APPENDIX 24

SOIL INVESTIGATION

APPENDIX 24 SOIL INVESTIGATION

This report is a digest of the Soil Investigation Report.

A24.1 Condition of Strata

The soil investigation was conducted at selected points along the proposed sewer pipeline and expected sewage treatment plant sites. Since the expected depth of pipe installation and excavation for foundation is shallow, an excavation depth of 3 m for test pits was found sufficient. Location of test pits are plotted in FIGURE A24-1 and boring logs of each test pit are shown in FIGUREs A24-2 and A24-3.

(1) Strata along the route for high elevation transmission line (100 m)

The route for the high elevation transmission line which aims to reach 100 m elevation line in San Bartolo is divided into 4 major sections, namely: Surco-San Juan, Villa El Salvador, Lurin River, and San Bartolo.

Surco-San Juan Section: This area is affected by flooding and erosion of Rimac River and Surco River. The topsoil is underlain by thin silty sand then gravelly soil strata. These soil formations are judged to be sedimentary sandy soil strata originated from rivers.

Villa El Salvador Section: This area represents the typical geological condition in Lima southern district. This condition, the so-called terraced deposit, was formed by several alternation of upheaval and submergence, and flooding and erosion by rivers. The top soil is underlain by sandy soil stratum. These soil formations are judged to be terraced sandy soil strata along coasts and rivers.

Lurin River Section: This area is strongly affected by flooding and erosion of Lurin River. The top soil is underlain by thin silty soil then gravelly soil strata. These soil formations are judged to be sedimentary sandy soil strata formed by rivers.

San Bartolo Section: This area represents a typical geological condition in Lima southern district. These strata was formed by wind erosion. Gravelly soil stratum exist under top soil. It is judged to be aeolian deposit sand dune.

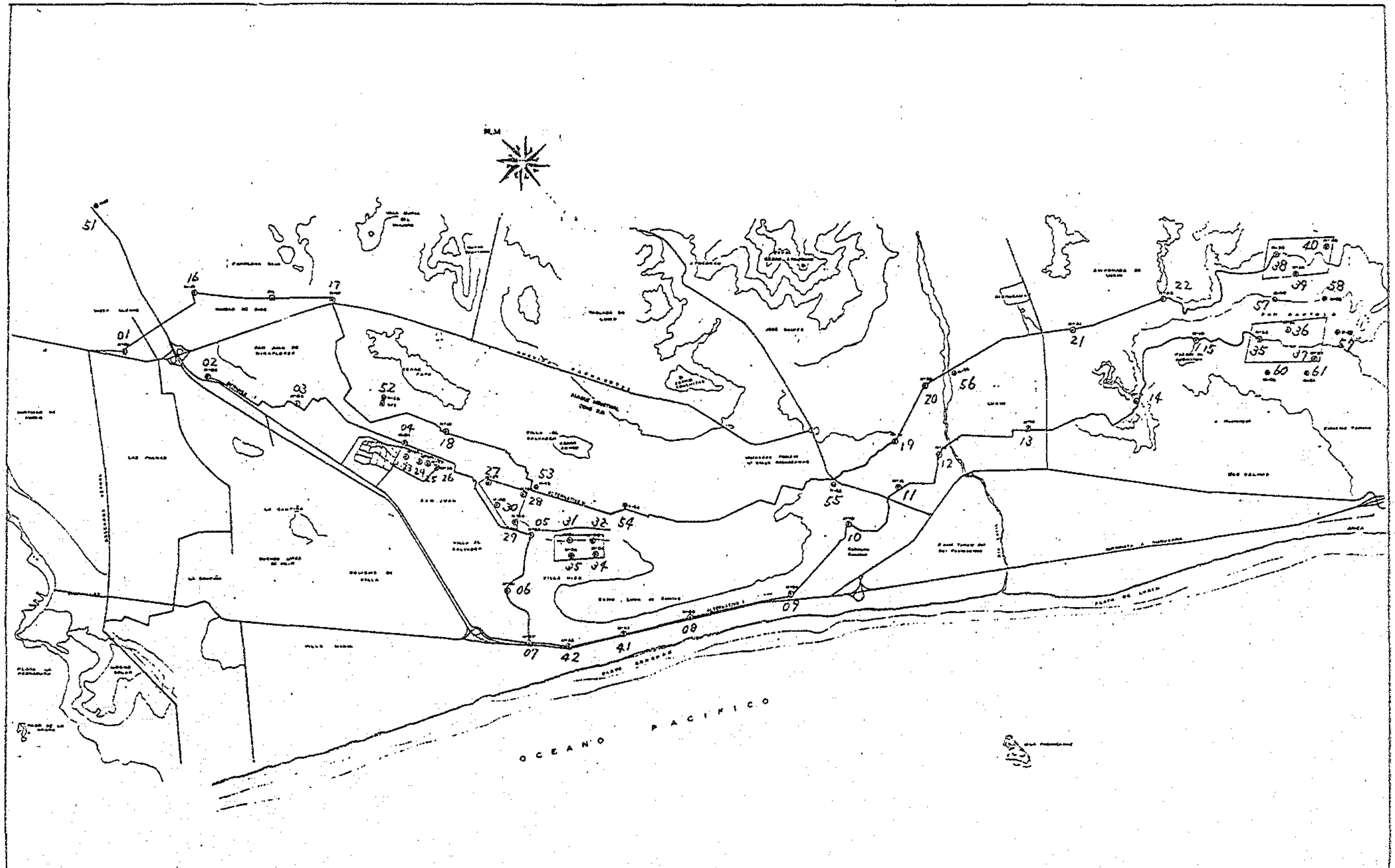
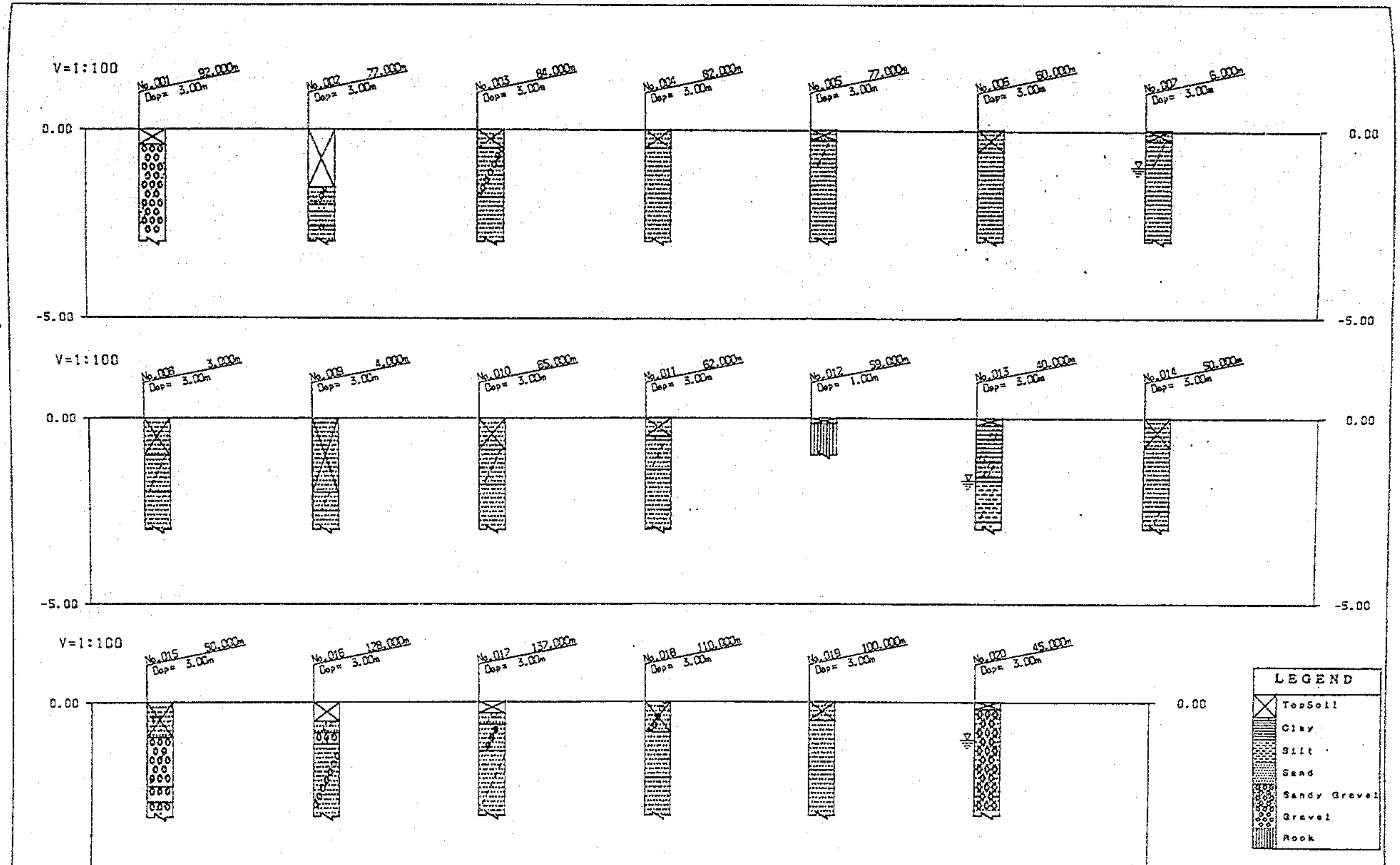
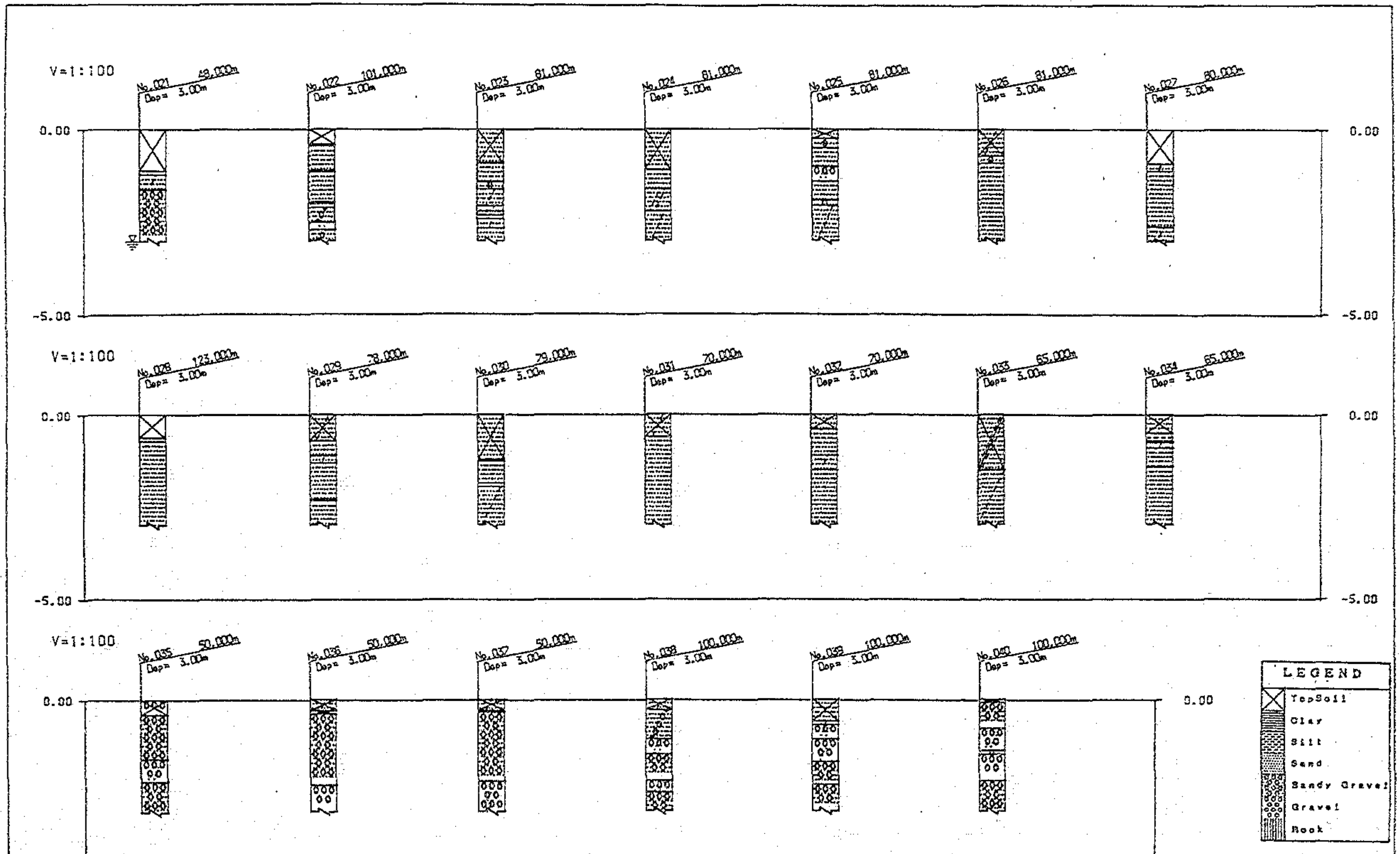


FIGURE A24-1 LOCATION OF TEST PITS



SOIL BORING LOG

FIGURE A24-2



SOIL BORING LOG

FIGURE A24-3

TABLE A24-1 STRATIGRAPHY (HIGH ELEVATION LINE)

	No.16	No.17	No.18	No.28	No.19	No.20	No.21	No.22	No.38	No.39	No.40
Topsoil	0.00 – 0.50	0.00 – 0.30	0.00 – 0.80	0.00 – 0.60	0.00 – 0.50	0.00 – 0.20	0.00 – 1.10	0.00 – 0.40	0.00 – 0.30	0.00 – 0.60	0.00 – 0.10
Fine sand with silt	0.50 – 0.80	0.30 – 0.60					0.10 – 1.60	0.40 – 0.45			
Fine sand			0.80 – 3.00	0.60 – 3.00	0.50 – 3.00			0.45 – 2.10			
Fine sand with gravel	0.80 – 3.00	0.60 – 3.00						2.10 – 3.00	0.30 – 3.00	0.60 – 3.00	0.10 – 3.00
Gravel						0.20 – 3.00	1.60 – 3.00				
Rock											
Area	Surco	San Juan	Villa El Salvador	Villa El Salvador	Villa El Salvador	Lurin	Lurin	San Bartolo	San Bartolo STP	San Bartolo STP	San Bartolo STP

(2) Strata along the route for low elevation transmission line (50m)

The route for low elevation transmission line which aims to reach 50 m elevation line in San Bartolo is also divided into 4 major sections, namely: Surco-San Juan, Villa El Salvador, Lurin River, and San Bartolo.

Surco-San Juan Section: Sedimentary sandy soil strata formed by Rimac River and Surco River.

Villa El Salvador Section: The geological condition in the area consists of terraced sandy soil strata along coasts and rivers. In the area adjacent to the coast, sandy soil with silt stratum with particles of salt and broken pieces of shell exist. This layer appears to be affected by sea water. Under this layer, soil condition is same as that of route for high elevation line.

Lurin River Section: Sandy soil stratum formed by river prevails in the area. Bed rock is exposed near Pachacamac Ruins.

San Bartolo Section: Aeolian deposit sand dune.

TABLE A24-2 STRATIGRAPHY (LOW ELEVATION LINE)

	No.1	No.2	No.3	No.4	No.6	No.23	No.24	No.25	No.26	No.7	No.8
Top soil	0.00 | 0.40	0.00 | 1.55	0.00 | 0.50	0.00 | 0.50	0.00 | 0.60	0.00 | 0.90	0.00 | 1.10	0.00 | 1.00	0.00 | 0.70	0.00 | 0.30	0.00 | 1.00
Fine sand with silt	0.40 | 0.50		0.50 | 0.60			0.90 | 2.20	0.10 | 1.60	1.00 | 1.90	0.70 | 1.60	0.30 | 1.00	1.00 | 2.00
Fine sand				0.50 | 3.00	0.60 | 3.00	2.20 | 3.00	1.60 | 3.00	1.90 | 3.00	1.60 | 3.00	1.00 | 3.00	2.00 | 3.00
Fine sand with gravel	0.50 | 3.00	1.55 | 3.00	0.60 | 3.00								
Gravel											
Rock											
Area	Surco	San Juan	San Juan	Villa El Salvador	Villa El Salvador	San Juan STP	San Juan STP	San Juan STP	San Juan STP	Coast of Conchan	Coast of Conchan

	No.9	No.10	No.11	No.12	No.13	No.14	No.15	No.35	No.36	No.37
Top soil	0.00 | 2.00	0.00 | 0.85	0.00 | 0.50	0.00 | 0.15	0.00 | 0.60	0.00 | 0.80	0.00 | 0.90	0.00 | 0.40	0.00 | 0.40	0.00 | 0.35
Fine sand with silt	2.00 | 2.50	0.85 | 1.80	0.50 | 1.40		0.20 | 2.80	0.80 | 3.00				
Fine sand	2.50 | 3.00	1.80 | 3.00	1.40 | 3.00							
Fine sand with gravel										
Gravel					2.80 | 3.00		0.90 | 3.00	0.40 | 3.00	0.40 | 3.00	0.35 | 3.00
Rock				0.15 | 1.00						
Area	Coast of Conchan	Coast of Conchan	Coast of Conchan	Lurin	Lurin	Lurin	San Bartolo	San Bartolo STP	San Bartolo STP	San Bartolo STP

A24.2 Coefficient of Permeability

Coefficient of permeability was calculated based on the results of grain size analysis. However, for the sample taken at the proposed site for STP in San Juan, the permeability test on undisturbed sample was performed in a laboratory to avoid adverse effects on the existing San Juan STP.

Many methods are suggested for the estimation of coefficient of permeability from grain size analysis result. In the Study, the average of values obtained by the following two methods is adopted.

a) Hazen's formula

$$K = C \cdot D_{10}^2$$

where: K : coefficient of permeability (cm/s)

C : constant (100-150), adopted 150

D_{10}: 10 % grain size, effective grain size

b) D_{20} and permeability by Creager

Creager reported the relation between 20 % grain size (D_{20}) of grading curve and coefficient of permeability of soil as shown in TABLE A24-3.

TABLE A24-3 D_{20} and Coefficient of Permeability by Creager

D_{20} (mm)	K (cm/s)	Soil Classification	D_{20} (mm)	K (cm/s)	Soil Classification
0.005	3.00×10^{-6}	Clay	0.18	6.85×10^{-3}	
0.01	3.00×10^{-5}		0.20	8.90×10^{-3}	Fine sand
0.02	4.00×10^{-6}		0.25	1.40×10^{-2}	
0.03	8.50×10^{-5}	Fine silt	0.30	2.20×10^{-2}	
0.04	1.75×10^{-4}		0.35	3.20×10^{-2}	
0.05	2.80×10^{-4}		0.40	4.50×10^{-2}	Middle sand
0.06	4.60×10^{-4}		0.45	5.80×10^{-2}	
0.07	6.50×10^{-4}		0.50	7.80×10^{-2}	
0.08	9.00×10^{-4}	Silt	0.60	1.10×10^{-1}	
0.09	1.40×10^{-3}		0.70	1.60×10^{-1}	
0.10	1.75×10^{-3}		0.80	2.15×10^{-1}	Coarse sand
0.12	2.60×10^{-3}		0.90	2.80×10^{-1}	
0.14	3.80×10^{-3}	Fine sand	1.00	3.60×10^{-1}	
0.16	5.10×10^{-3}		2.00	1.80	Fine gravel

The above relation is expressed by the following formula:

$$K = 0.359\ D_{20}^{2.327}$$

where: D_{20} : 20 % grain size (mm)

The coefficient of permeabilities obtained through the above two methods and laboratory test are summarized in TABLEs A24-4 and A24-5.

TABLE A24-4 Coefficient of Permeability (High Elevation Line)

Area	Soil Classification	Depth (m)	Coefficient of Permeability (average) (cm/s)
Surco-San Juan	Fine sand with gravel	1.50 - 2.00	6.9×10^{-3}
Villa El Salvador	Fine sand	1.40 - 2.50	1.0×10^{-2}
Lurin River	Gravel	2.00 - 2.30	7.6×10^{0}
San Bartolo	Fine sand	1.95	1.1×10^{-3}
	Fine sand with gravel	2.60 - 2.85	1.2×10^{-2}
San Bartolo STP	Fine sand with gravel	1.30 - 2.60	1.8×10^{-1}

TABLE A24-5 Coefficient of Permeability (Low Elevation Line)

Area	Soil Classification	Depth (m)	Coefficient of Permeability (average) (cm/s)
Surco-San Juan	Fine sand with silt	0.45	9.7×10^{-1}
	Fine sand with gravel	1.00 - 3.00	2.5×10^{-2}
Villa El Salvador	Fine sand with silt	0.65	9.4×10^{-3}
	Fine sand	0.80 - 2.30	1.1×10^{-2}
Along	Fine sand with silt	1.00 - 2.25	2.0×10^{-2}
Coast	Fine sand	2.00	7.8×10^{-3}
Lurin River	Fine sand with silt	1.65 - 2.25	7.9×10^{-3}
San Bartolo	Gravel	1.55	2.5×10^{-1}
San Juan STP	Fine sand with silt	1.50	1.3×10^{-3} (max. in labo. test)
	Fine sand	1.70 - 2.50	7.9×10^{-3}
San Bartolo STP	Fine sand with gravel	1.35 - 2.60	1.4×10^{0}

A24.3 Mechanical Properties

Direct shear tests on undisturbed samples taken from several places were conducted in order to determine the mechanical properties of the different soil formations encountered.

The results are presented in TABLE A24-6.

TABLE A24-6 Mechanical Properties

Area	Test Pit	Soil Classification	Depth (m)	Internal Friction Angle (degree)	Cohesion (kg/cm^2)
Surco-San Juan	No.17	Fine sand with gravel	2.20	30.9	0.00
Lurin	No.13	Fine sand with silt	1.70	15.9	0.31
San Juan STP	No.25	Fine sand with silt	1.65	30.1	0.09
Villa El Salvador	No.30	Fine sand	2.50	44.3	0.04
Coast	No.34	Fine sand soil	2.00	30.9	0.00

Compaction test on samples taken at proposed site for San Juan STP was conducted for expecting earth works. The results are as follows:

TABLE A24-7 Compaction Test

Sample No.	Soil Classification	Depth (m)	Natural Moisture Content	Maximum dry density d max	Optimum Moisture Content	d max x 95%	Moisture Content at d max x 95%
No.1	Fine sand with silt	1.00	1 - 3 %	1.75 t/m^3	12 %	1.663 t/m^3	9 - 16 %
No.2	Fine sand with silt	1.00	1 - 3 %	1.76	11 %	1.672	8 - 14 %
No.3	Fine sand with silt	1.00	1 - 3 %	1.76	12 %	1.682	9 - 15 %

Based on the results of test, maximum dry density of fine sand with silt at San Juan STP is:

$$d\ max = 1.75 \sim 1.77\ t/m^3$$

and optimum water content is 11 ~ 12 %

At the time of construction, soil density is desirable to be managed within 95 % of maximum dry density. The water content at that time is also presented in TABLE A24-7.

A24.4 Chemical Properties

The soil at the coastal area of Villa El Salvador contains salt particles. Chemical test on soil was performed for several samples as shown in TABLE A24-8.

TABLE A24-8 Results of Chemical Test

Test Pit	Depth (m)	Soil Classification	pH	Electric Conductivity μ mhos/cm	Cl- ppm	SO_4^- ppm	Concentration of Soluble Salinity ppm	CO_3 Ca %	Gypsum %
C-7	1.10	Fine sand	7.6	3.15	868.8	547.5	2,208		
C-9	2.00 - 2.50	Fine sand with silt	7.8	1.33	443.3	297.8	1,006		
C-30	0.50	Top soil	7.4	4.32	709.2	1,742.0	3,210		
C-32	0.30	Top soil	7.3	29.88	13,120.2	2,761.2	27,940	1.66	67.08

Chemical test on groundwater was also conducted for samples at point No. 7 as shown in TABLE A24-9.

TABLE A24-9 Groundwater Chemical Test

Test Pit	Depth (m)	pH 25°C	Cl- (mg/l)	SO_4^- (mg/l)
P-7	1.00	7.79	3,800	3,210

Based on the results of chemical test, concentrations of chloride ion and sulfate ion are high in both the groundwater and the soil in some places.

The design of the structure shall be, therefore, be developed in consideration of these facts.

A24.5 Electrical Properties

In San Juan area, a leakage accident occurred near an electric sub-station. An investigation on the presence of stray current conducted near the place where the accident occurred, yielded the following results.

<u>Result of Investigation</u>

The measurement points were:

<u>Point 1</u> : High tension transformer station
Point 1A: At a distance of 20 m from the station
Point 1B: At a distance of 15 m from the station
Point 1C: At a distance of 1 km from the station

<u>Point 2</u> : High tension lines
Point 2A: At 30 m from two high tension pylons
Point 2B: Zone where then is no current source
Point 2C: At 1 km from point 2B

<u>Potential Gradients</u>

Potential results and its stabilization are shown in TABLE A24-10.

TABLE A24-10 POTENTIAL GRADIENT MEASUREMENTS

MEASUREMENT POINT	POTENTIAL ROUND THE CIRCUMFERENCE (mV/m)			
	0°	90°	180°	270°
1A	6.3	15.2	1.5	4.8
1B	11.6	1.3	-5.0	2.2
1C	3.5	4.6	14.5	17.5
2A	11.5	20.0	26.5	13.0
2B	8.5	4.4	4.5	13.5
2C	-4.5	10.5	0.2	6.3

Measurements using metal samples

Current intensity results as measured after two hours from the sample installation, from points with and without a probable source of stray current are shown in TABLE A24-11.

TABLE A24-11 *Current Intensity Measurements*

Measurement Point	Current Intensity (μA)
1B (at high tension source)	0.02
2B	0.01

From potential gradient measurements (given in TABLE A24-10) and taking as reference point 2B which is considered as having no influence of erratic current sources, it was observed that values in the probable stray current points have an equal variation range. From this it can be concluded that there is no significant potential gradient which can prove the presence of stray current.

From the current intensity measurements (TABLE A24-11), it can be noticed that the detected levels cannot be considered because of a stray current source.

DC sources are the most dangerous in terms of metal structures corrosion. High tension AC systems produce not only the stray-current leakages but their prolongation.

In almost all erratic current cases, the damage is caused by DC current sources. On the other hand, scientific information have shown that the corrosion of some buried metal structures can be caused by AC sources at 50 Hz. In these cases, corrosion is less severe than that caused by DC sources. According to scientific reports damages caused by AC sources at 50 Hz is only around 1 % of that caused by DC sources.

In this investigation, presence of DC current was found but current is very small. Thus, it can be judged that there is no possibility of electric corrosion.

APPENDIX 25

STUDY ON STABILITY OF SLOPE IN S.T.P.

APPENDIX 25 STUDY ON STABILITY OF SLOPE IN S.T.P.

Ponds and Lagoons to be constructed for the S.T.P. will be enclosed by embankments. The study on stability of slopes of embankments is discussed in this section.

Sites proposed for the S.T.P. are as follows (refer to FIGURE A25-1):

a) Mechanization of the existing San Juan S.T.P.
b) San Juan
c) Villa El Salvador
d) Villa Rica
e) & f) San Bartolo
g) Cerro La Chira

Among the above proposed sites, three sites are not subject to further study due to the following reasons:

for a)	Facilities are existing
for d)	Site is hard to acquire
for g)	R.C. structure instead of earth embankment is expected because of introduction of high grade treatment process

Therefore, only sites b), c) and e) & f) are considered in the study.

(1) Soil Condition

The results of soil investigation at the sites through test pitting at four points per site are as follows (for details refer to APPENDIX 24):

a) San Juan (Inv. Pt. No.23, 24, 25, and 26. refer to FIGUREs A25-2 and A25-3)

- Classification : SP/SM
- Grain Size : #200 sieve, 10% passed
- Result of Direct Shearing Test :
  - Internal Friction Angle 30°
  - Cohesion 0.09kg/cm^2

b) Villa El Salvador (Inv. Pt. No.27, 28, 29, and 30. refer to FIGUREs A25-4 and A25-5)

- Classification : SP/SM
- Grain Size : #200 sieve, 5% passed
- Result of Direct Shearing Test :

  Internal Friction Angle 44.3°

  Cohesion 0.09kg/cm^2

Therefore, the soil condition at San Juan and Villa El Salvador is assumed for planning and designing as follows:

- Internal Friction Angle : 30°
- Cohesion : 0.05kg/cm^2
- Classification : SP/SM

c) San Bartolo (Inv. Pt. No. 35, 36, 37, 38, 39, 40, refer to FIGURE A25-6)

- Classification: SP-GP-GW
- Grain Size : #200 sieve, 0-2% passed
- Internal Friction Angle :

  Supposed to be 35-40°. No problem on sliding failure of planned section.
- Permeability : Supposed to be very high

(2) Planned Section of Embankment

Typical section of embankment is planned in consideration of the existing San Juan S.T.P., and shape and size of each site are as follows:

a) In case of stabilization Pond System (hereinafter referred to as Pond)

- Water Depth 1.5m (refer to FIGURE A25-7)

b) In case of Aerated Lagoon (hereinafter referred to as Lagoon)

- Water Depth 3.0m (refer to FIGURE A25-8)

In the plans for San Juan and Villa El Salvador, both cases are studied, and for San Bartolo, only case b) is studied.

(3) Embankment

a) Structure

- The portion below the planned water level is constructed by excavation and the 60cm high free board is constructed by banking. Surface of slope near the water level line is protected by a 1 m wide concrete lining.

- Lining will not be provided except for the bottom of reservoir and slope of embankment (refer to existing San Juan S.T.P.).

b) Stability

For the study on the stability of an embankment slope, calculation by the circular arc method was applied.

Assumed soil conditions are as follows:

Internal Friction Angle	: 30°
Cohesion	: 0.5 ton/m^2
Unit Weight	: 1.68 ton/m^3
Seismic Coefficient	: 0.1
Phreatic line	: assuming a seepage point at middle of planned water depth in lower pond. (safety side assumption)

c) Phreatic Line

- In case an earth dam condition is assumed.

  Since the seepage will reach the slope, slope protection is required.

- In case the seepage of free groundwater into the ground is expected.

  In case of San Juan and Villa El Salvador, ground water level is so deep that the seepage will not reach the surface of the embankment slope.

  In case of existing San Juan S.T.P., failure of slope had not occurred because of this reason.

- In this Project, seepage is not expected to reach the surface of the embankment slope.

d) The results of calculations are as follows (refer to FIGUREs A25-9 to A25-11):

Sewage Treatment Plant	Water Depth	Sliding Center (X)	(Y)	Circle Radius (R)	Safety Factor	Remarks
San Juan						FIG.A25-9
Pond	1.5m	3.0	9.0	10.0	1.84	
Aerated Lagoon	3.0m	3.0	12.0	13.29	1.77	
Villa El Salvador						
Pond	1.5m					FIG.A25-10
A-A		3.0	12.0	12.8	1.53	
B-B		3.0	9.0	9.5	1.76	
Aerated Lagoon	3.0m					FIG.A25-11
A-A		3.0	15.0	15.37	1.46	
B-B		3.0	12.0	12.57	1.62	

e) Conclusion

- In any case, the safety factor exceeds 1.4. Therefore, the embankment is safe even in case of an earthquake.

- All of the embankments were assumed to be constructed by excavation.

- In case the embankment is constructed by banking, soil compaction work shall be done carefully with close attention given to grain size, water content, etc.

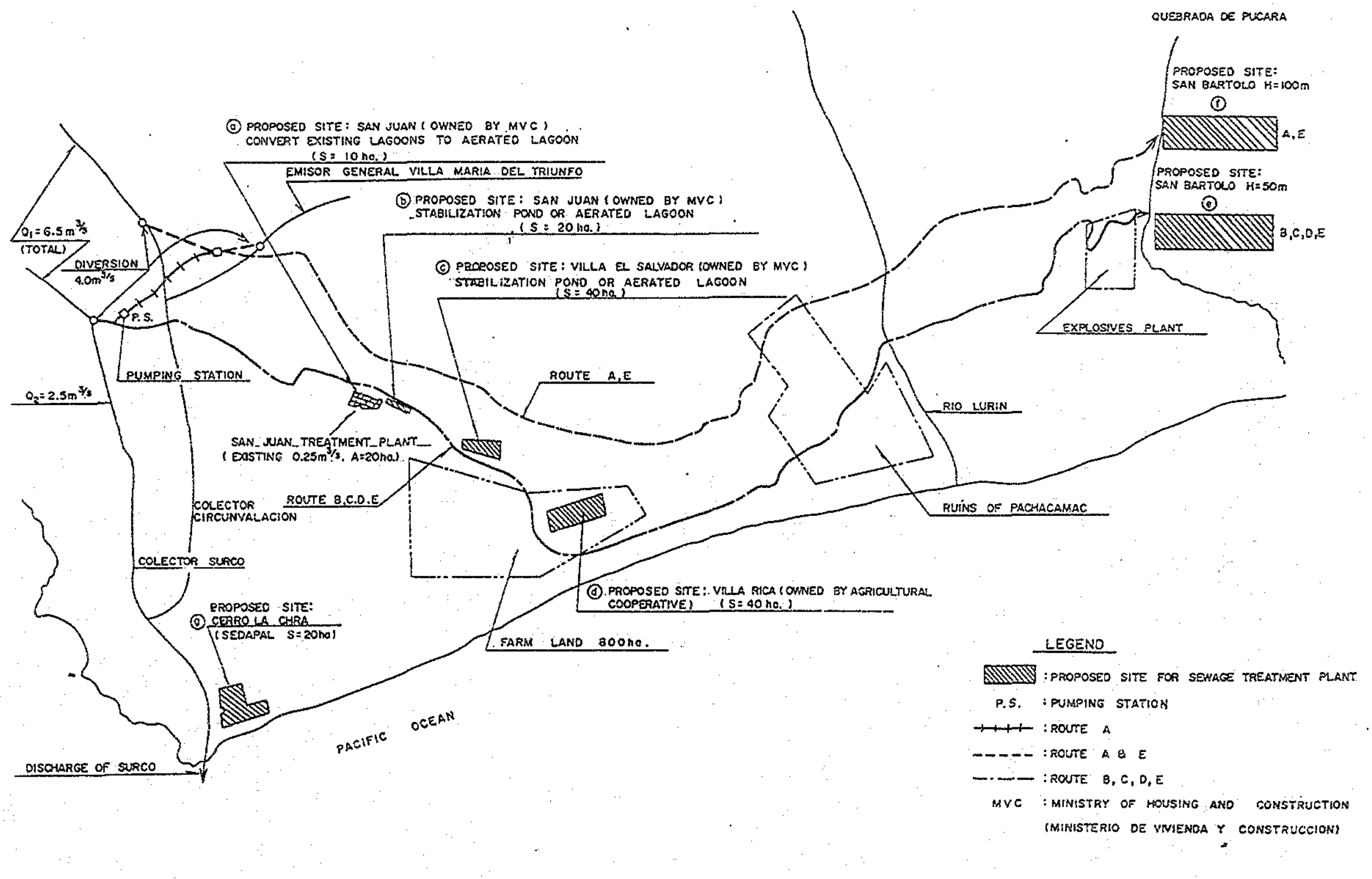


FIGURE A25-1 LOCATION OF PROPOSED SITE FOR SEWAGE TREATMENT PLANT.

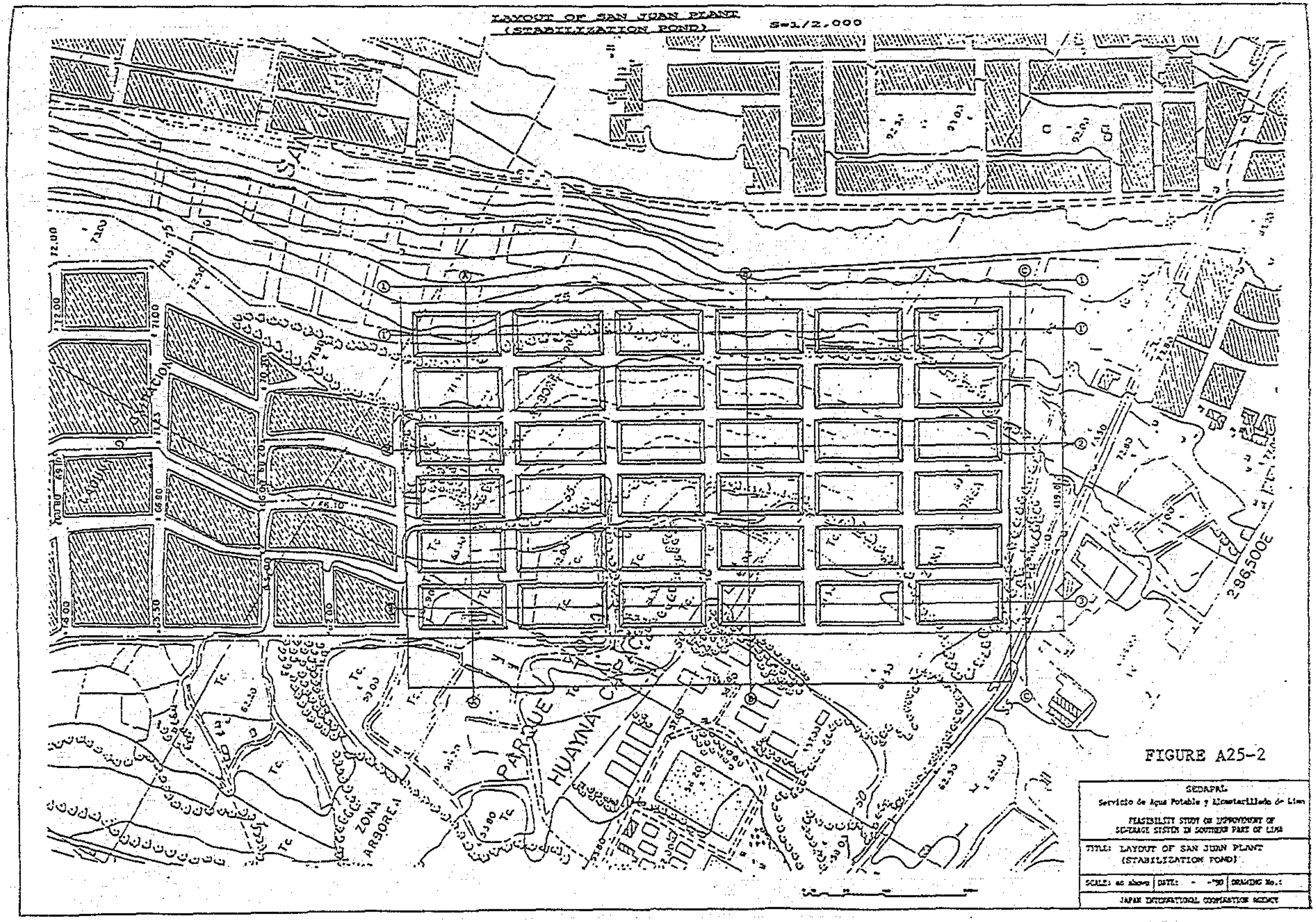
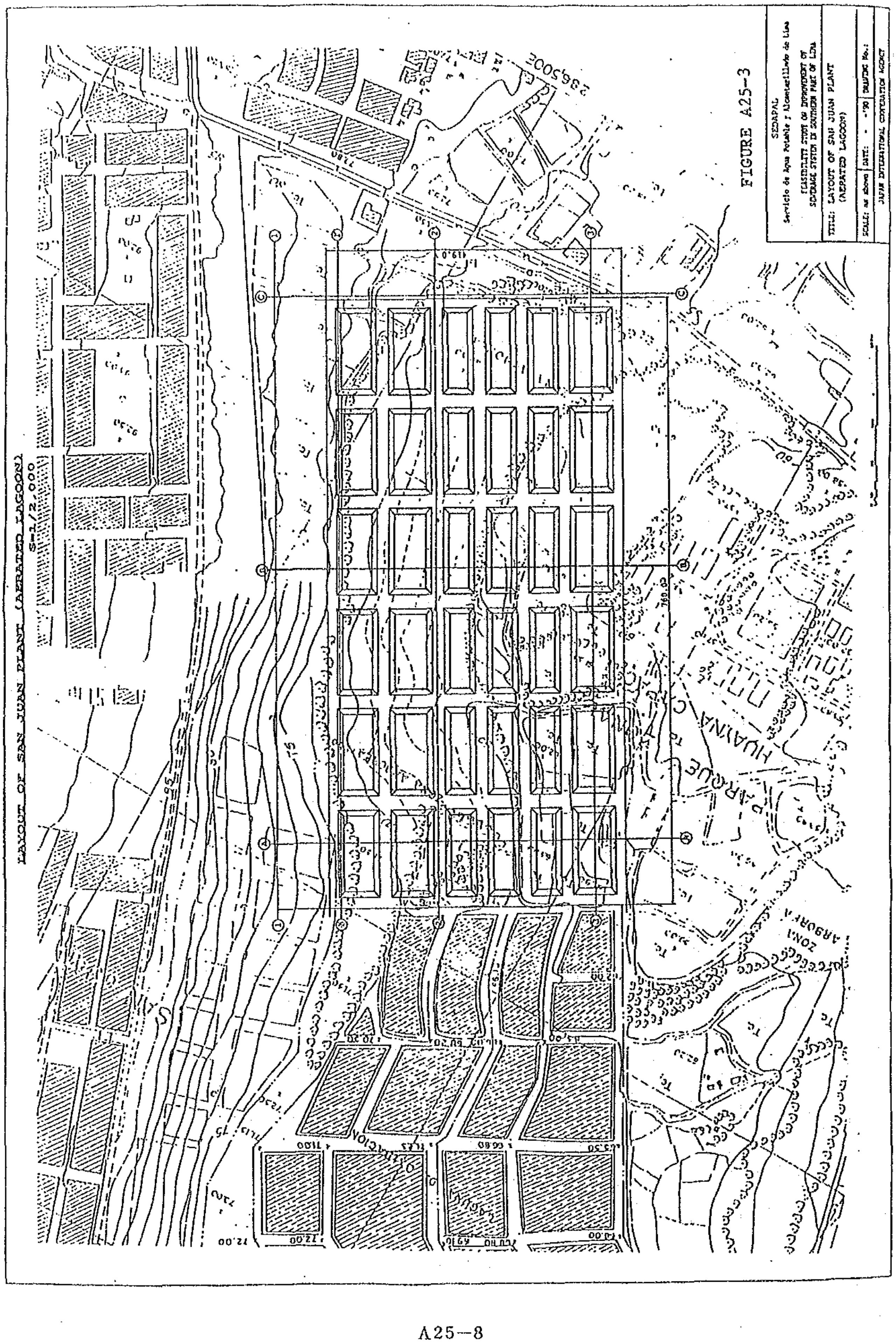
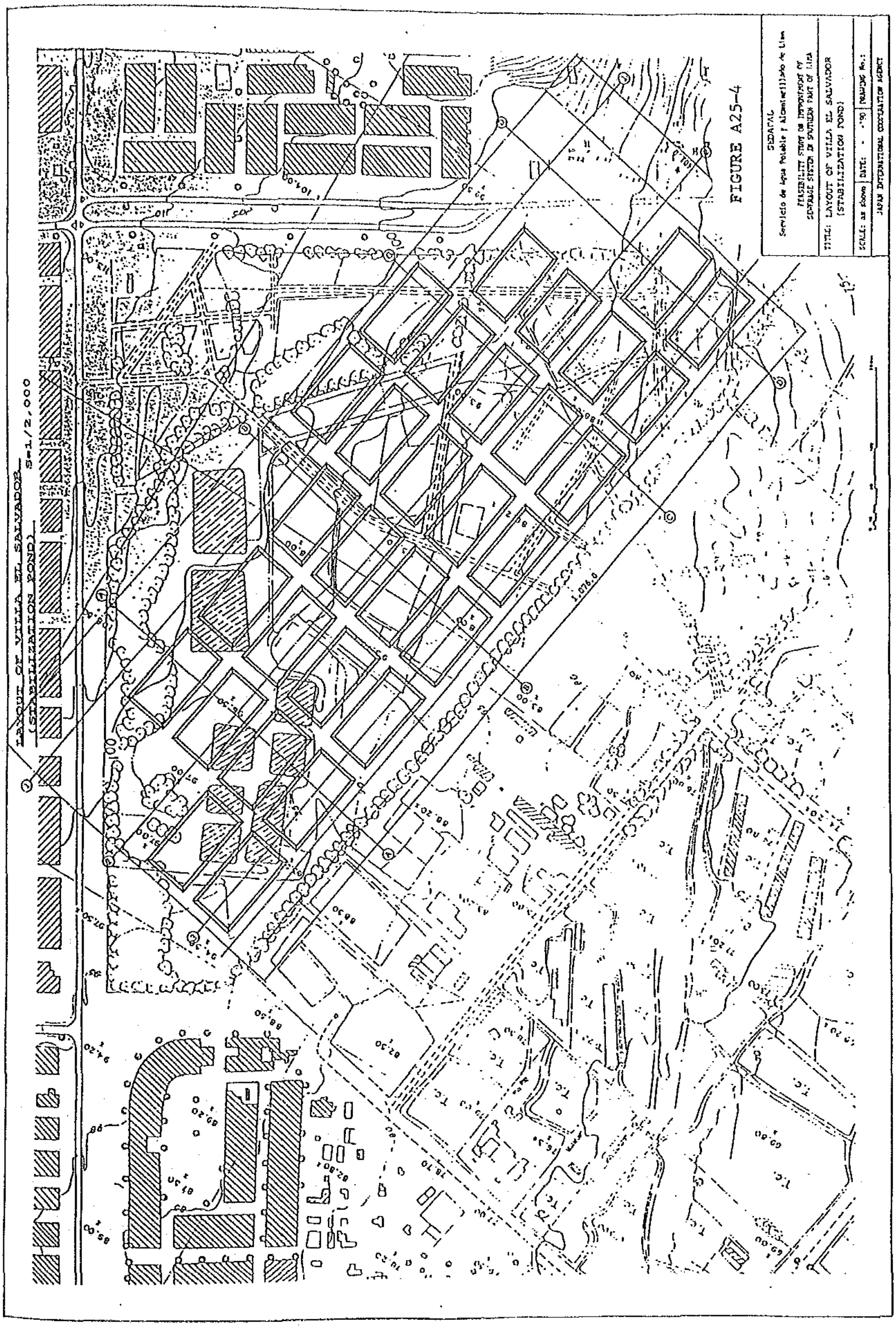

LAYOUT OF SAN JUAN PLANT
(STABILIZATION POND)
S=1/2,000
PARQUE
HUAYNA CAPAC
ZONA
ARBOREA
296,500E
SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF
SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: LAYOUT OF SAN JUAN PLANT
(STABILIZATION POND)
SCALE: as above
DATE: - -'90
DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE A25-2


LAYOUT OF SAN JUAN PLANT (AERATED LAGOON)
S=1/2,000
FIGURE A25-3
SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: LAYOUT OF SAN JUAN PLANT (AERATED LAGOON)
SCALE: as above
DATE: - -'90
DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY
PARQUE HUAYNA CAPAC
ZONA ARBORIA
286500E


LAYOUT OF VILLA EL SALVADOR
(STABILIZATION POND)
S=1/2,000
FIGURE A25-4
SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF
SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: LAYOUT OF VILLA EL SALVADOR
(STABILIZATION POND)
SCALE: as shown
DATE: . '90
DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY

LAYOUT OF VILLA EL SALVADOR
(AERATED LAGOON) S=1/2,000

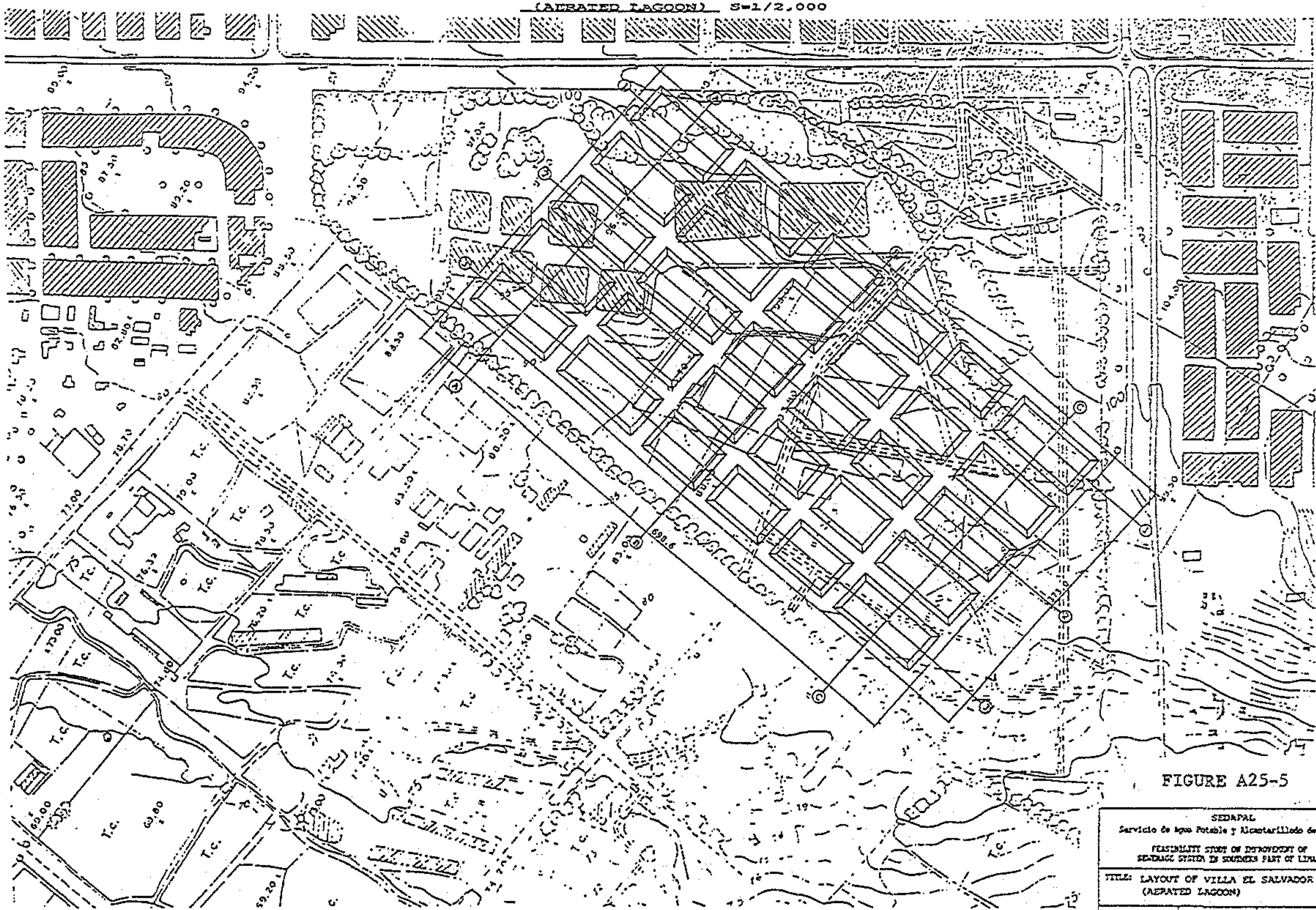


FIGURE A25-5

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: LAYOUT OF VILLA EL SALVADOR (AERATED LAGOON)
SCALE: as above | DATE: '90 | DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY

PLAN OF SEWAGE TREATMENT PLANT IN SAN BALTOLO

1) Arrangement of One System for Sewage Treatment Plant

One system will be composed by 18 stabilization pond and the dimension of each pond is as follows :

W : 110m

L : 110m

D : 1.5m

2) Capacity of Treatment for One System

Capacity Q is as follows :

Water surface area = 110m × 110m × 18 = 21.8ha

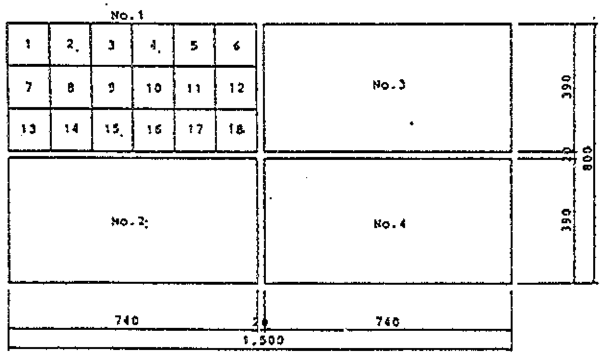
$$Q = \frac{21.8}{88.95} \times 1.0m^3/s \fallingdotseq 0.25\ m^3/s \text{ per system}$$

3) Plan of Arrangement in the Case of Capacity of $1.0m^3/sec$

Number of sysytem is as follows :

$1.0m^3/s \div 0.25\ m^3/s = 4$(system)

Arrangement of system is shown as below.

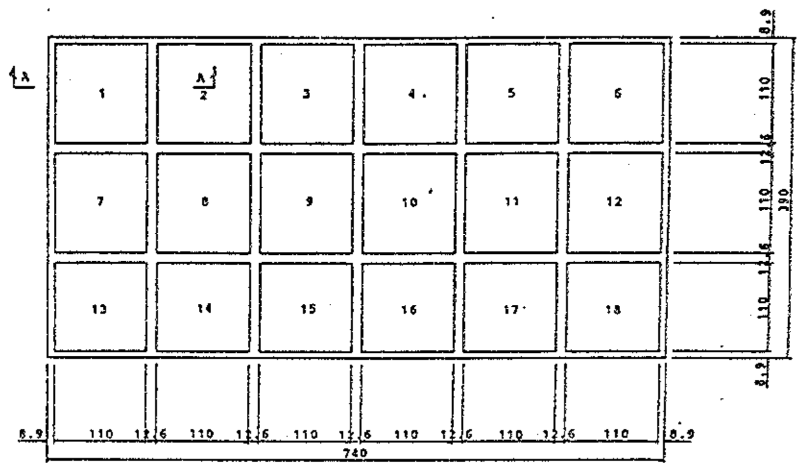


4) Number of System for Plan A and Plan B

Number of system for each plan is shown as Table below.

PLAN	PHASE I		PHASE II		Remarks
	Planed Volume of Sewage	Number of System	Planed Volume of Sewage	Number of System	
A_1 B_1	3.5 m^3/s	14	0 m^3/s	0	
A_2 B_2	1.5	6	2.0	8	
A_3 B_3	0.5	2	3.0	12	

Plan of Stabilization Pond



Section A - A

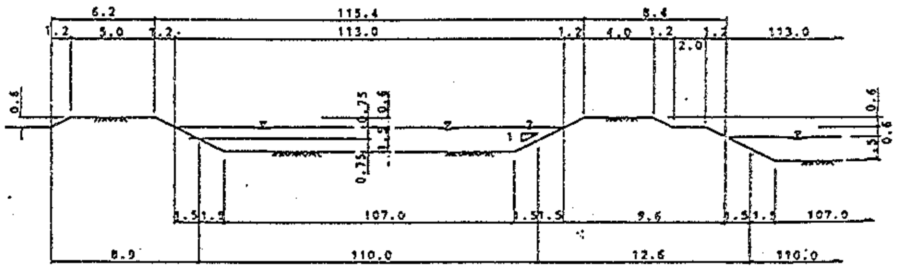


FIGURE A25-6

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

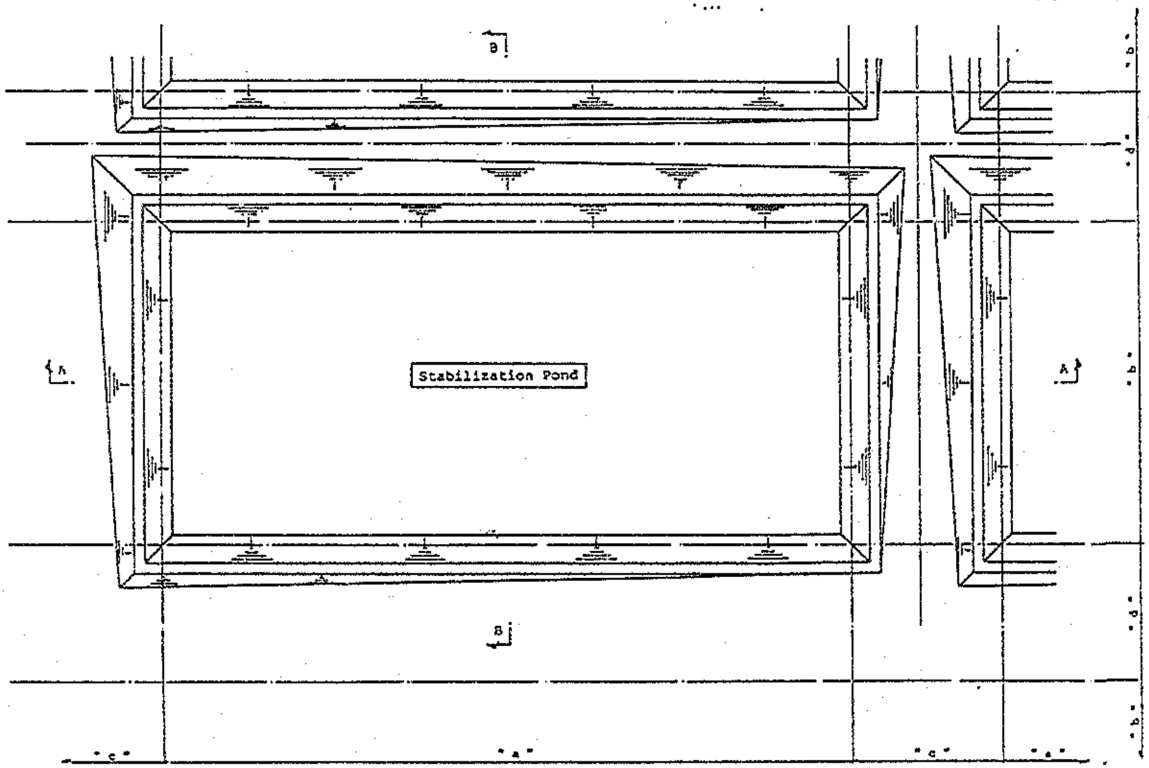
TITLE: PLAN OF SEWAGE TREATMENT PLANT IN SAN BALTOLO

SCALE: as shown | DATE: - -'90 | DRAWING No.:

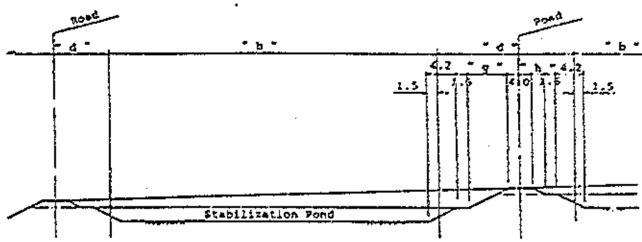
JAPAN INTERNATIONAL COOPERATION AGENCY

TYPICAL SECTION OF STABILIZATION POND

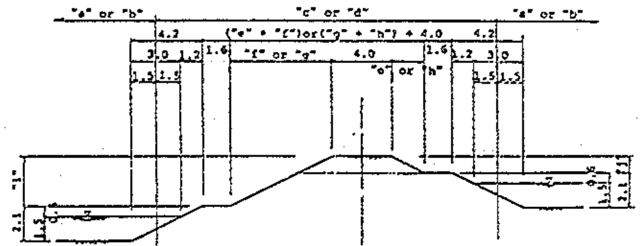
S=1/500, S=1/200



Plan

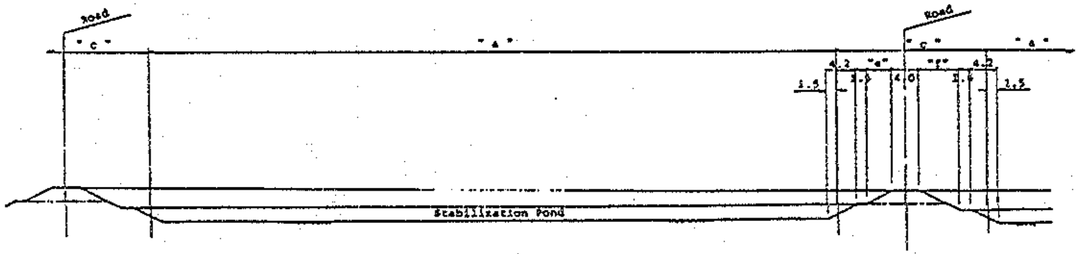


Section B-B



Dimention of Basin

	San Juan	El Salvedor	Remarks
"a"	100.0	109.0	
"b"	48.0	54.0	
"c"	27.6	27.6	
"d"	20.6	27.6	
"e"	4.0	4.0	
"f"	6.0	8.0	
"g"	6.0	8.0	
"h"	2.0	4.0	
"i"	3.0	4.0	
"j"	"e"=2.0,"h"=1.0	2.0	



Section A-A

FIGURE A25-7

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

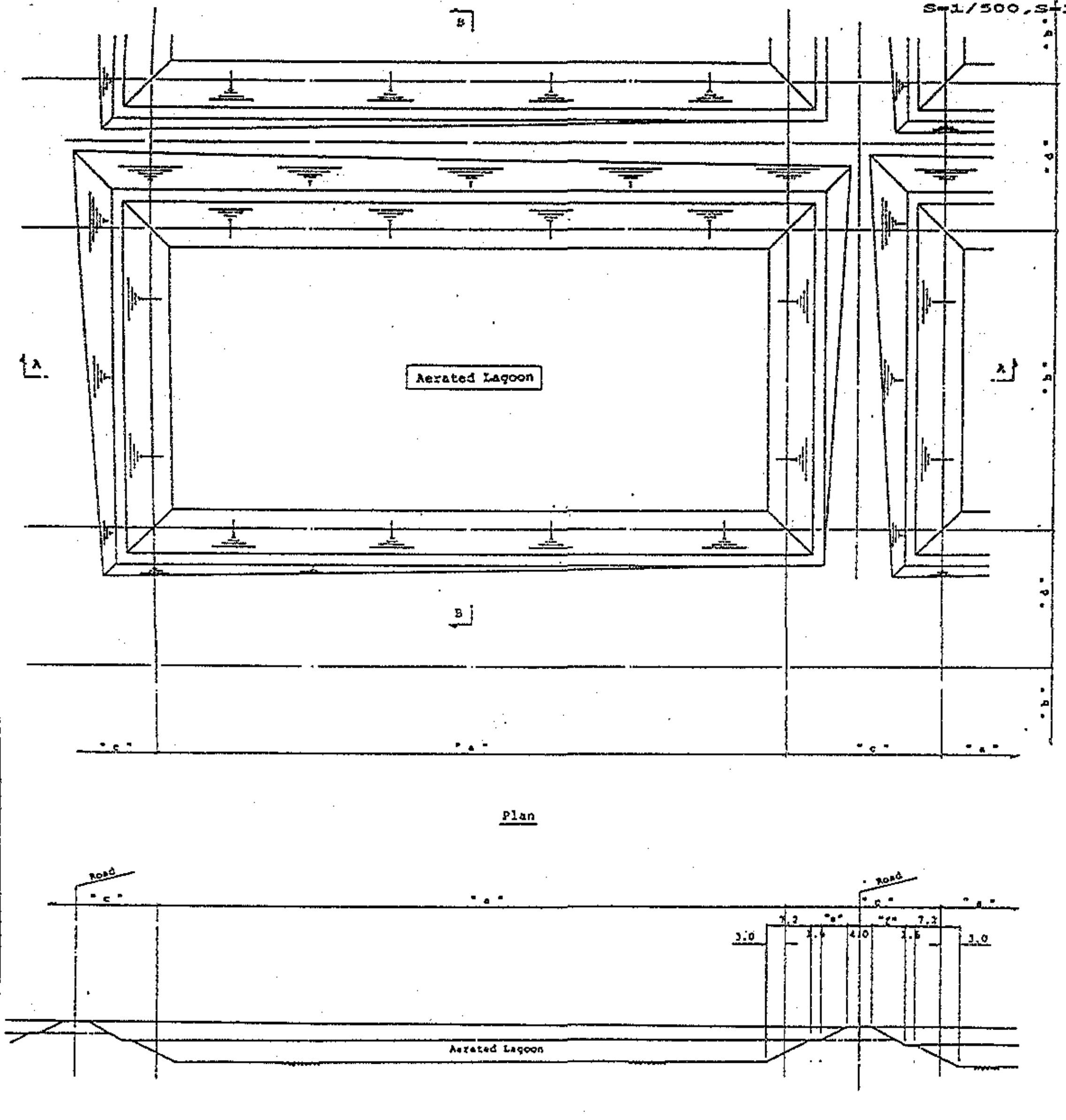
TITLE: TYPICAL SECTION OF STABILIZATION POND

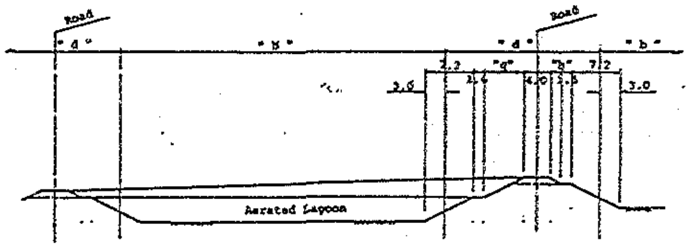
SCALE: as shown | DATE: - -'90 | DRAWING No.:

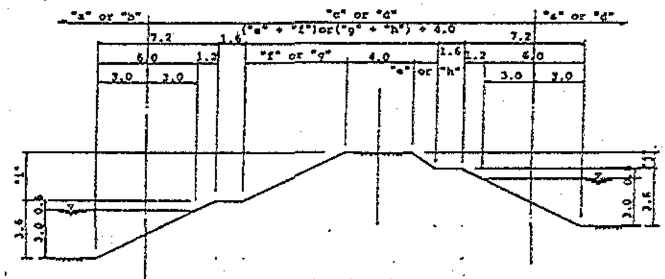
JAPAN INTERNATIONAL COOPERATION AGENCY

TYPICAL SECTION OF AERATED LAGOON

S=1/500, S=1/200







Dimention of Basin

	Sun Juan	El Salvador	Remarks
"a"	100.0	[illegible] 71.0	
"b"	40.0 [illegible]	46.0	
"c"	25.6	27.6	
"d"	23.6	27.6	
"e"	4.0	4.0	
"f"	6.0	8.0	
"g"	6.0	8.0	
"h"	2.0	4.0	
"i"	3.0	4.0	
"j"	"e"=2.0, "h"=1.0	2.0	

FIGURE A25-8

SEDAPAL Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: TYPICAL SECTION OF AERATED LAGOON
SCALE: as shown | DATE: - -'90 | DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY

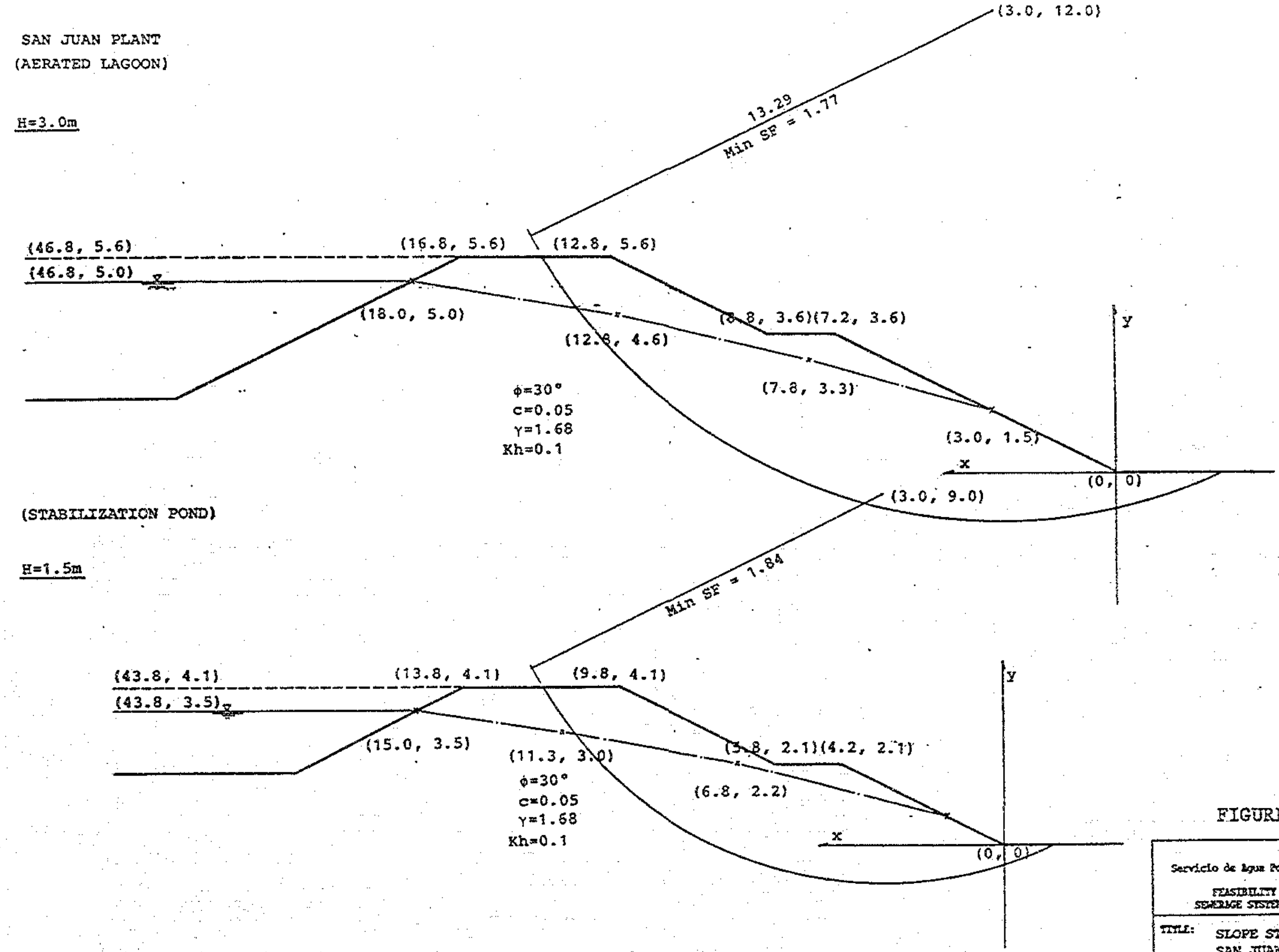


FIGURE A25-9

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: SLOPE STABILITY ANALYSIS
SAN JUAN
AERATED LAGOON /
STABILIZATION POND

SCALE: | DATE: , 1990 | DRAWING No.:

JAPAN INTERNATIONAL COOPERATION AGENCY

VILLA EL SALVADOR
(STABILIZATION POND)

H=1.5m

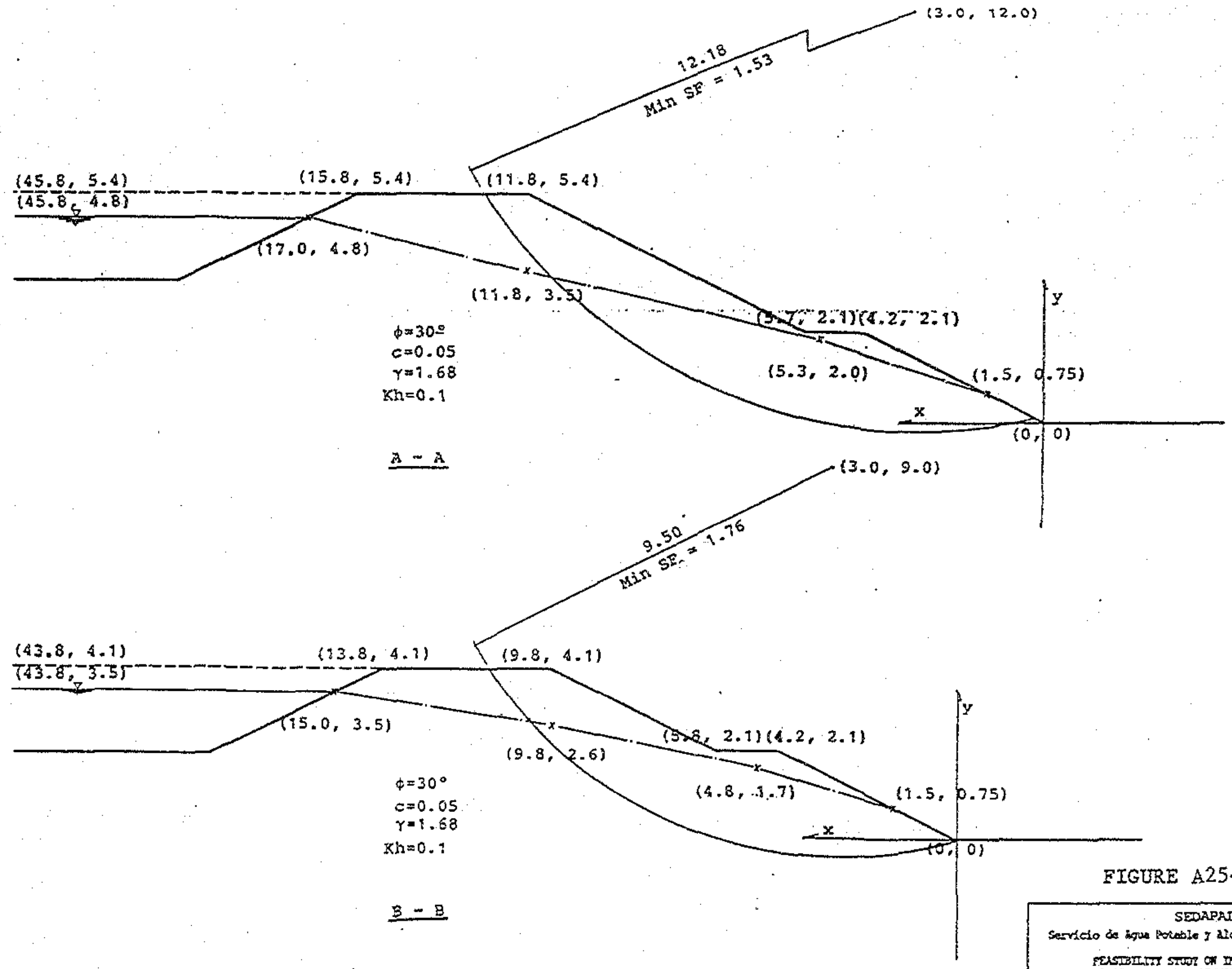


FIGURE A25-10

SEDAPAL Servicio de Agua Potable y Alcantarillado de Lima FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: SLOPE STABILITY ANALYSIS VILLA EL SALVADOL STABILIZATION POND
SCALE: DATE: , 1990   DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY

VILLA EL SALVADOR
(AERATED LAGOON)

H=3.0m

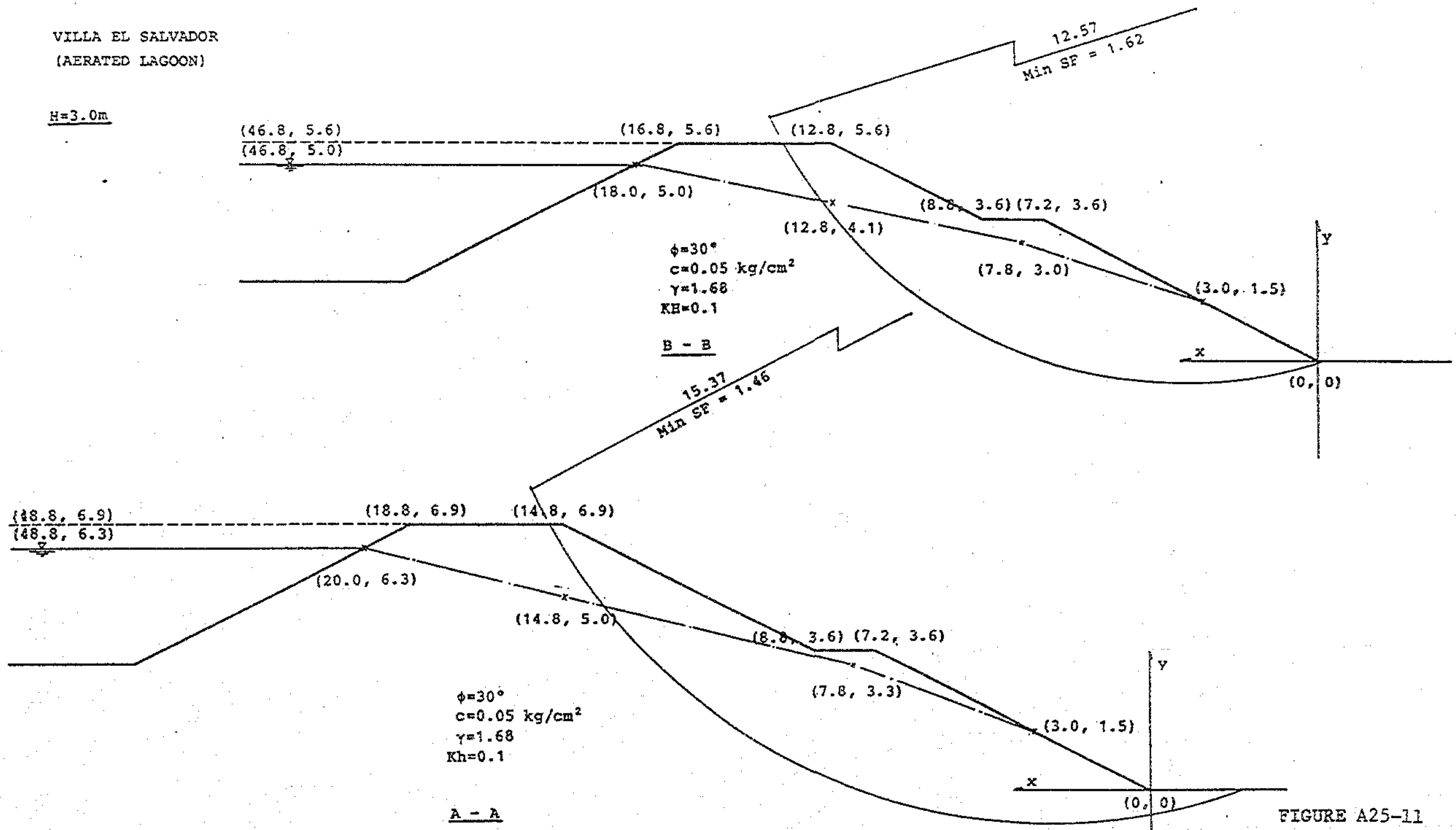


FIGURE A25-11

SEDAPAL Servicio de Agua Potable y Alcantarillado de Lima	
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA	
TITLE:	SLOPE STABILITY ANALYSIS VILLA EL SALVADOL AERATED LAGOON
SCALE:	DATE: , 1990 DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY	

APPENDIX 26

PLAN OF SEWAGE TREATMENT PLANT IN PROPOSED SITE: "CERRO DE LA CHIRA"

APPENDIX 26 PLAN OF SEWAGE TREATMENT PLANT IN PROPOSED SITE: "CERRO DE LA CHIRA"

(1) Available Area

This proposed site is adjacent to the discharge point of Colector Surco and is owned by SEDAPAL. Available area is around 20 ha.

(2) Design Criteria

- Design Flow : $Q = 2.5\ m^3/s = 216{,}000\ m^3/day$

- Influent Water Quality

  Influent BOD5 : 250 mg/l

  Influent SS : 250 mg/l

- Treated Water Quality

  Because the treated water is discharged to the sea, effluent water quality is required to be at laeast over Level 3.

  Effluent BOD5 : under 35 mg/l

  F-Coliform : under 1,000 MPN/100ml

(3) Treatment Method

Treatment method in this site must be able to cope with the sewage flow of $2.5\ m^3/s$ within a limited plant area. In the three treatment methods selected in APPENDIX 19, only Oxidation Ditch System meets this condition, but mechanical dewatering facility will have to be employed because of the constraint in land area.

In case of Oxidation Ditch System, estimated treated water quality will be:

BOD5=20 mg/l

SS = 30 mg/l

(4) Flow Diagram

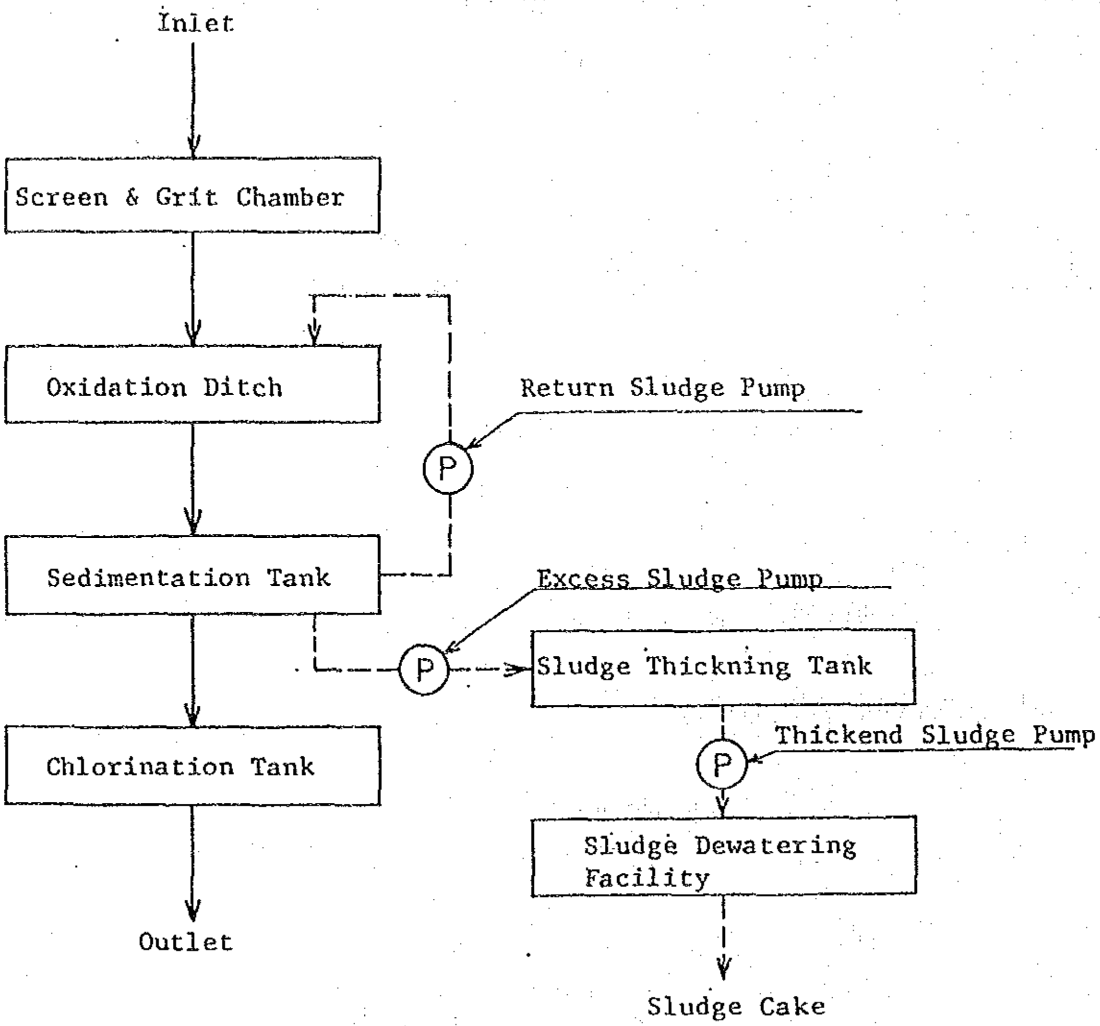


FIGURE A26-1 *Flow Diagram of Oxidation Ditch System*

(5) Design Calculation

Design calculation is based on the design criteria in APPENDIX 18.

a. Oxidation Ditch

Type : *Circulating Channel*

Volume : Vo = (216,000 x 250)/(4,000 x 0.05) = 270,000 m^3

Detention Time : t* = 270,000/216,000 x 24 = 30 hours

BOD Volumetric Load :

Vv = (216,000 x 250 x 10^{-3})/270,000 = 0.2 $kg/m^3/day$

Depth : Do = 2.5 m

Water Surface Area : Ao = 270,000/2.5 = 108,000 m^2

Water Surface Area : Ao = 270,000/2.5 = 108,000 m^2

Dimension : W 7.0 m x L 322 m x D 2.5 m x 48 basins

Oxygen Requirement : Ro = 216,000 x 250 x 10^{-3} x 2.0 x 1.3
= 140,400 kg-O_2/day

Power Requirement : P = 140,400 x 1/24 x 1/2.0 = 2,925 kW

Aerator : 30 kW x 144 sets

b. Sedimentation Tank

Type : Circular Tank

Water Surface Area : As = 216,000 x 1/15 = 14,400 m^2

Depth : Ds = 3.0 m

Volume : Vs = 14,400 x 3 = 43,200 m^3

Detention Time : t* = 43,200/216,000 x 24 = 4.8 hours

Dimension : ϕ 28.0 m x D 3.0 m x 24 basins

c. Thickening Tank

Excess Sludge :

Ds = 216,000 x (250 -30) x 10^3 = 47,520 kg-Ds/day

Vs = 47,520/(100 - 99.2) x 100 = 5,940 m^3/day

Dry Solid Surface Area Load : Dl = 40 kg-Ds/m^2/day

Water Surface Area : At = 47,520/40 = 1,188 m^2

Depth : Dt = 4.0 m

Volume : Vt = 1,188 x 4.0 = 4,752 m^3

Detention Time : t* = 4,752/5,940 x 24 = 19.2 hours

Dimension : ϕ 13.8 m x D 4.0 m x 8 basins

Thichened Sludge : Vs = 47,520/(100 - 97) = 1,584 m^3/day

d. Dewatering Equipment

Working Period : 7 hours/day

Required Capacity : C = 1,584/7 = 226 m^3/hr

Dewatering Equipment : 30 m^3/hr x 8 sets

(6) Arrangement Plan

Arrangement plan for Oxidation Ditch System in proposed site is shown in FIGURE A26-2.

(7) Construction Cost

Construction cost is estimated at around US$179,000,000.

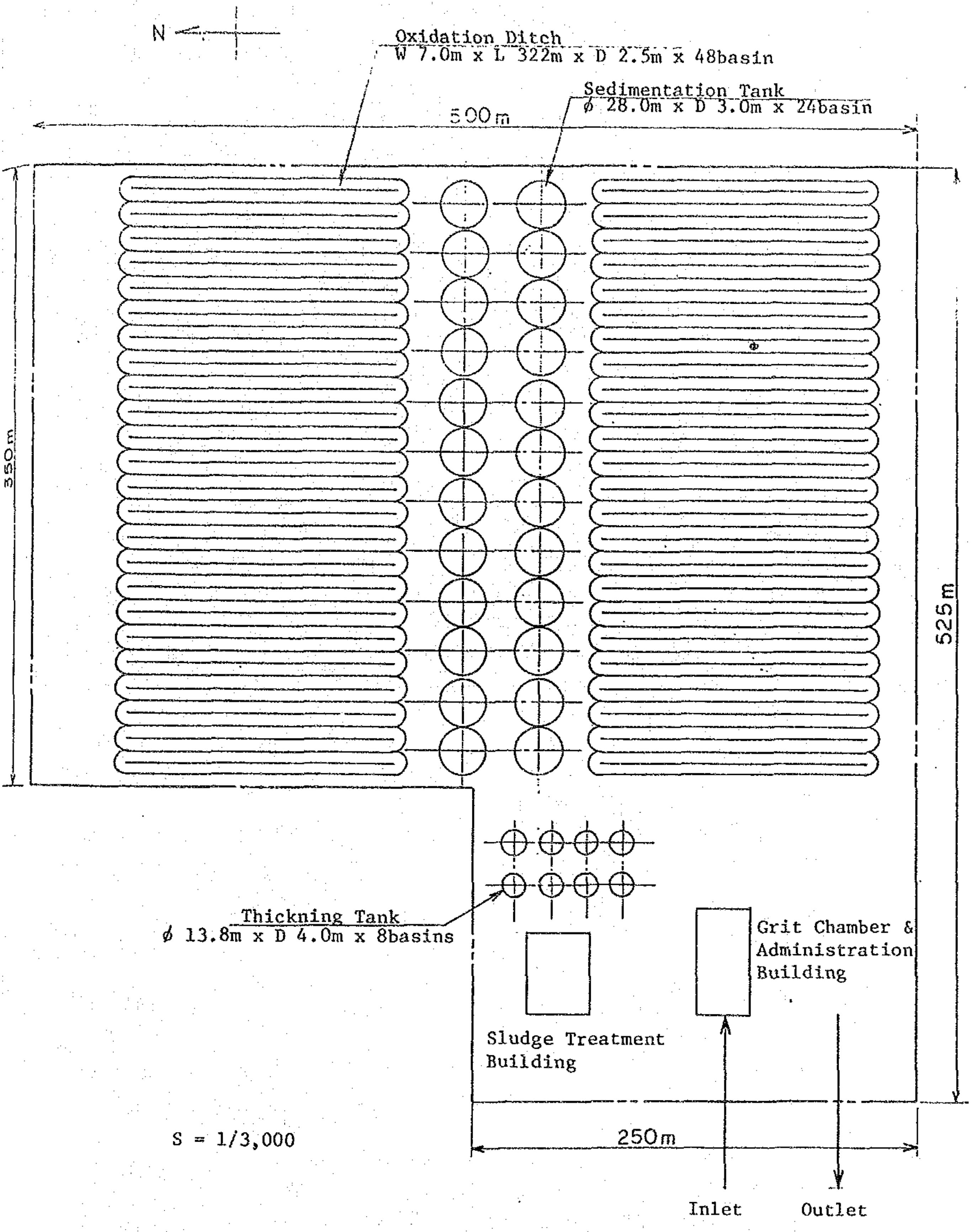


FIGURE A26-2 Layout Plan for Oxidation Ditch System in Proposed site "Cerro de la Chira"

APPENDIX 27

EXISTING SEWAGE REUSE PROEJCT

APPENDIX 27 EXISTING SEWAGE REUSE PROJECT

Large-scale reuse of sewage for irrigation is seen in many of the drier areas in South America, where water supply is scarce. There are about 40 sewage reuse projects in progress in desert areas of Peru as shown in TABLE A27-1.

Irrigation water for these sewage reuse projects is obtained from the treated sewage of the stabilization ponds mainly or directly from domestic sewage and industrial wastewater.

a) Areas Irrigated with Sewage

In all of Peru there are approximately 6,000 hectares of land irrigated with wastewater. In Metropolitan Lima, there are around 220 hectares irrigated with water from the stabilization ponds and about 4,500 hectares irrigated directly by untreated sewage and industrial wastewater.

b) Uses

The so-called reuse of sewage for irrigation is applied in the following areas:

Forestry: -Creation of a green belt around the city
-In the recreational parks
-For forestation of the landfills

Agriculture: -Vegetables, trees, fruit trees
-Forage
-Flower plant cultivation

On the other hand, CEPIS is engaged in an aquiculture project involving the tilapia and shrimp species using treated water from the San Juan Stabilization Pond.

TABLE A27-1 EXISTING SEWAGE TREATMENT PLANTS IN PERU

Location	Flow (lps)	Area 1/ (ha)	Treatment Provided
1. Ayacucho	60	-	Imhoff tanks + Fac. ponds
2. Tacna	150	200	Aerated ponds + Fac. ponds
3. Piura	110	-	Ponds
4. Ica	270	300	Facultative ponds
5. Nazca	20	-	Facultative ponds
6. Huaral	50	-	Facultative ponds
7. Puente Piedra	37	-	Aerated ponds 2/
8. Monsefu	15	-	Ponds
9. Viru	5	-	Facultative
10. Chocope	6	-	Aerated ponds
11. Moquegua	30	-	Facultative ponds
12. Lurin	-	-	Imhoff tank
13. Olmos	-	-	Imhoff tank
14. San Pedro de Lajas	-	-	Imhoff tank
15. Chiquian	-	-	Imhoff tank
16. Buenos Aires	-	-	Facultative ponds
17. Arequipa	1,160 3/	-	Percolating filters
18. Ventanilla	-	195	Facultative ponds
19. Cañete	-	-	Raw for vegetables
20. Sullana	-	-	Facultative ponds
21. Paita	-	-	Facultative ponds
22. Cajamarca	-	-	Facultative ponds
23. Chincha	-	-	Facultative ponds
24. Chepen	-	-	Facultative ponds
25. Huanta	-	-	Percolating filters
26. Juliaca	-	-	Facultative ponds
27. Lambayeque	-	-	Facultative ponds
28. Parcona	-	75	Facultative ponds
29. Lima			
- San Juan	200	1,600	Raw for silviculture
- San Juan	160	220	Facultative ponds
- V.El Salvador	1,000	-	Raw for vegetables
- Callao, Colector No.6	1,000	1,000	Raw for vegetables 2/
- San Martin de Porres, Colector Comas	940	1,750	Raw for vegetables 2/
- San Miguel, Colector Palomino	10	40	Raw for vegetables

Note: 1/ Indicates sewage reuse area.
2/ Including industrial wastes
3/ 1,160 lps is total flow generated by city. Inflow of STP is only 330 lps.

Source: Reuse of Waste Water at the San Juan Stabilization Ponds, CEPIS, 1984.

c) Irrigation Systems

There are three types of irrigation systems: flooding, sprinkling and dripping. In Peru, flooding by ridge is used as it does not require any pipeline facility to convey the water.

d) Problems on Sewage Irrigation

The use of sewage for irrigation is advantageous since it makes up for the deficit in irrigation water from other sources and it enriches the soil. At the same time, the practice are also presents the following problems:

- Fluctuation of demand: There is not much variation in the sewage flow during the year, but there exists an appreciable difference in demand for irrigation according to the season of the year. In the summer, the demand for irrigation water is generally four times that of the demand during winter. Measures to offset the imbalance between demand and sewage flow should therefore be taken accordingly.

- Chemical composition: It is likely that some components, like nitrogen, occuring in high levels of concentration may have negative effects on the plants' growth.

- Risk of contamination: It is highly likely that it can become a focus of infection for water-borne diseases including pathogens and parasites, especially, if raw sewage is used. It is confirmed that the inhabitants of San Juan experimental area experience a higher percentage of infection by enteric parasites than in other areas, probably because crops in the former are irrigated by untreated sewage.

e) Guideline for the Reuse of Sewage

TABLE A27-2 gives a general guideline for the reuse of sewage for irrigation in Peru, taking into account the risk of contamination.

TABLE A27-2 GUIDELINE FOR THE REUSE OF SEWAGE IN AGRICULTURE IN PERU

Items	Guideline
Orchards and vineyards	Untreated, provided not less than 20 days had elapsed between last watering and harvest.
Fodder fibre crops and seed crops	As for orchards and vineyards for crops for industrial use such as cotton, maize, sugar cane; secondary effluent for fodder crops but no grazing permitted.
Crops for human consumption that will be processed to kill pathogens	Primary effluent, as a minimum treatment. Irrigation up to 20 days before harvesting only.
Crops for human consumption	Fruit or vegetables grown on short-stemmed or creeping plants, and which are eaten raw, shall not be watered with either treated or untreated sewage.
Local water application rates.	Approx. 1 l/s/ha

SOURCES : Lay Generalde Aguas (Decreate Ley No. 17752), Government of Peru

f) Experimental Project on the Reuse of Sewage in Villa El Salvador.

At present, a large-scale experimental project on the reuse of sewage for irrigation is being undertaken mainly by the "Ministerio de Agricultura" in Villa El Salvador in the southern part of Metropolitan Lima.

Irrigation water is obtained from the treated water of existing San Juan Stabilization ponds and other Ponds under construction in "Parque Zonal No.26" (a few ponds are already in operation.)

Local water application rates	: 0.8-1.0 l/s/ha
Total treated water quantity for irrigation	: approx. 0.5 m^3/s
Total irrigation area	: approx. 450 ha

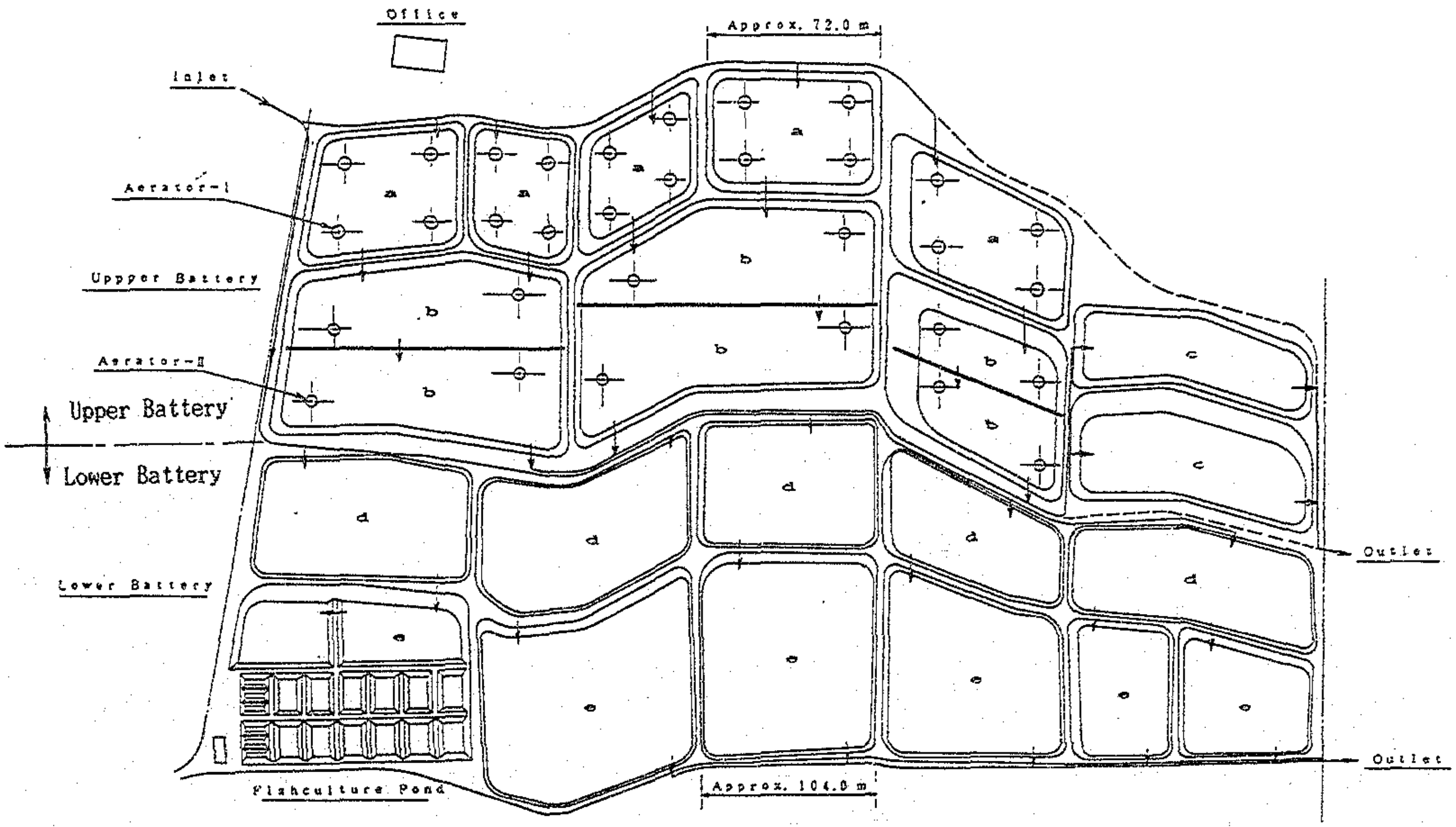
APPENDIX 28

DRAWINGS OF PRELIMINARY DESIGN

APPENDIX 28 DRAWINGS OF PRELIMINARY DESIGN

Following drawings were prepared in preliminary design for cost estimates.

MODIFICATION PLAN IN SAN JUAN STABILIZATION POND



Legend

Aerated Lagoon (Upper Battery)

a : Completely Mixing Aerated Lagoon

b : Facultative Aerated Lagoon

c : Sedimentation Pond

——— : Sewage

Stabilization Pond (Lower Battery)

d : Primary Facultative Pond

e : Secondary Facultative Pond

FIGURE A28-1

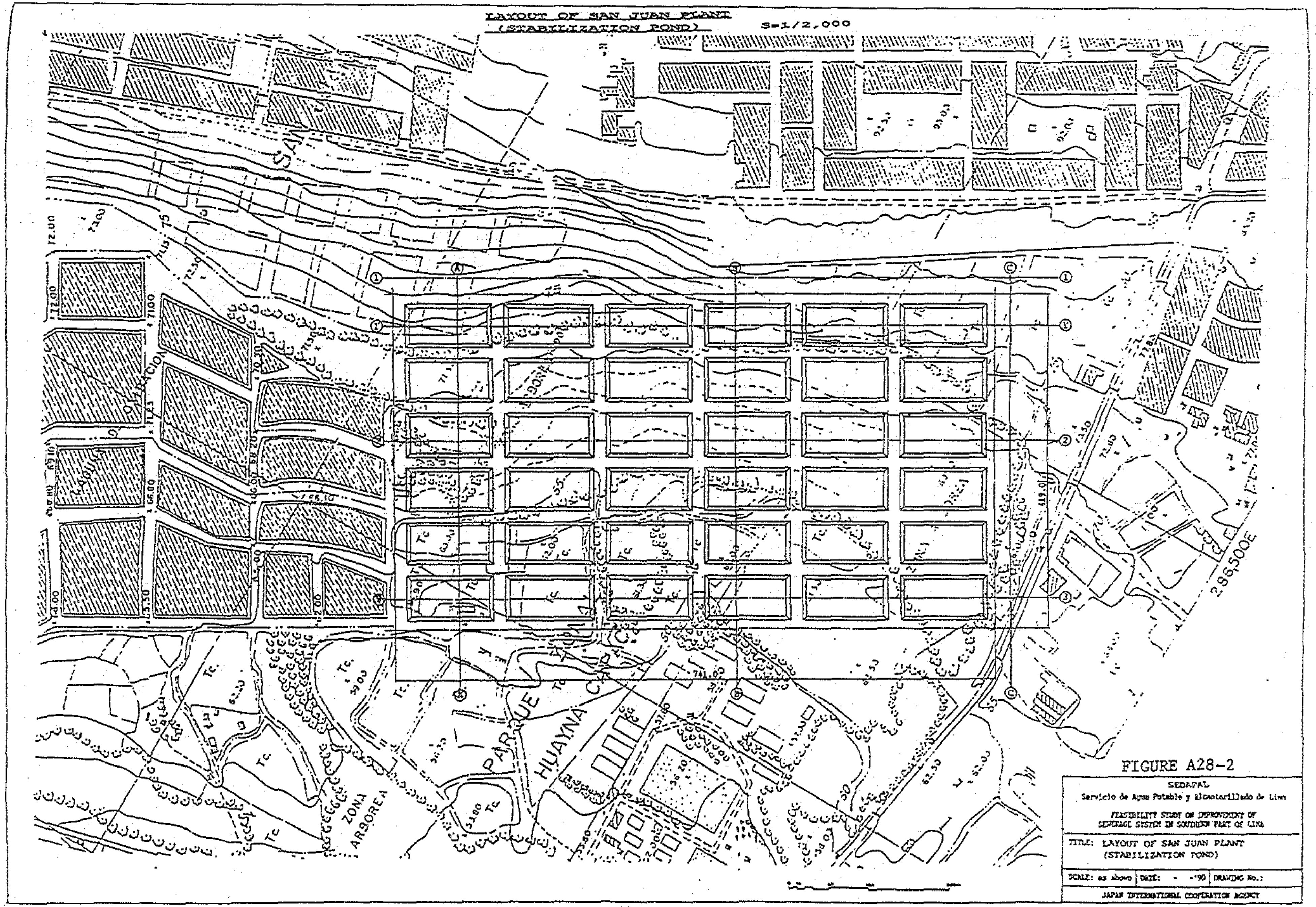
SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: MODIFICATION PLAN FOR AERATED LAGOON IN PROPOSED SITE (a) "SAN JUAN S. T. P."

SCALE: approx. 1/2000 | DATE: - -'90 | DRAWING No.:

JAPAN INTERNATIONAL COOPERATION AGENCY


LAYOUT OF SAN JUAN PLANT
(STABILIZATION POND)
S=1/2,000
PARQUE HUAYNA CAPAC
ZONA ARBOREA
286500E
SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: LAYOUT OF SAN JUAN PLANT (STABILIZATION POND)
SCALE: as above
DATE: - -'90
DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY
FIGURE A28-2

PROFILE OF STABILIZATION POND
H=1/2,000 V=1/200

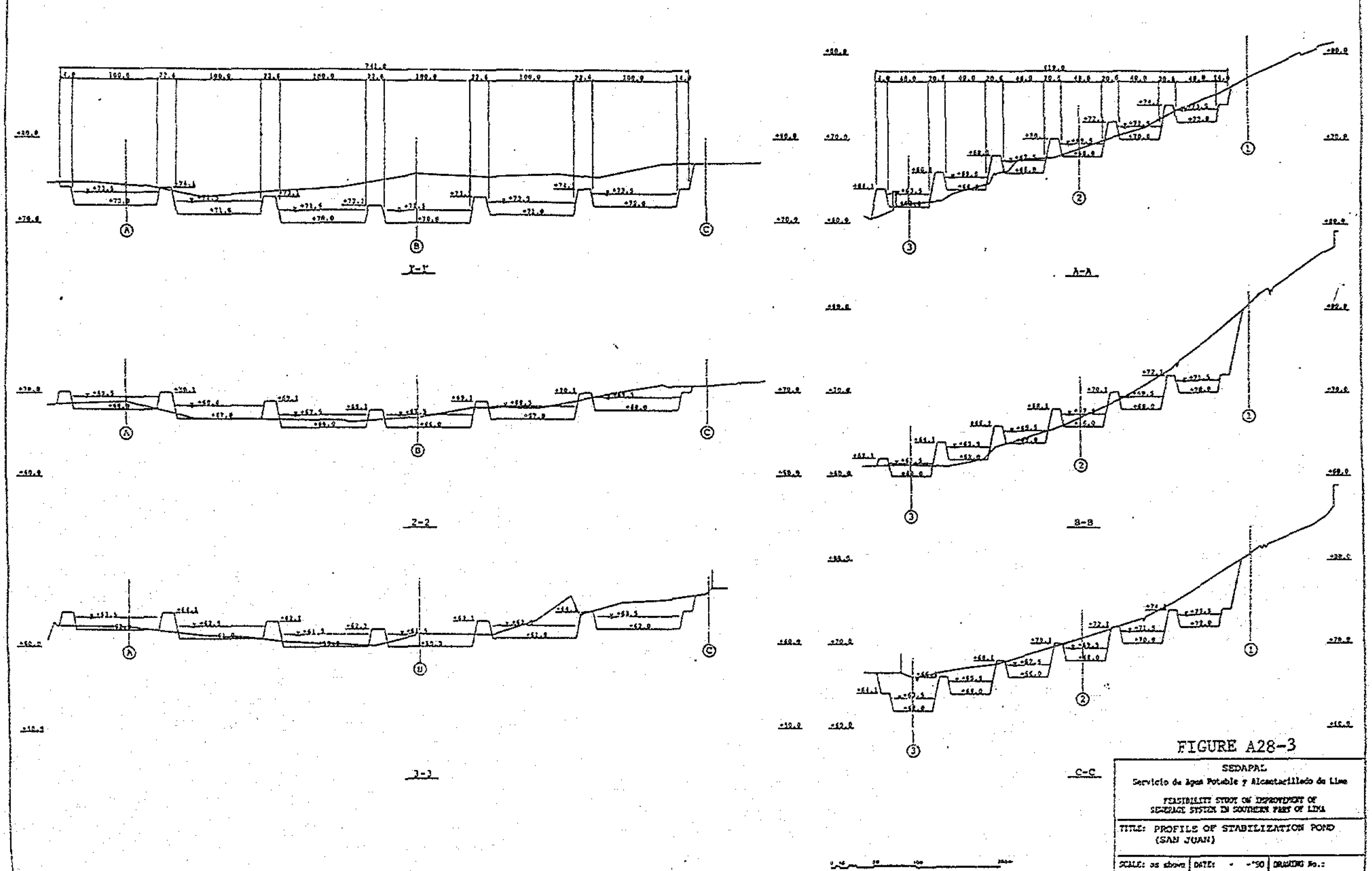


FIGURE A28-3

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima

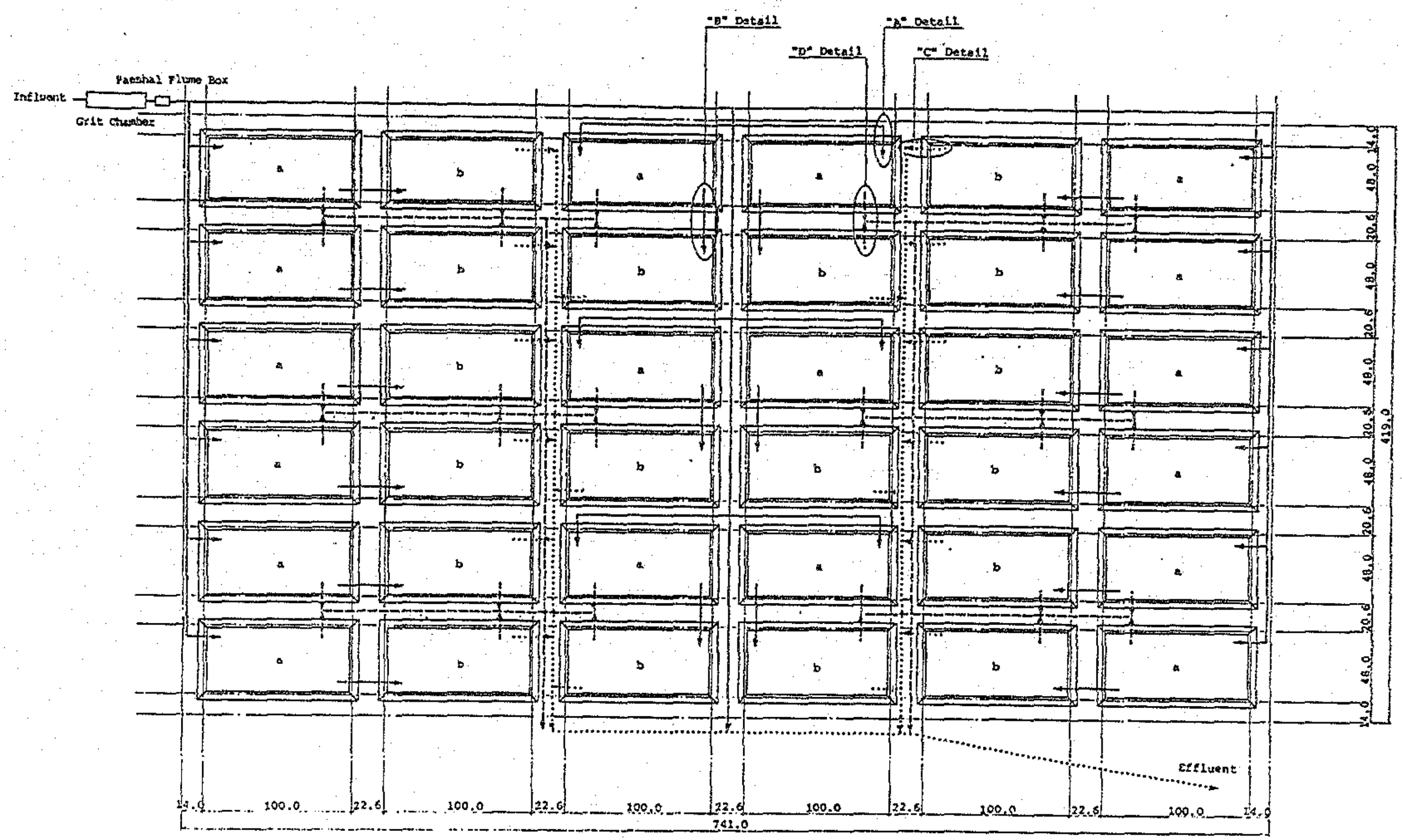
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: PROFILE OF STABILIZATION POND (SAN JUAN)

SCALE: as shown | DATE: - -'90 | DRAWING No.:

JAPAN INTERNATIONAL COOPERATION AGENCY

PLAN OF TREATMENT PLANT IN SAN JUAN STABILIZATION POND S=1/2,000



Legend

a : Primary Facultative Pond

b : Secondary Facultative Pond

——— : Sewage

········ : Treated Sewage

-·-·-·- : Drain

FIGURE A28-4

SEDAPAL

Servicio de Agua Potable y Alcantarillado de Lima

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: PLAN OF TREATMENT PLANT IN SAN JUAN STABILIZATION POND

SCALE: as shown | DATE: - -'90 | DRAWING No.:

JAPAN INTERNATIONAL COOPERATION AGENCY

LAYOUT OF SAN JUAN PLANT (AERATED LAGOON)

S=1/2,000

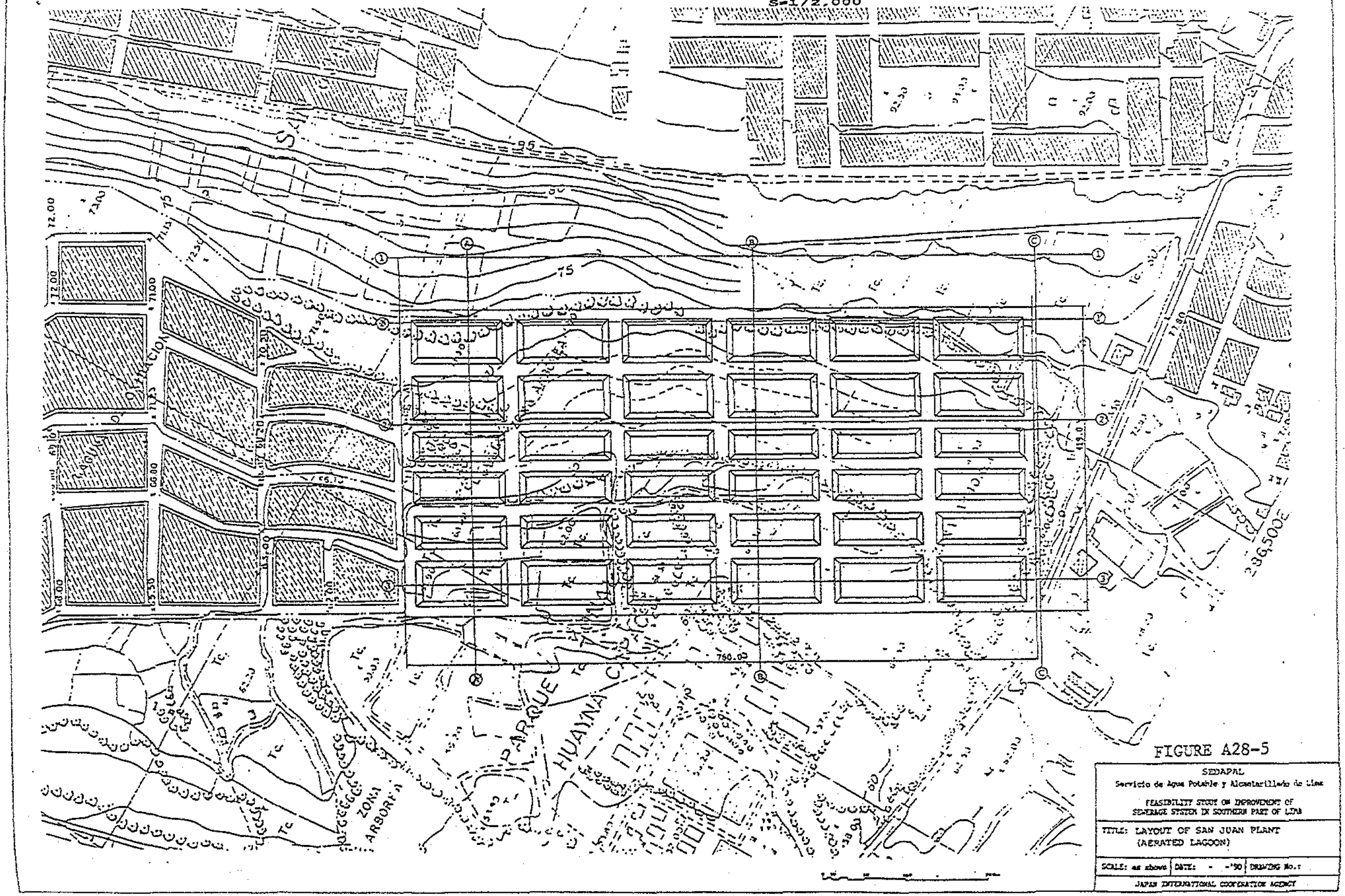


FIGURE A28-5

PROFILE OF AERATED LAGOON
H=1/2,000 V=1/200

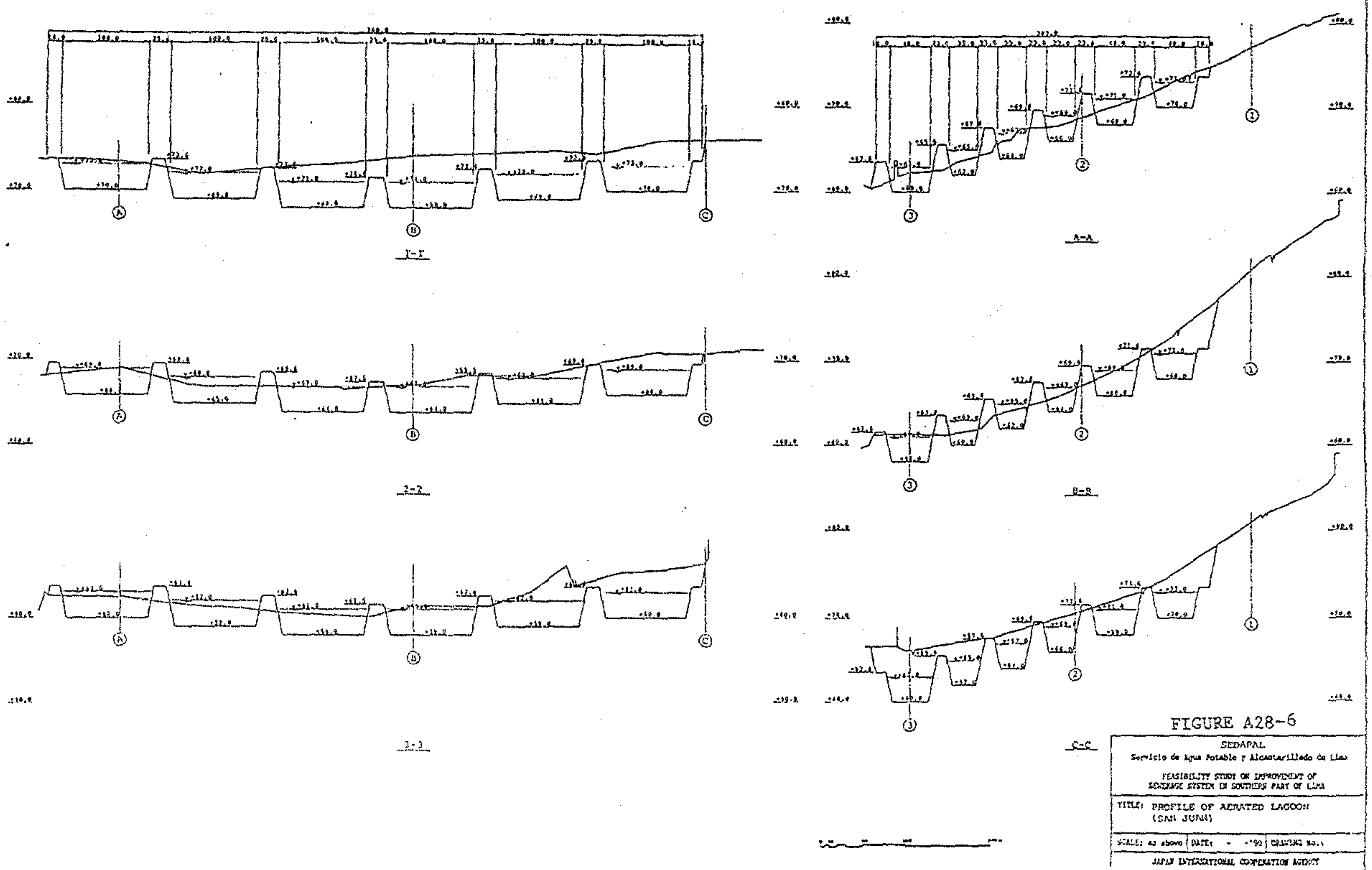
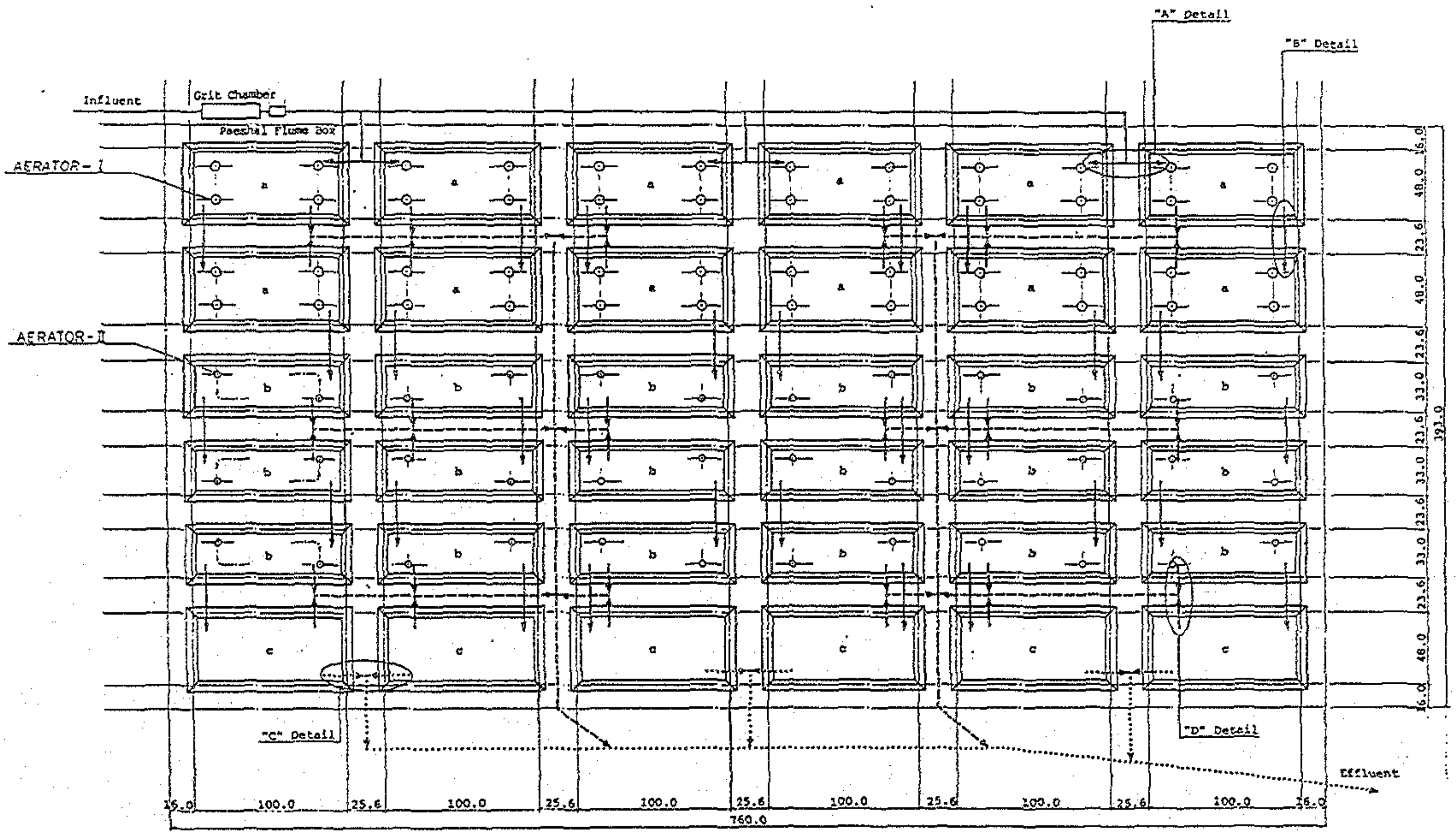


FIGURE A28-6

PLAN OF TREATMENT PLANT IN SAN JUAN AERATED LAGOON S=1/2,000

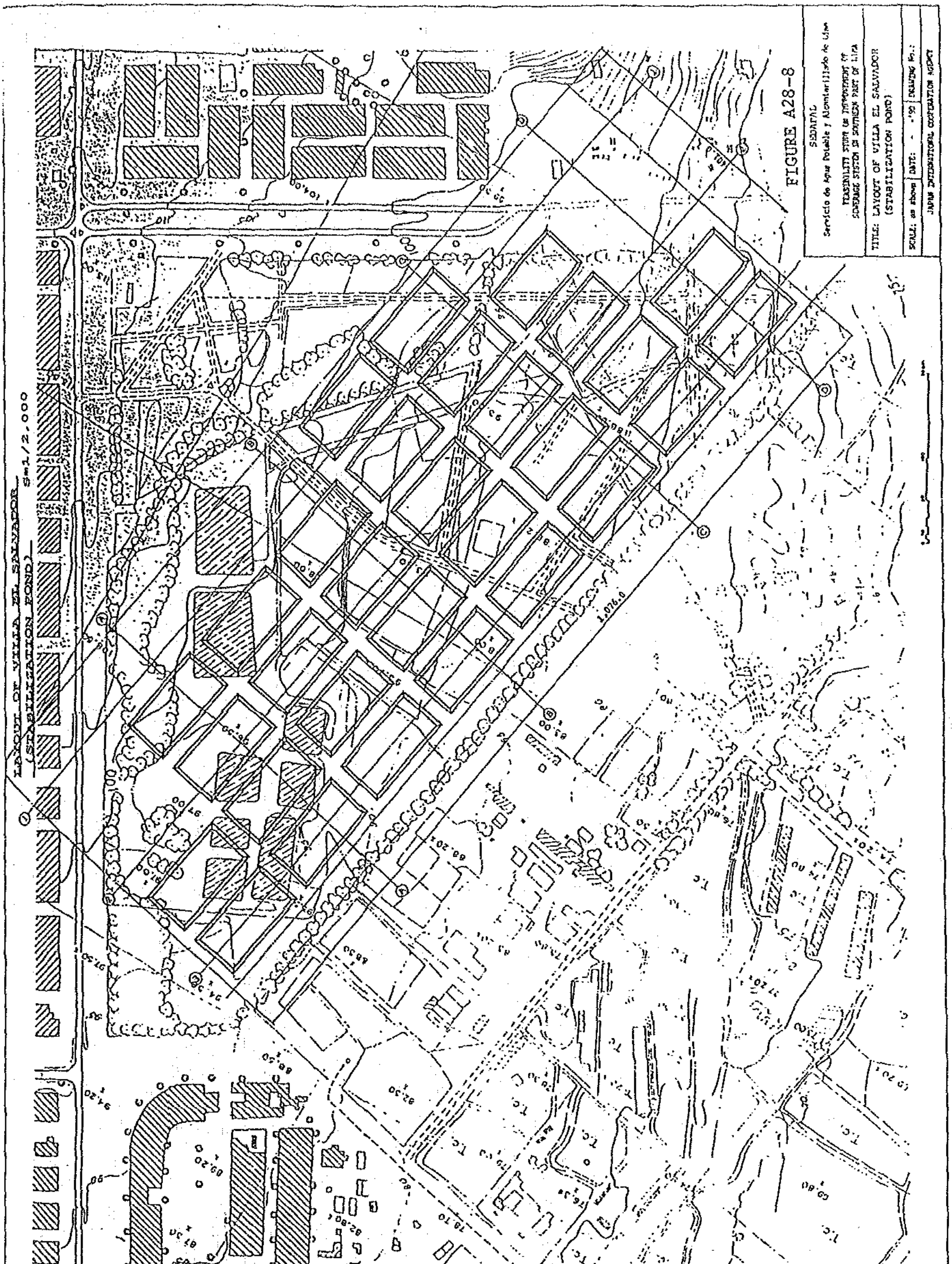


Legend

a : Complete Mixing Aerated Lagoon
b : Facultative Aerated Lagoon
c : Sedimentation Pond
——— : Sewage
.... : Treated Sewage
—— —— : Drain
O : Aerator-I
o : Aerator-II

FIGURE A28-7

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: PLAN OF TREATMENT PLANT IN SAN JUAN AERATED LAGOON
SCALE: as shown | DATE: - -'90 | DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY


LAYOUT OF VILLA EL SALVADOR
(STABILIZATION POND)
S=1/2,000
FIGURE A28-8
SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: LAYOUT OF VILLA EL SALVADOR (STABILIZATION POND)
SCALE: as shown
DATE: - '99
DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY
1,076.0

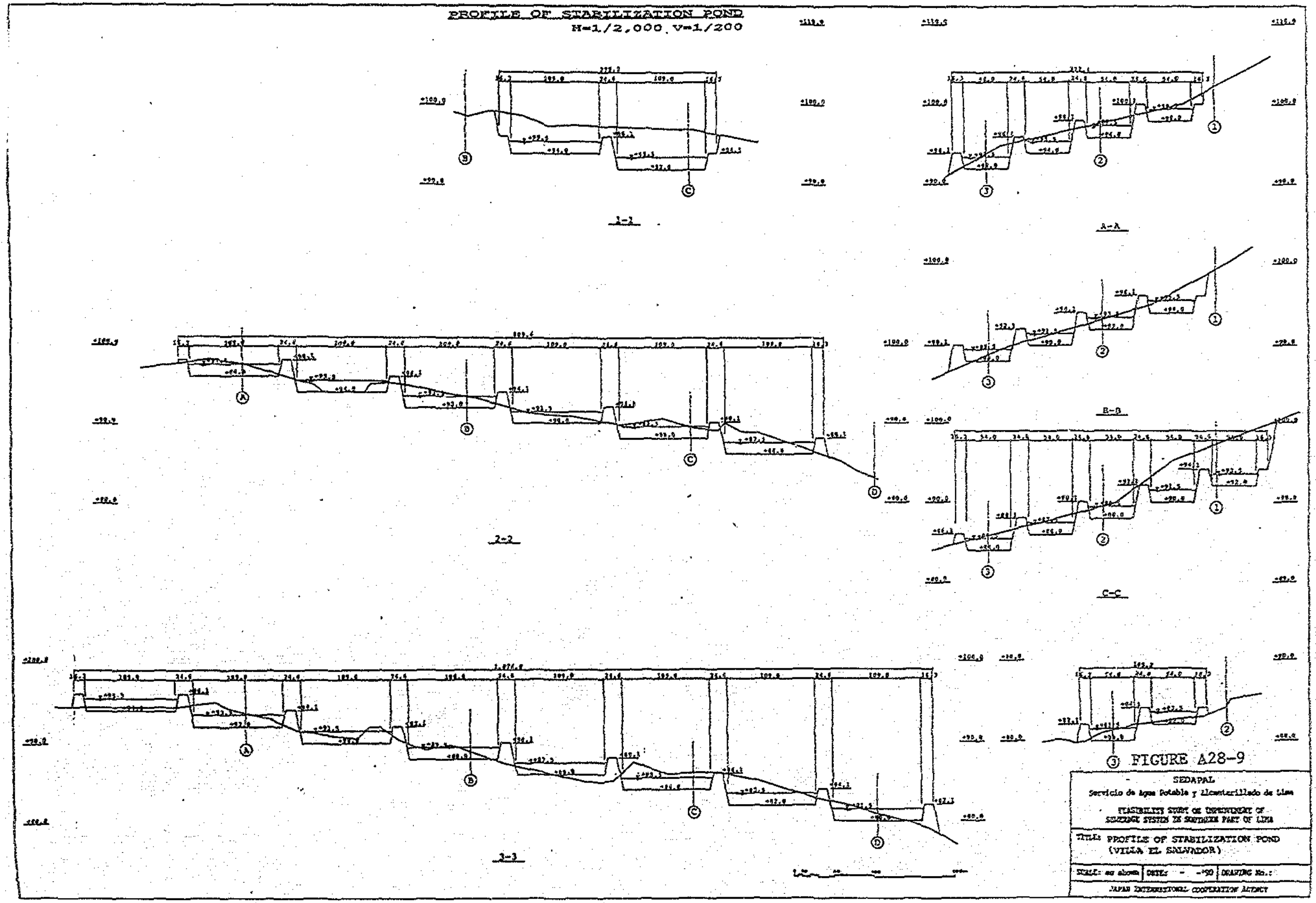
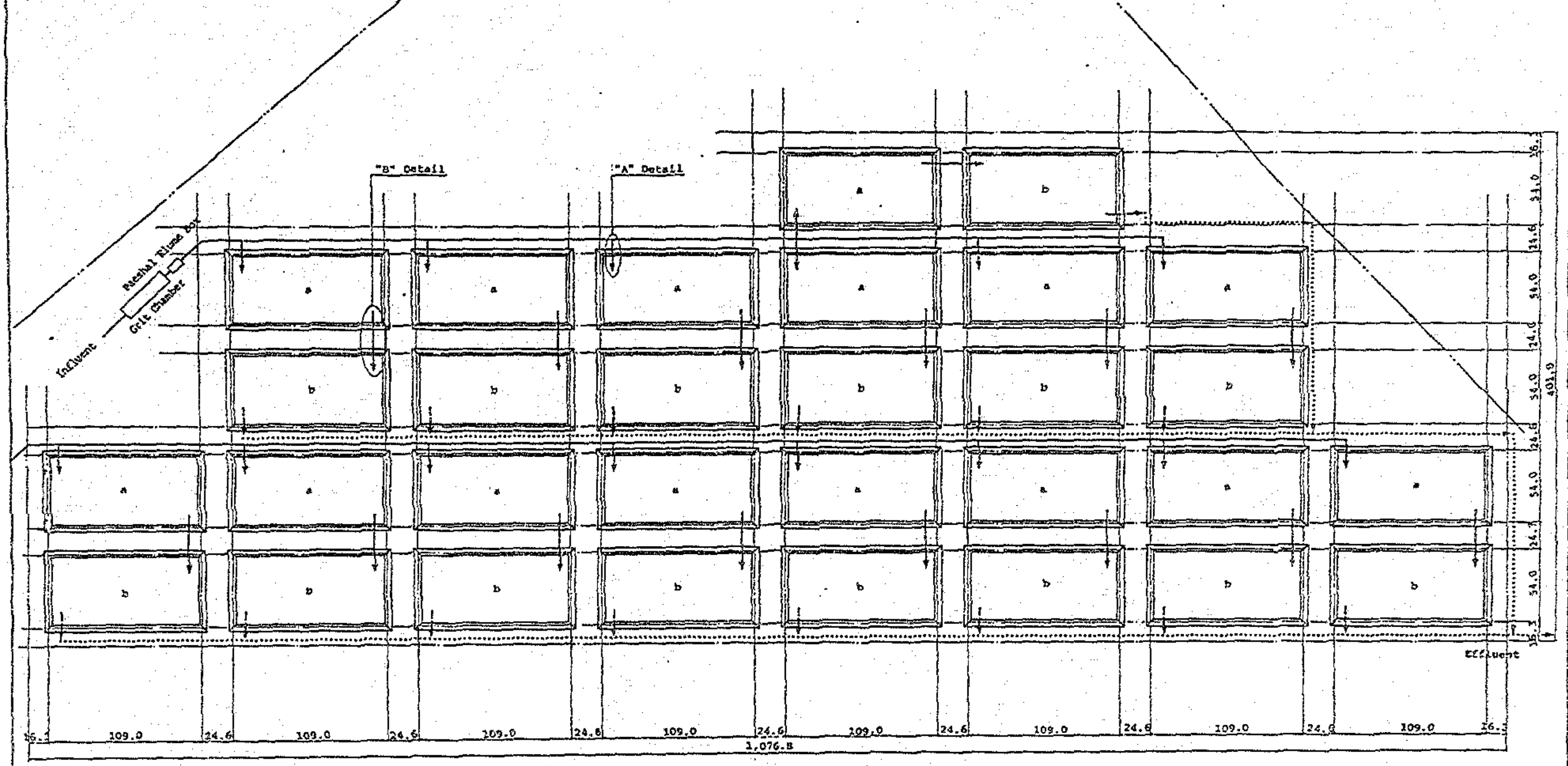

PROFILE OF STABILIZATION POND
H=1/2,000 V=1/200
1-1
A-A
B-B
2-2
C-C
3-3
SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: PROFILE OF STABILIZATION POND (VILLA EL SALVADOR)
SCALE: as shown
DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY

FIGURE A28-9

PLAN OF TREATMENT PLANT IN VILLA EL SALVADOR
STABILIZATION POND
S=1/2,000



Legend

a : Primary Facultative Pond

b : Secondary Facultative Pond

——— : Sewage

.... : Treated Sewage

—·—·— : Drain

FIGURE A28-10

SEDAPAL

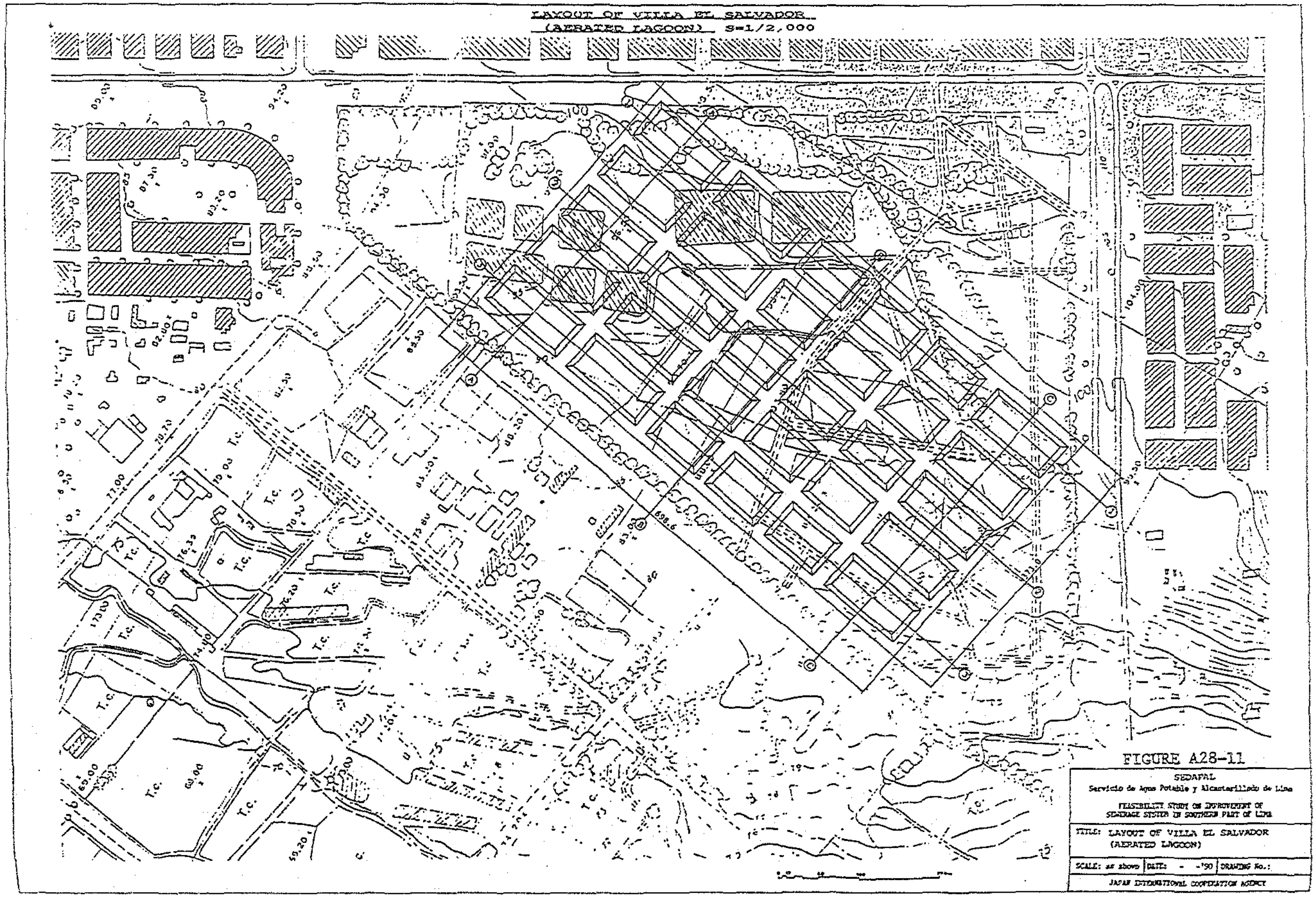
Servicio de Agua Potable y Alcantarillado de Lima

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: PLAN OF TREATMENT PLANT IN VILLA EL SALVADOR STABILIZATION POND

SCALE: as shown | DATE: - -'90 | DRAWING No.:

JAPAN INTERNATIONAL COOPERATION AGENCY


LAYOUT OF VILLA EL SALVADOR
(AERATED LAGOON) S=1/2,000
FIGURE A28-11
SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF
SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: LAYOUT OF VILLA EL SALVADOR
(AERATED LAGOON)
SCALE: as shown
DATE: - -'90
DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY

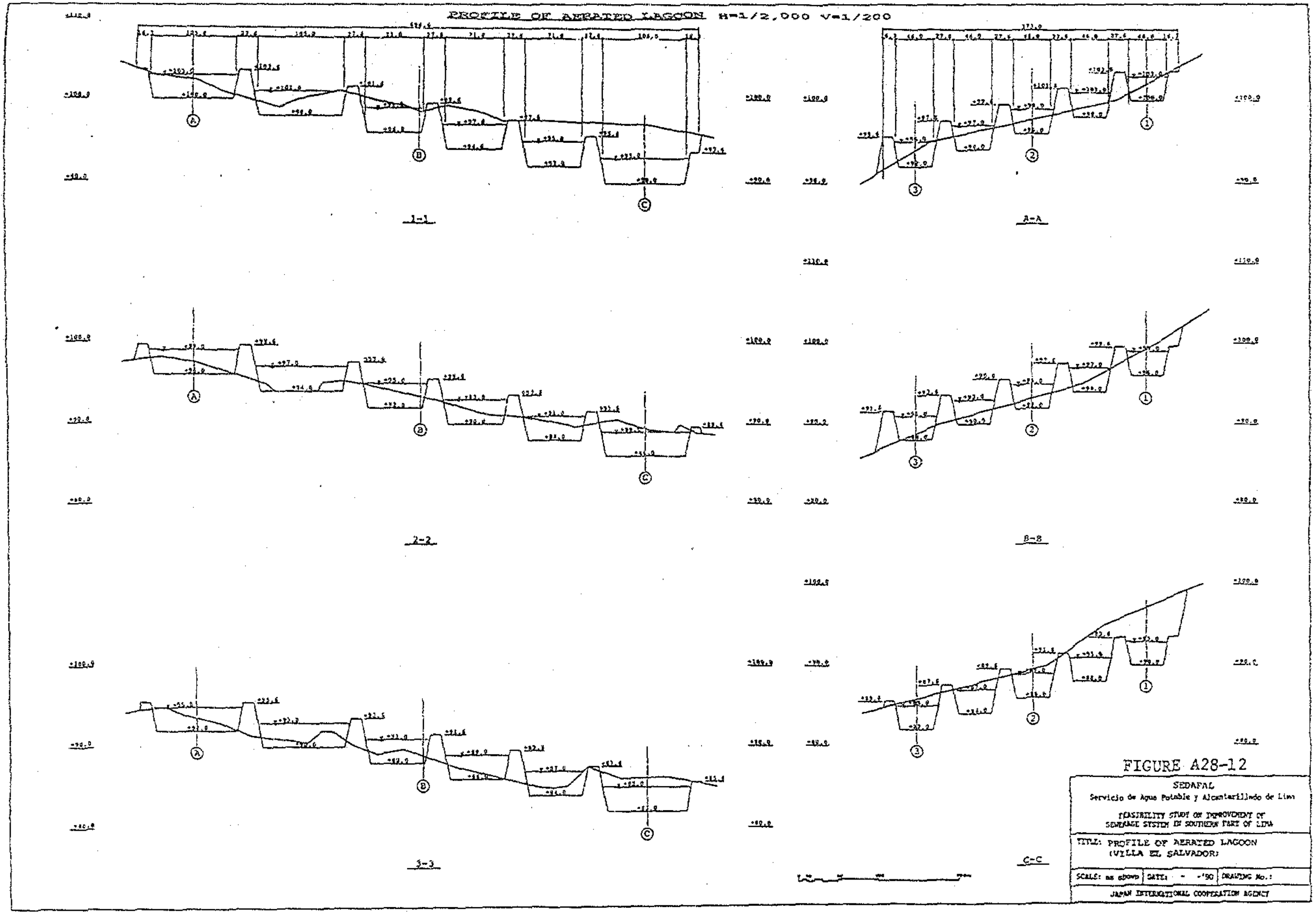
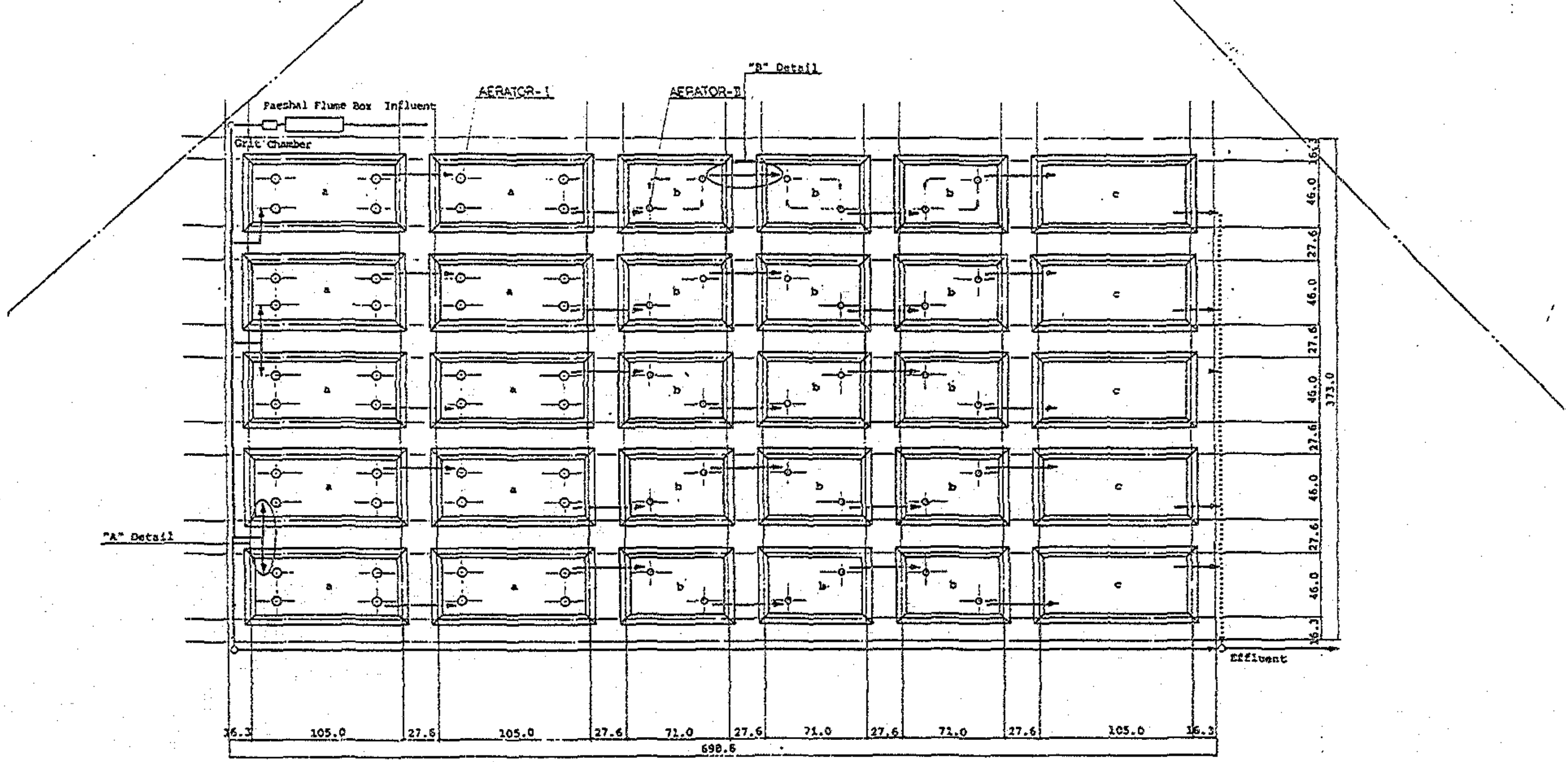


FIGURE A28-12

PLAN OF TREATMENT PLANT IN VILLA EL SALVADOR
AERATED LAGOON
S=1/2,000



Legend

a : Complete Mixing Aerated Lagoon
b : Facultative Aerated Lagoon
c : Sedimentation Pond
——— : Sewage
········ : Treated Sewage
◯ : Aerator-I
○ : Aerator-II

FIGURE A28-13

SEDAPAL Servicio de Agua Potable y Alcantarillado de Lima FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA		
TITLE: PLAN OF TREATMENT PLANT IN VILLA EL SALVADOR AERATED LAGOON		
SCALE: as shown	DATE: - -'90	DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY		

PLAN OF SEWAGE TREATMENT PLANT IN SAN BALTOLO

1) Arrangement of One System for Sewage Treatment Plant

One system will be composed by 18 stabilization pond and the dimension of each pond is as follows :

W : 110m

L : 110m

D : 1.5m

2) Capacity of Treatment for One System

Capacity Q is as follows :

Water surface area = 110m × 110m × 18 = 21.8ha

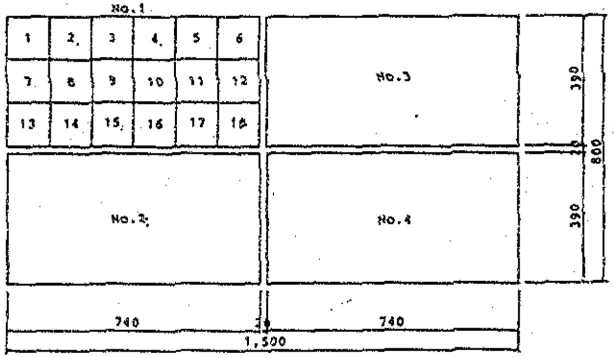
$$Q = \frac{21.8}{88.95} \times 1.0m^3/s \fallingdotseq 0.25\ m^3/s \text{ per system}$$

3) Plan of Arrangement in the Case of Capacity of $1.0m^3/sec$

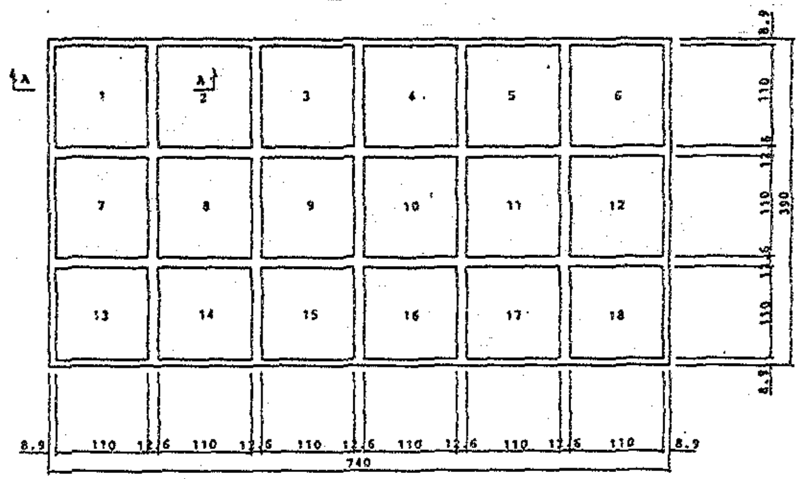
Number of sysytem is as follows :

$1.0m^3/s \div 0.25\ m^3/s = 4$ (system)

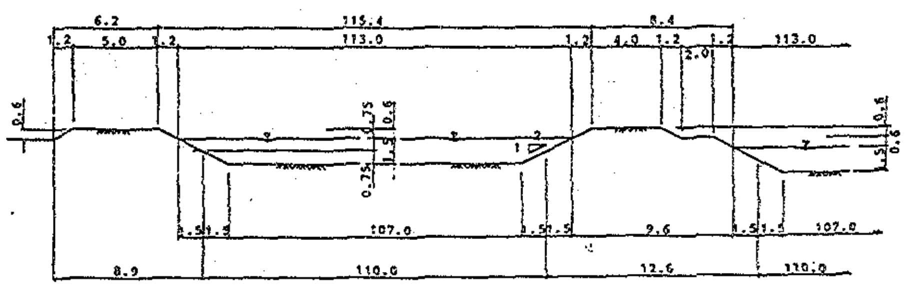
Arrangement of system is shown as below.



Plan of Stabilization Pond



Section A - A



4) Number of System for Plan A and Plan B

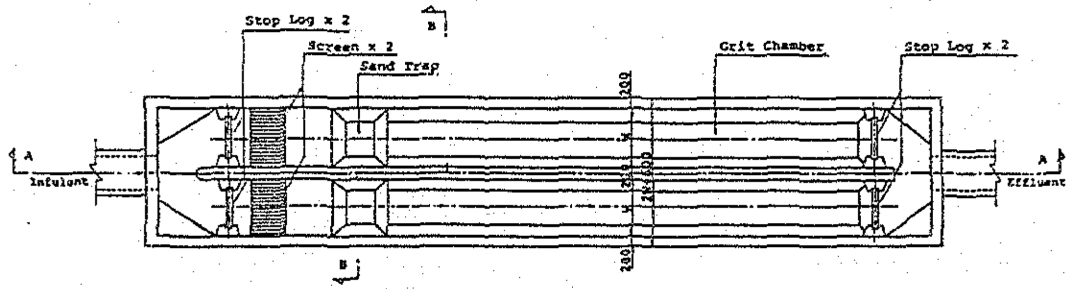
Number of system for each plan is shown as Table below.

PLAN		PHASE I		PHASE II		Remarks
		Planed Volume of Sewage	Number of System	Planed Volume of Sewage	Number of System	
A_1	B_1	3.5 m^3/s	14	0 m^3/s	0	
A_2	B_2	1.5	6	2.0	8	
A_3	B_3	0.5	2	3.0	12	

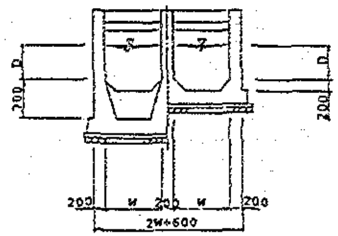
FIGURE A28-14

SEDAPAL Servicio de Agua Potable y Alcantarillado de Lima FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA		
TITLE: PLAN OF SEWAGE TREATMENT PLANT IN SAN BALTOLO		
SCALE: as shown	DATE: - -'90	DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY		

PLAN OF GRIT CHAMBER - TYPE I



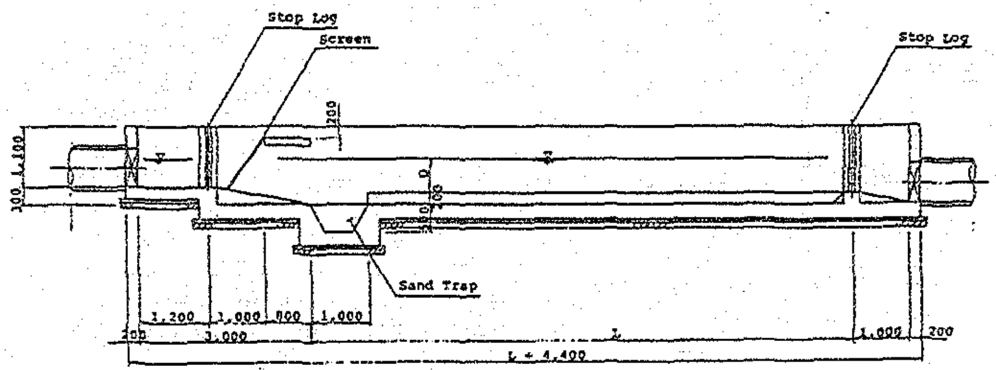
PLAN



SECTION B - B

DIMENSION - TYPE I

Design	Dimension of Grit Chamber			
Flow	Width	Length	Depth	Unit
0.19 m3/s	1,000 mm	9,500 mm	600 mm	1 Set
0.50	1,400	8,600	600	2



SECTION A - A

FIGURE A28-15

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima

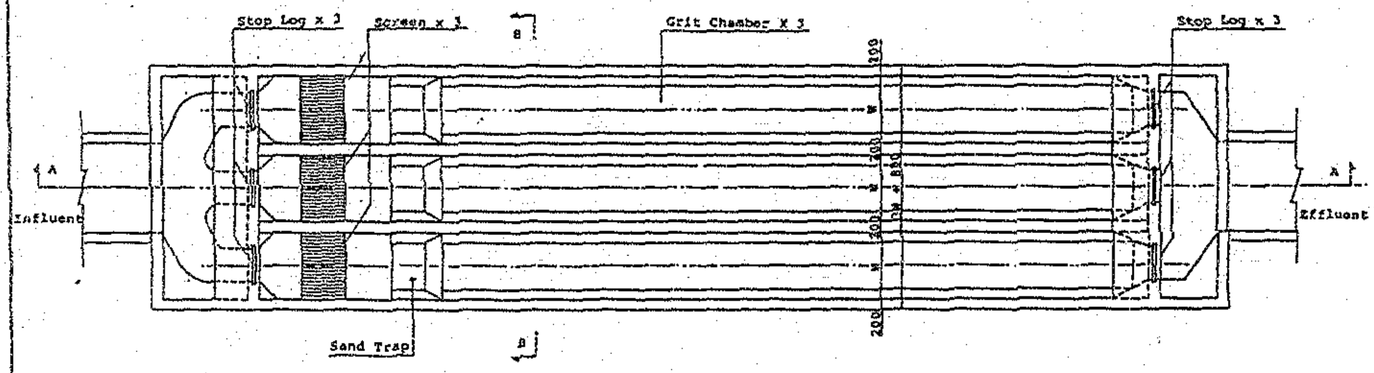
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: PLAN OF GRIT CHAMBER - TYPE I

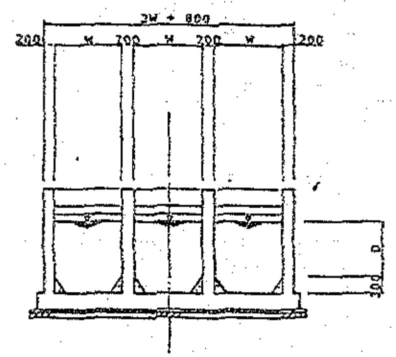
SCALE: as shown | DATE: - -'90 | DRAWING No.:

JAPAN INTERNATIONAL COOPERATION AGENCY

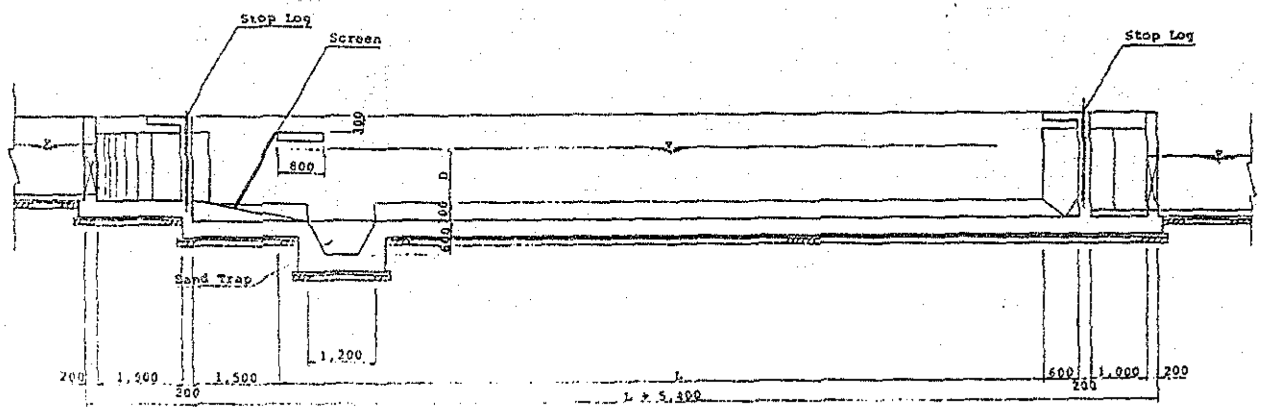
PLAN OF GRIT CHAMBER - TYPE II



PLAN



SECTION B - B



SECTION A - A

DIMENSION - TYPE II

Design Flow	Dimension of Grit Chamber			
	Width	Length	Depth	Unit
1.0 m³/S	1,200 mm	13,500 mm	1,000 mm	3 Set
1.5	1,400	18,000	1,200	3

FIGURE A28-16

SEDAPAL

Servicio de Agua Potable y Alcantarillado de Lima

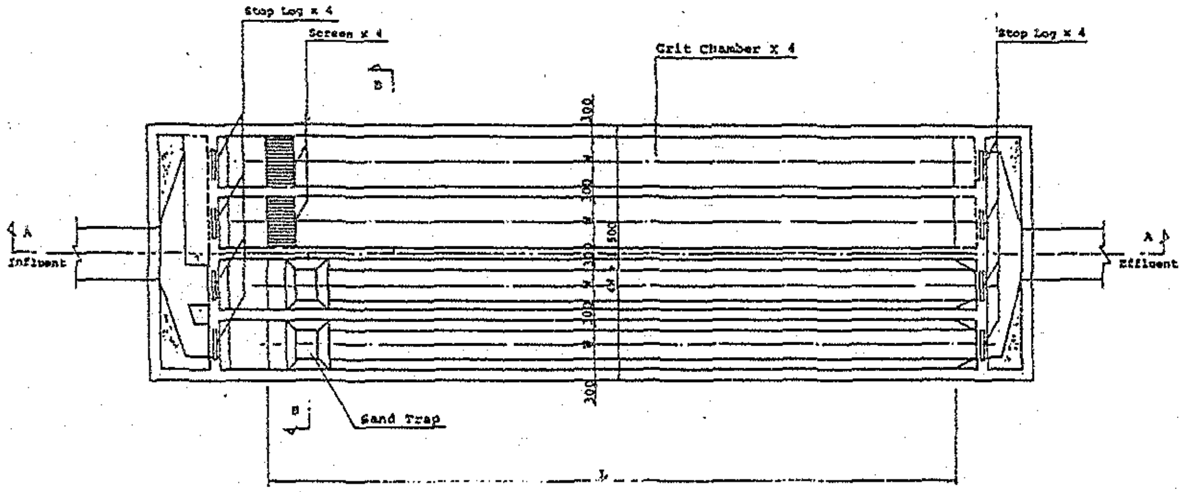
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: PLAN OF GRIT CHAMBER - TYPE II

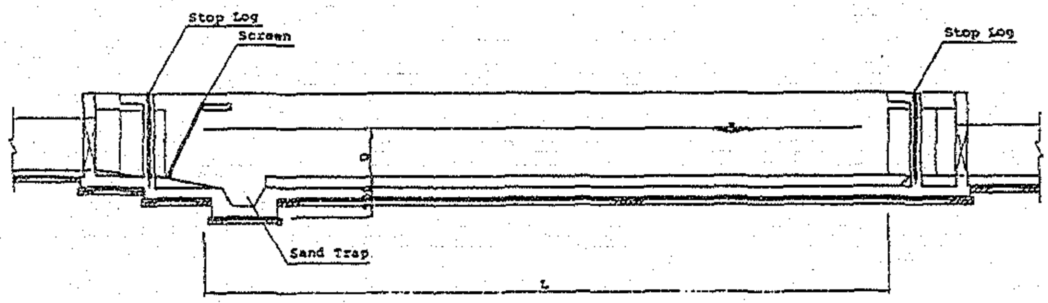
SCALE: as shown | DATE: - -'90 | DRAWING No.:

JAPAN INTERNATIONAL COOPERATION AGENCY

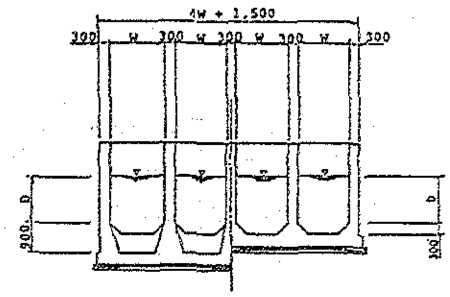
PLAN OF GRIT CHAMBER - TYPE III



PLAN



SECTION A - A



SECTION B - B

DIMENSION - TYPE III

Design Flow	Dimension of Grit Chamber			
	Width	Length	Depth	Unit
2.0 m3/sec	2,300	19,200	1,400	4
2.5 m3/sec	2,500	20,000	1,400	4

FIGURE A28-17

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima

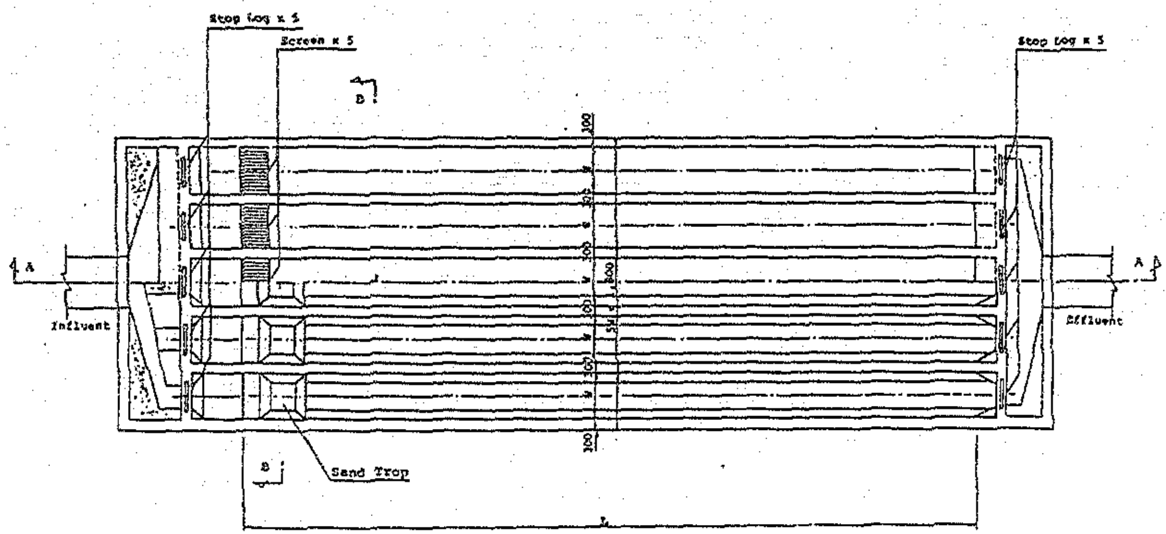
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: PLAN OF GRIT CHAMBER - TYPE III

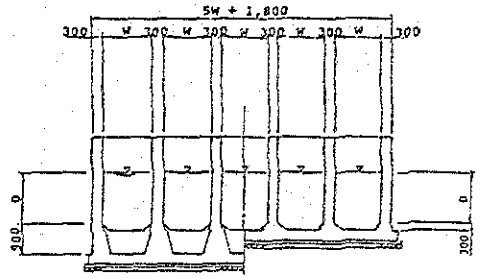
SCALE: as shown | DATE: - '90 | DRAWING No.:

JAPAN INTERNATIONAL COOPERATION AGENCY

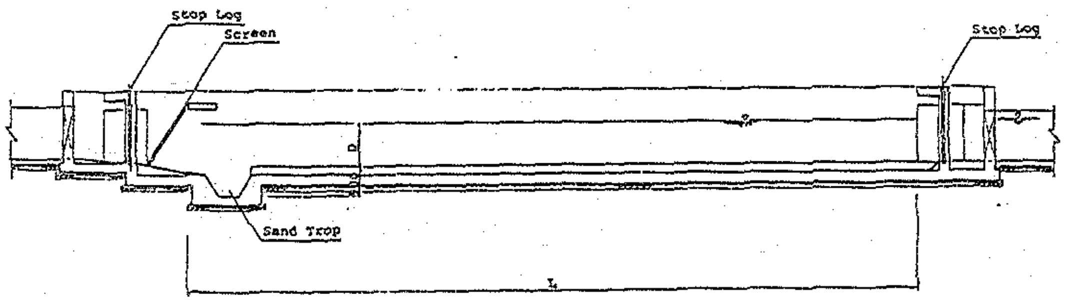
PLAN OF GRIT CHAMBER - TYPE IV



PLAN



SECTION B - B



SECTION A -'A

DIMENSION - TYPE IV

Design Flow	Dimension of Grit Chamber			
	Width	Length	Depth	Unit
m3/s	mm	mm	mm	set
3.0	1,400	20,600	1,500	5
3.5	1,500	22,400	1,600	5
4.0	1,700	22,600	1,600	5

FIGURE A28-18

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: PLAN OF GRIT CHAMBER - TYPE IV
SCALE: as shown | DATE: - -'90 | DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY

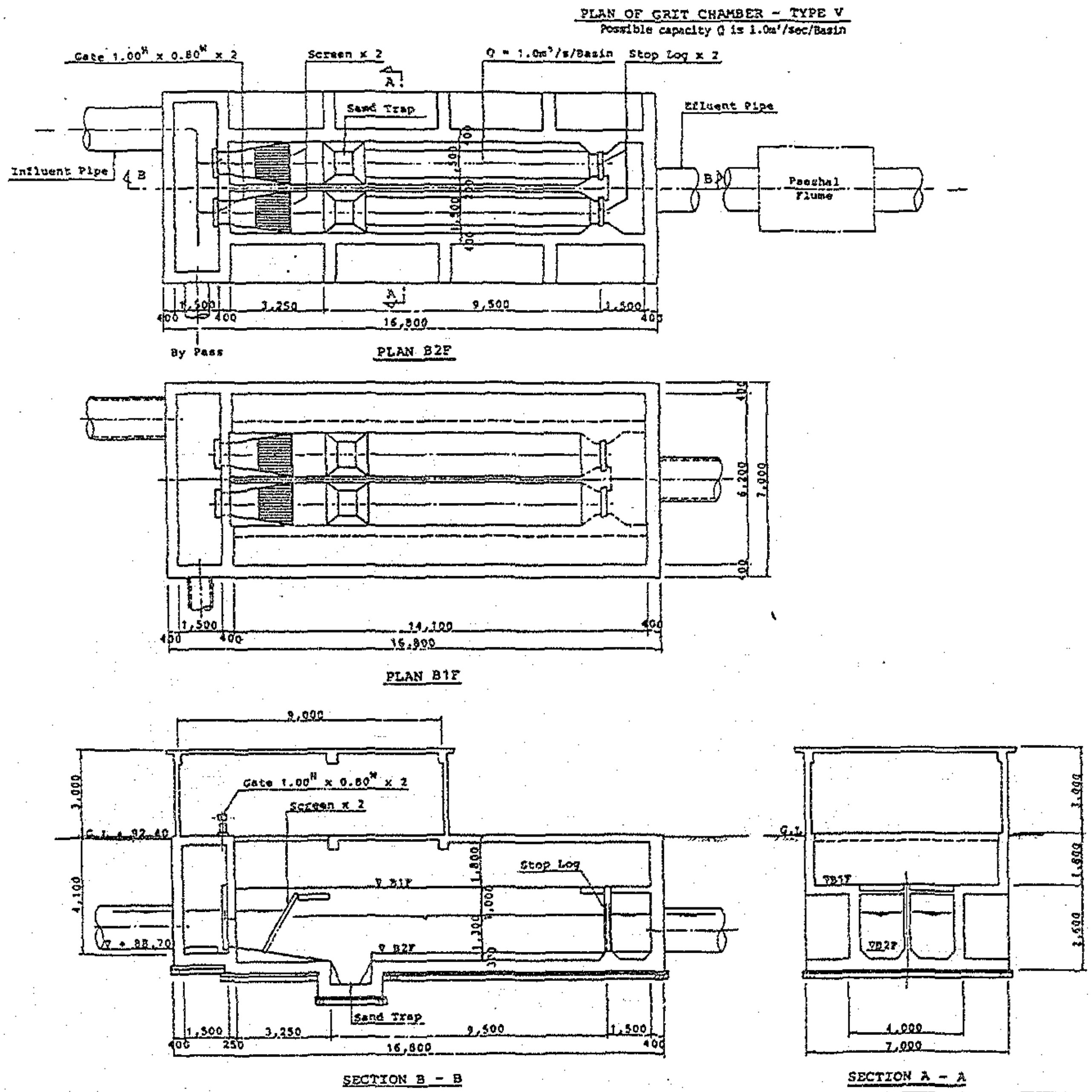
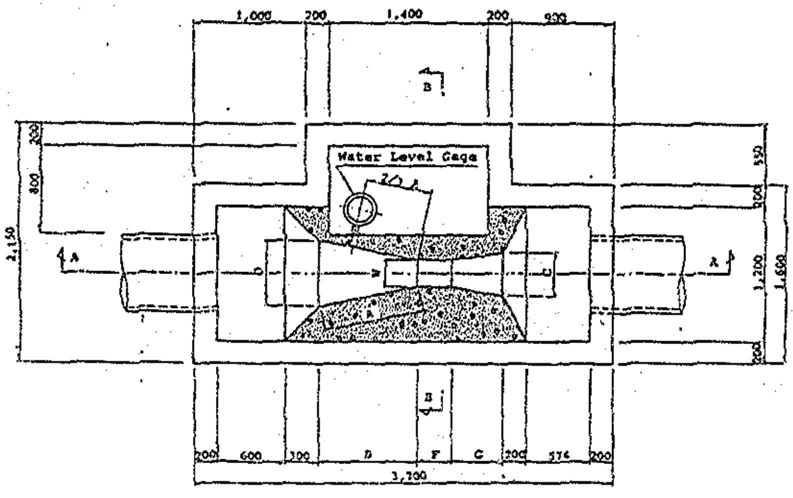


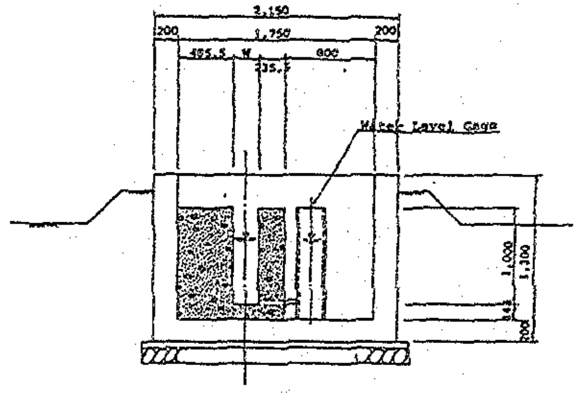
FIGURE A28-19

SEDAPAL Servicio de Agua Potable y Alcantarillado de Lima FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA		
TITLE: PLAN OF GRIT CHAMBER - TYPE V		
SCALE: as shown	DATE: - -'90	DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY		

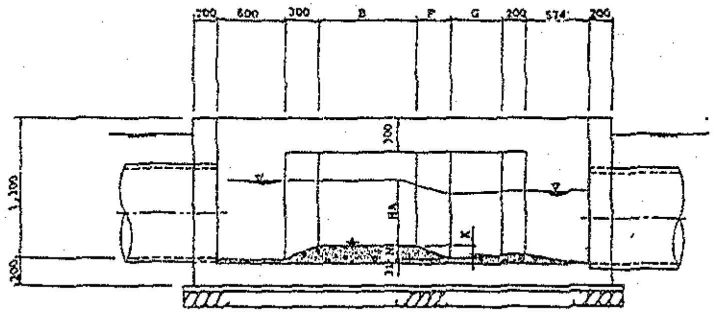
PLAN OF PAESHAL FLUME BOX - TYPE I



PLAN



SECTION B - B



SECTION A - A

Note: This Drawing shows the Case of THROAT W=9"

DIMENSION - TYPE I

(Unit : m/m)

Throat "W"			9" / 229	10" / 305	1'6" / 457
Dimension of Parshal Flume		A	879	1,372	1,448
		B	864	1,344	1,419
		C	381	610	762
		D	575	845	1,026
		F	305	610	610
		G	457	914	914
		K	76	76	76
		N	114	229	229
Measuring Range	Minimum	Hb	30	61	61
		m3/day	220.5	856.5	1,250
		m3/sec.	0.00255	0.00992	0.01445
	Maximum	HA	579	762	762
		m3/day	20,500	39,400	60,250
		m3/sec.	0.1325	0.4558	0.6900

FIGURE A28-20

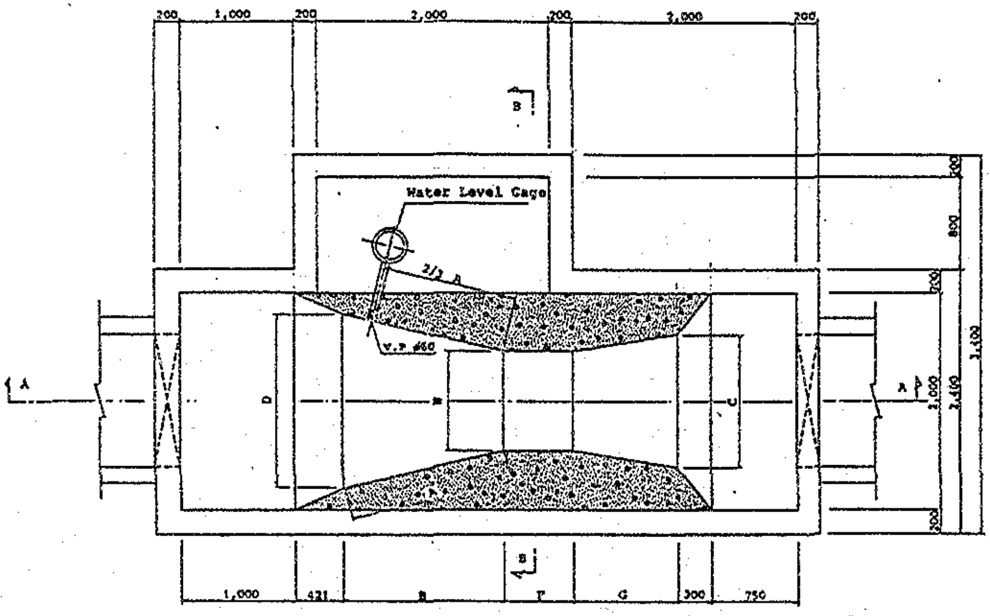
SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

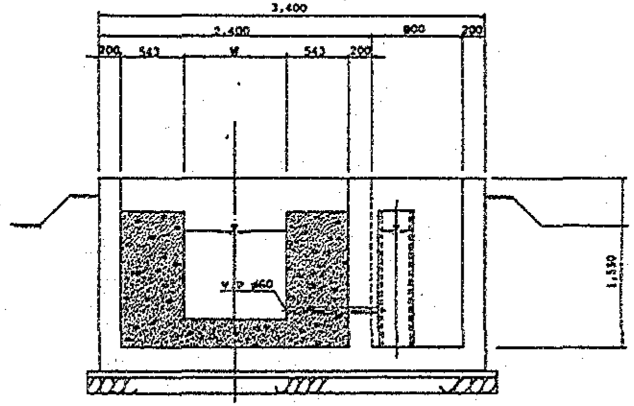
TITLE: PLAN OF PARSHALL FLUME BOX TYPE I

SCALE: as shown | DATE: - -'90 | DRAWING No.:

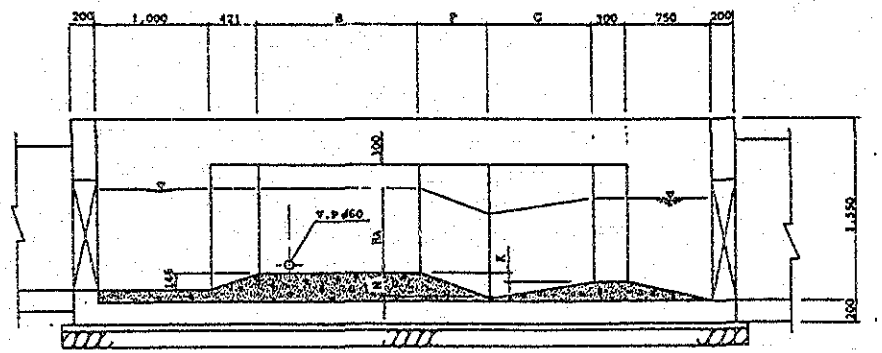
JAPAN INTERNATIONAL COOPERATION AGENCY

PLAN OF PARSHAL FLUME BOX - TYPE II





SECTION B - B



SECTION A - A

Note: This Drawing shows the Case of THROAT W=3'

DIMENSION - TYPE II

(Unit : m/m)

Throat "W"			3' / 914	4' / 1,219	6' / 1,829	8' / 2,438
Dimension of Parshal Flume		A	1,676	1,829	2,134	2,438
		B	1,646	1,794	2,094	2,137
		C	1,219	1,524	2,134	3,743
		D	1,572	1,937	2,667	3,397
		F	610	610	610	610
		G	914	914	914	914
		K	76	76	76	76
		N	229	229	229	229
Measuring Range	Minimum	Hq	61	61	91	91
		m³/day	2,378	3,088	8,625	11,208
		m³/sec.	0.02745	0.03573	0.09970	0.13100
	Maximum	HA	762	762	762	762
		m³/day	123,400	166,200	253,000	342,000
		m³/sec.	1.4280	1.925	2.925	3.931

FIGURE A28-21

SEDAPAL Servicio de Agua Potable y Alcantarillado de Lima FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA		
TITLE: PLAN OF PARSHALL FLUME BOX TYPE II		
SCALE: as shown	DATE: - -'90	DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY		

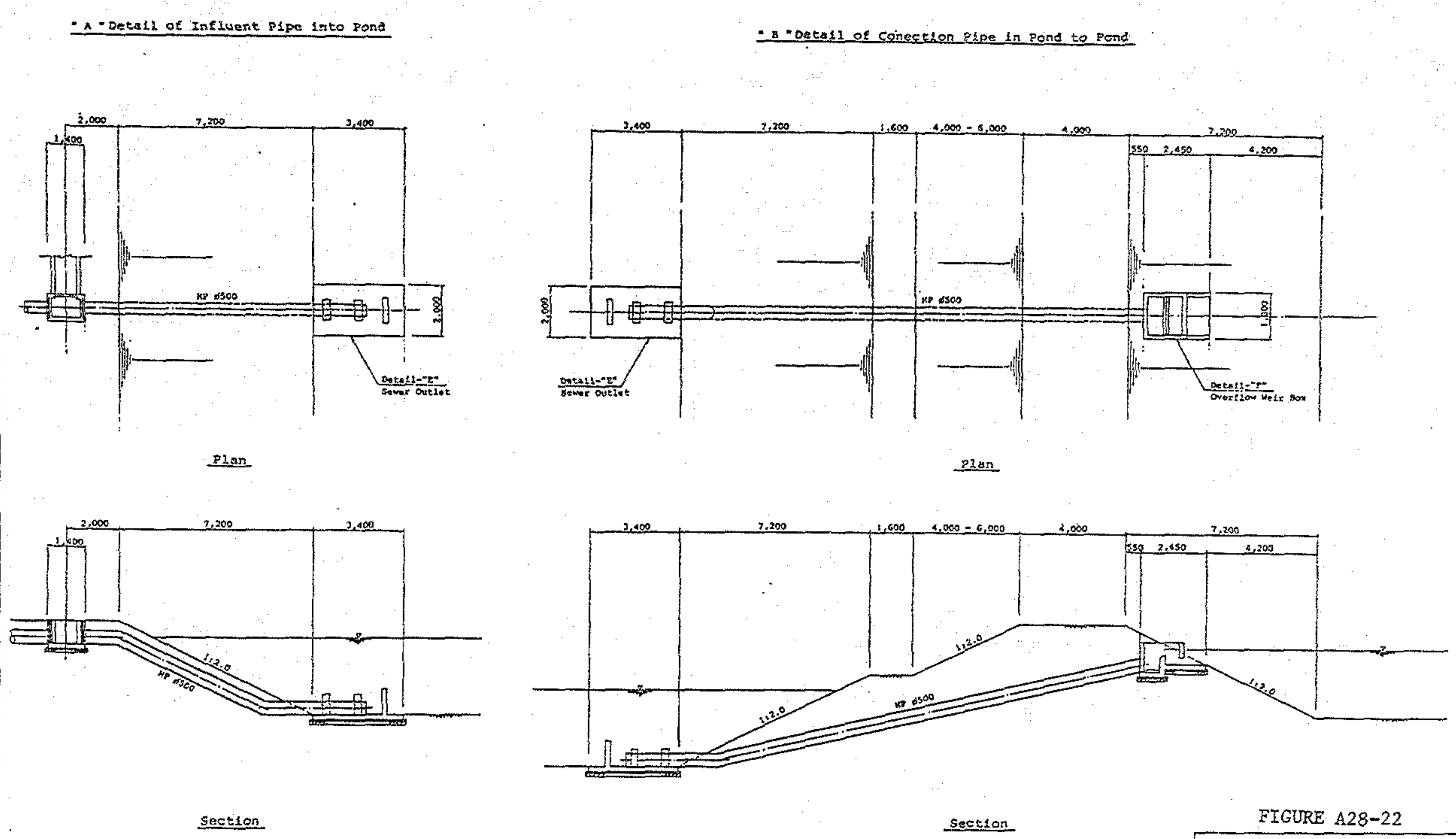


FIGURE A28-22

SEDAPAL

Servicio de Agua Potable y Alcantarillado de Lima

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: ACCESSORY FACILITIES OF PLANT No. 1

SCALE: as shown	DATE: - -'90	DRAWING No.:

JAPAN INTERNATIONAL COOPERATION AGENCY

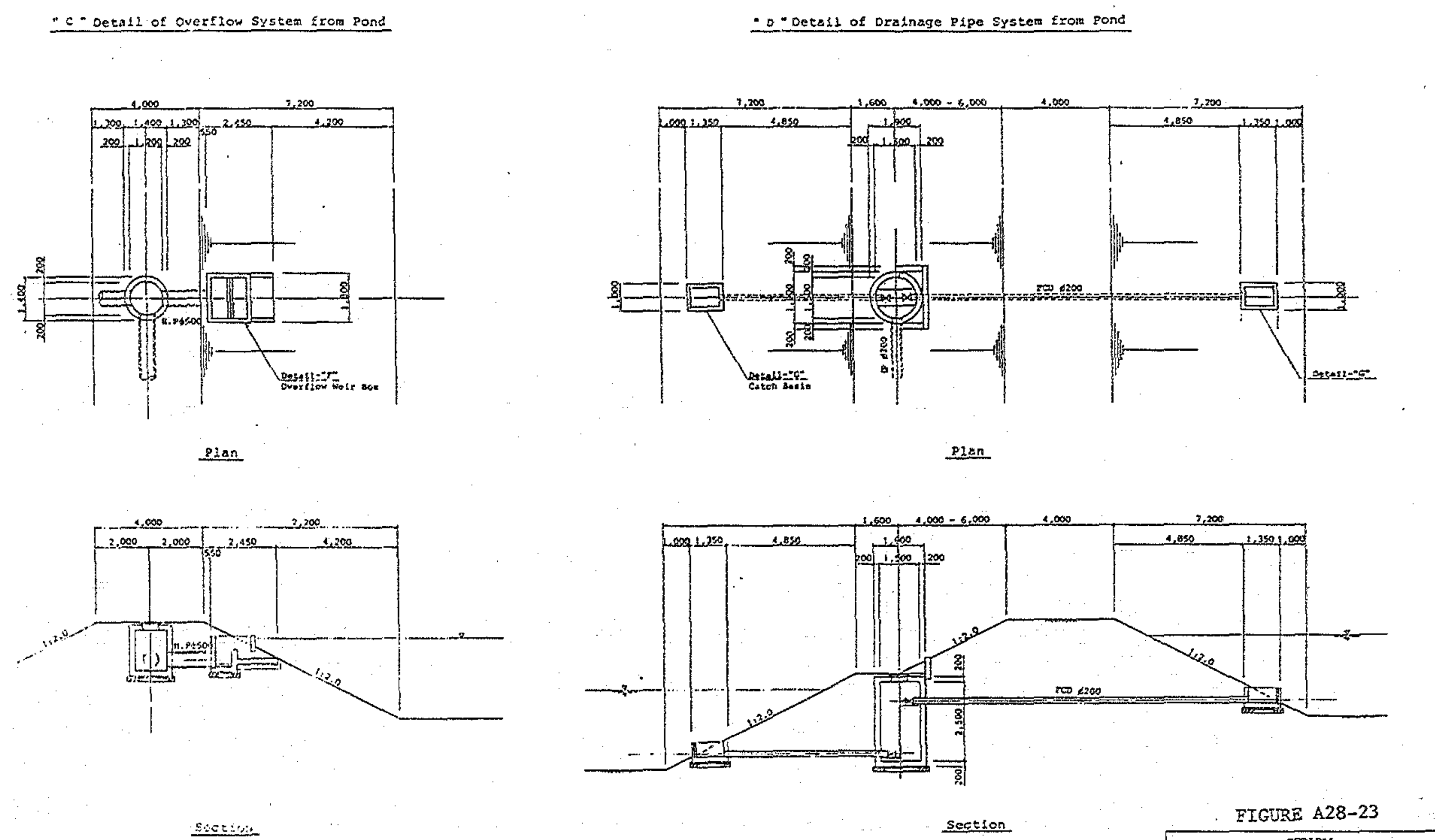


FIGURE A28-23

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: ACCESSORY FACILITIES OF PLANT No. 2

SCALE: as shown | DATE: - -'90 | DRAWING No.:

JAPAN INTERNATIONAL COOPERATION AGENCY

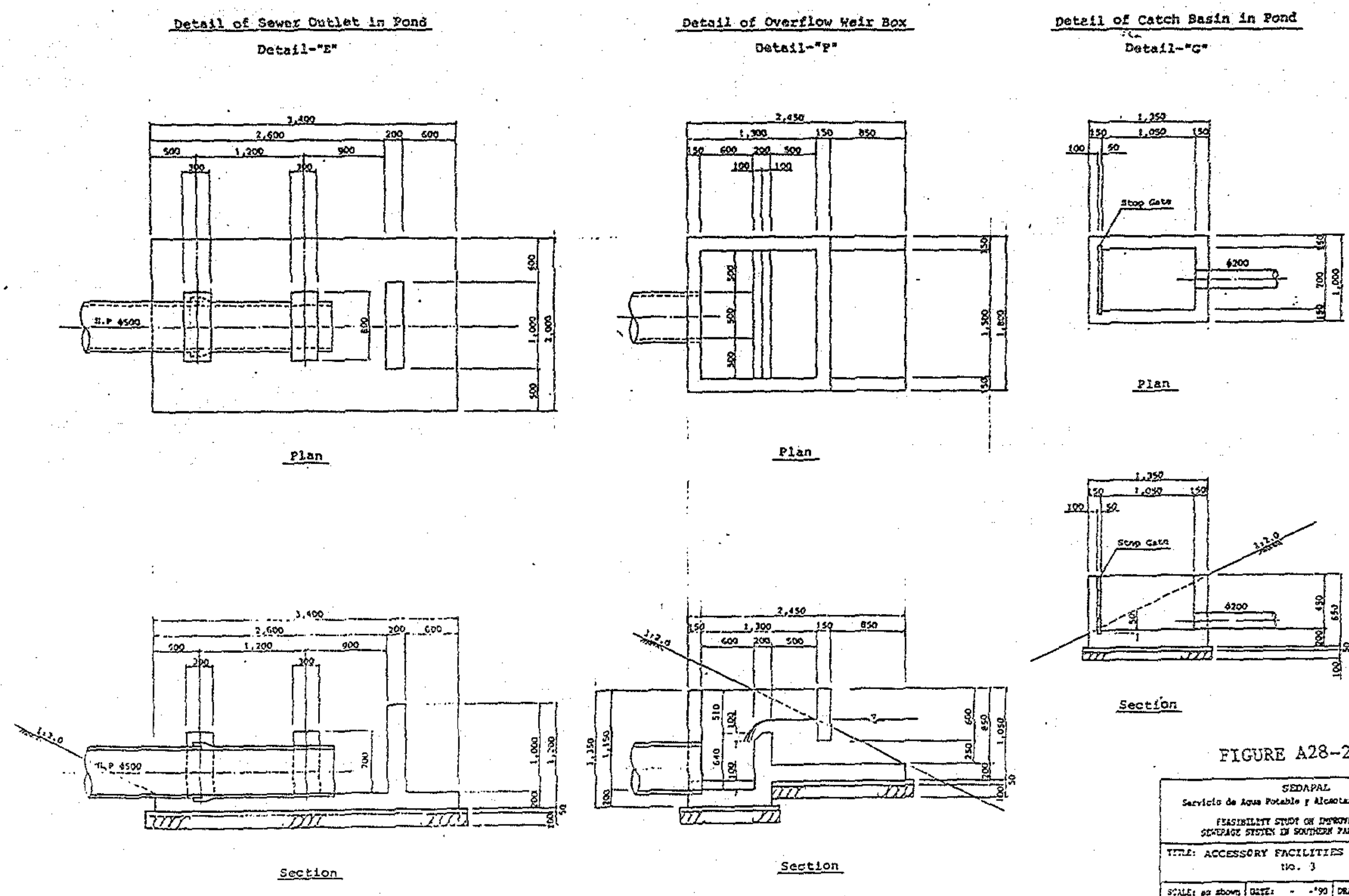
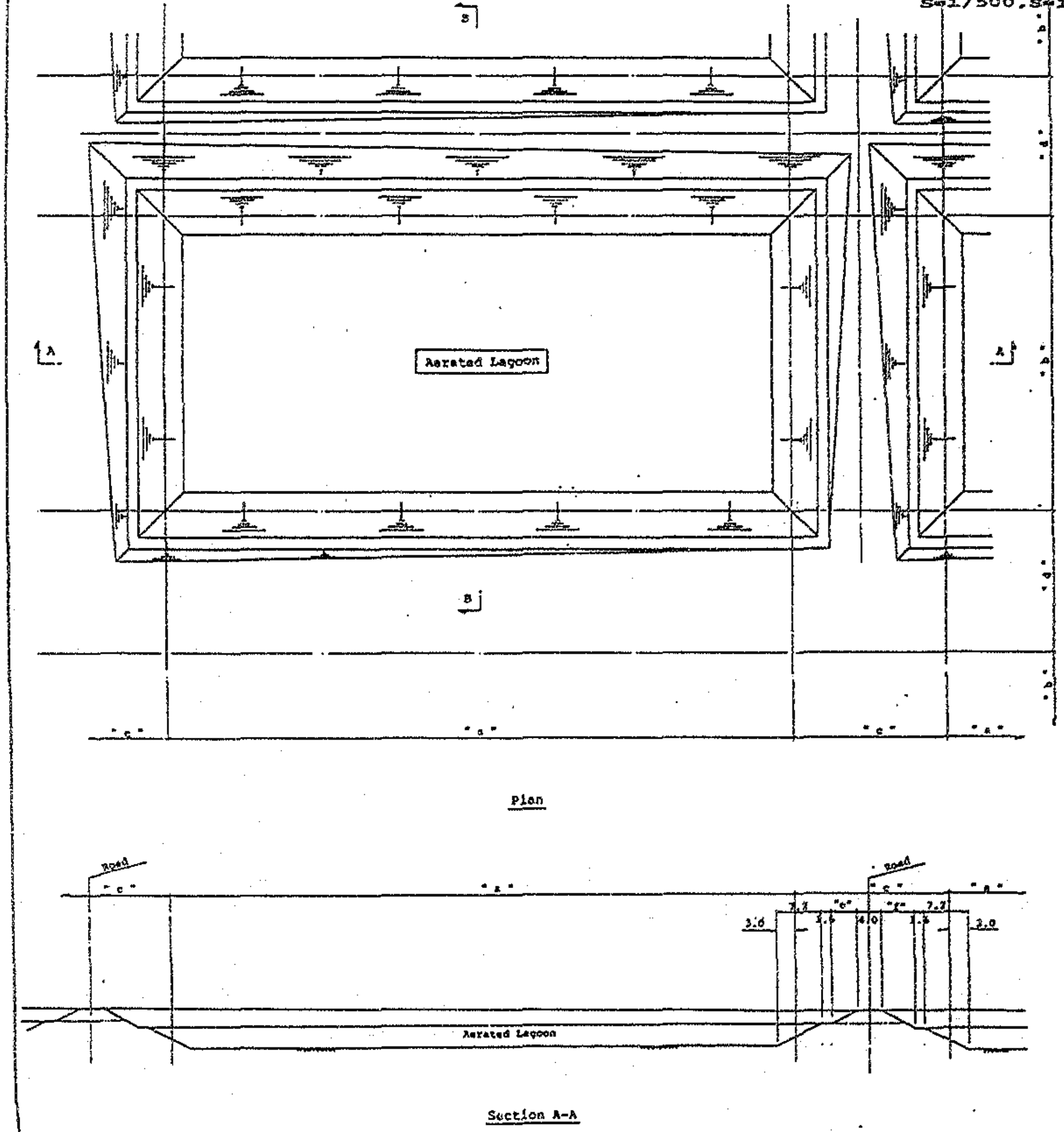


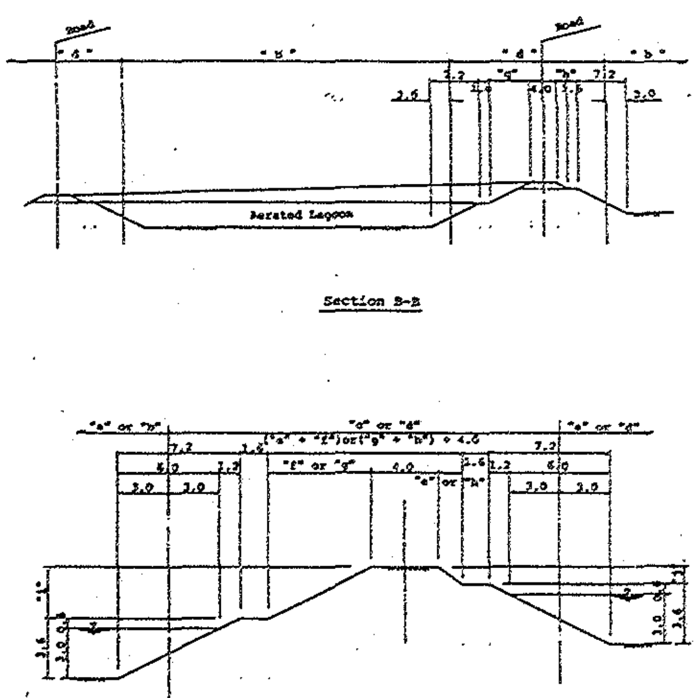
FIGURE A28-24

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima
FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA
TITLE: ACCESSORY FACILITIES OF PLANT No. 3
SCALE: as shown | DATE: - -'90 | DRAWING No.:
JAPAN INTERNATIONAL COOPERATION AGENCY

TYPICAL SECTION OF AERATED LAGOON

S=1/500, S=1/200





Dimention of Basin

	San Juan	El Salvador	Remarks
" a "	200.0	31.0	
" b "	48.0	46.0	
" c "	25.6	27.6	
" d "	23.6	27.6	
" e "	4.0	4.0	
" f "	6.0	8.0	
" g "	6.0	8.0	
" h "	2.0	4.0	
" i "	3.0	4.0	
" j "	"e"=2.0,"h"=1.0	2.0	

FIGURE A28-25

SEDAPAL
Servicio de Agua Potable y Alcantarillado de Lima

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

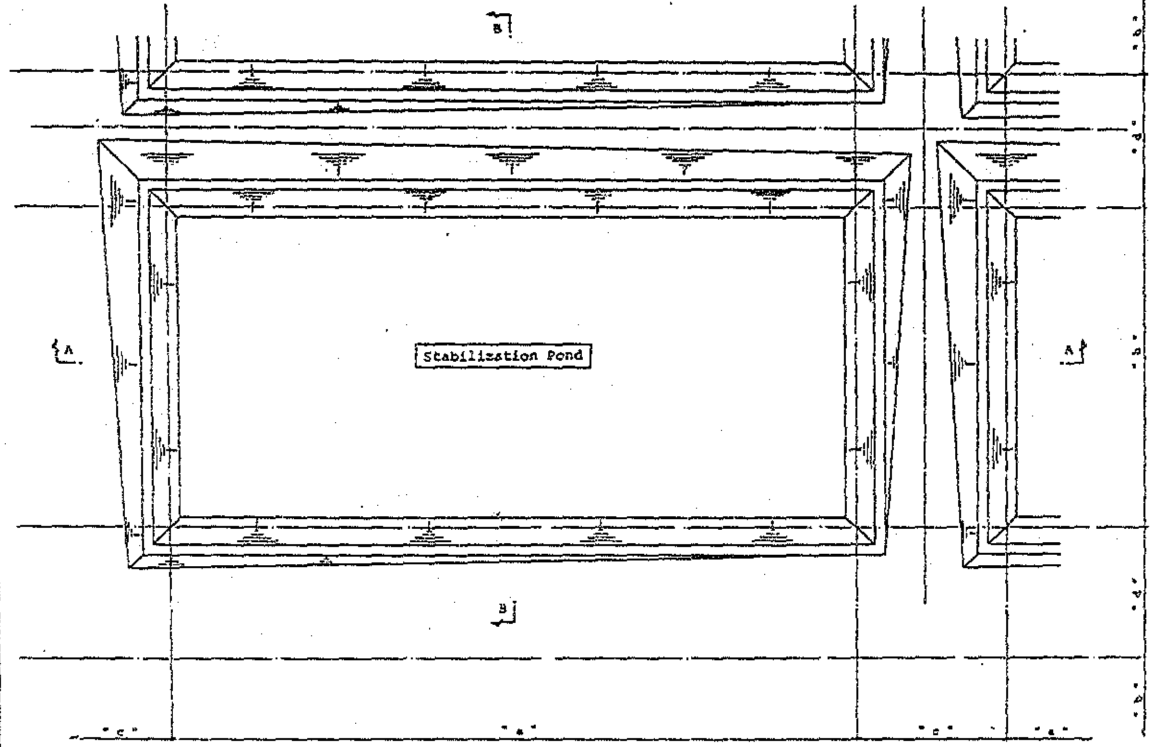
TITLE: TYPICAL SECTION OF AERATED LAGOON

SCALE: as shown | DATE: - -'90 | DRAWING No.:

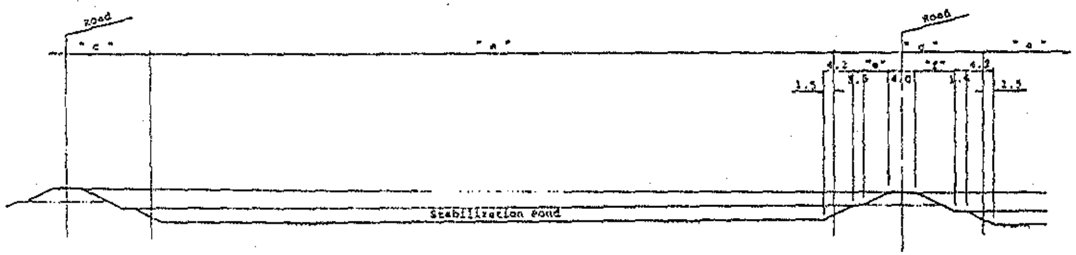
JAPAN INTERNATIONAL COOPERATION AGENCY

TYPICAL SECTION OF STABILIZATION POND

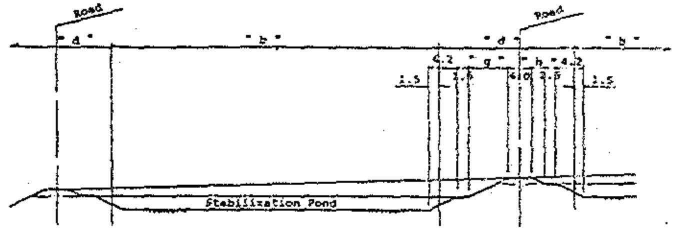
S=1/500, S=1/200



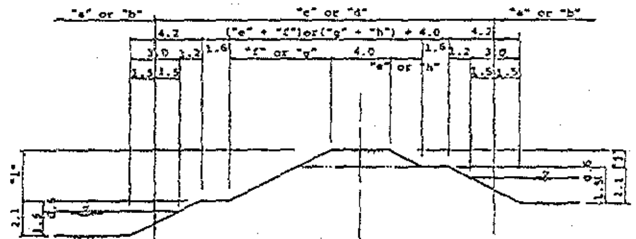
Plan



Section A-A



Section B-B



Dimention of Basin

	Son Juan	El Salvador	Remarks
"a"	100.0	109.0	
"b"	46.0	54.0	
"c"	22.6	27.6	
"d"	20.6	27.6	
"e"	4.0	4.0	
"f"	6.0	8.0	
"g"	6.0	8.0	
"h"	2.0	4.0	
"i"	3.0	4.0	
"j"	"e"=2.0,"h"=1.0	2.0	

FIGURE A28-26

SEDAPAL

Servicio de Agua Potable y Alcantarillado de Lima

FEASIBILITY STUDY ON IMPROVEMENT OF SEWERAGE SYSTEM IN SOUTHERN PART OF LIMA

TITLE: TYPICAL SECTION OF STABILIZATION POND

SCALE: as shown | DATE: - -'90 | DRAWING No.:

JAPAN INTERNATIONAL COOPERATION AGENCY

JICA