		3rd	1,000	12.0	12,000
	Secretary	-	500	6.0	3,000
	Operator	-	500	12.0	6,000
	Technician	-	500	18.0	9,000
	Driver	-	500	18.0	9,000
	Car	-	5,000	2.0	10,000
	Subtotal	-	-		77,000
Total					581,500
TVA	Total x 18%				186,170
Grand Total					**767,670**

Table 4.2-2 Approximate Cost of Engineering Services

(Tender Evaluation & Supervision)

	Item	Rank	Unit Cost ($/Month)	Quantity (Month)	Cost ($)
International	Engineering Cost	1st	30,000	1.5	45,000
		2nd	25,000	19.0	475,000
		3rd	20,000	9.0	18,000
	Daily Allowance	-	3,000	29.5	88,500
	Travel Expense	-	5,000	7 times	35,000
	Office	-	2,000	18.0	36,000
	Subtotal	-			697,500
	Training & Diffusing	-		Subtotal x about 10 %	69,500
	Total	-	-	-	767,000
Local	Engineering Cost	1st	2,000	7.0	14,000
		2nd	1,500	49.0	73,500
		3rd	1,000	49.0	49,000
	Secretary	-	500	20.0	10,000
	Driver	-	500	40.0	20,000
	Subtotal				166,500
	Training & Diffusing			Subtotal x about 10%	16,500
	Total				183,000
Total					950,000
TVA				Total x about 18%	171,000
Ground total					**1,121,000**

Table 4.2-3 Approximate Total Cost of Engineering Services

Item	Cost ($)	% for the Construction Cost
Detail Design	686,170	3.2 %
Supervision	1,121,000	5.3 %
Total	1,807,170	8.5 %

Note : Total construction cost is 21,190,440 ($) (include equipment procurement)

Table 4.2-4 Annual Cost Allocation of Engineering Services

Year	Glina	Balaceanca	Cletuaresca	Total
1997	184,048	328,111	174,011	686,170
1998	300,680	359,144	190,470	850,294
1999	0	176,892	93,814	270,706
Total	484,728	864,147	458,295	1,807,170

4.3 Operation Cost of Sanitary Landfill Sites

1) Daily Operation Quantity of Each Site

According to the annual disposal volume and allocation plan, improved Glina site and two new disposal site will be constructed completely in 1999, and maximum daily disposal quantity of each site is following;

1. Glina site 321,030 m3/year, (880 m3/day, 2004);
2. Balaccanca 494,047 m3/year, (1,354 m3/day, 2000)
3. Cretulcasca 171,429 m3/ year, (470 m3/day, 2000)

Landfill operation will be done only weekday,therefore daily treated quantity is bigger than annual average quantity. The quantity is calculated as following;

Glina daily operation quantity = 880m3/day x 365days/(365- 52x 2) days = 880 x 1.40 = 1,232 m3/day.
Balaccanca daily operation quantity = 1,354 x 1.40 = 1,896 m3/day
Cretulcasca daily operation quantity = 470 x 1.40 = 658 m3/day
The allocation quantity of each site is shown in Table 4.3-1.

Fig.4.3-1 The Allocation of The Quantity and Treated Total Quantity

Site name	(1) Annual average waste quantity (m3/day)	(2) Daily operation waste quantity (m3/day)	(3) Soil cover material quantity (m3/day)	(4) Total operation quantity (2)+(3) (m3/day)
Glina	880	1,232	246	1,478
Balaccanca	1,354	1,896	379	2,275
Cretulcasca	470	658	132	790

Note: Soil cover material is 20% of (2).

2) Operation Plan

a. Heavy Equipment Plan

Some heavy equipment is required for bedding and compaction of waste and cover material. It is estimated that bulldozer and excavator with wide caterpillars,dump truck to move for cover material from stock yard to landfill site will be required for the

planned sanitary landfill operation judging from the amount of waste and cover material to be handled. Specification of each equipment is following;

Bulldozer	Class 15t/unit , Capability 45 m3/hour/unit (Spread and Compaction)
Excavator	Class 1.0 m3, Capability 60 m3/hour/unit (Excavation and Loading)
Dump truck	Class 11t, Capability 25m3/h/unit (L=1km)

(1) Glina Disposal Site

The following assumptions are used for calculating required number of units;

waste to be handled;		1,232 ton/day and
cover soil to be applied;		246 ton/day.
Bulldozer	For Waste	1,232 / 45 x 7 = 3.91 -- 4
	For Soil	246 / 45 x 7 = 0.78--- 1
Excavator	For Soil	246 / 60 x 7 = 0.59 -- 1
Dump truck	For soil	246 / 25 x 7 = 1.41 -- 2

The results is shown in Table 4.3-2.

Table 4.3-2 Required Heavy Equipment in Glina Site

Equipment	Number	Remark
Bulldoze	6 (4 + 1 + *1 = 6)	*1 unit is a standby
Excavator	1	
Dump truck	2	

(2) Cretuleasca

The following assumptions are used for calculating required number of units;

waste to be handled;	658 ton/day and
cover soil to be applied;	132 ton/day.

Bulldozer	For Waste	658 / 45 x 7 = 2.09 -- 3
	For Soil	132 / 45 x 7 = 0.42--- 1
Excavator	For Soil	132 / 60 x 7 = 0.31--- 1
Dump truck	For Soil	132 / 25 x 7 = 0.75 --- 1

The result is shown in Table 4.3-3.

Table 4.3-3 Required Heavy Equipment in Cretuleasca

Equipment	Number	Remark
Bulldozer	5 (3 + 1 + *1)	*1 unit is a stand by
Excavator	1	
Dump truck	1	

(3) Balaceanca

The following assumptions are used for calculating required number of units;

waste to be handled; 1,896 ton/day and
cover soil material 379 ton/day.

Bulldozer	For Waste	1,896 / 45 x 7 = 6.02 -- 7
	For Soil	379 / 45 x 7 = 1.20 -- 2
Excavator	For Soil	379 / 60 x 7 = 0.90 -- 1
Dump truck	For Soil	379 / 25 x 7 = 2.17 -- 3

The result is shown in Table 4.3-4.

Table 4.3-4 Required Heavy Equipment in Balaceanca Site

Equipment	Number	Remark
Bulldozer	10 (7 + 2 + *1)	*1 unit is a standby
Excavator	1	
Dump truck	3	

(4) Total Number of Equipment

Total number of required heavy equipment is shown in Table 4.3-5.

Table 4.3-5 Total Number of Heavy Equipment

Equipment	Glina	Cretureasca	Balachcanca	Remark	Total
Bulldozer	*6	*5	*10	*each site unit should be a standby (total 3 units)	21
Excavator	1	1	1	-	3
Dump truck	2	1	3	-	6

3) Management Plan

Municipality Waste Disposal Administration should be organized appropriate site office member.We proposed organization of each site is shown in Table 4.3-6.

Table 4.3-6 Site Office Member

Site name	Office Member	Number
Glina	-Manager (1) -Secretary (1) -Chief of engineering section (1) -Truck scale engineer (2) -Chief operator (1) -Operator (9)	(15)
Cretuleasca	-Manager (1) -Secretary (1) -Chief of engineering section (1) -Truck scale engineer (2) -Chief operator (1) -Operator (7)	(13)
Balaccanca	-Manager (1) -Secretary (1) -Chief of engineering section (1) -Truck scale engineer (2) -Chief operator (1) -Operator (14)	(20)

Note) 1. Number of operator is included one shift person.
2. Security guard should be contracted out.

Each member has a responsibility as following;

director	all responsibility of handling the site , contact and report to MWDA closely;
secretary	control and regulate the schedule of Director, register income and outlay of daily management;
chief of engineering section	responsible for all engineering matter, planning and conduct suitable landfill operation method;
truck scale engineer	control the waste quantity and quality, conduct to landfill daily area;
chief operator	control daily operator's work,conduct to daily landfill area in site and
operator	efficiently landfill work.

4) Heavy Equipment Investment Cost

The cost of heavy equipments and management car those are should be provided on each site are shown in Tables 4.3-7 ~ 4.3-10.

Table 4.3-7 Heavy Equipments (Glina)

Item	Type	Quantity	Unit Cost	Cost
Bulldozer	S 1500	6	31,700	190,200
Excavator	S 1203	1	52,300	52,300
Truck	R 10215	2	23,000	46,000
Jeep	ARO 244	1	6,750	6,750
Subtotal	-	-	-	295,250
Price contingency	-	-	Subtotal x about 10%	28,750
Total	-	-	-	**324,000**

*** 324,000 x 18% TVA = 382,320 ($)**

Table 4.3-8 Heavy Equipments (Balaceanca)

Item	Type	Quantity	Unit Cost	Cost
Bulldozer	S 1500	10	31,700	317,000
Excavator	S 1203	1	52,300	52,300
Truck	R 10215	3	23,000	69,000
Jeep	ARO 244	1	6,750	6,750
Subtotal	-	-	-	445,050
Price contingency	-	-	Subtotal x about 10%	43,950
Total	-	-	-	**489,000**

*** 489,000 x 18% TVA = 577,020 ($)**

Table 4.3-9 Heavy Equipments (Cretuleasca)

Item	Type	Quantity	Unit Cost	Cost
Bulldozer	S 1500	5	31,700	158,500
Excavator	S 1203	1	52,300	52,300
Truck	R 10215	1	23,000	23,000
Jeep	ARO 244	1	6,750	6,750
Subtotal	-	-	-	240,550
Price contingency	-	-	Subtotal x about 18%	23,450
Total	-	-	-	**264,000**

*** 264,000 x 18% TVA = 311,520 ($)**

Table 4.3-10 Heavy Equipment's (Total)

Item	Type	Quantity	Unit Cost	Cost
Bulldozer	S 1500	21	31,700	665,700
Excavator	S 1203	3	52,300	156,900
Truck	R 10215	6	23,000	138,000
Jeep	ARO 244	3	6,750	20,250
Subtotal	-	-	-	980,850
Price contingency	-	-	Subtotal x about 10%	96,150
Total	-	-	-	**1,077,000**

*** 1,077,000 x 18% TVA = 1,270,860 ($)**

5) Project Cost

The Project Cost of civil work and heavy equipment for new disposal system is summarized as Table 4.3-11.

Table 4.3-11 Project Cost

Site Name	Civil Work	Heavy Equipments	Total Cost	Remark (Additional Cost)
	($)	($)	($)	
Glina	5,305,280	382,320	**5,687,600**	716,260 (2000)
Balaceanca	9,553,280	577,020	**10,130,300**	607,700 (2001) 615,960 (2004)
Cretulesca	5,061,020	311,520	**5,372,540**	
Total	**19,919,580**	**1,270,860**	**21,190,440**	1,939,920

6) Operation and Maintenance Cost

The Engineering Fee of each site for new disposal system is shown in Tables 4.3-12 ~ 4.3-14.

a. Engineering Fee

Table 4.3-12 Engineering Fee of Glina Site

Class	Monthly Fee			Number	Total Cost ($/Month)
	Unit cost ($/d)	Quantity (d/Month)	Monthly Fee ($/month)		
Director	20	22	440	1	440
Section Chief	17	22	374	1	374
Truck scale Engineer	14	22	308	2	616
Secretary	12	22	264	1	264
Chief Operator	14	22	308	1	308
Operator	12	22	264	9	2,326
Total	-	-	-	-	**4,378**

Table 4.3-13 Engineering Fee of Balaceanca Site

Class	Monthly Fee			Number	Total Cost
	Unit Cost ($/d)	Quantity (d/month)	Monthly Fee ($/month)		($/Month)
Director	20	22	440	1	440
Section chief	17	22	374	1	374
Truck scale engineer	14	22	308	2	616
Secretary	12	22	264	1	264
Chief operator	14	22	308	1	308
Operator	12	22	264	14	3,696
Total	-	-	-	-	**5,698**

Table 4.3-14 Engineering Fee of Cretuleasca Site

Class	Monthly Fee			Number	Total Cost ($/Month)
	Unit cost ($/d)	Quantity (d/Month)	Monthly Fee ($/month)		
Director	20	22	440	1	440
Section Chief	17	22	374	1	374
Truck scale Engineer	14	22	308	2	616
Secretary	12	22	264	1	264
Chief Operator	14	22	308	1	308
Operator	12	22	264	7	1,848
Total	-	-	-	-	**3,848**

b. Operation Cost

Table 4.3-15 Operation Cost (per/month)

	Fuel	Electricity Site name		Water	Gas	Total
	(equipment)	Office	Pump			
Glina	0.20 $/l	105.6 $	818.4 $	9.9 $	30 $	963.9 $
Balaceanca	0.20 $/l	105.6 $	550.6 $	13.2 $	30 $	699.4 $
Cretuleasca	0.20 $/l	105.6 $	550.6 $	8.6 $	30 $	694.8 $

(1) Fuel (For example, Glina)

Bulldozer For waste 3.9 units x 7 hours x 20 l x 600/2000 $ = 163.8 $

For soil 0.8 unit x 7 hours x 20 l x 600/2000 = 33.6 $

Excavator 0.6 unit x 7 hours x 20 l x 600/2000 $ = 25.2 $

Truck 1.4 unit x 7 hours x 15 l x 600/2000 $ = 44.1 $

Total (163.8 + 33.6 + 25.2 + 44.1)$ = 266.7 $

Per ton 266.7 $ / 1232 t = 0.22 --- 0.2 $/t

(2) Electricity

Office 3 kw x 8hr/day x 22 day x 400/2000 $ = 105.6 $/M

Pump Glina 5.5 x 24 x 31 x 400/2000 $ = 818.4 $/M

Balachanca 3.7 x 24 x 31 x 400/2000 $ = 550.6 $/M

Cretulcasca 3.7 x 24 x 31 x 400/2000 $ = 550.6 $/M

(3) Water

Office Glina 200l/p/1000 x 15 x 22 x 300/2000 $ = 9.9 $

Balachanca 200l/p/1000 x 20 x 22 x 300/2000 $ = 13.2 $

Cleturcasca 200l/p/1000 x 13 x 22 x 300/2000 $ = 8.6 $

(4) Gas

Office 20 m3/month x 3000/2000 $ = 30 $

Table 4.3-16 Operation and Maintenance Cost (Glina)

Year	Waste Quantity (m3t/year)	Engineering Fee ($/year)	Fuel ($/year)	Electricity & etc. ($/year)	Total ($/year)
1999	499,090	52,536	99,818	11,567	163,921
2000	217,863	52,536	43,573	11,567	107,676
2001	242,597	52,536	48,519	11,567	112,622
2002	268,023	52,536	53,605	11,567	117,708
2003	294,161	52,536	58,832	11,567	122,935
2004	321,030	52,536	64,206	11,567	128,309
2005	312,919	52,536	62,584	11,567	126,687
Total					879,858

*** 879,858 x Price contingency 10% = 967,844**

Table 4.3-17 Operation and Maintenance Cost (Balaceanca)

Year	Waste Quantity (m3/year)	Engineering Fee ($/year)	Fuel ($/year)	Electricity & etc. ($/year)	Total ($/year)
1999	247,023	34,188	49,405	4,196	87,789
2000	494,047	68,376	98,809	8,393	175,578
2001	494,047	68,376	98,809	8,393	175,578
2002	494,047	68,376	98,809	8,393	175,578
2003	494,047	68,376	98,809	8,393	175,578
2004	494,047	68,376	98,809	8,393	175,578
2005	529,781	68,376	105,956	8,393	182,725
2006	529,781	34,188	42,258	4,196	80,642
Total					1,229,046

*** 1,229,046 x Price Contingency 10% = 1,351,951**

Table 4.3-18 Operation and Maintenance Cost (Cretuleasca)

Year	Waste Quantity (m3/year)	Engineering Fee ($/year)	Fuel ($/year)	Electricity & etc. ($/year)	Total ($/year)
1999	85,713	23,088	17,143	4,169	44,400
2000	171,429	46,176	34,286	8,338	88,800
2001	171,429	46,176	34,286	8,338	88,800
2002	171,429	46,176	34,286	8,338	88,800
2003	171,429	46,176	34,286	8,338	88,800
2004	171,429	46,176	34,286	8,338	88,800
2005	171,429	46,176	34,286	8,338	88,800
2006	85,713	23,088	17,143	4,169	44,400
Total					621,600

***621,600 x Price Contingency 10 % = 683,760**

Table 4.3-19 Operation & Maintenance Cost (Total Cost)

Year	Waste Quantity (m3/year)	Glina ($)	Balaccanca ($)	Cretuleasca ($)	Total ($)
1996	718,777	215,723	0	0	215,723
1997	745,319	219,996	0	0	219,996
1998	785,157	226,410	0	0	226,410
1999	831,826	180,313	96,568	48,840	325,721
2000	883,339	118,444	193,136	97,680	409,260
2001	908,073	123,884	193,136	97,680	414,700
2002	933,499	129,479	193,136	97,680	420,295
2003	959,637	135,228	193,136	97,680	426,044
2004	986,506	141,140	193,136	97,680	431,956
2005	1,014,129	139,556	200,997	97,680	438,033
2006	1,042,524	0	88,706	48,840	137,546 (322,066)
2007	1,071,714	0	0	0	(462,980)
2008	1,101,723	0	0	0	(475,944)
2009	1,132,571	0	0	0	(489,271)
2010	1,164,283	0	0	0	(502,970)

Note :

1. 10 % price contingency added (from 1999)
2. ( ) is the cost of other sites

Table 4.3-20 Construction Cost of Other Sites (2005 - 2006)

Item	Direct Cost ($)	Include Overhead ($)	Include Contingency ($)	Include TVA ($)
Afumati	3,453,180	4,144,000	4,760,000	5,616,800
Berceni	2,227,408	2,670,000	3,070,000	3,662,600
Jilava	3,795,668	4,555,000	5,240,000	6,183,200
Total	9,476,256	11,369,000	13,070,000	**15,462,600**

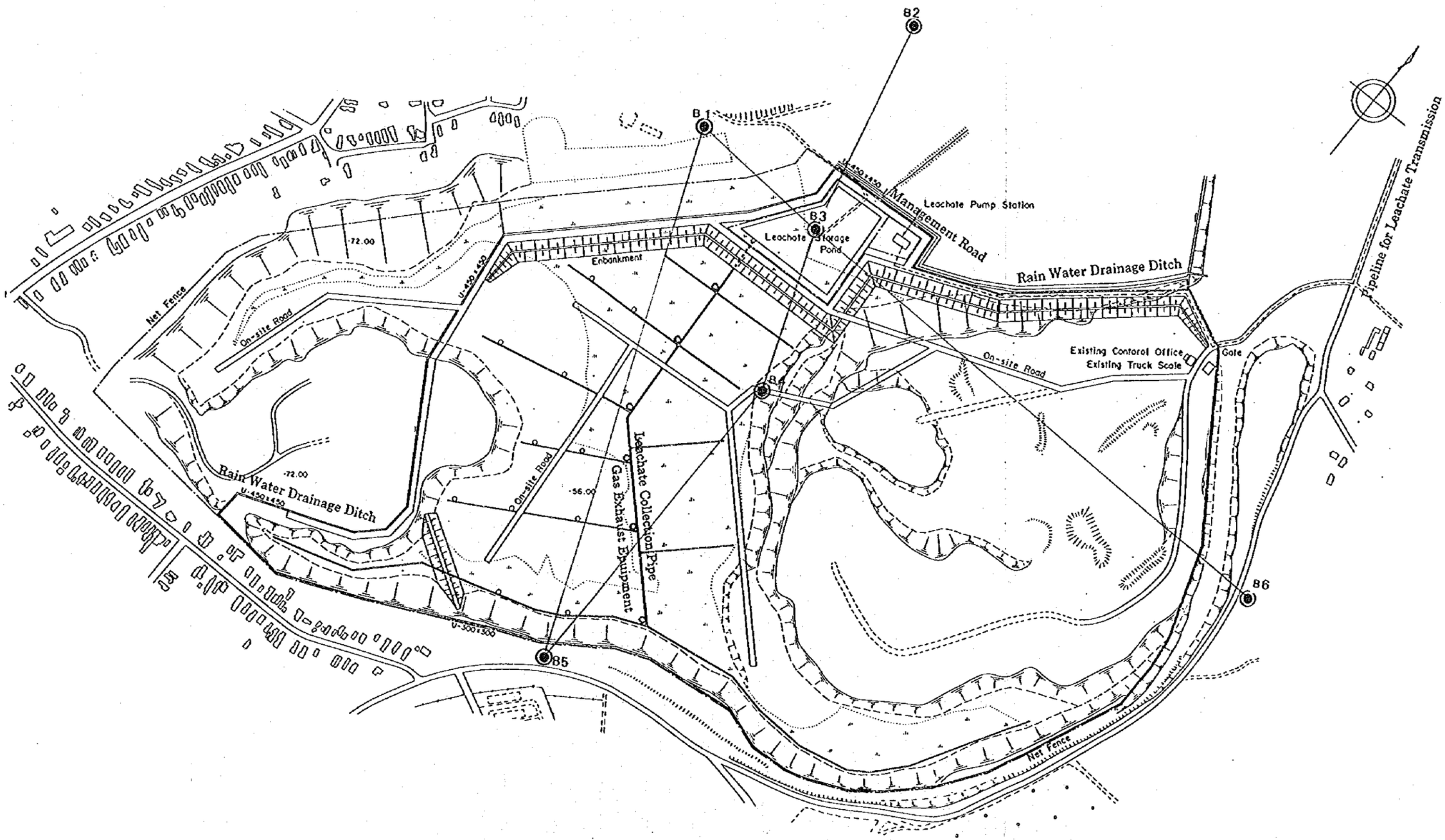
Note :

1. Overhead = About 20%, TVA = 18%, 5% Price & 10% Phisical Contingency.
2. Engineering Services needs 8 % of construction cost.

***15,462,600 x 8 % = 1,240,000 ($)**

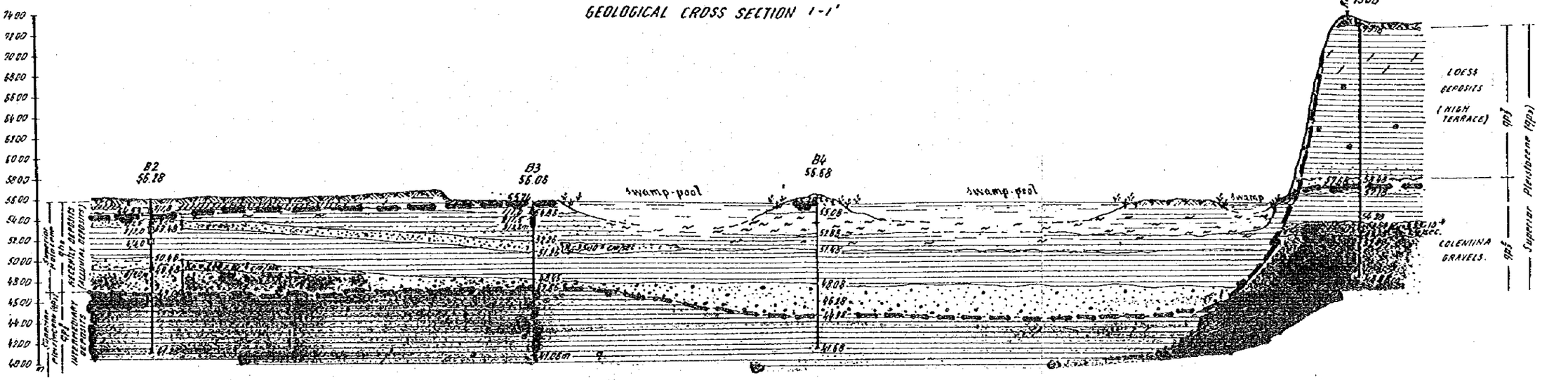
Attachment

Geological Maps

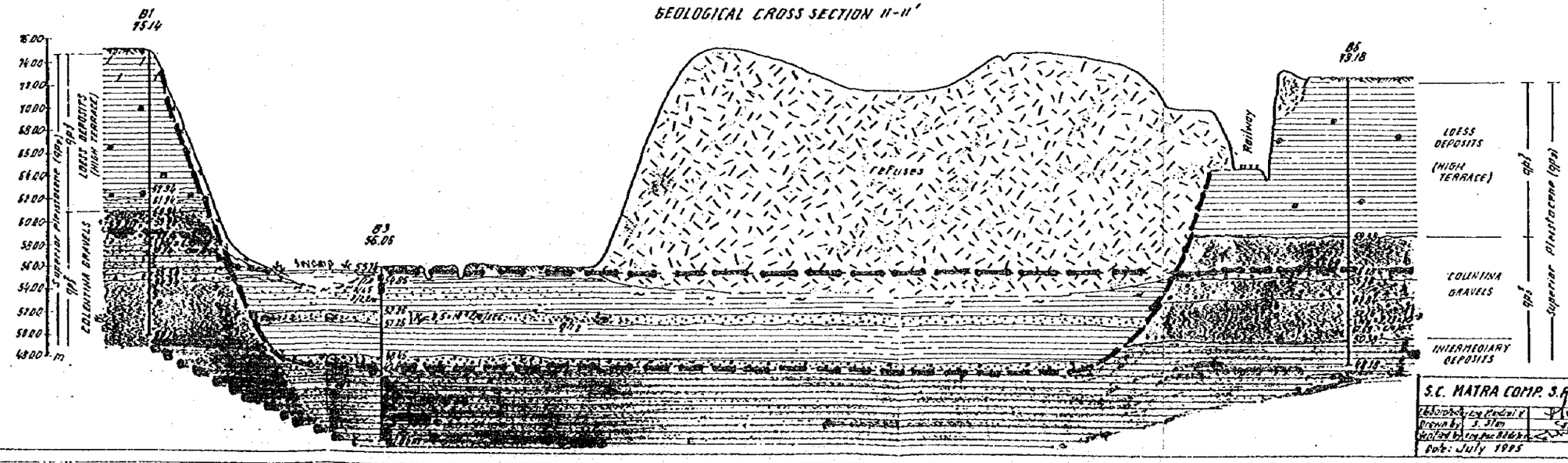


Location Map of Boring Points at Glina Site

GEOLOGICAL CROSS SECTION I-I'



GEOLOGICAL CROSS SECTION II-II'



S.C. MATRA COMP. S.R.L.

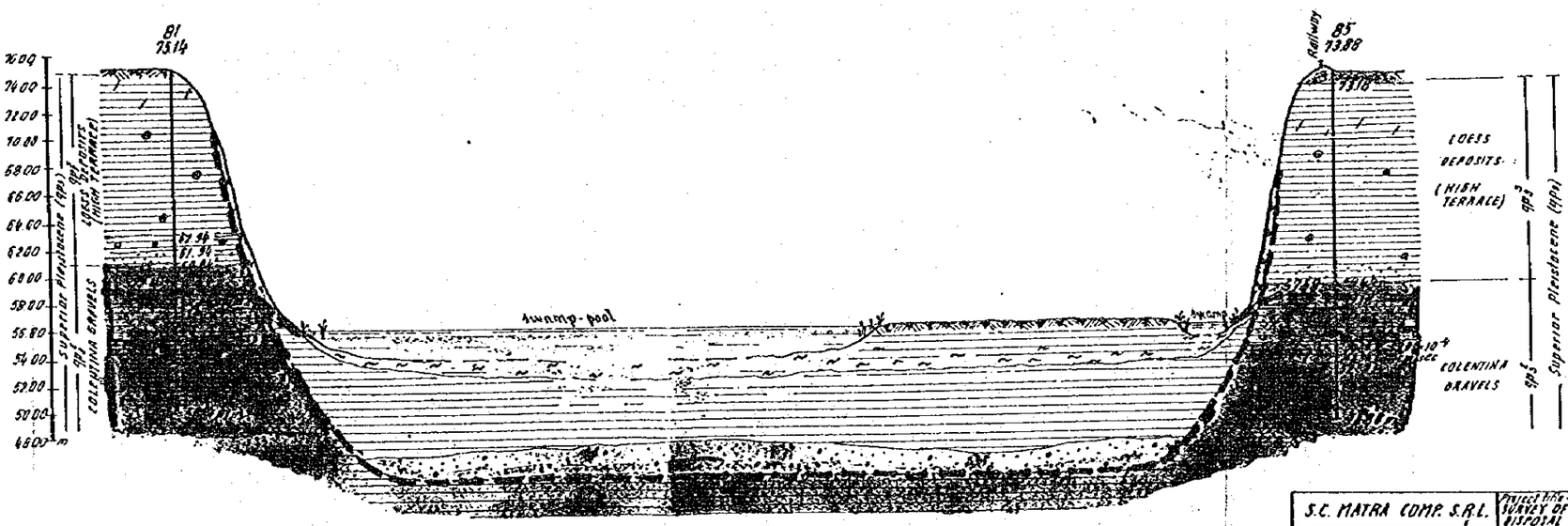
Drawn by: S. Stim

Date: July 1995

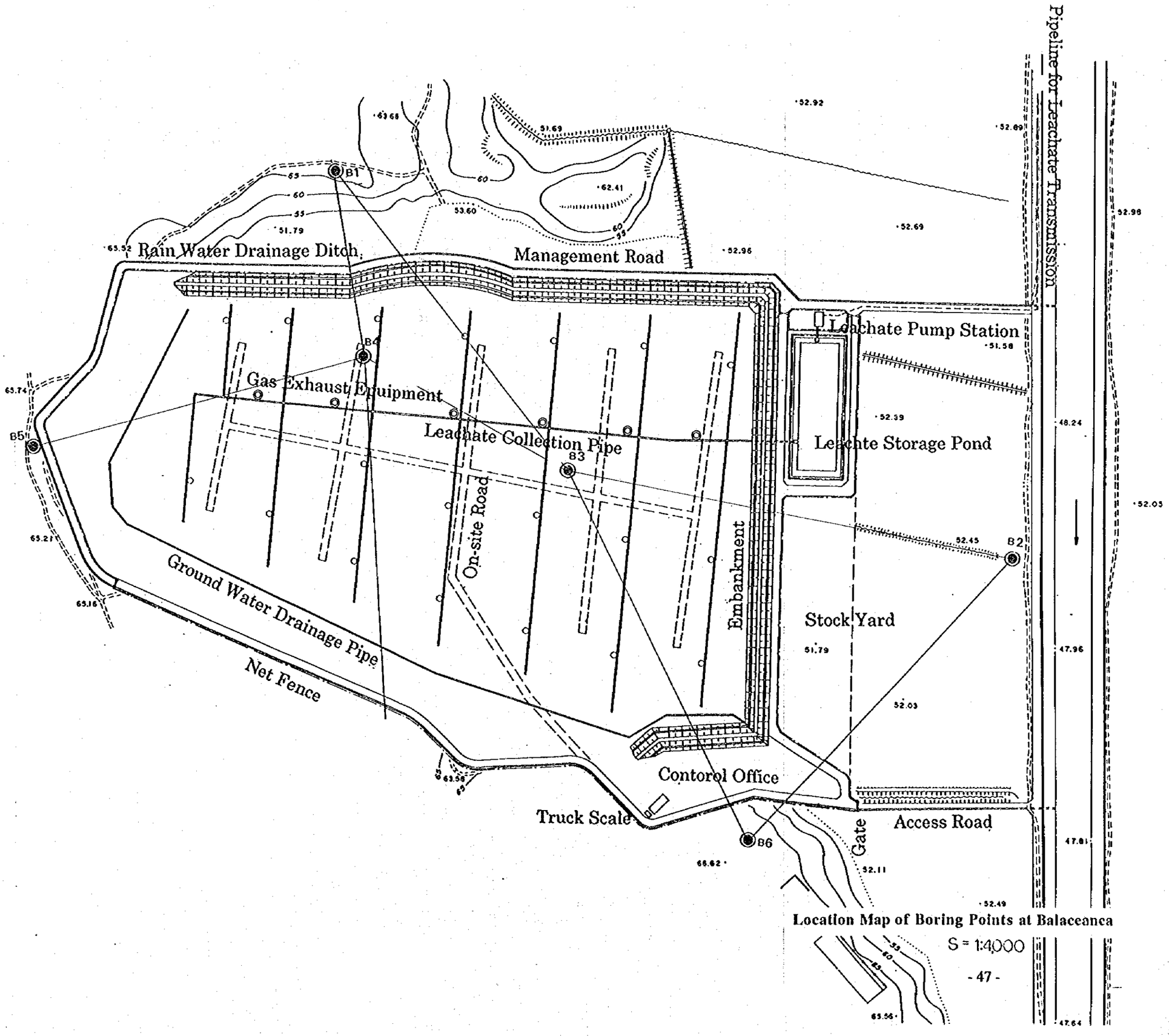
Project Title: GEOLOGICAL SURVEY OF GAINA - DEJESTI SITE

GEOLOGICAL CROSS SECTIONS I-I' II-II'

GEOLOGICAL CROSS SECTION III-III'



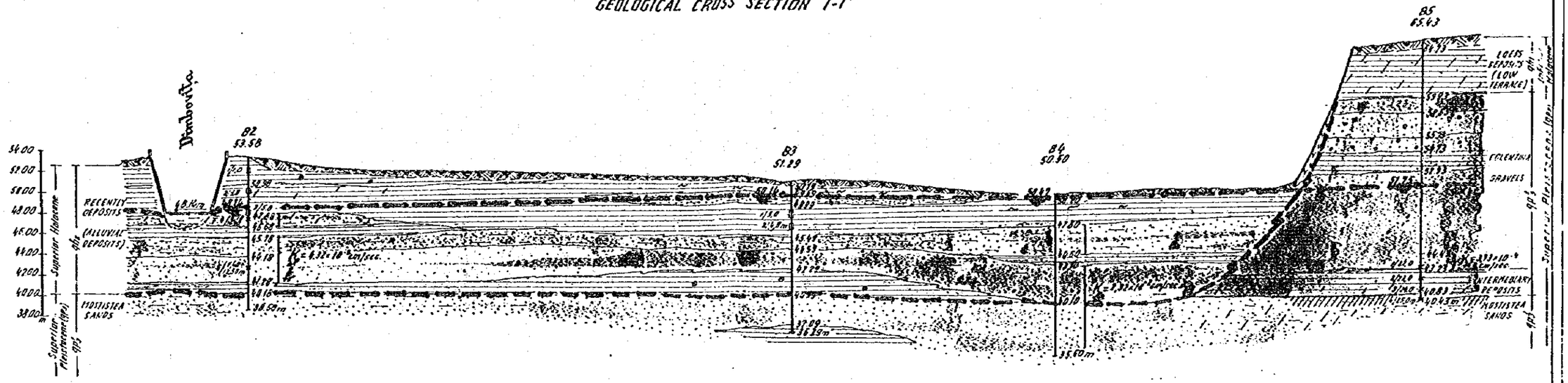
S.C. MATRA COMP. S.R.L.	Project title: GEOLOGICAL SURVEY OF BUNA DISPOSAL SITE.	
Elaborated by: Ing. Nicolae V.	GEOLOGICAL CROSS SECTIONS III-III'	Scale 1:200 / 1:200 — Pl. no. 6
Drawn by: C. Stoia		
Verified by: Ing. Dan Bălănescu		
Date: July 1995		



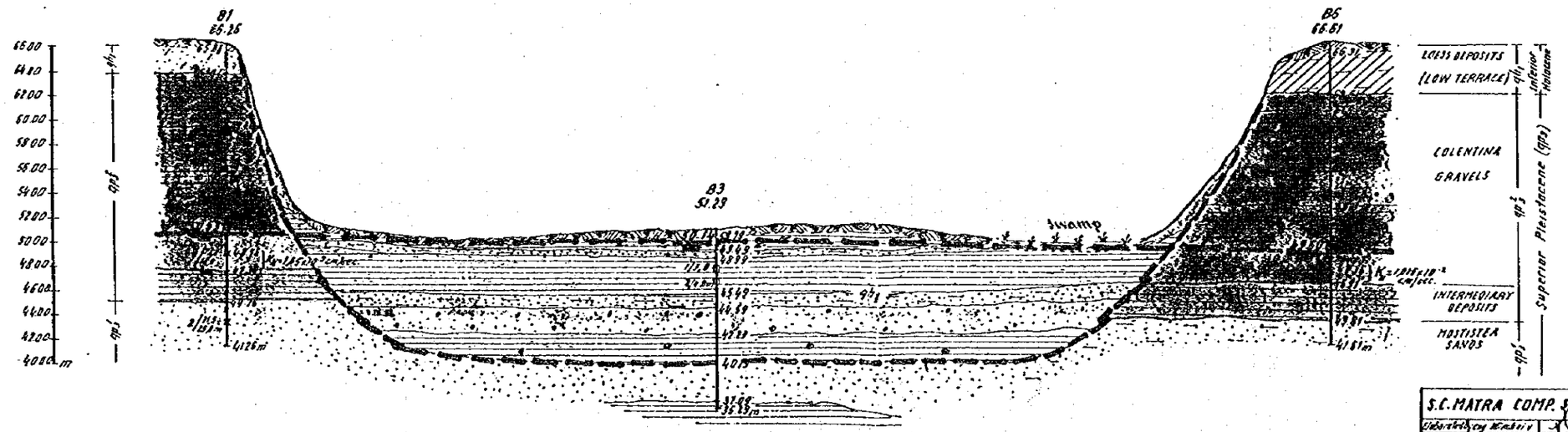
Location Map of Boring Points at Balaceanca

S = 1:4000

GEOLOGICAL CROSS SECTION I-I'

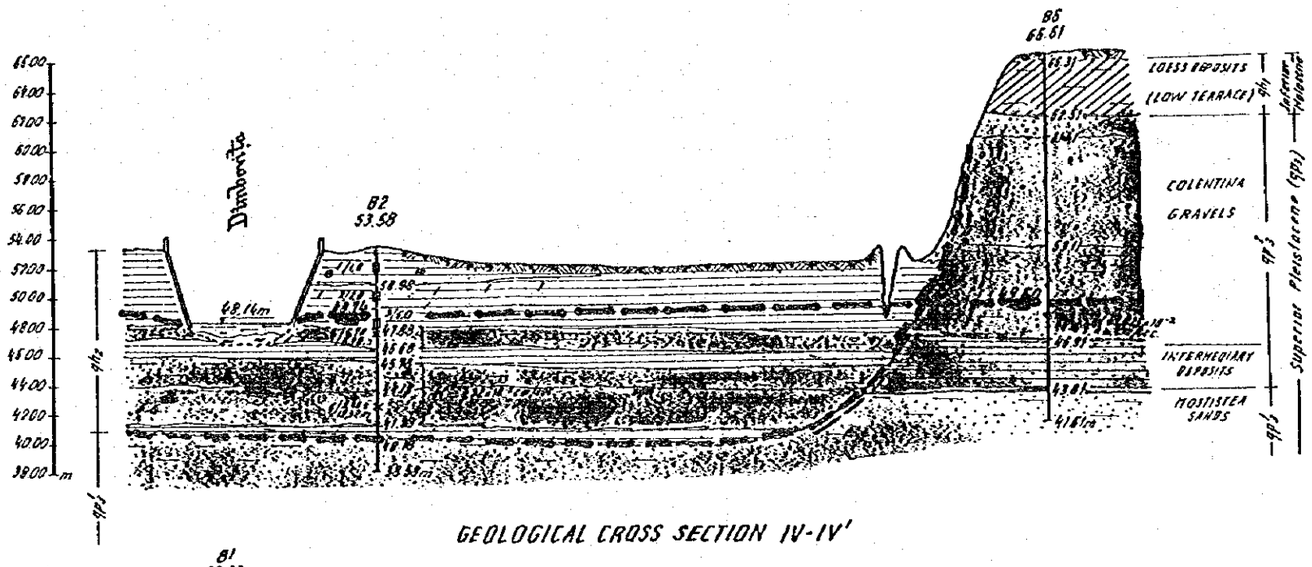


GEOLOGICAL CROSS SECTION II-II'

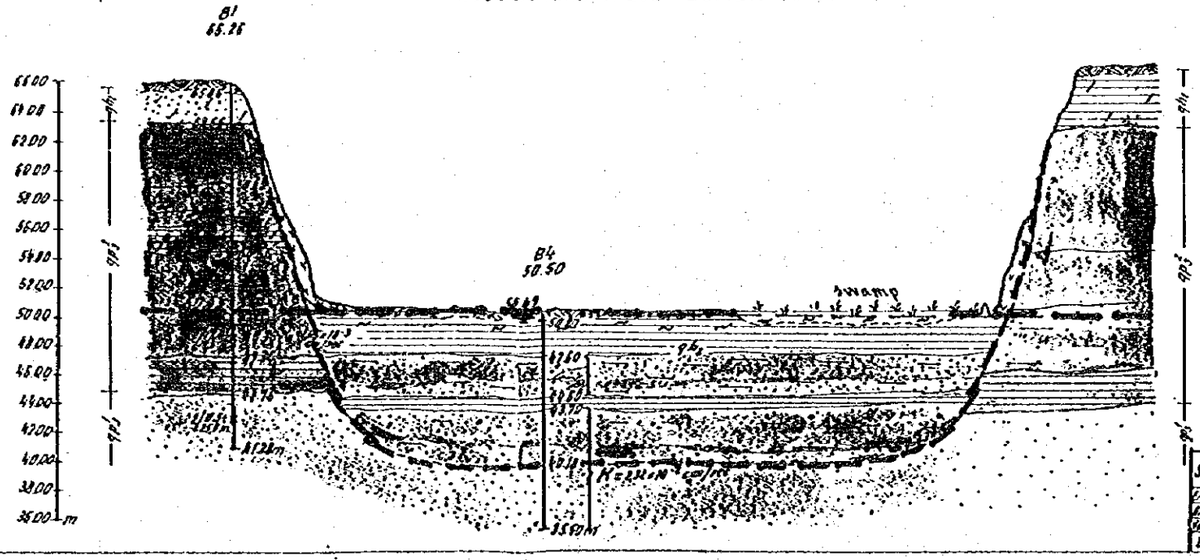


S.C. MATRA COMP. S.R.L.		Project title: GEOLOGICAL SURVEY OF GALACEANCA DISPOSAL SITE	
Elaborated by: Ing. M. Radu		GEOLOGICAL CROSS SECTIONS I-I' II-II'	Scale: 1:500 / 1:500 — Pl. no: 5
Drawn by: S. Ilies			
Verified by: Ing. Ion Baldea			
Date: July 1985			

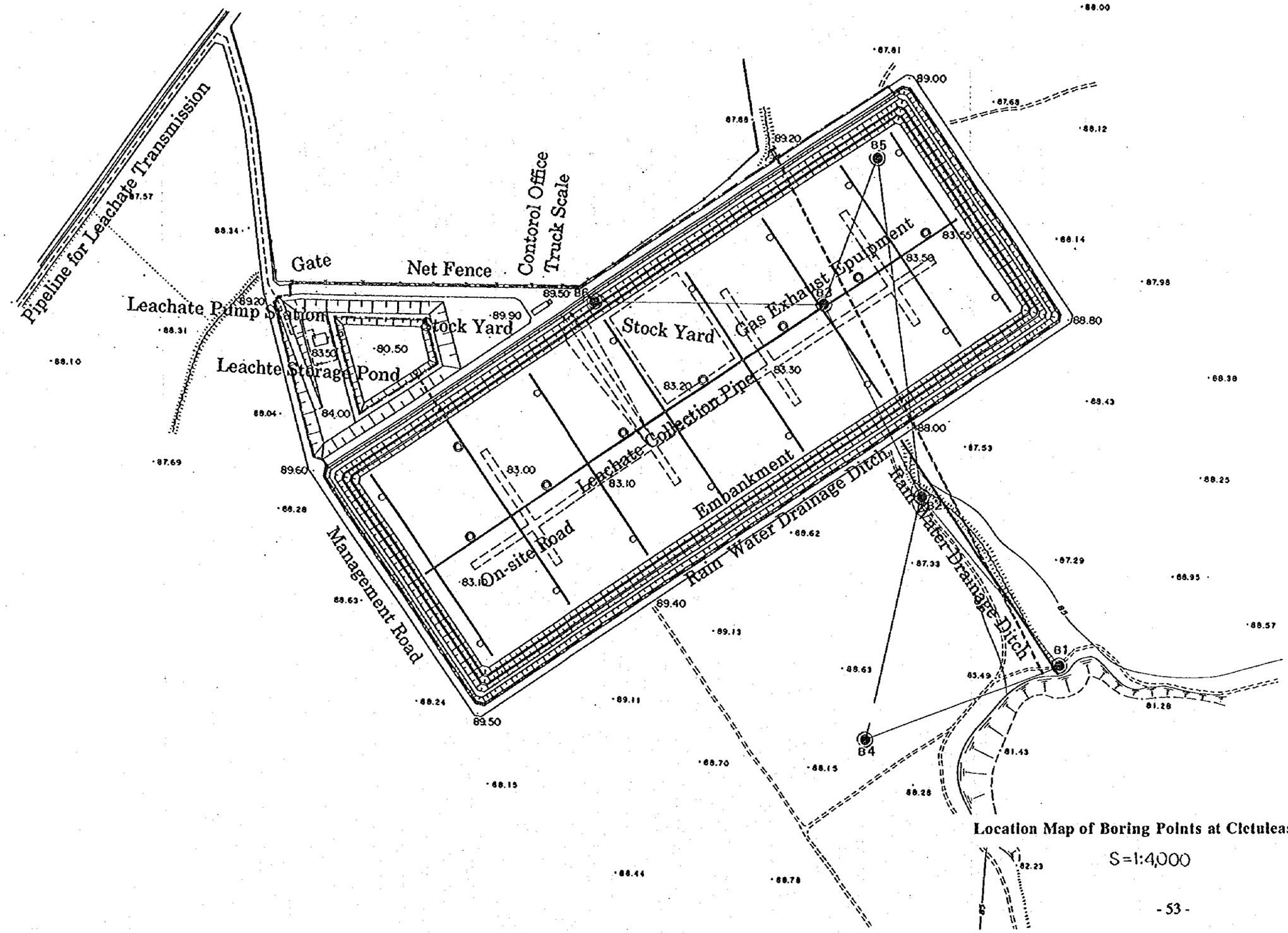
GEOLOGICAL CROSS SECTION III-III'



GEOLOGICAL CROSS SECTION IV-IV'

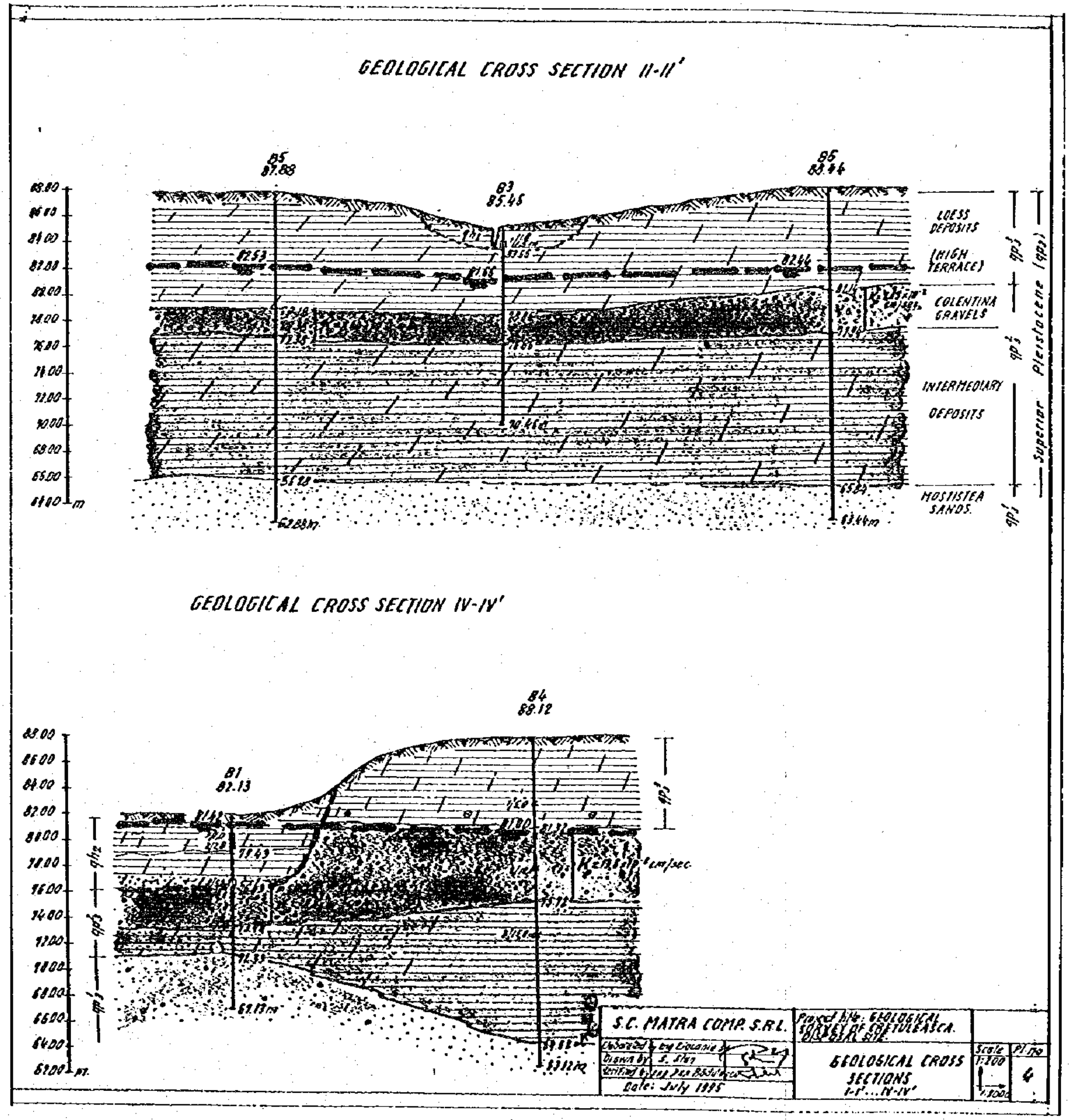


S.C. MATRA COMP. S.R.L.	Project Title: GEOLOGICAL SURVEY OF BALACEANCA. DISPOSAL SITE		
Elaborated by: ing. Ciocoiu V.	GEOLOGICAL CROSS SECTIONS III-III' IV-IV'	Scale: 1:100 / 1:1000	Pl. no. 6
Drawn by: S. Ilies			
Verified by: ing. Ion Radulescu			
Date: July 1995			

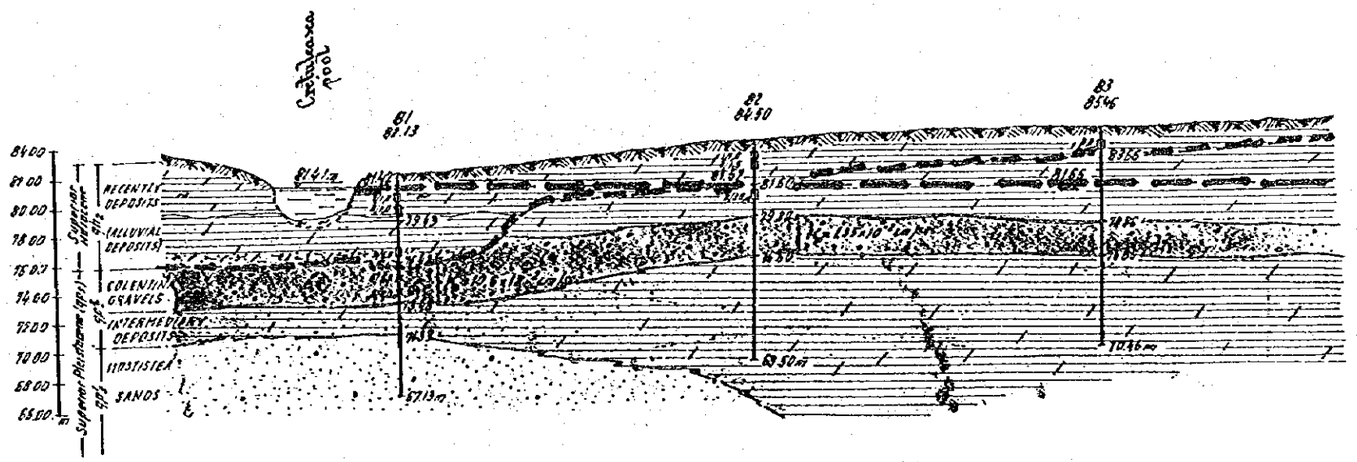


Location Map of Boring Points at Cletuleasca

S=1:4,000


GEOLOGICAL CROSS SECTION II-II'
B5
B3
85.46
LOESS DEPOSITS
(HIGH TERRACE)
COLENTINA GRAVELS
INTERMEDIARY DEPOSITS
MOSTISTEA SANDS
Superior Pleistocene
GEOLOGICAL CROSS SECTION IV-IV'
B4
88.12
B1
82.13
S.C. MATRA COMP. S.R.L.
Date: July 1995
GEOLOGICAL CROSS SECTIONS
Scale
1:100
4

GEOLOGICAL CROSS SECTION I-I'



GEOLOGICAL CROSS SECTION III-III'