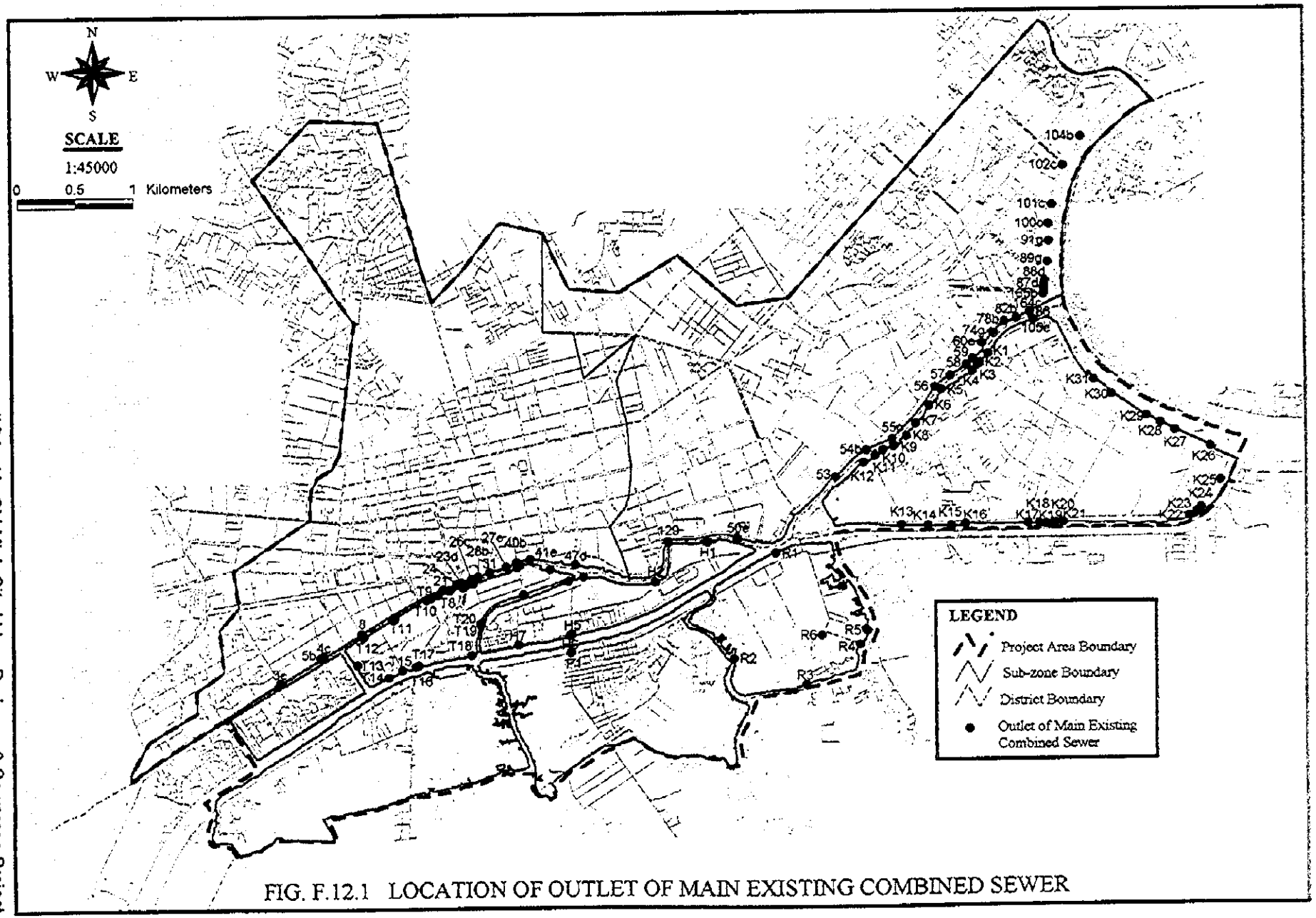


FIG. F.12.1 LOCATION OF OUTLET OF MAIN EXISTING COMBINED SEWER

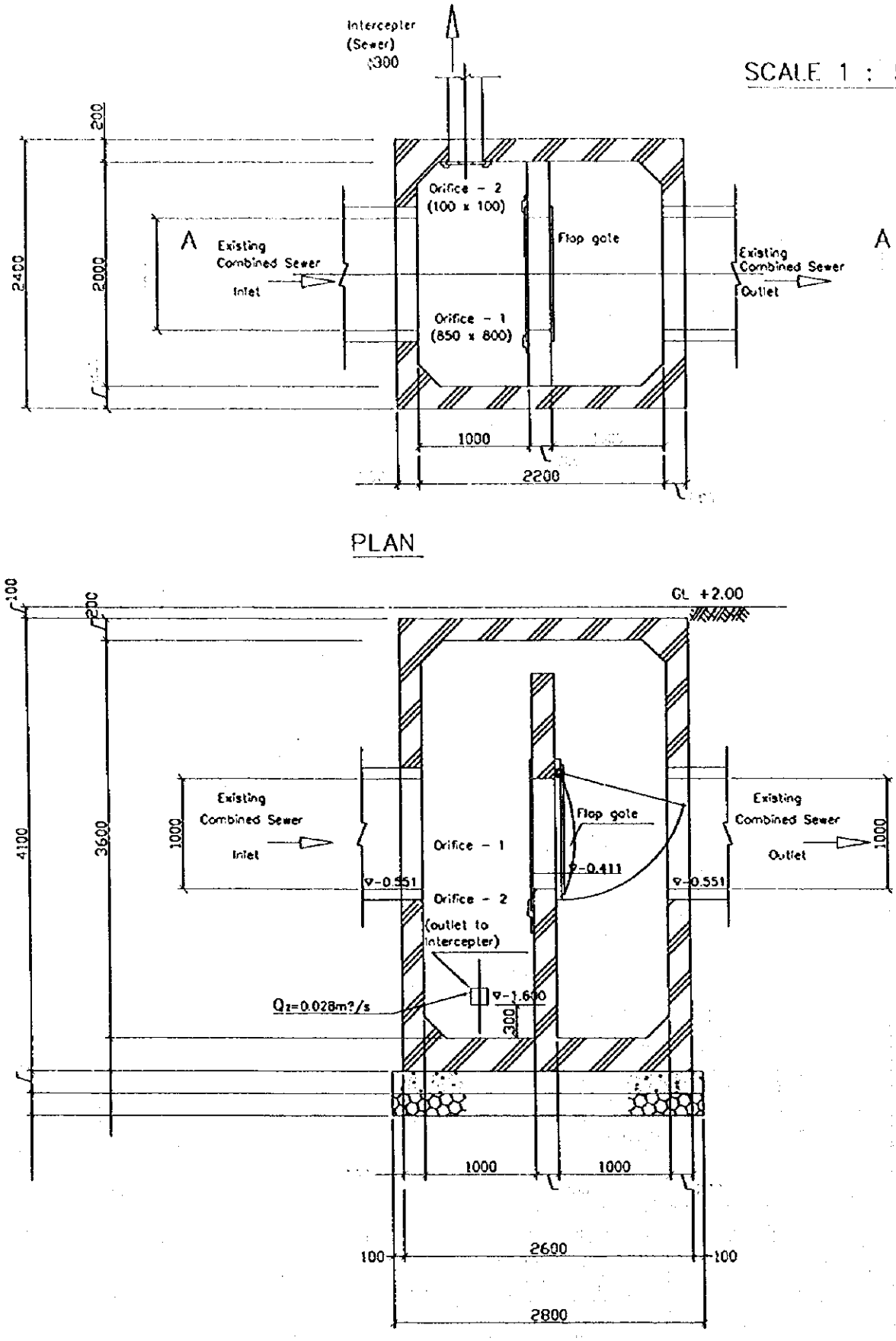
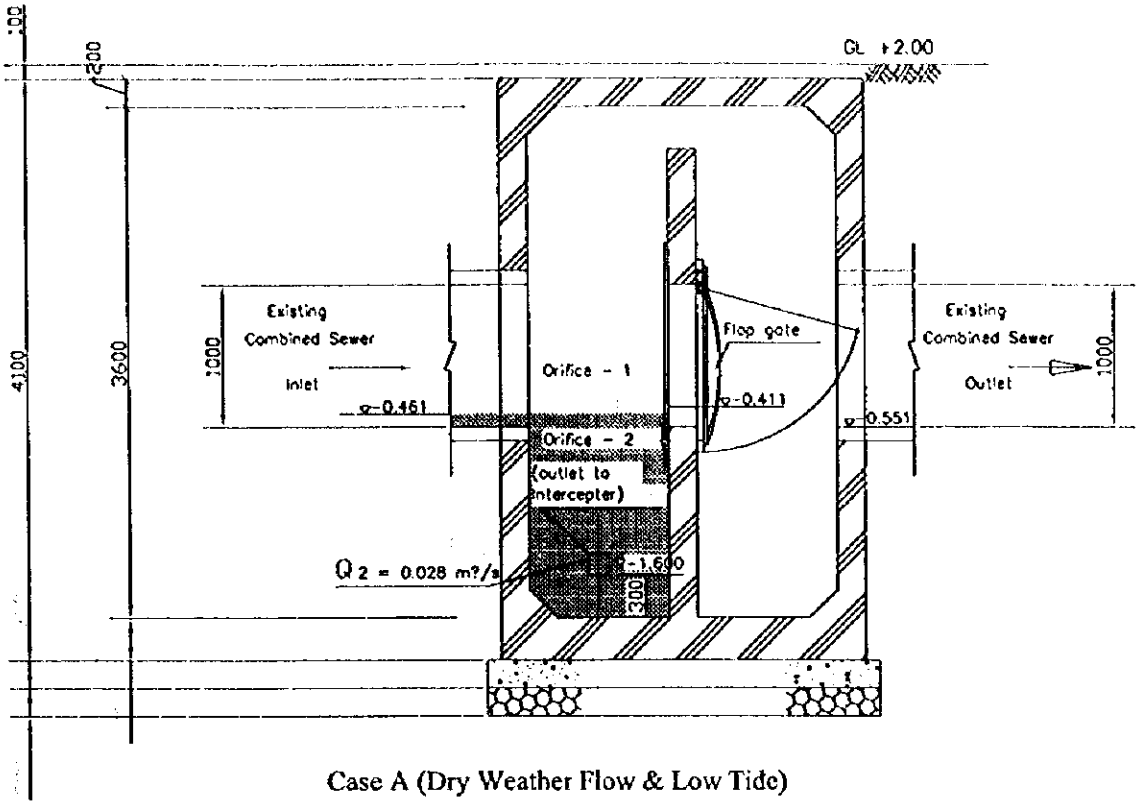
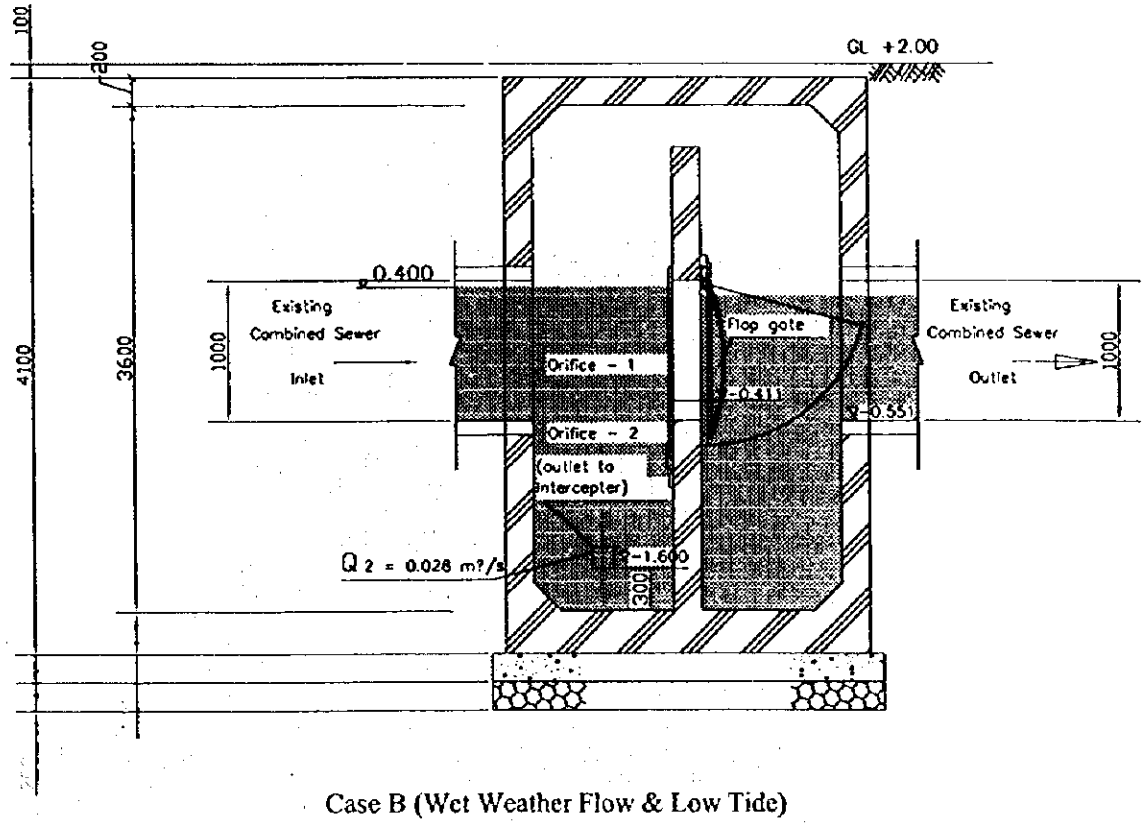


FIG. F.12.2 PROPOSED TYPICAL SECTION DIVERSION CHAMBER

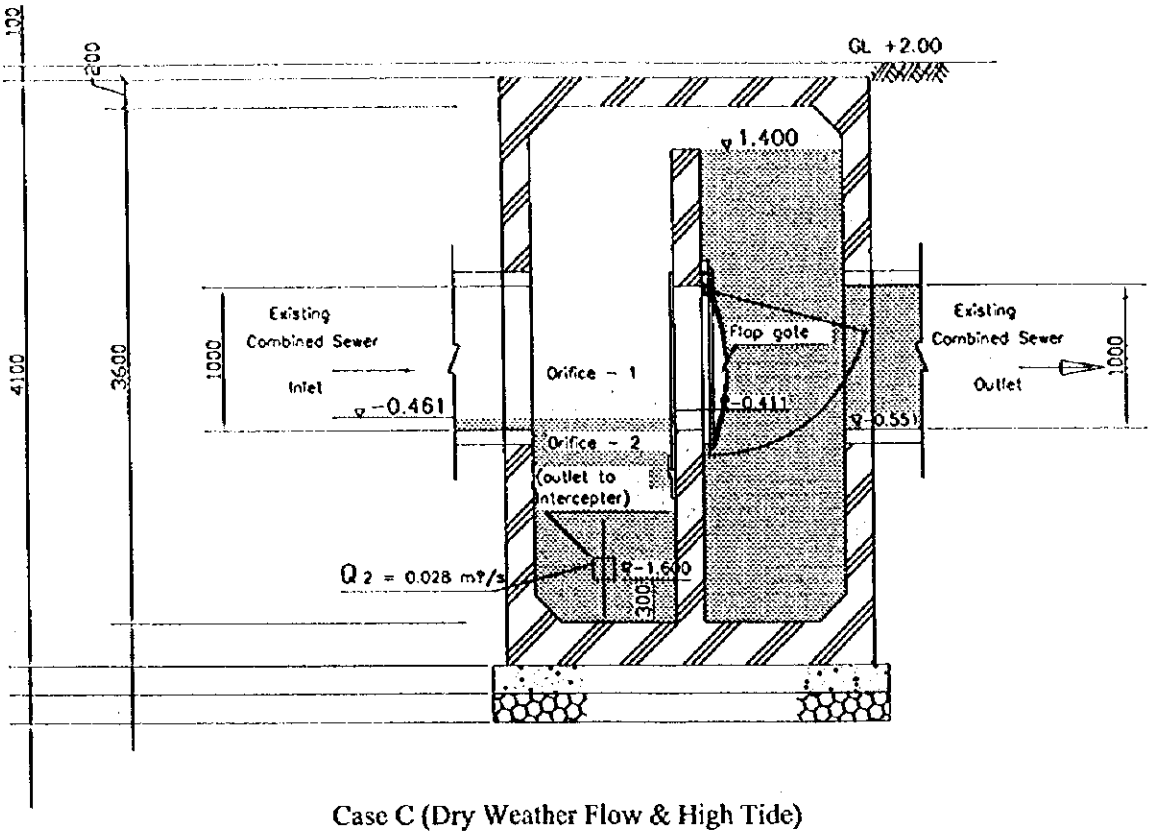


Case A (Dry Weather Flow & Low Tide)

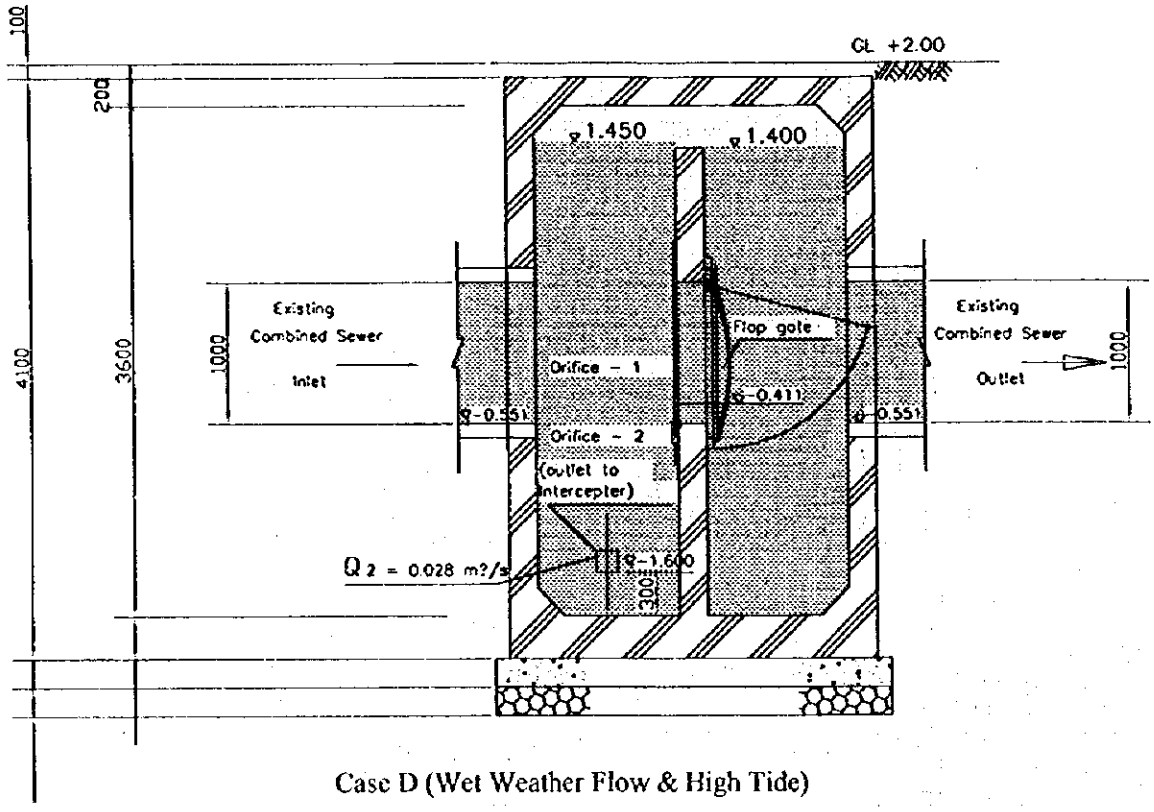


Case B (Wet Weather Flow & Low Tide)

FIG. F.12.3 HYDRAULIC CONDITION OF DIVERSION CHAMBER (CASE A & B)



Case C (Dry Weather Flow & High Tide)



Case D (Wet Weather Flow & High Tide)

FIG. F.12.4 HYDRAULIC CONDITION OF DIVERSION CHAMBER (CASE C & D)

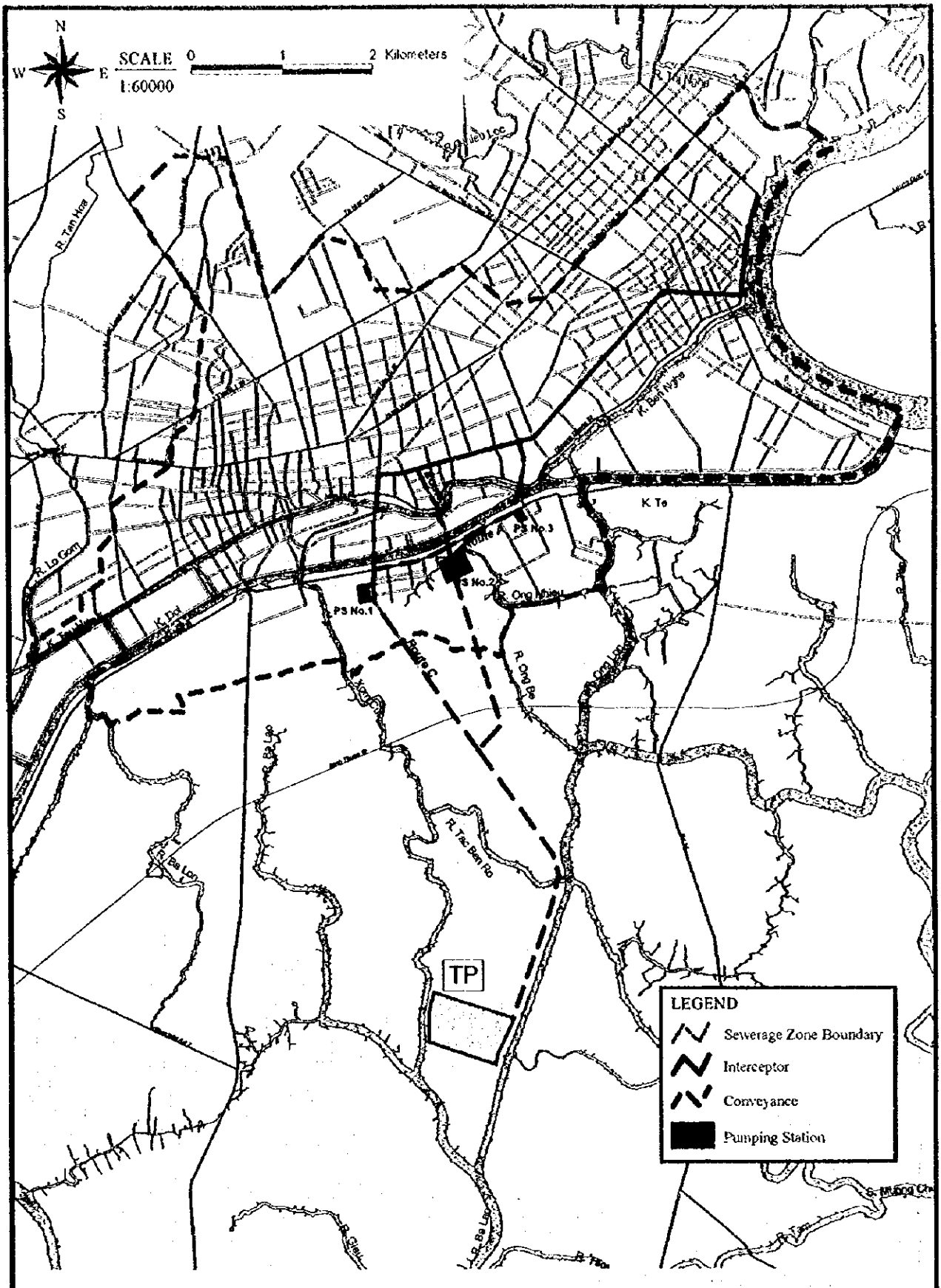


FIG. F.13.1 ALTERNATIVE STUDY ON CONVEYANCE ROUTE

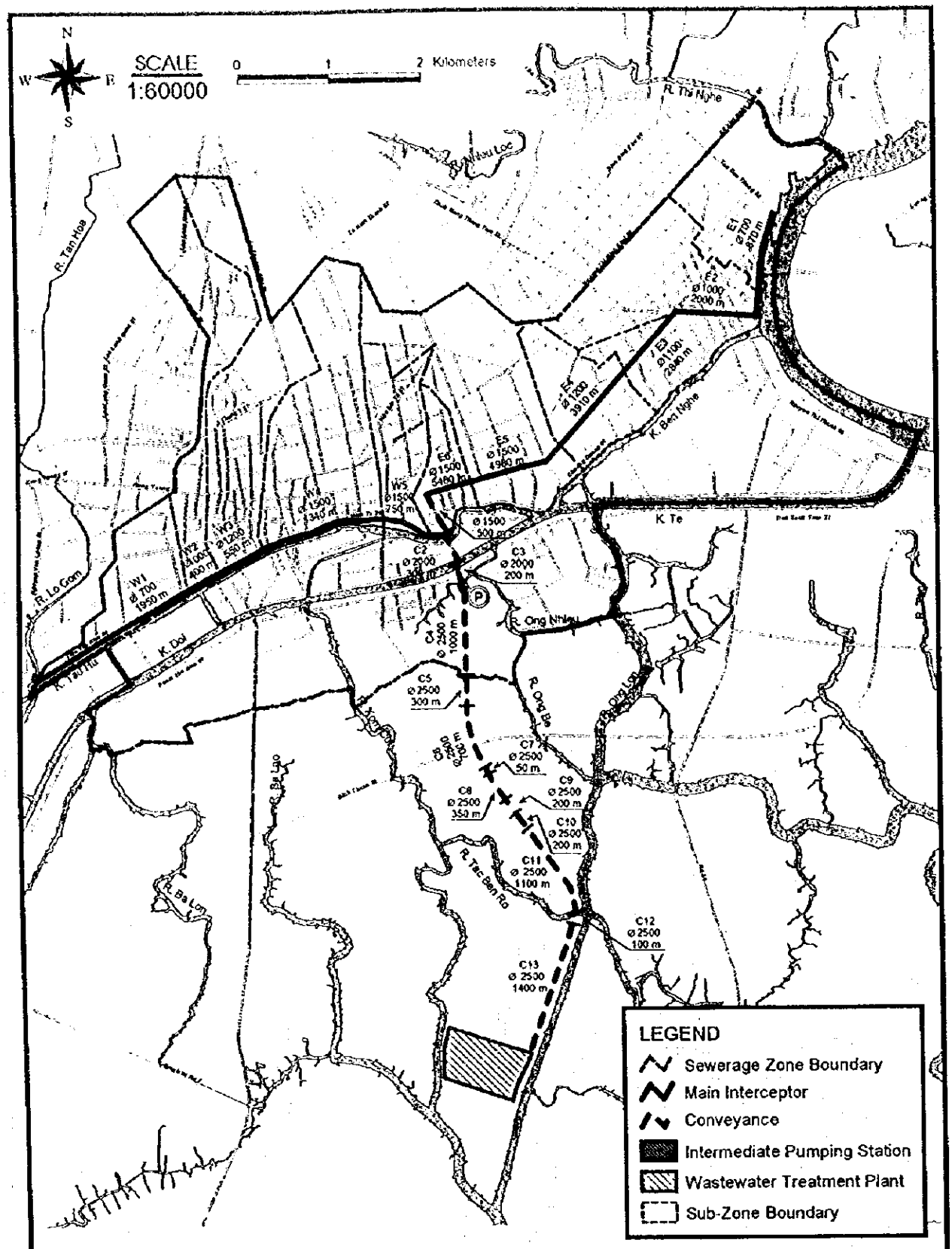


FIG.F.13.2 PROPOSED ALIGNMENTS OF INTERCEPTOR SEWERS

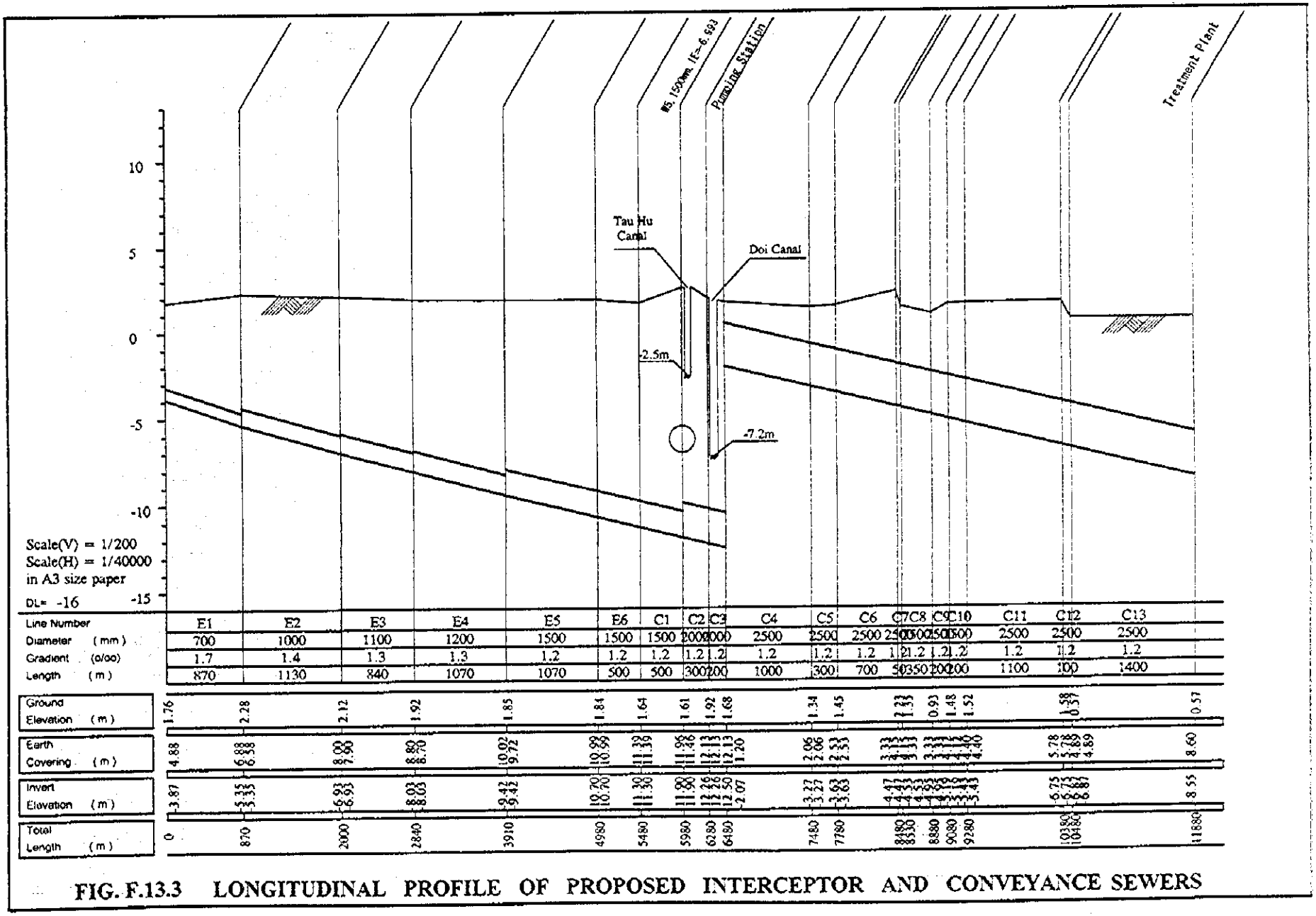


FIG. F.13.3 LONGITUDINAL PROFILE OF PROPOSED INTERCEPTOR AND CONVEYANCE SEWERS

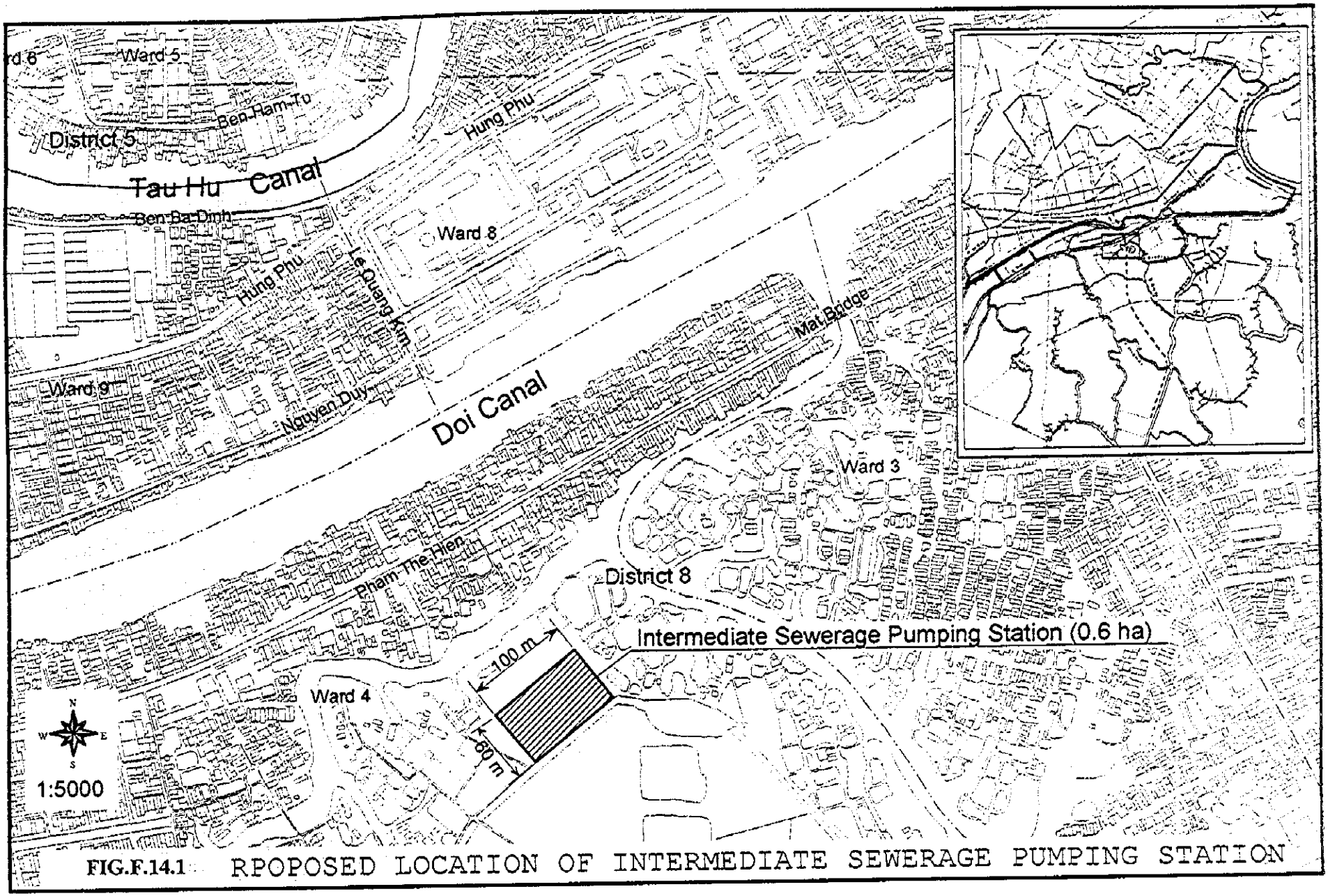
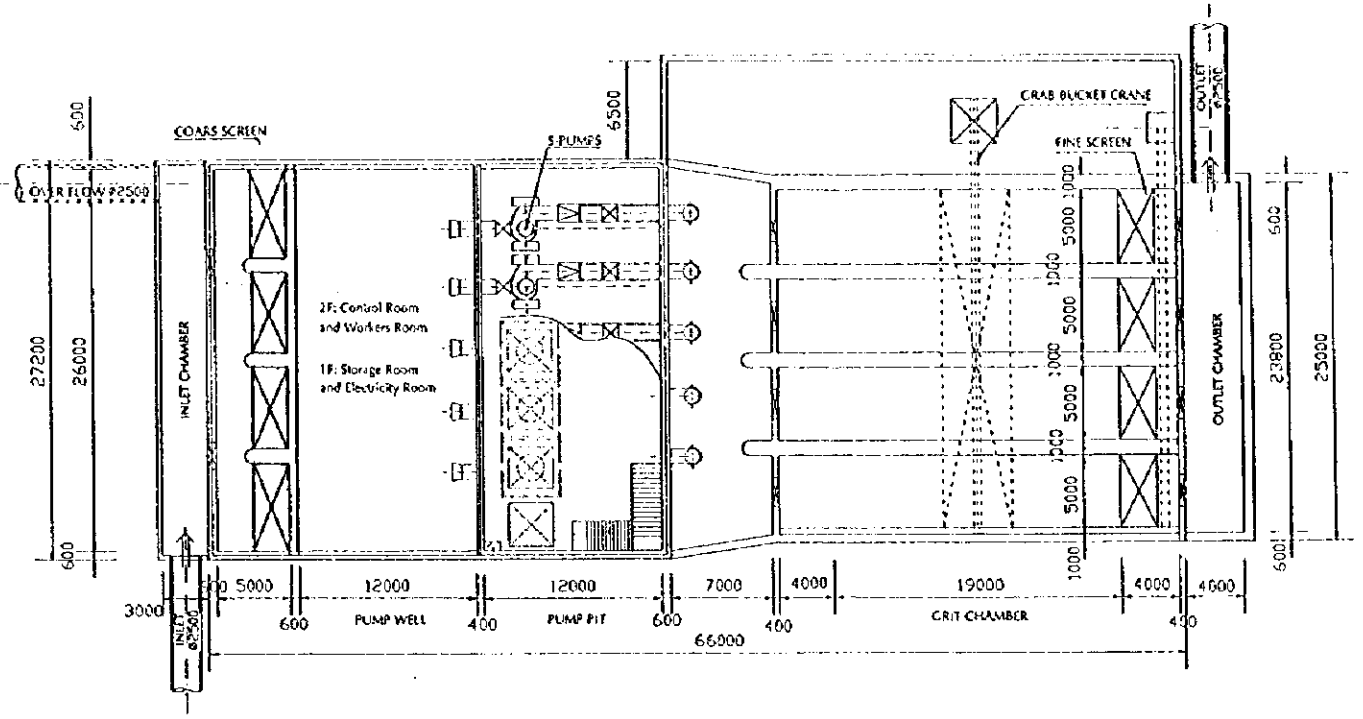


FIG.F.14.1 RPOPOSED LOCATION OF INTERMEDIATE SEWERAGE PUMPING STATION

SCALE 1:500



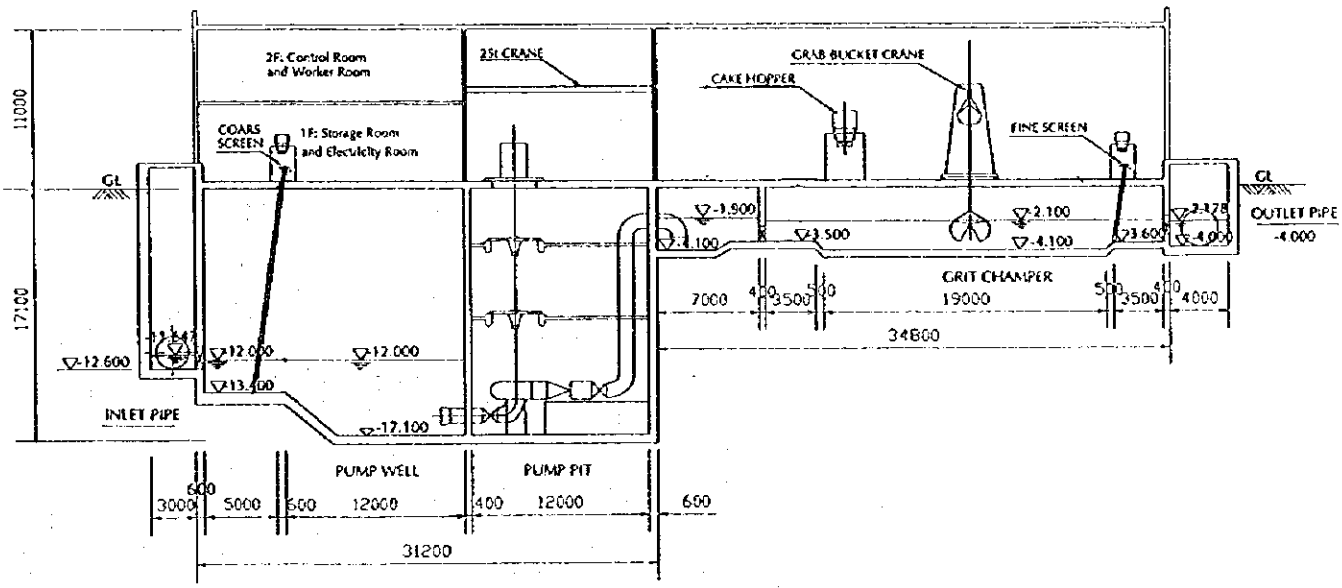


FIG. F. 14.2 COMPARISON STUDY ON INTERMEDIATE SEWAGE PUMPING STATION (OPTION A - PROPOSED)

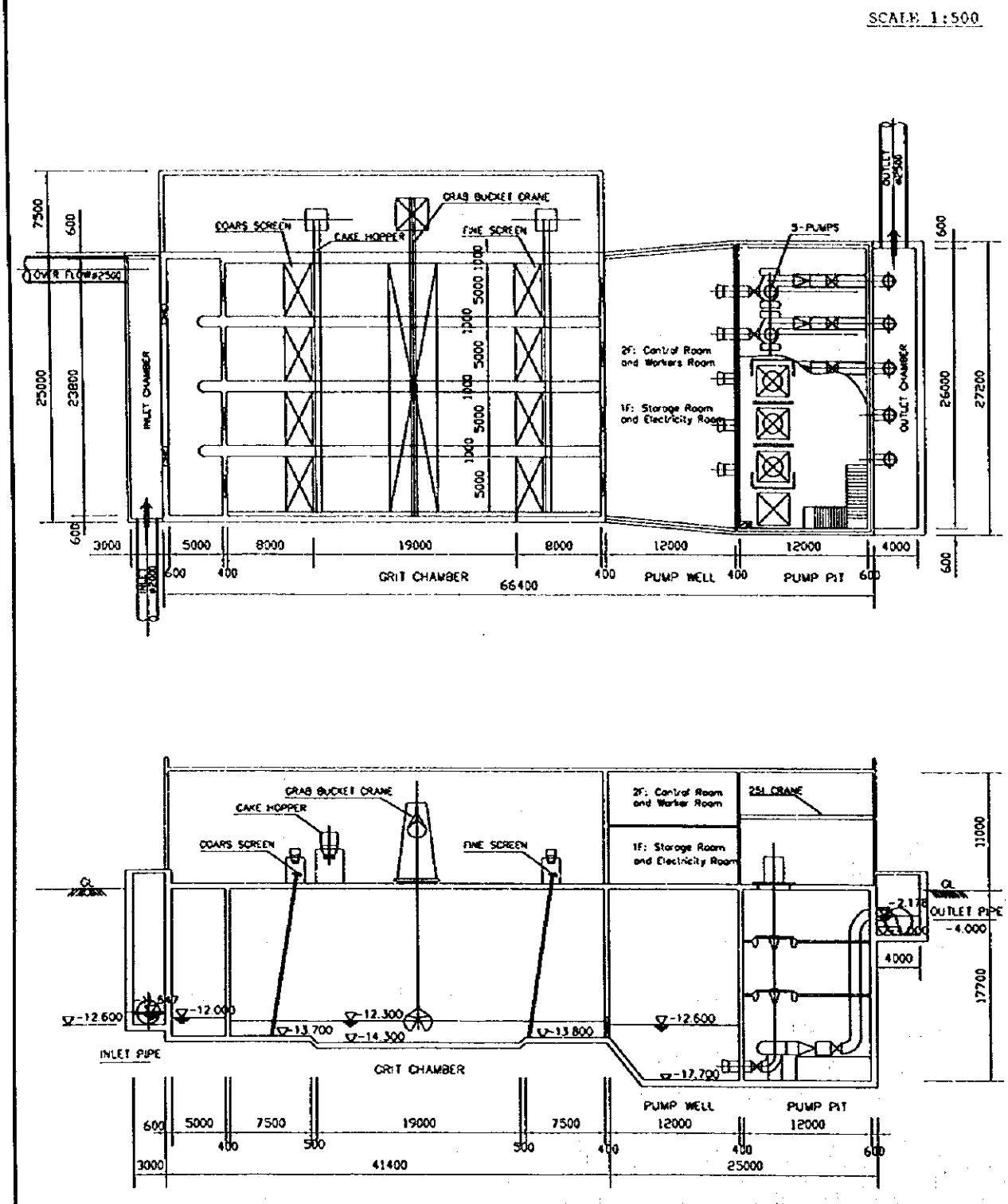


FIG. F. 14.3 COMPARISON STUDY ON INTERMEDIATE SEWAGE PUMPING STATION (OPTION B)

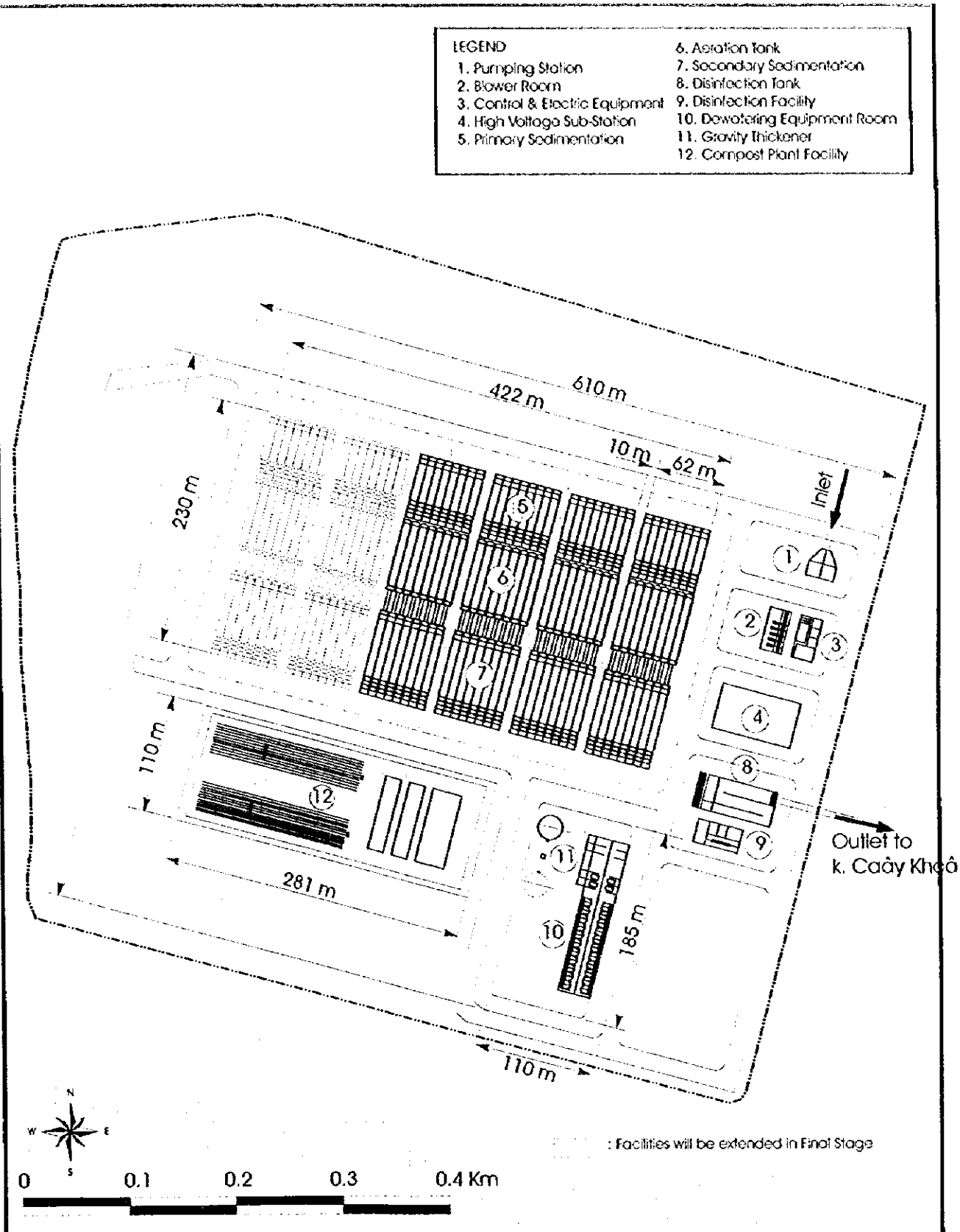


FIG. F.15.1 PROPOSED LAYOUT OF WASTEWATER TREATMENT PLANT

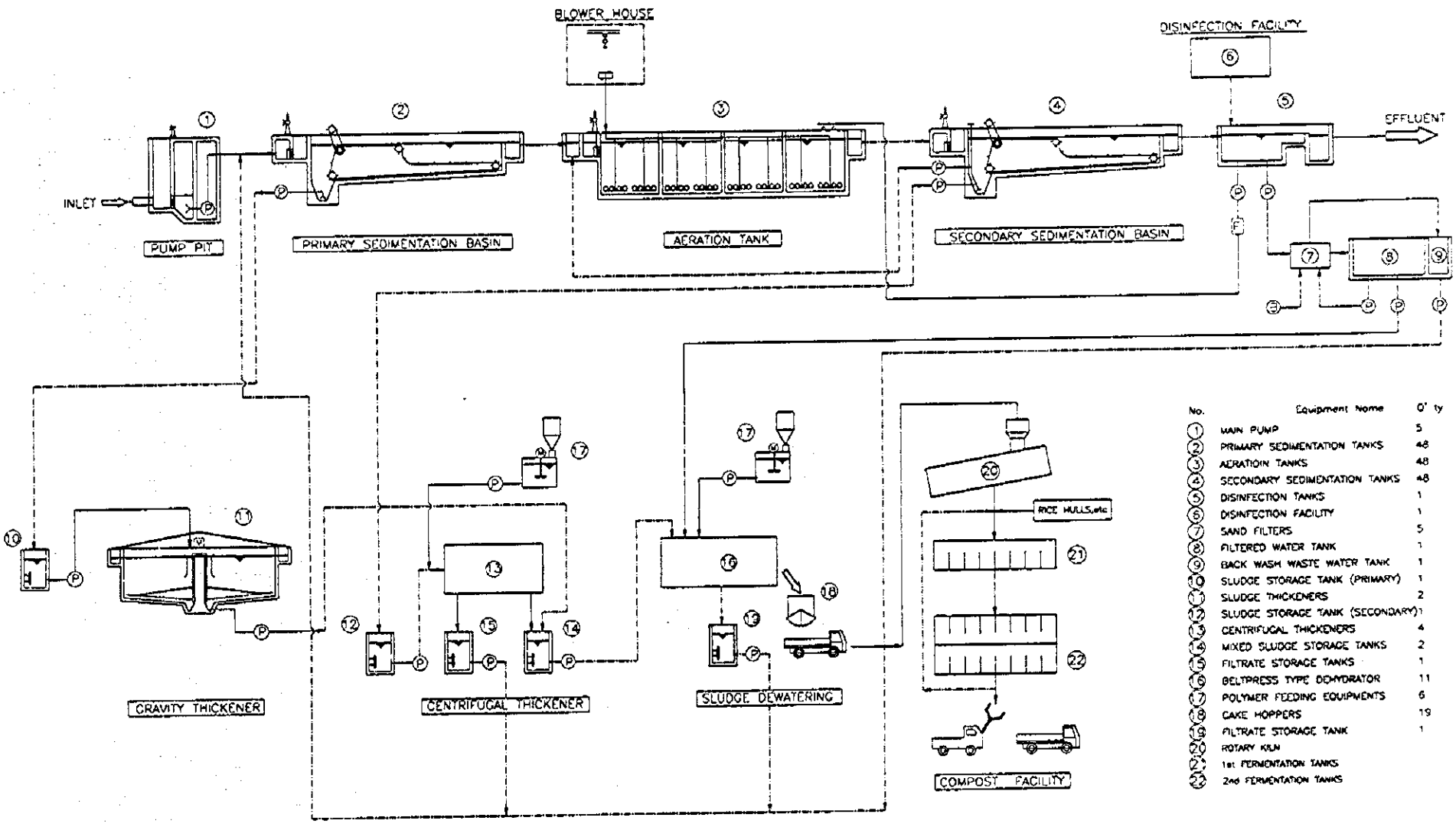


FIG.F.15.2 FLOW SHEET OF PROPOSED SYSTEM

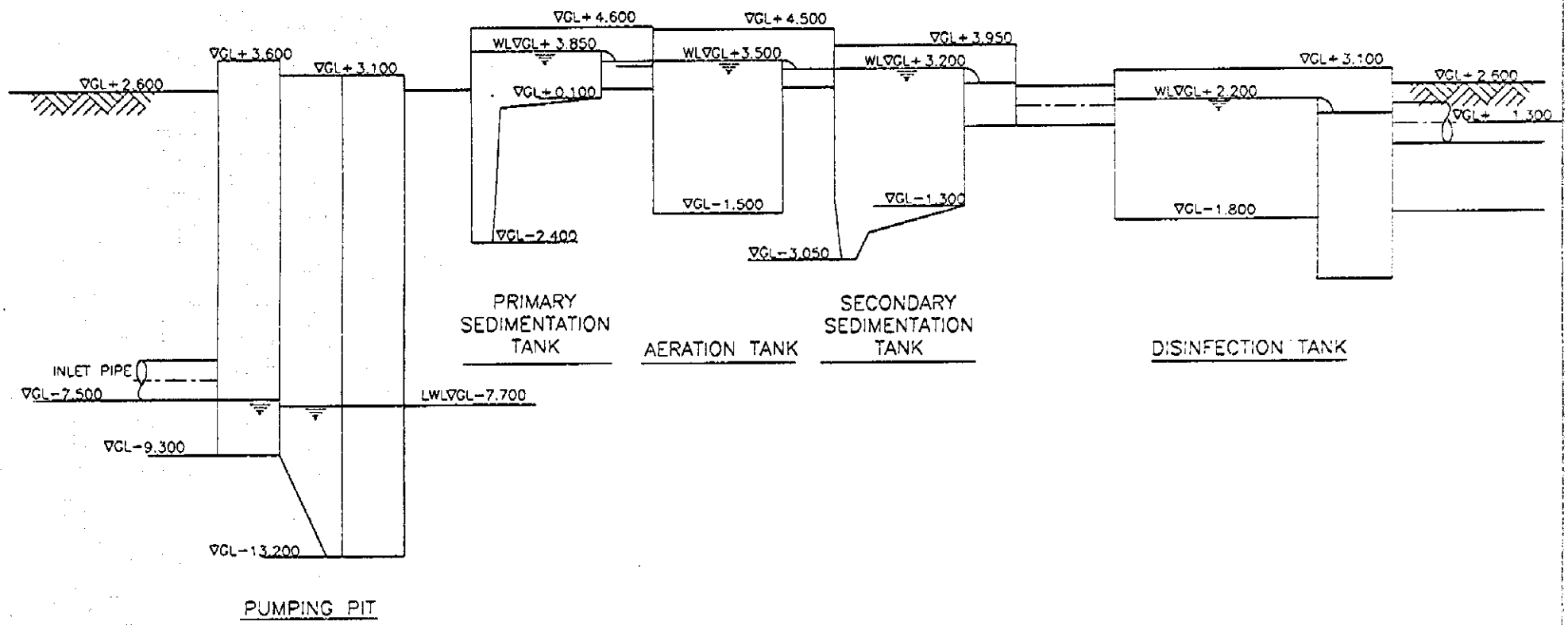


FIG. F.15.3 HYDRAULIC PROFILE OF THBNDT WASTEWATER TREATMENT PLANT

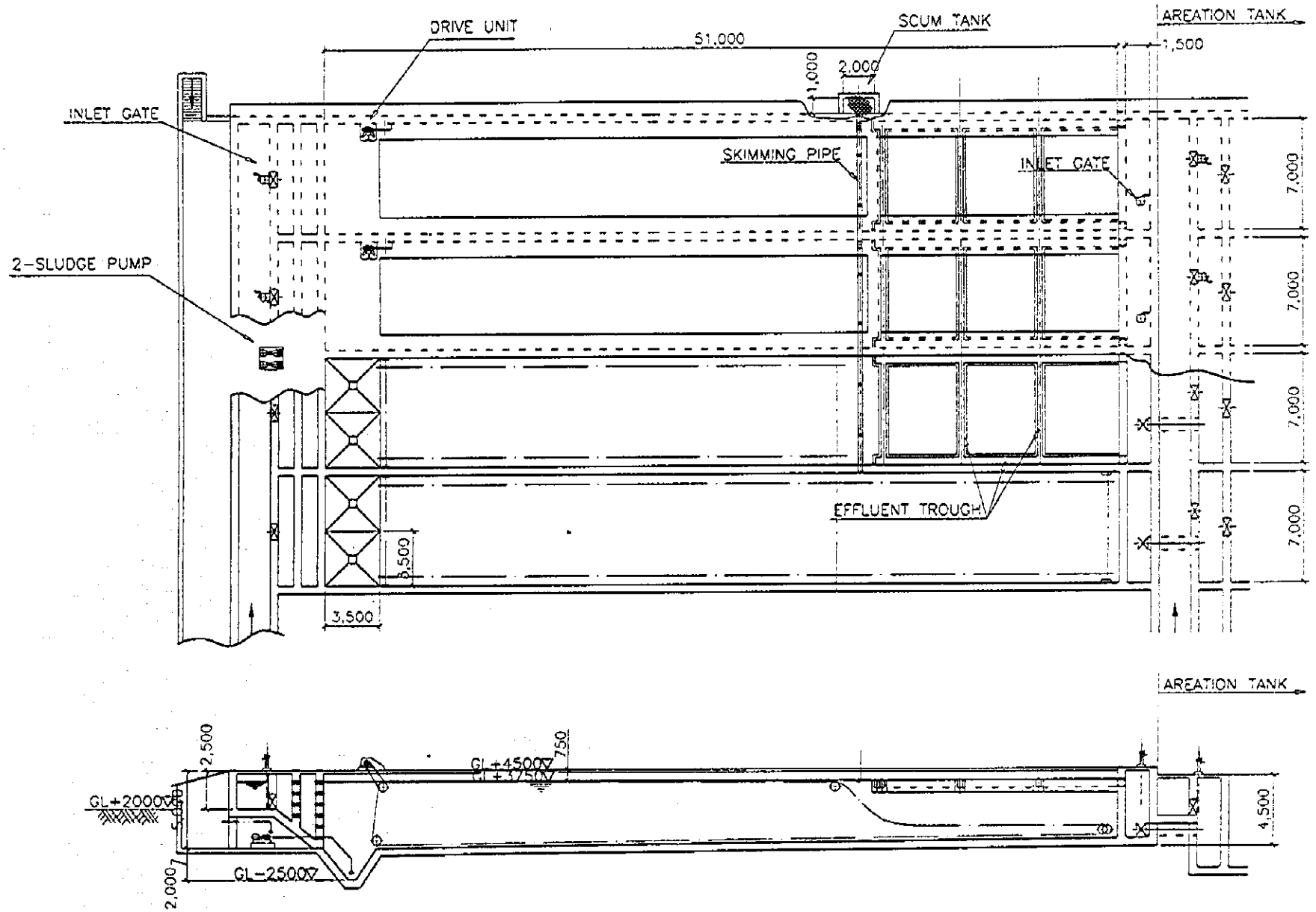


FIG. F.15.4 PROPOSED LAYOUT OF PRIMARY SEDMENTATION BASIN

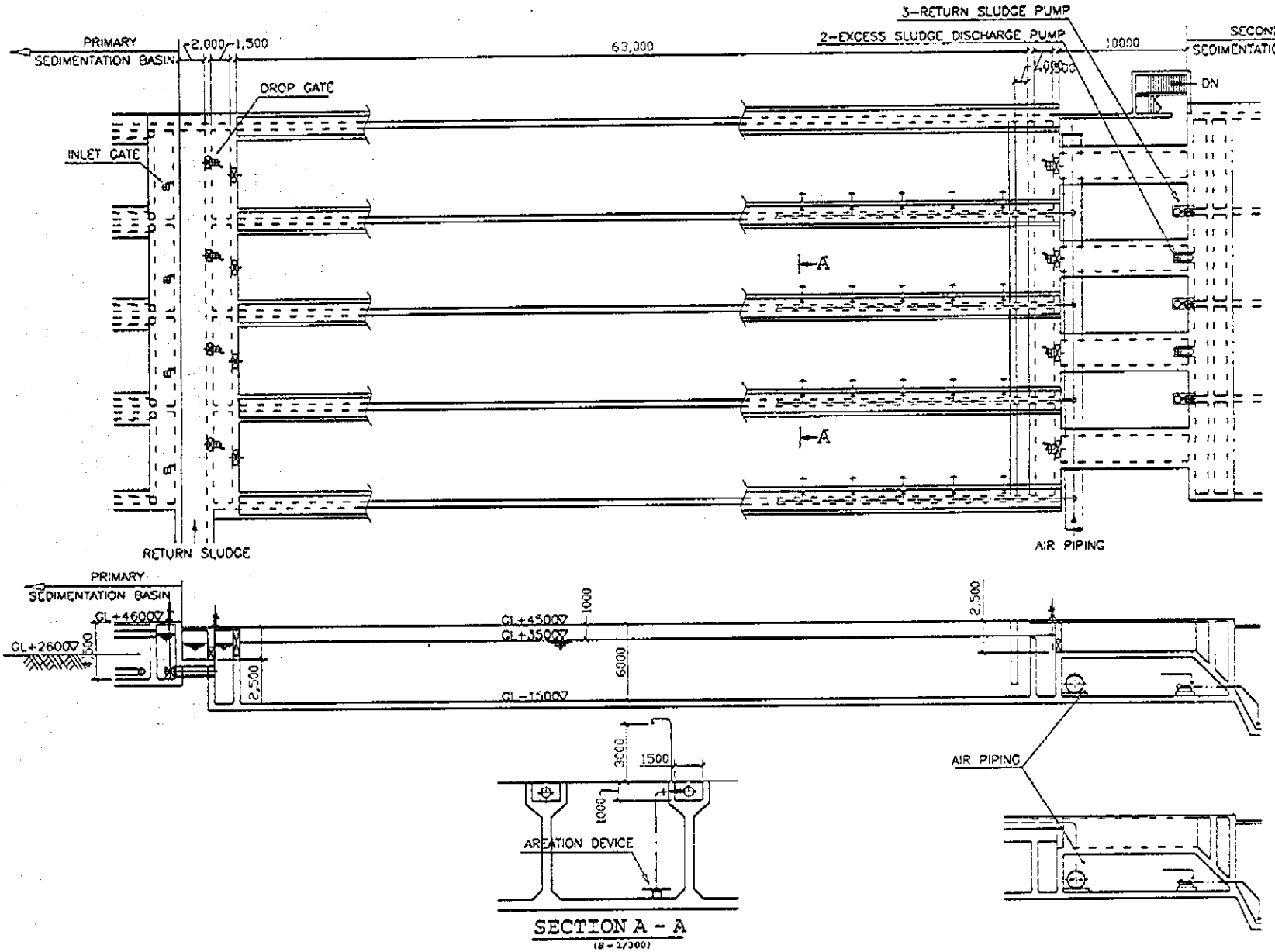


FIG. F.15.5 PROPOSED LAYOUT OF AERATION TANK

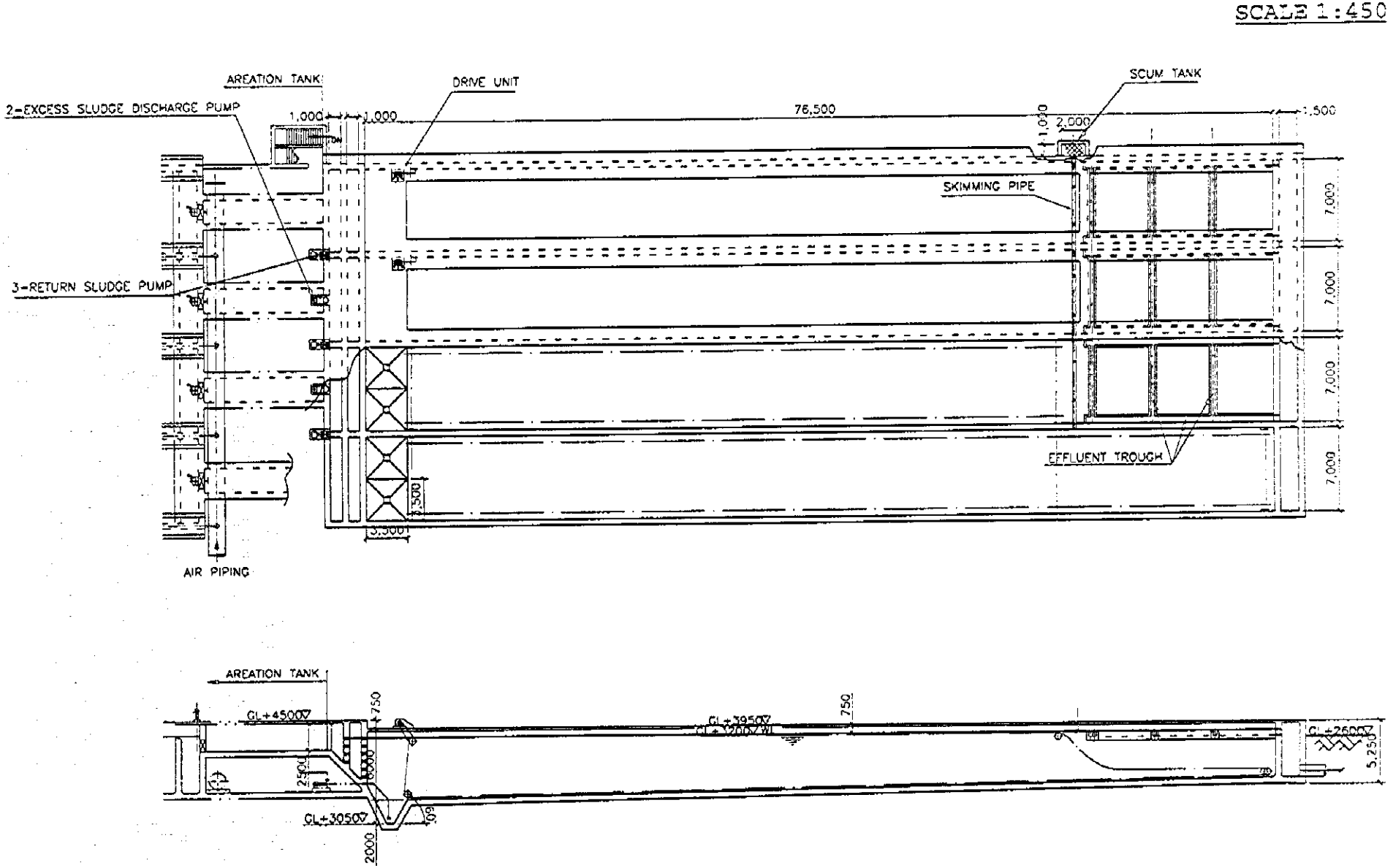
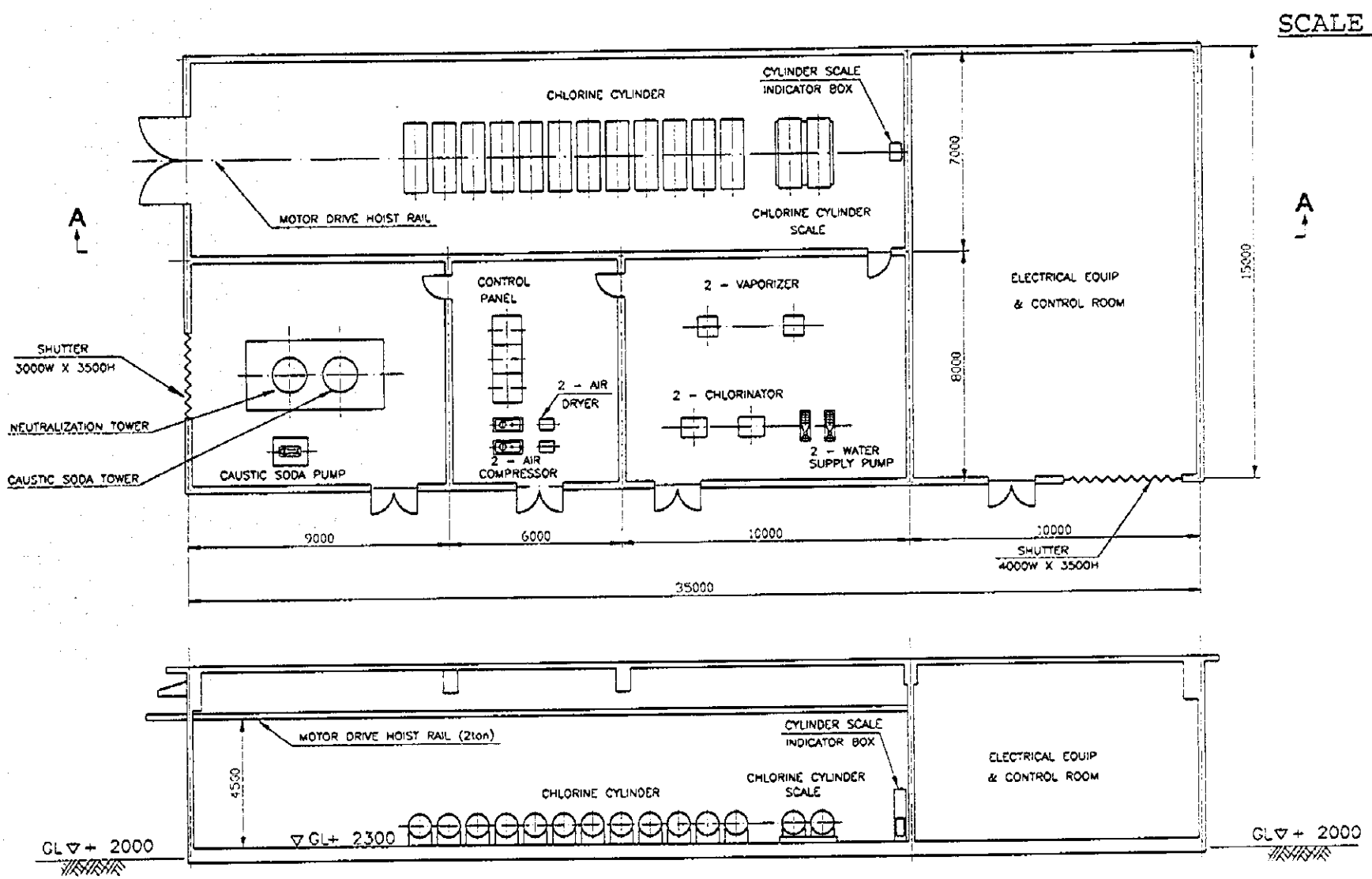


FIG. F.15.6 PROPOSED LAYOUT OF SECONDARY SEDIMENTATION BASIN



SECTION A - A

FIG. F.15.7 PROPOSED LAYOUT OF DISINFECTION FACILITY

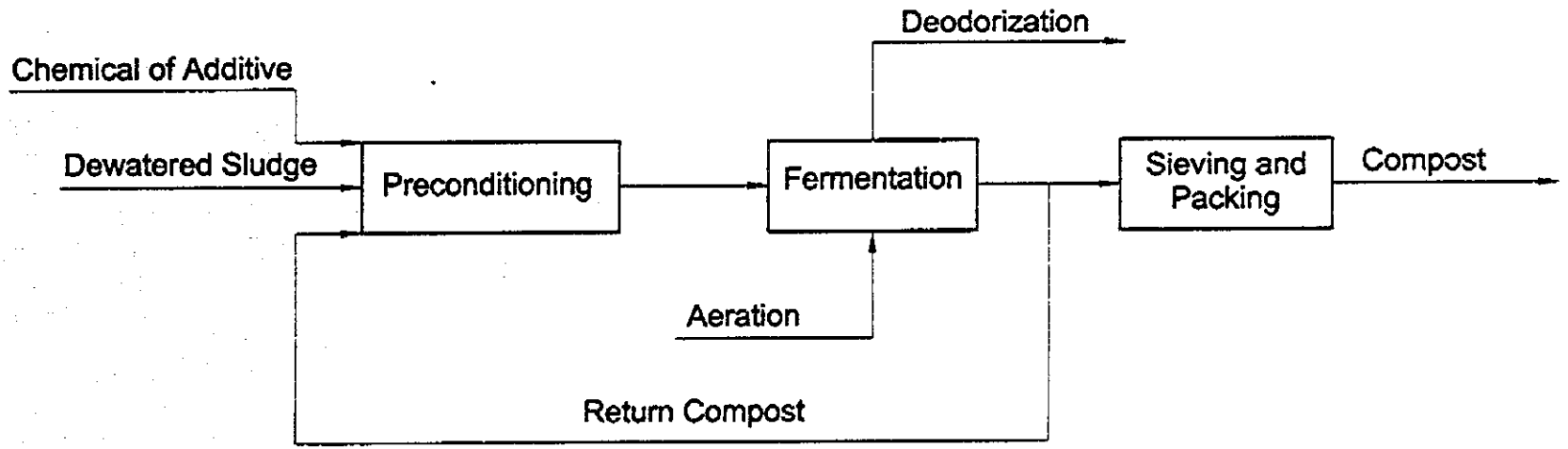


FIG. F.15.8 TYPICAL SLUDGE TREATMENT PROCESS

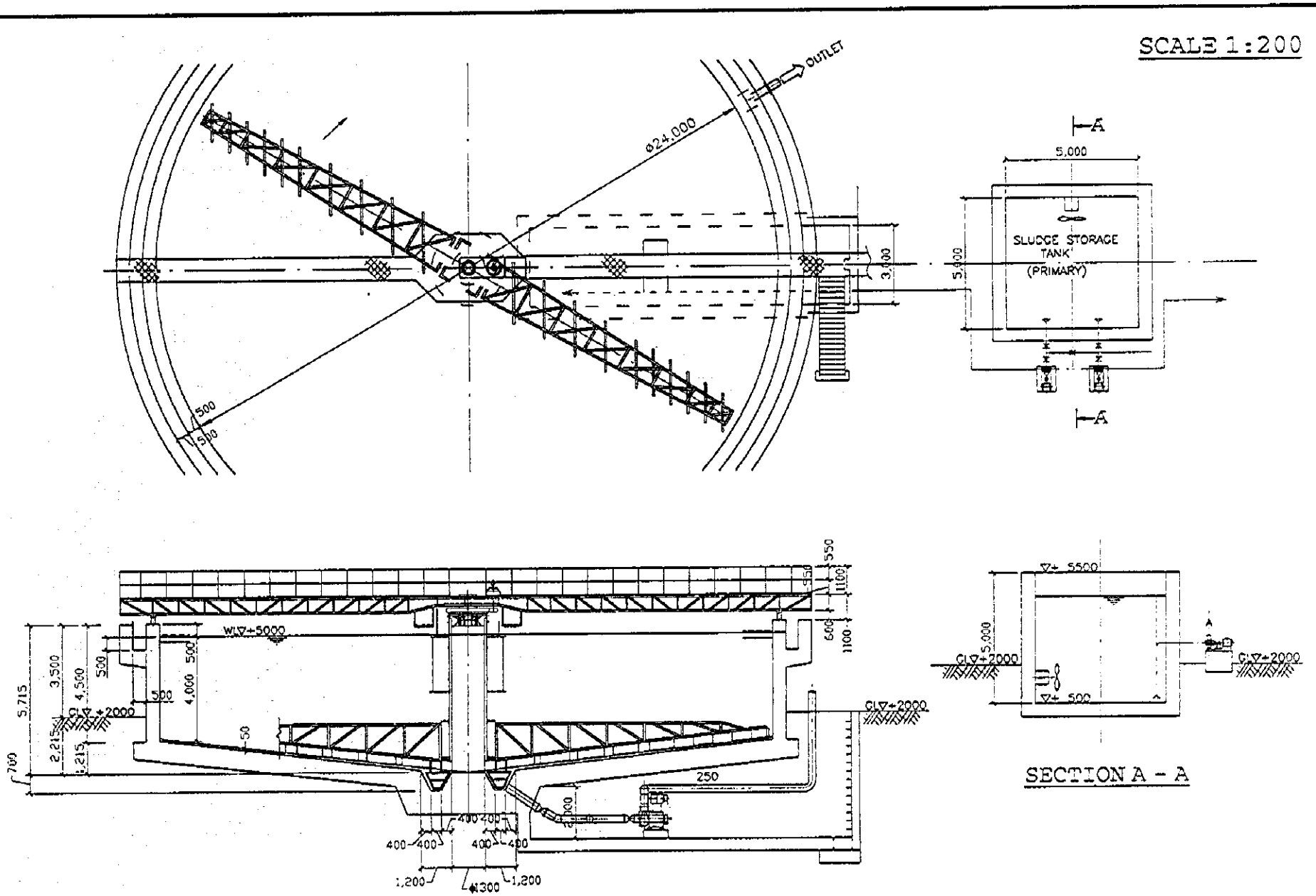


FIG. F.15.9 PROPOSED LAYOUT OF GRAVITY THICKNER

SCALE 1:750

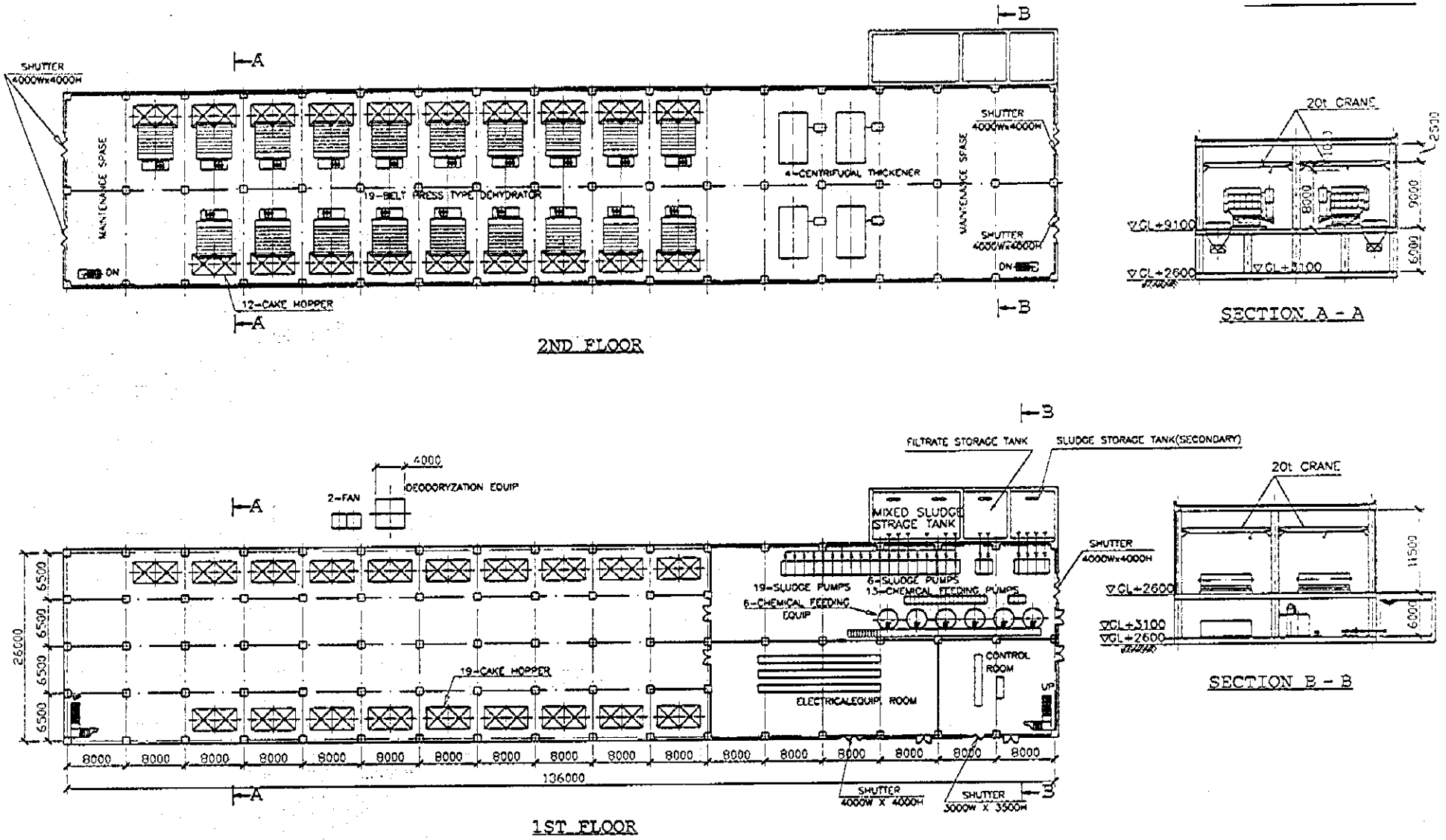
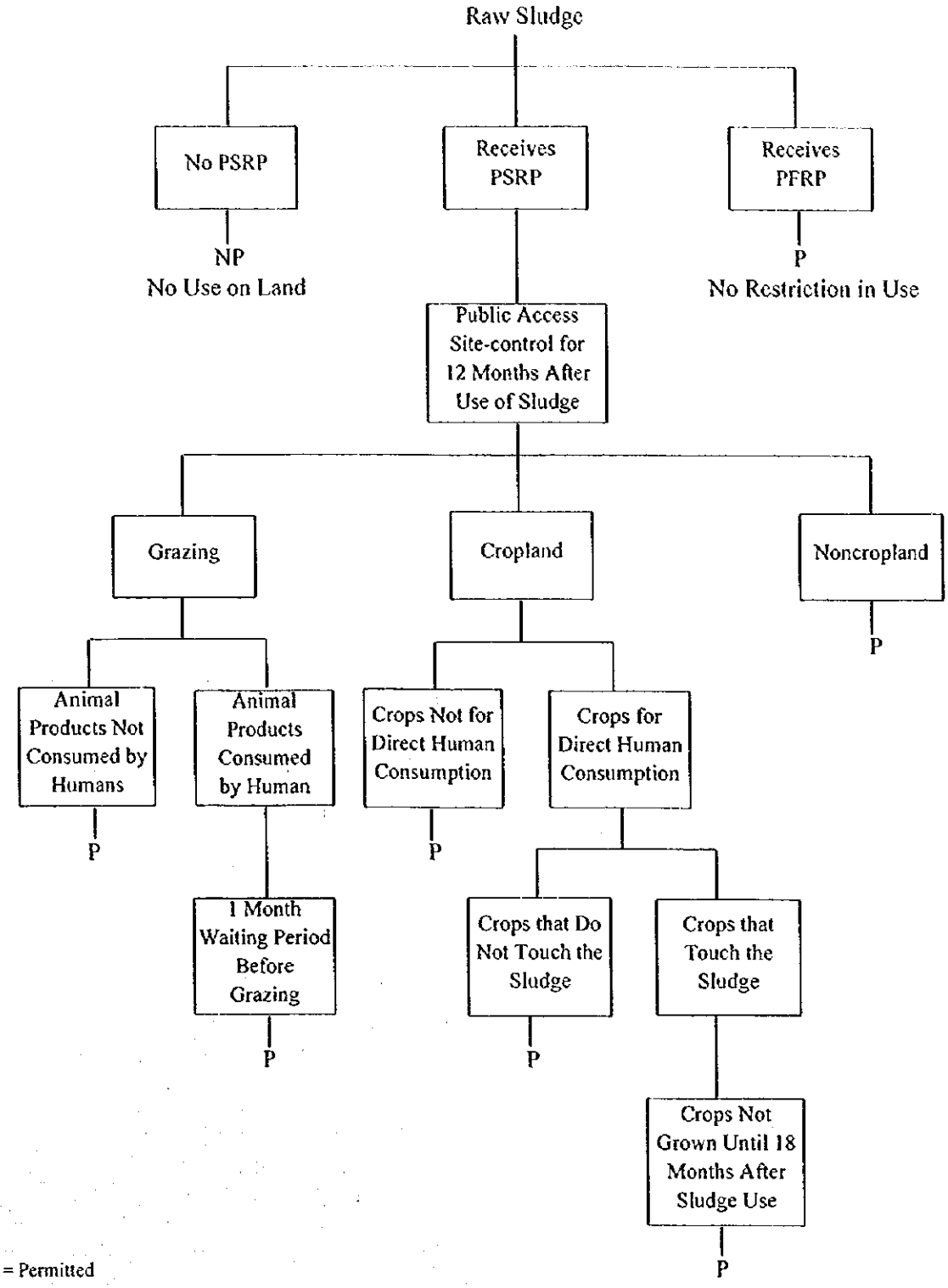


FIG. F.15.10 PROPOSED LAYOUT OF CENTRIFUGAL THICKENER



P = Permitted

NP = Not permitted

PSRP = Process to significantly reduce pathogens (aerobic digestion, anaerobic digestion, air drying, lime stsbilization)

PFRP = Process to fuether reduce pathogens (composting, heat drying, heat treatment, thermophilic aerobic digestion)

FIG. F.15.11 EPA Regulations for Using Processed Sludges on Agricultural Land

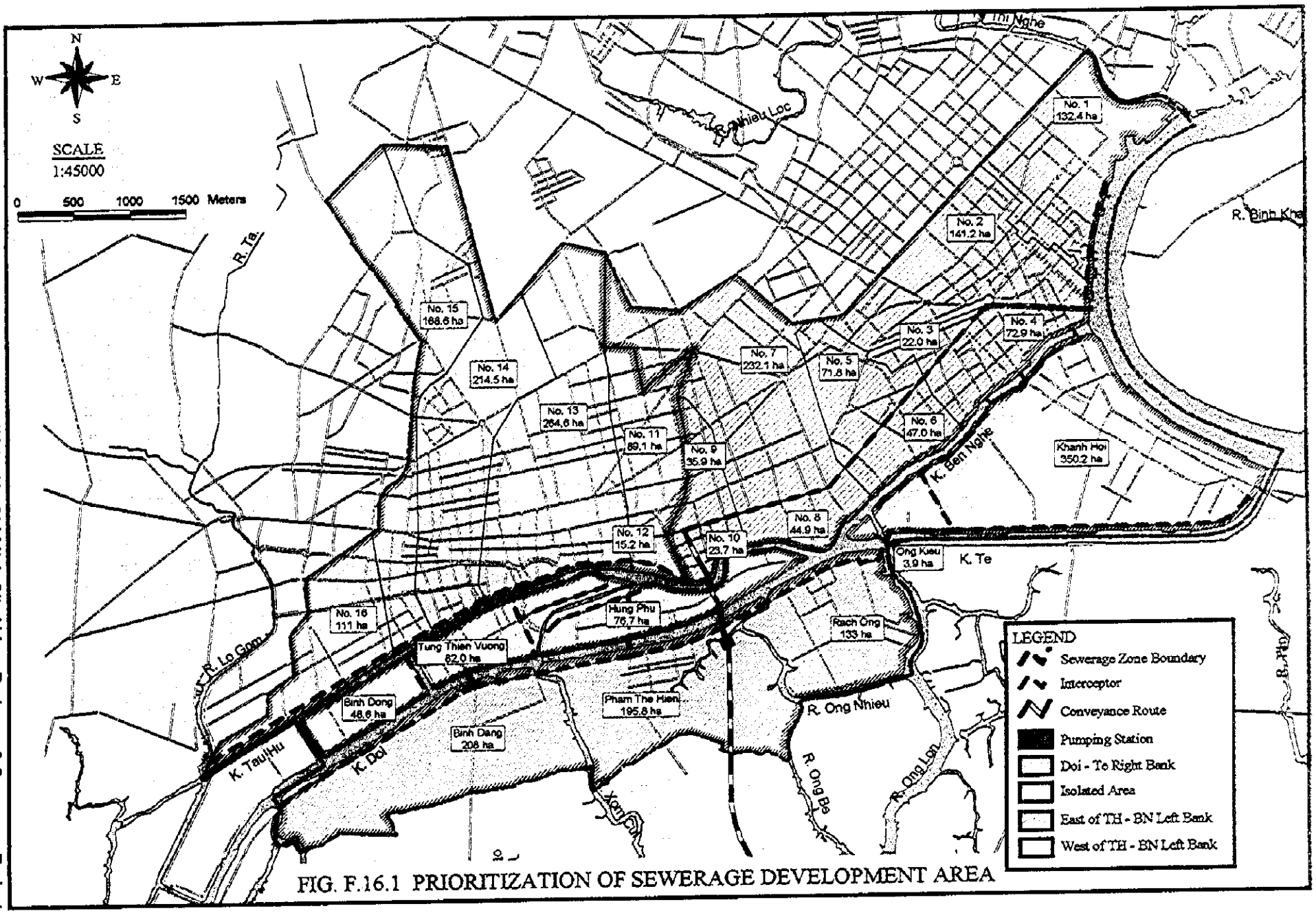


FIG. F.16.1 PRIORITIZATION OF SEWERAGE DEVELOPMENT AREA

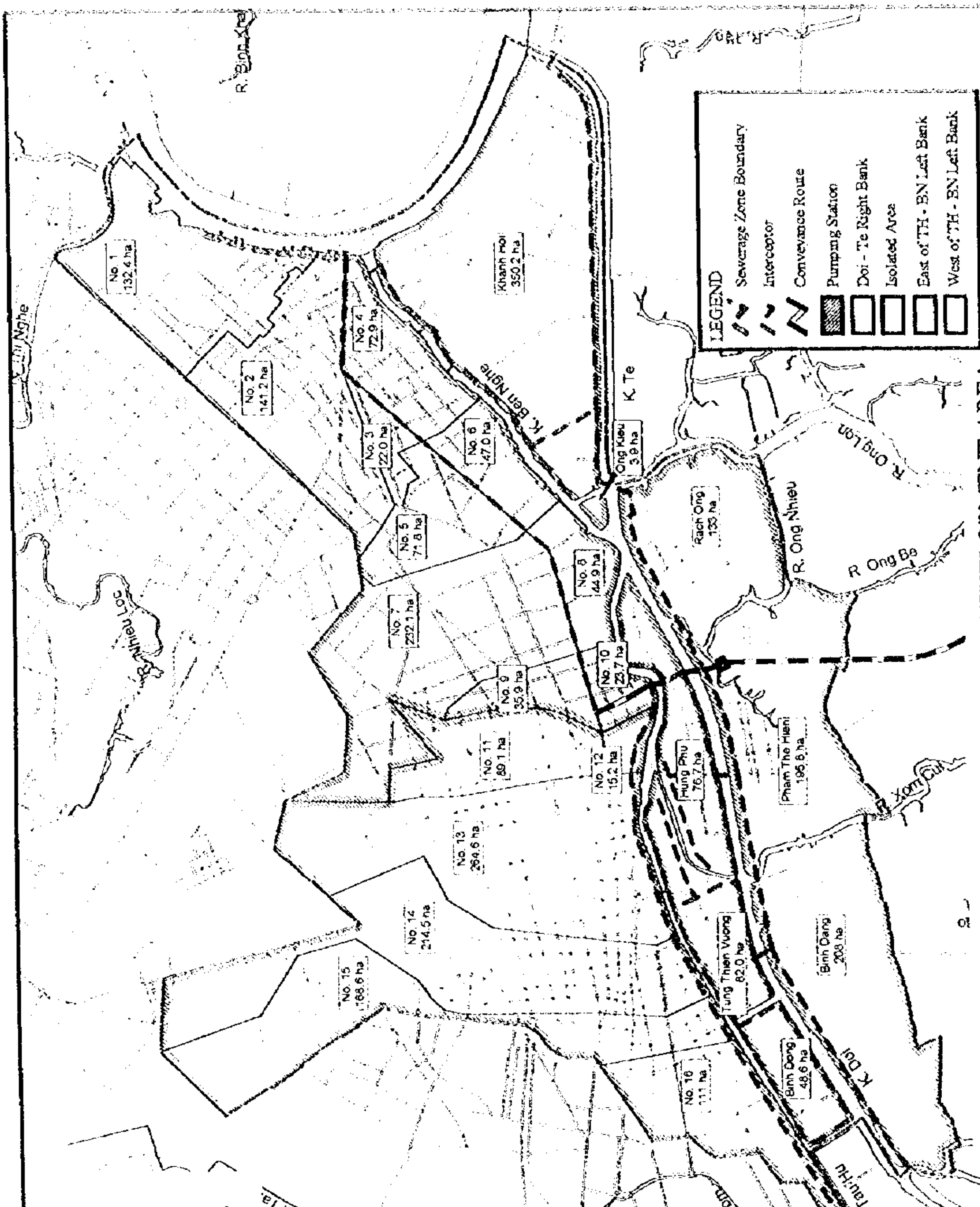


FIG. F.16.1 PRIORITIZATION OF SEWERAGE DEVELOPMENT AREA

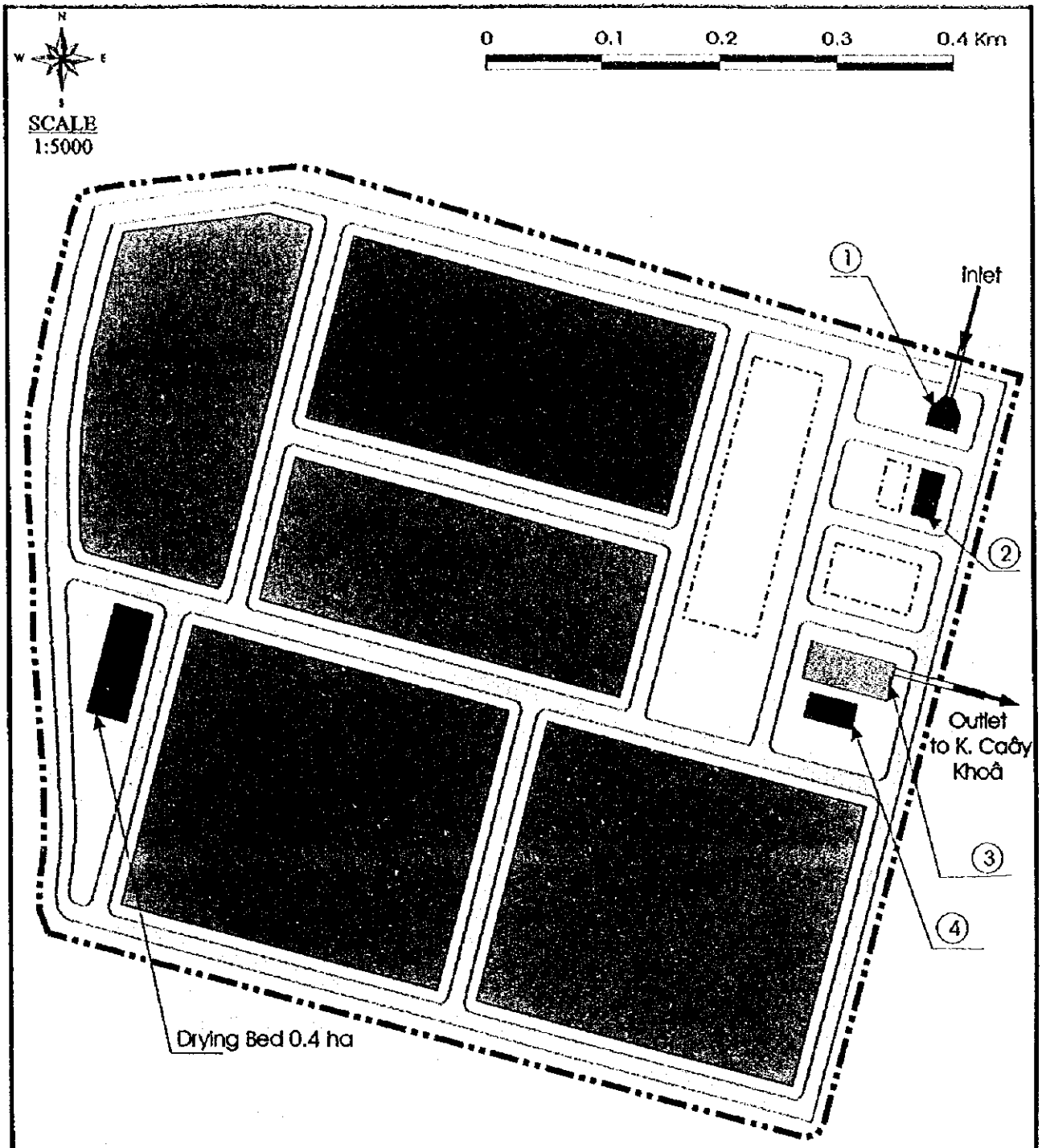


FIG. F.17.1 ALTERNATIVE 1: STABILIZATION POND

Q =141,000 m^3/day BOD_{5in}: 180mg/l BOD_{5out}: 50mg/l

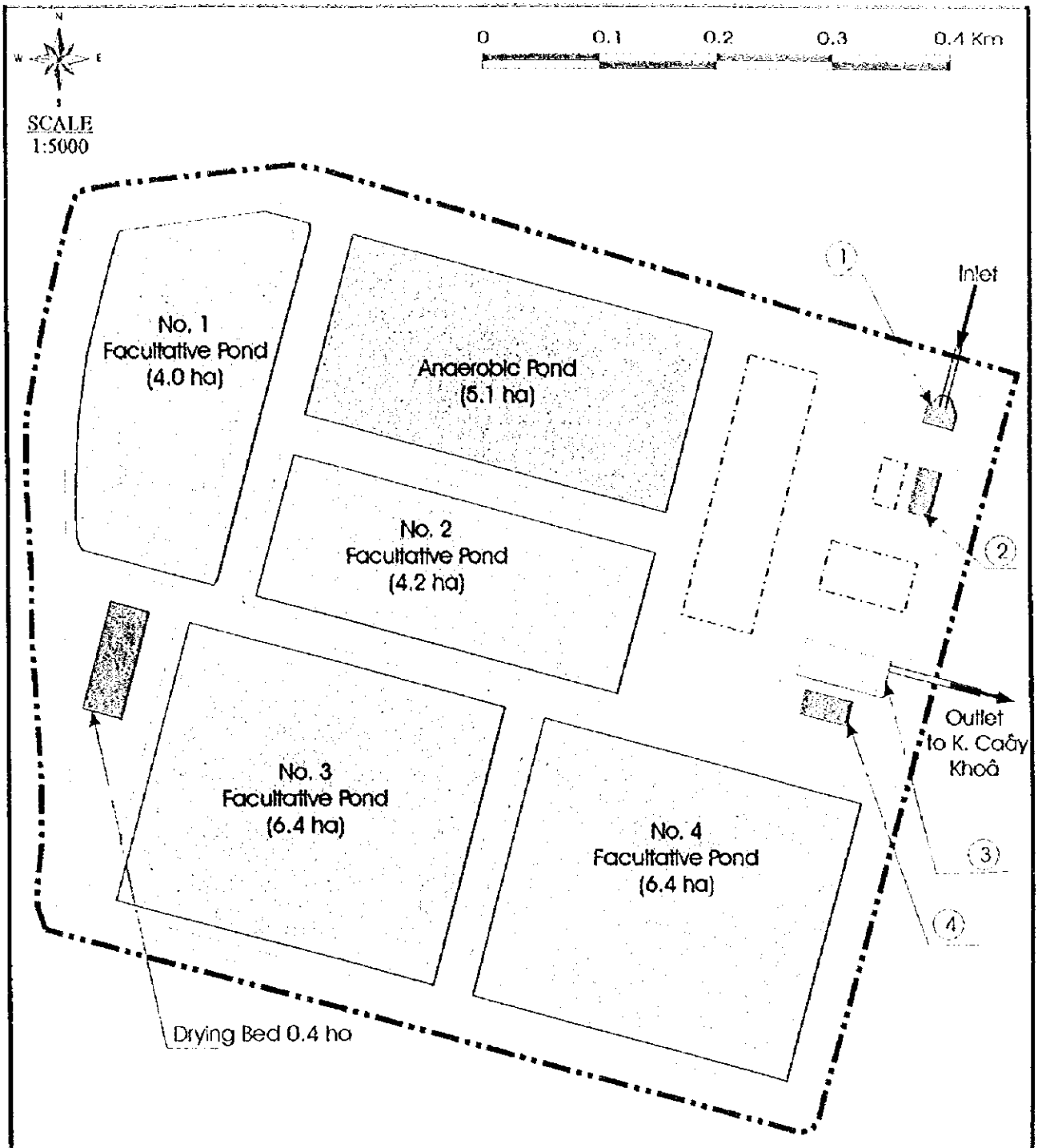


FIG. F.17.1 ALTERNATIVE 1: STABILIZATION POND

Q =141,000 m^3/day BOD_{5in}: 180mg/l BOD_{5out}: 50mg/l

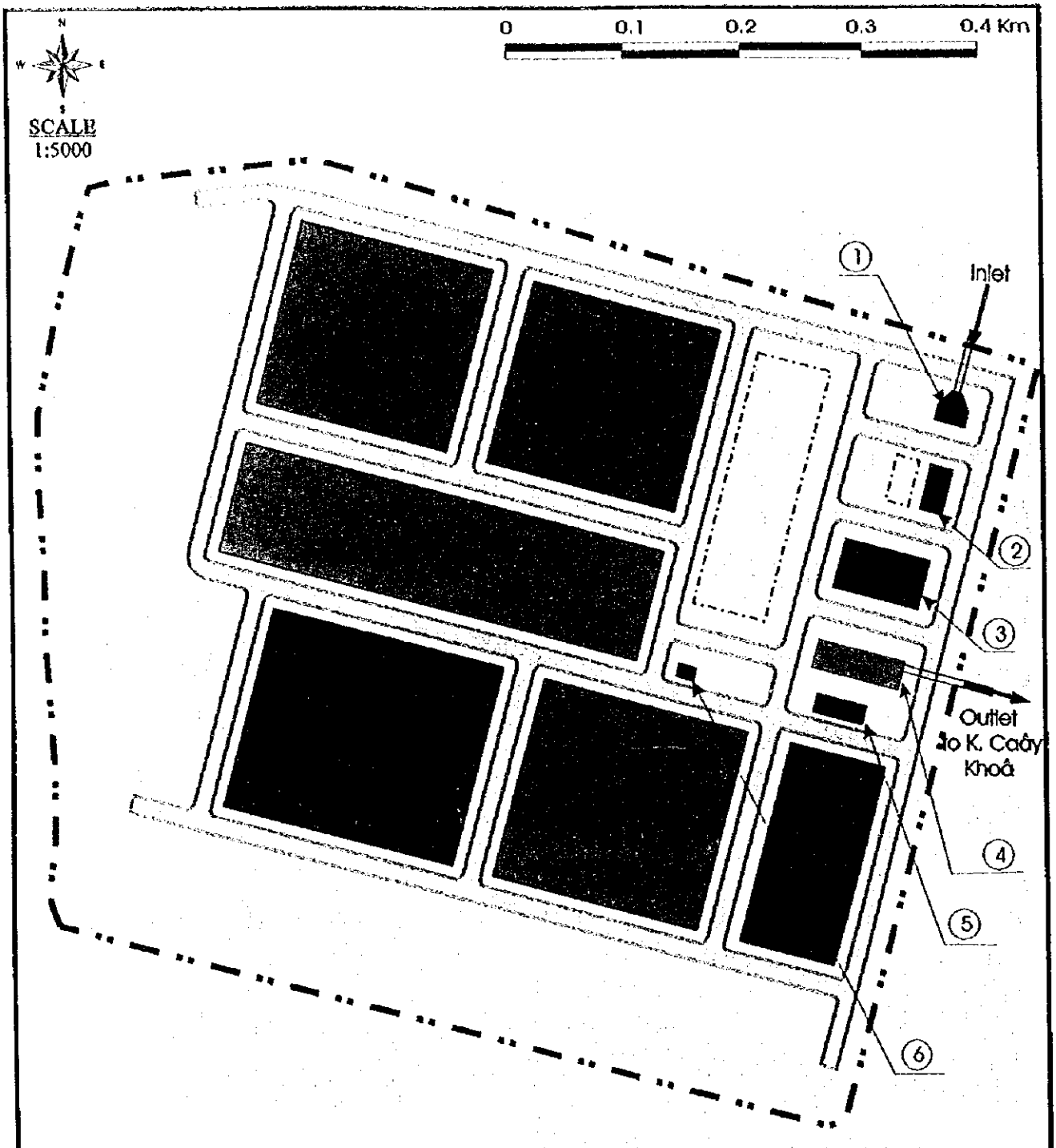


FIG. F.17.2 ALTERNATIVE 2: AERATED LAGOON

Q =141,000 m³/day BOD_{in}: 180mg/l BOD_{out}: 50mg/l

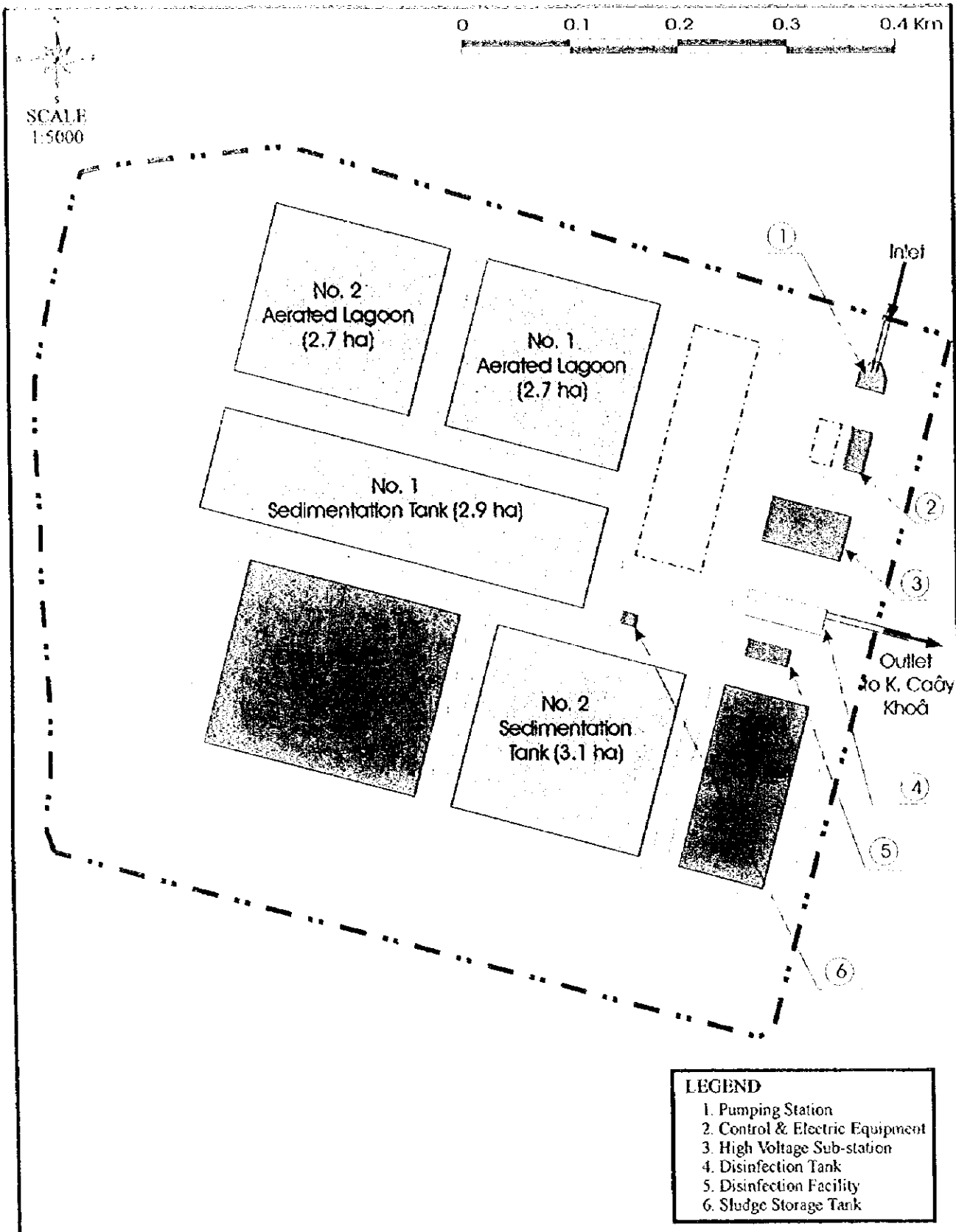


FIG. F.17.2 ALTERNATIVE 2: AERATED LAGOON

Q =141,000 m^3/day BOD_{5in}: 180mg/l BOD_{5out}: 50mg/l

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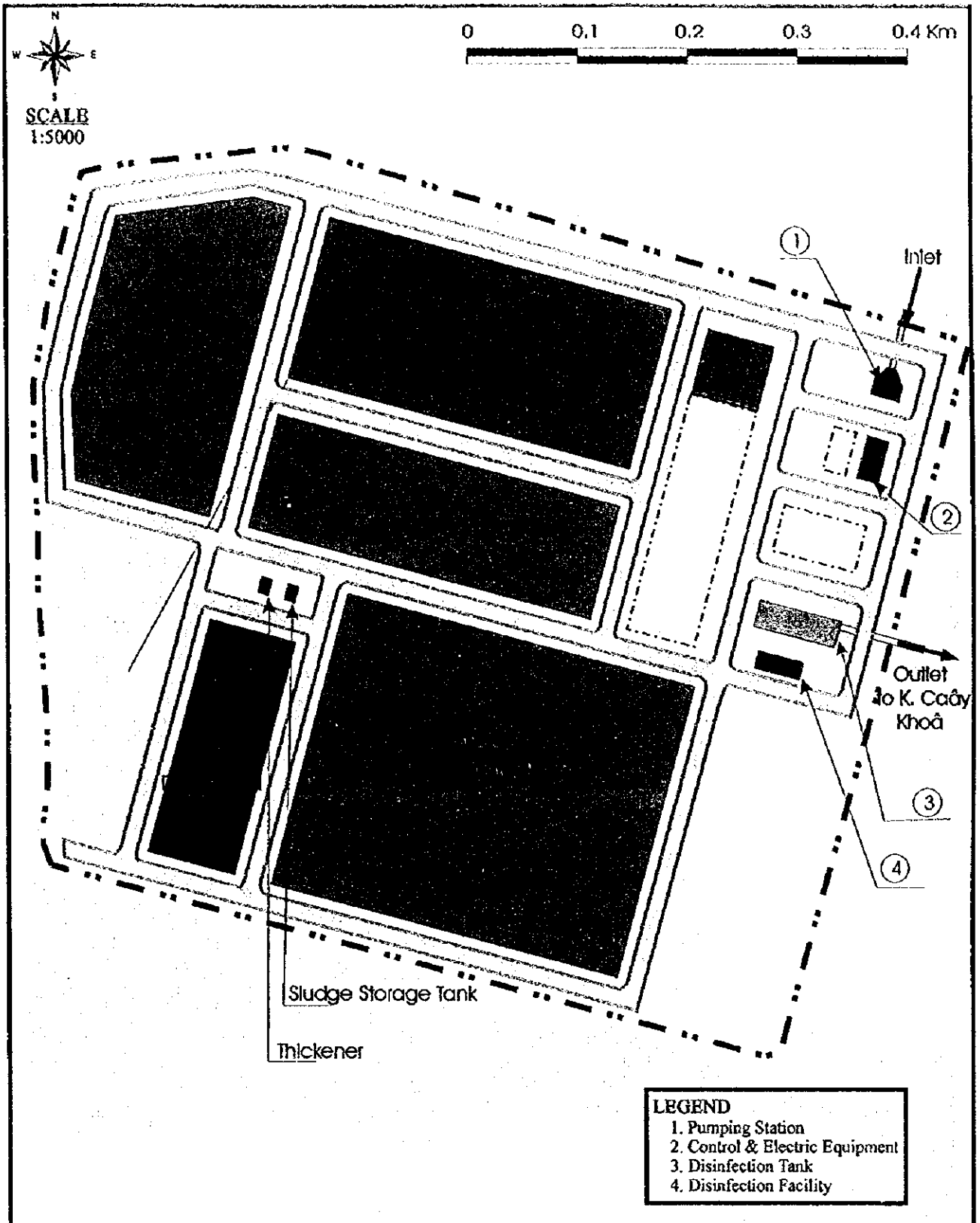


FIG. F.17.3 ALTERNATIVE 3 PRIMARY SEDIMENTATION and STABILIZATION POND

Q =141,000 m^3/day BOD_{Sin}: 180mg/l BOD_{Sout}: 50mg/l

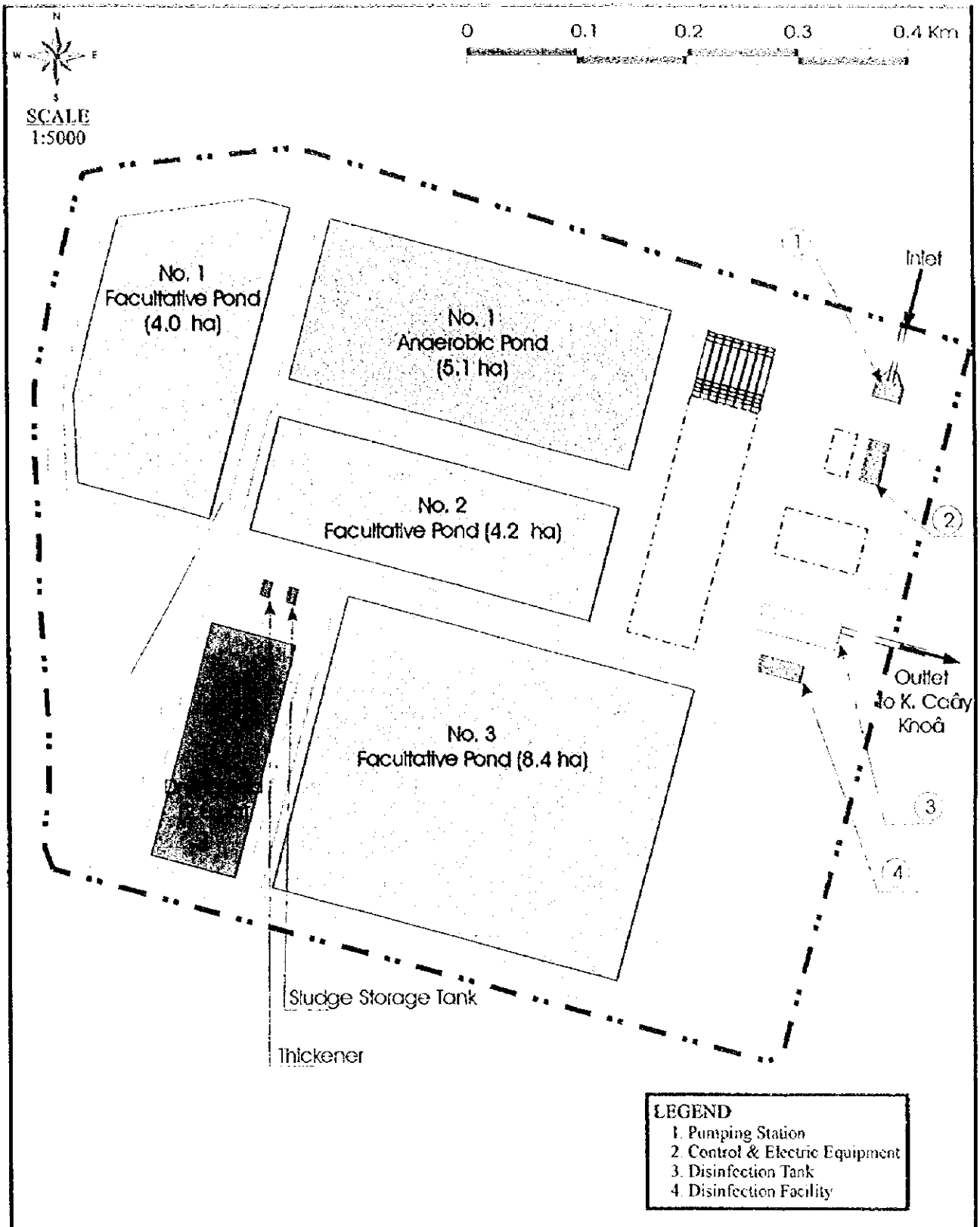


FIG. F.17.3 ALTERNATIVE 3 PRIMARY SEDIMENTATION and STABILIZATION POND

Q =141,000 m^3/day BOD_{Inf}: 180mg/l BOD_{Sout}: 50mg/l

JICA - Ho Chi Minh city Urban Drainage & Sewerage Project

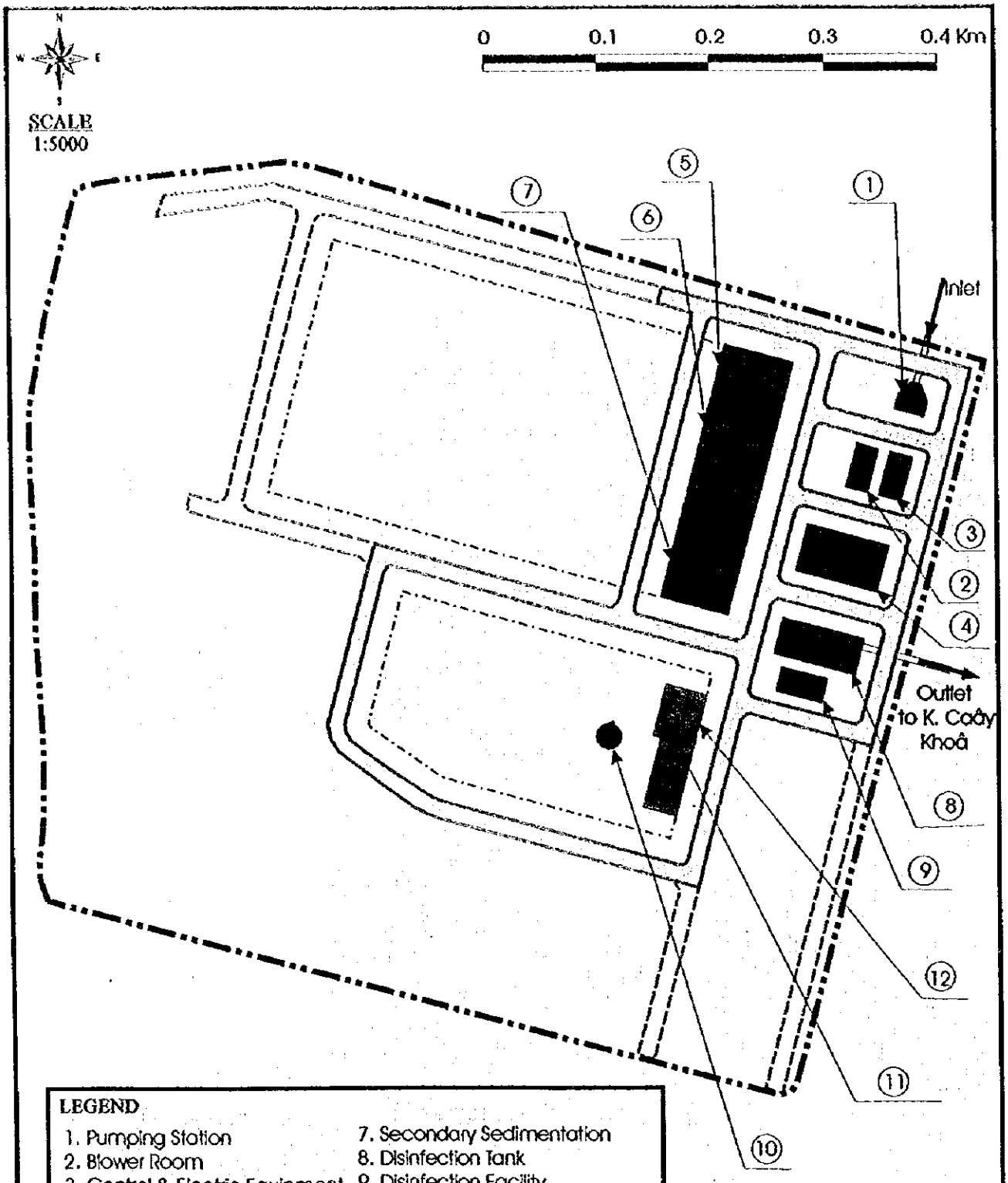


FIG. F.17.4 ALTERNATIVE 4: MODIFIED ACTIVATED SLUDGE

Q =141,000 m^3/day BOD_{5in}: 180mg/l BOD_{5out}: 50 mg/l

JICA - Ho Chi Minh city Urban Drainage & Sewerage Project

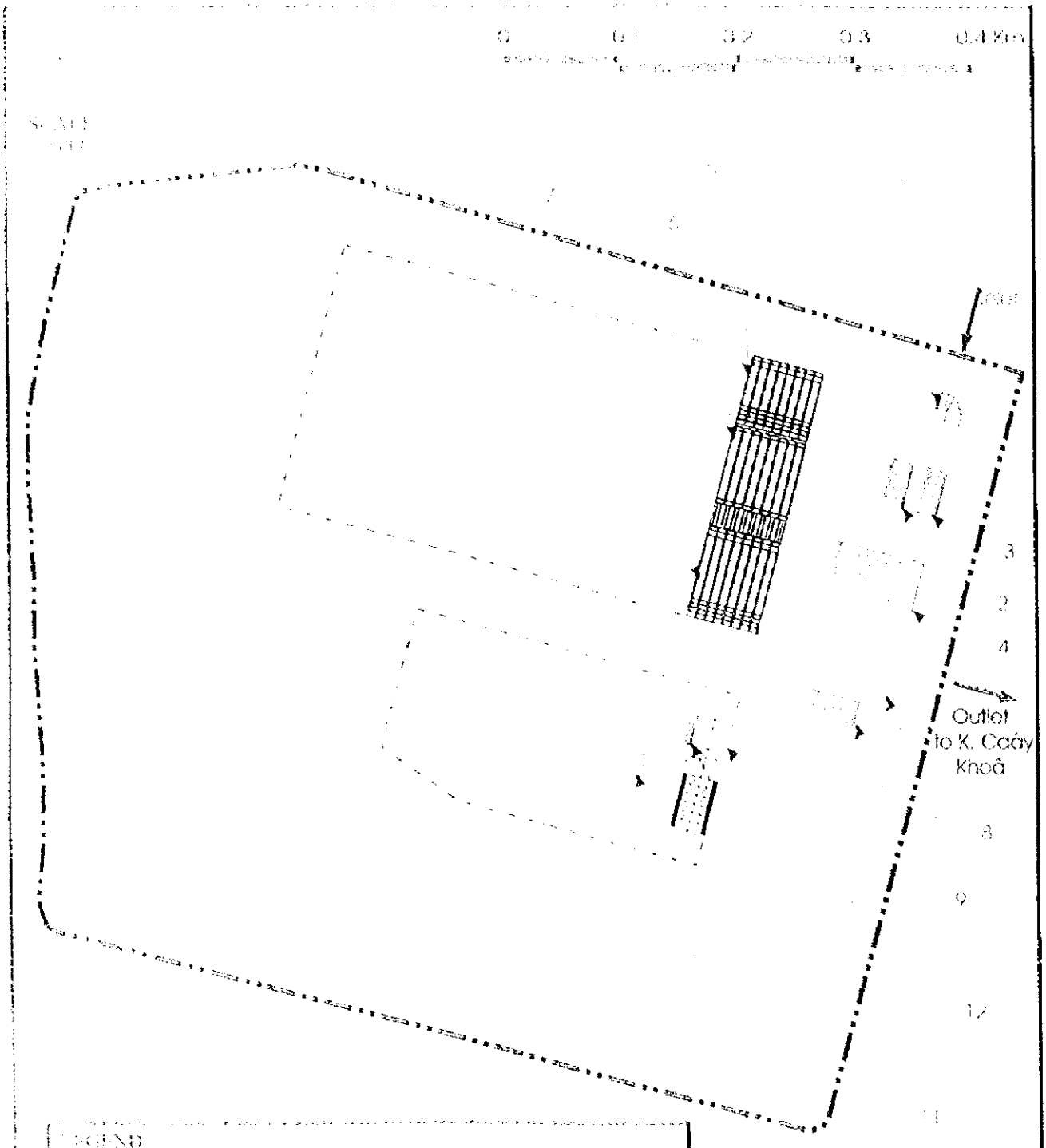
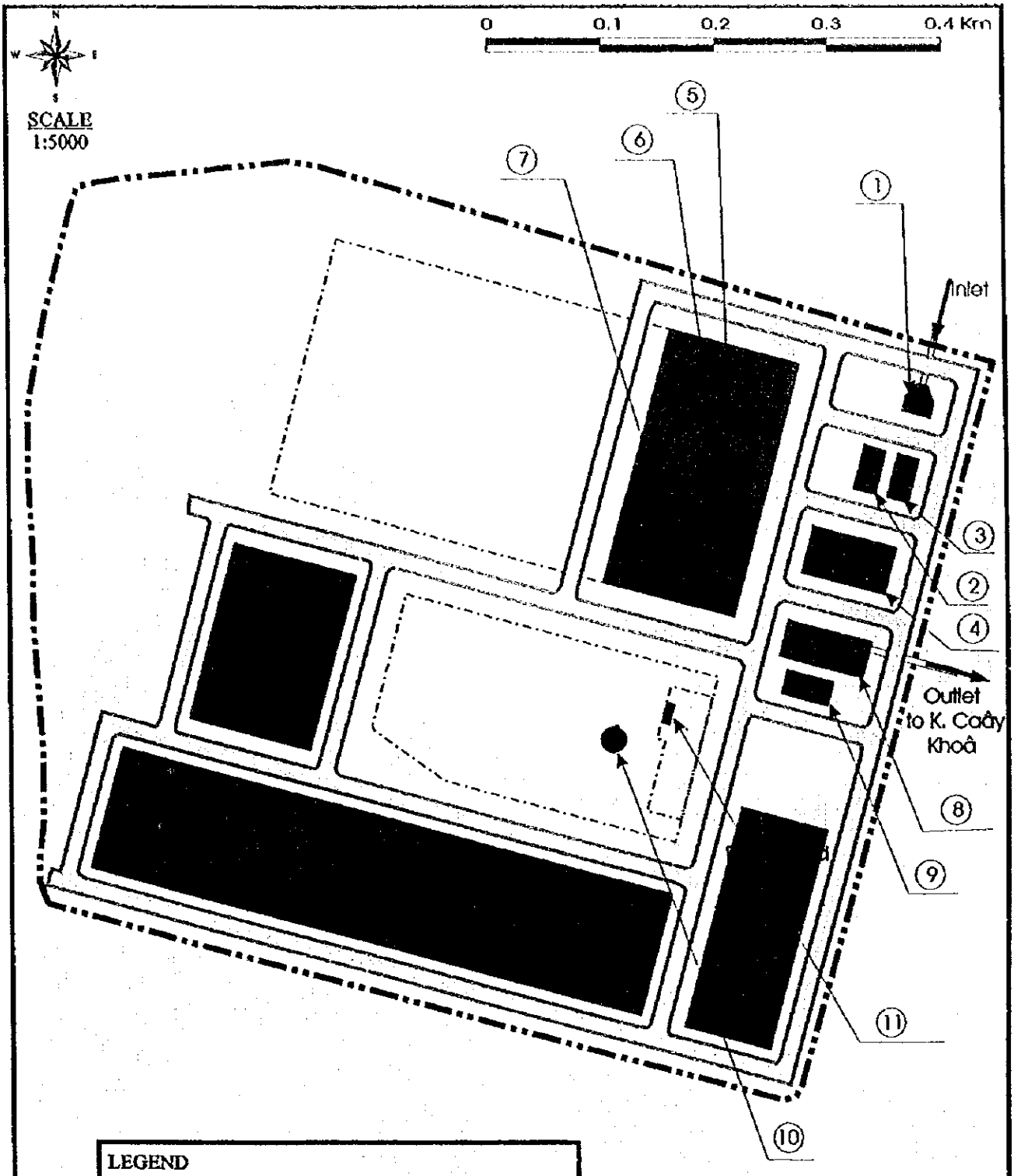


FIG. F 7.4 ALTERNATIVE 4: MODIFIED ACTIVATED SLUDGE

Q 111,000 m³/day BOD$_5$ 180mg/l BOD$_5$ 50 mg/l

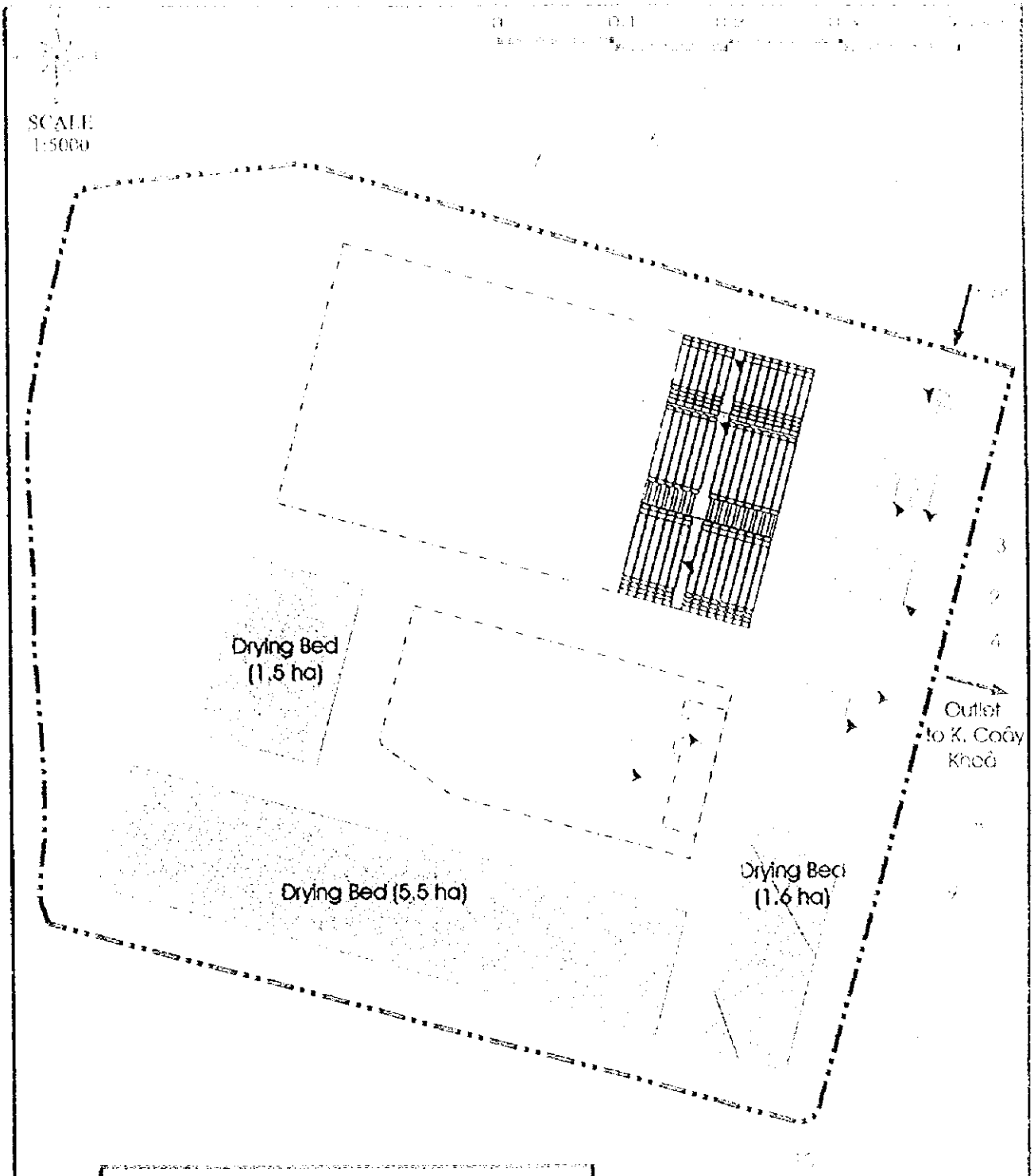


LEGEND

1. Pumping Station	6. Aeration Tank
2. Blower Room	7. Secondary Sedimentation
3. Control & Electric Equipment	8. Disinfection Tank
4. High Voltage Sub-Station	9. Disin fection Facility
5. Primary Sedimentation	10. Tbickener
	11. Sludge Storage Tank

FIG. F.17 .5 ALTERNATIVE S -1: CONVENTIONAL ACTIVATED SLUDGE

Q =141,000 m^3/day BOD_{5in}: 180mg/l BOD_{5out}: 20 mg/l

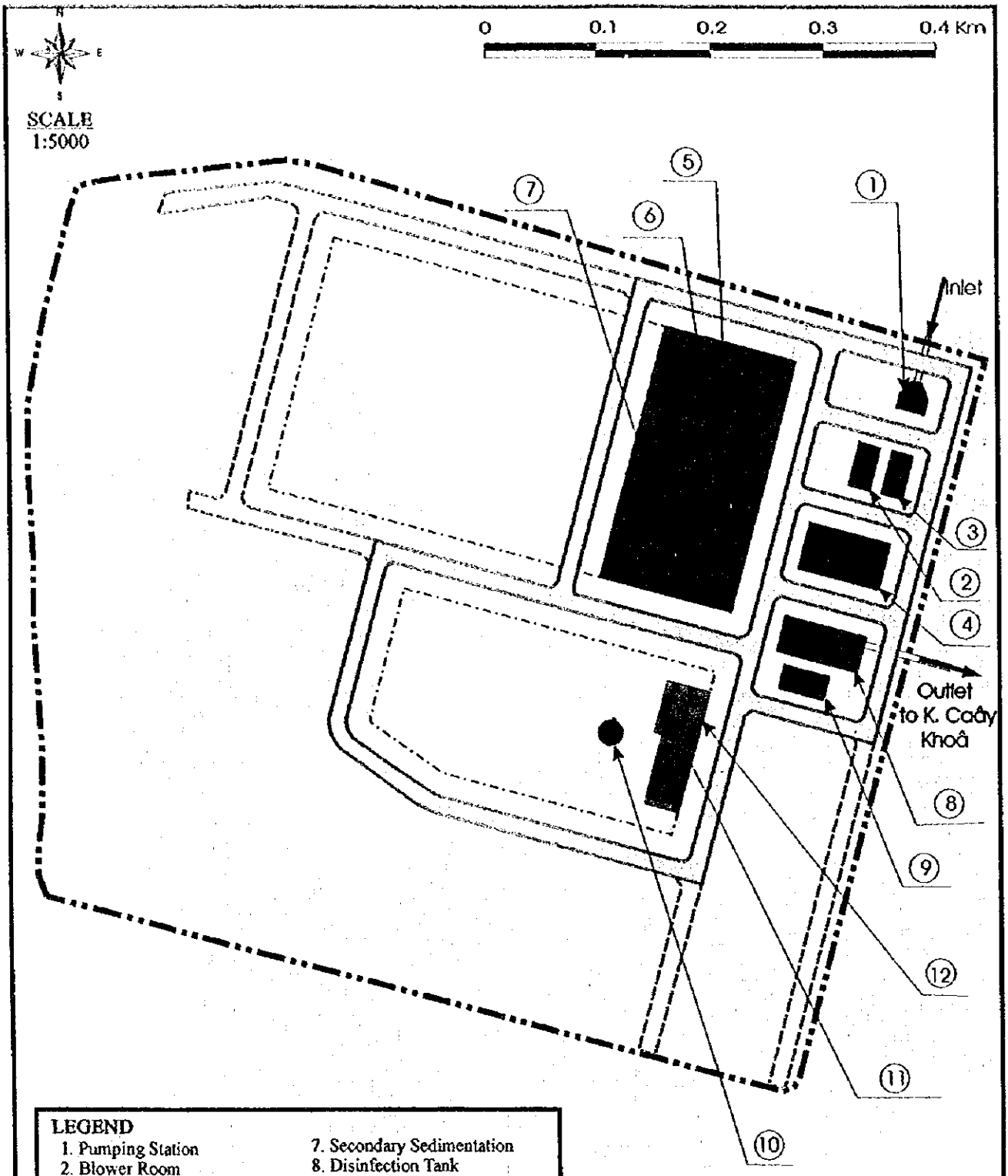


LEGEND

1. Pumping Station	6. Aeration Tank
2. Blower Room	7. Secondary Sedimentation
3. Control & Electric Equipment	8. Disinfection Tank
4. High Voltage Sub-Station	9. Disinfection Facility
5. Primary Sedimentation	10. Thickener
	11. Sludge Storage Tank

FIG. F.17.5 ALTERNATIVE S -1: CONVENTIONAL ACTIVATED SLUDGE

Q =141,000 m^3/day BOD$_{in}$ 180mg/l BOD$_{out}$ 20 mg/l



LEGEND

1. Pumping Station
2. Blower Room
3. Control & Electric Equipment
4. High Voltage Sub-Station
5. Primary Sedimentation
6. Aeration Tank
7. Secondary Sedimentation
8. Disinfection Tank
9. Disin fection Facility
10. Thickener
11. Sludge Storage Tank
12. Dewatering Equipment Room

FIG. F.17.6 ALTERNATIVE S -2: CONVENTIONAL ACTIVATED SLUDGE

Q =141,000 m^3/day BOD_{Sin}: 180mg/l BOD_{Sout}: 20 mg/l

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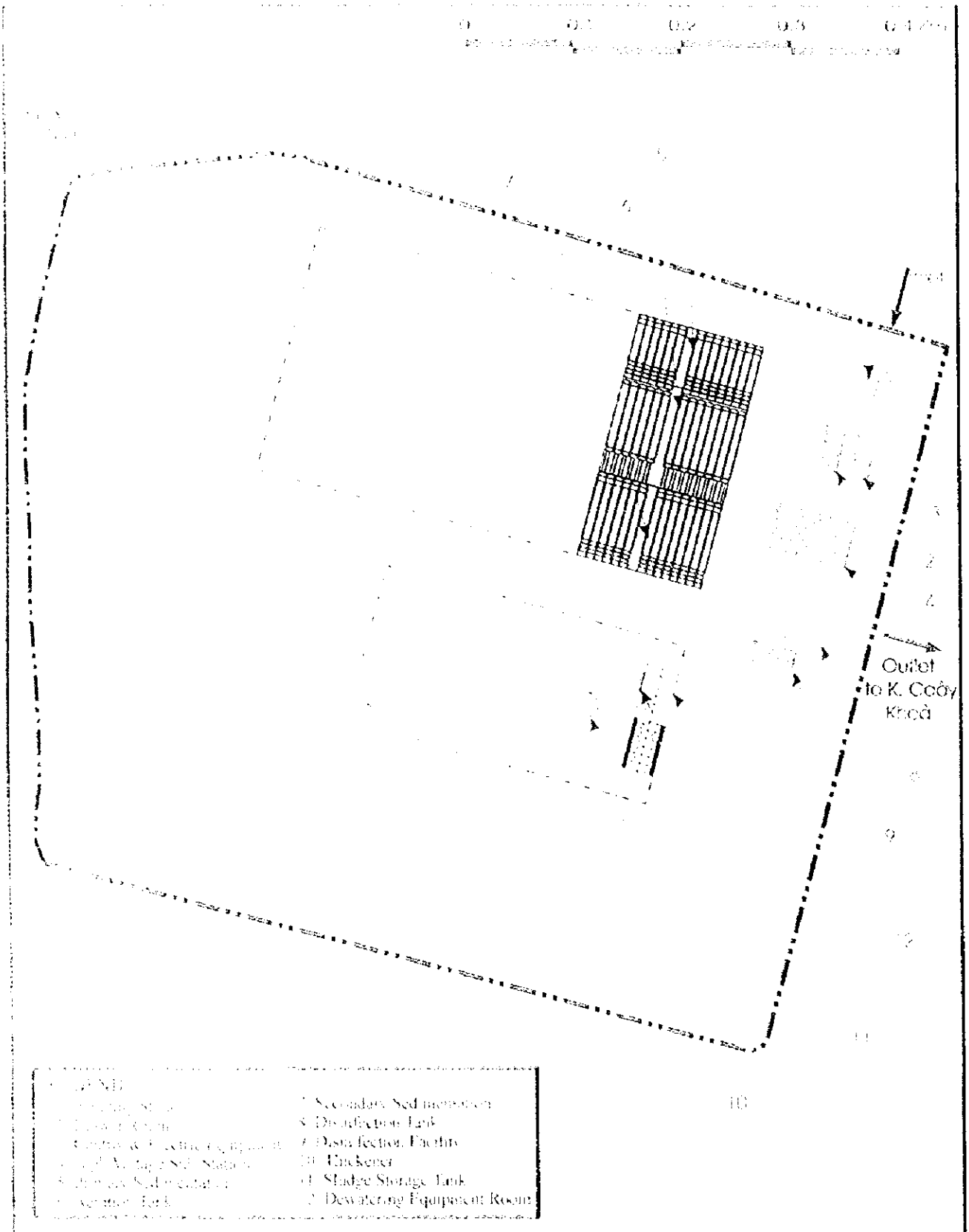

FIG F-7.6 ALTERNATIVE S-2: CONVENTIONAL ACTIVATED SLUDGE

Q = 141,050 m³/day BOD$_5$ = 180mg/l BOD$_{5out}$ = 20 mg/l

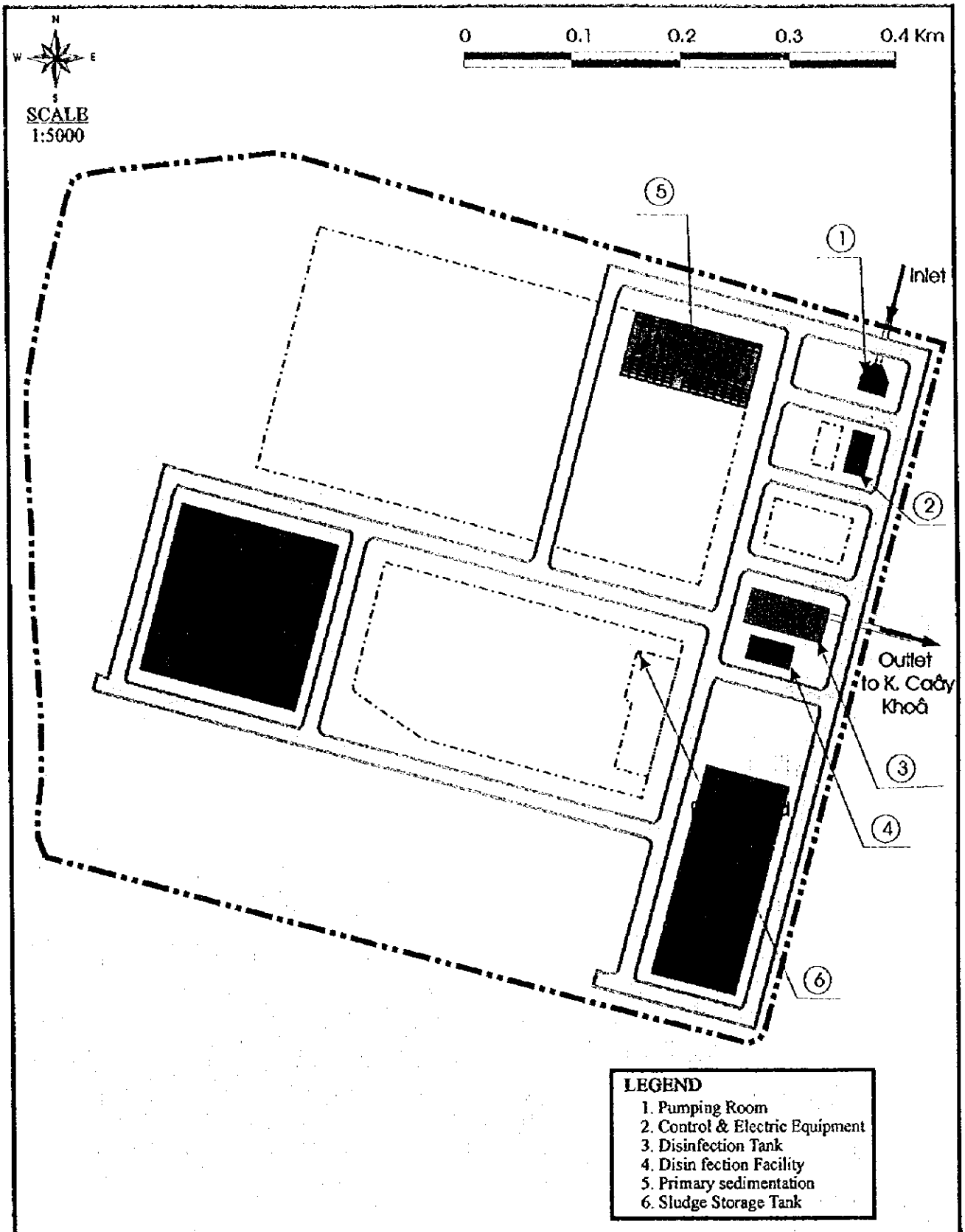

FIG. F.17.7 ALTERNATIVE S - 3: PRIMARY SEDIMENTATION

Q =141,000 m^3/day BOD_{5in}: 180 mg/l BOD_{5out}: 125 mg/l

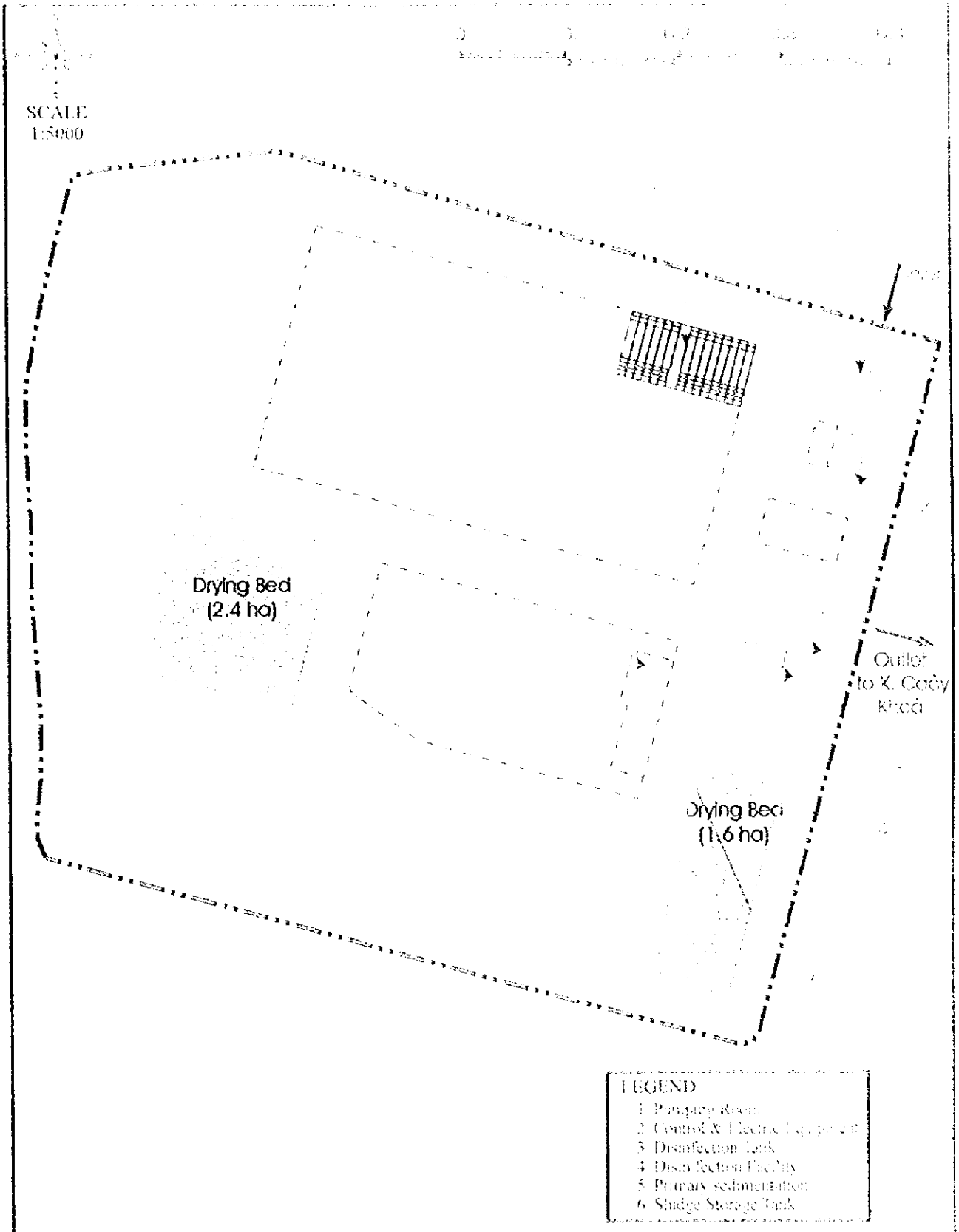

FIG. F.17.7 ALTERNATIVE S - 3: PRIMARY SEDIMENTATION

Q =141,000 m³/day BOD : 180 mg/l BOD : 125 mg/l

APPENDIX G
OPERATION AND MAINTENANCE

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LIST OF TABLES

LIST OF FIGURES

ATTACHED MATERIALS

APPENDIX G OPERATION AND MAINTENANCE

1. General

In order to make the proper plan for O/M frameworks in urban drainage and sewerage development, an investigation on the present conditions of O/M works in HCMC was carried out at first to identify the actual problems on this aspect, and based on the results of this investigation the corresponding O/M plans were elaborated accordingly for the envisaged facilities of the Project.

1.1 Method of Investigation

(1) The investigation on the aspect of O/M for urban drainage and sewage treatment was carried out through the formulation of questionnaires to the corresponding agencies based on the reviews of previous related reports and information (Ref. Appendix G: Attached Material 1), the discussions with these concerned organizations for hearing their opinions and the visits to related sites for confirming the actual situation on this aspect.

(2) For the investigation on urban drainage, the meetings as well as questionnaires and discussions were carried out with officials of OWM, UDC, WSC, District Public Service Enterprises, CDM, and PMU counterparts. And the site visits were carried out at the important drainage-projected areas such as Ben Me Coc, Kinh Doi, Kinh Te, Rach Ben Nghe, Rach Thi Nghe, Districts 6, 8, 11, Thanh Da Area and Saigon River for confirming the present drainage system and operation. For confirming the present maintenance works, the visits to the dredging sites of sewers in Districts 3, 8, 11 and the repairing sites of outlets along Rach Thi Nghe were carried out accordingly..

(3) For the investigation on sewerage development, the meetings as well as questionnaires and discussions were carried out with officials of UDC, WSC, HCMC Water Supply and Sewerage Association, CITENCO in HCMC, Team 2 of CITENCO in District 11, District Public Service Enterprises, CDM and PMU counterparts. And the site visits were carried out at the projected site of the Sewage Treatment Plant in Can Giuoc, the existing Tan Thuan Residential Area Sewage Treatment Plant in South Saigon (treatment-capacity: 500 m3/day), the Tan Ky – Tan Qui Compost Plant in Tan Binh District, the Sludge Dumping Site of CITENCO in Hoc Mon, and the working sites for desludging from domestic septic tanks in District 3 for confirming the present situation of O/M on this aspect.

1.2 Results of Investigation

(1) From the aforementioned discussions, all concerned officials acknowledged the present situation of old facilities and malfunctioning systems (Ref. Appendix G: Attached Material 2). This was reportedly due to the consistent continuity of the initial urban development plan made by the French colonial administration in the last century. This plan basically envisaged a future population of more or less 1.5 million inhabitants only. At that time, the population of Saigon was about 200.000 inhabitants. Meanwhile, the city has been developed for presently covering a population of about 5 million inhabitants with 22 Districts, causing a basic problem on urban drainage capacity based on the old sewer installations.

(2) With this initial plan, the basic social infrastructures were firstly developed from the center of inner city nearby the Saigon River, presently District 1. At that time, as there were many swamps and canals spreading in the area, large landfilling works were reportedly carried out to develop this central part of the city. The stormy water and domestic sewerage will be drained out into this river. From this fact, except for the consolidated area of Tan Son Nhut Airport, other areas are basically lowlands. This has caused the basic problem in urban drainage by gravity for many lowland areas to connect their local sewer systems (Grade 4) to the trunk drains (Grade 3 sewers) expanded from the inner city. Besides, the recent works for upgrading roads have caused inundation in the surrounding lowland areas during stormy times also.

(3) Based on this initial concept, since the city is located in the tropical monsoon region with many large river systems, the urban drainage and sewage system was basically based on the installation of a combined sewer system set up along main roads to drain out by gravity the collected domestic sewerage and the stormwater into the Saigon River system for a final natural cleansing.

(4) This initial concept has been carried out up to now. Even with the present development of a cosmopolitan city, there are no basic changes from the three initial factors: (1) gravity drainage through installed sewer network facilities through outlets into nearby canals and rivers (2) partial drainage through soil infiltration and solar evaporation, and (3) the domestic sewerage drained out to rivers to be treated by natural cleansing.

(5) In order to improve this unproper situation, an F/S for improving the urban drainage and sewerage treatment system was carried out by USAID in 1971 (Consulting Co.: Henningson, Durham & Richardson and Lyon Associates Inc). In this F/S (Saigon Sewerage Feasibility Study) the urban drainage and the sewerage treatment will be improved by a modernization of the drainage system and the application of a limited sewage treatment based on the relatively modern sewage treatment techniques. The plan was not implemented due to war reasons.

(6) Regarding the basic facilities for urban drainage in HCMC (the city sewer network, the inner canals in districts, and the large water streams), only the central urban area of HCMC has a combined sewer system mostly constructed during the French era for the collection of wastewater and stormwater. It consists of a network of underground culverts, sewers and open drains. This sewer system is presently found very old and poorly maintained, causing many basic defects in operation.

(7) For the administrative demarkation on O/M works, the large waterways are controlled by OWM. Meanwhile, for the urban drainage sewer network of 4 grades, UDC is in charge for 3 grades (Grades 1, 2 and 3) and districts (District Public Service Enterprises) are subjected to control the Grade 4 sewers only. The definition of these Grades and corresponding coverage are mentioned in the Chapter of Drainage Improvement.

(8) The demarkation of facilities for conducting O/M works has been clearly carried out but there is no permanent coordination and no mutual work operation program among OWM, UDC and the District Public Service Enterprises for performing an integrated systematic control system for the whole drainage network.

2. Present Conditions of Urban Drainage and Sewerage Facilities

2.1 Present Conditions of Facilities for Urban Drainage

(1) Regarding the urban drainage in HCMC, there are three (3) basic facilities: 1) the city sewer network to collect the storm water and the domestic sewerage, 2) the inner canals/channels, and 3) the large water streams (canals and rivers) finally receiving the drainage water drained out from the city.

(2) Only the central urban area has a combined sewer system constructed during the French era for collecting the domestic wastewater and stormwater. It consists of a network of underground culverts, sewers and open drains. This sewer system is presently found very old and poorly maintained.

(3) Basically the sewer network is very old and ununified, mostly constructed about 100 years ago and gradually expanded afterwards. As most parts of this sewer network have a small diameter (600-800 mm) with an average distance of 30-50 m between two culvert boxes/manholes, this situation has caused difficulties for manual cleaning as largely applied up to now. Besides, the inner canal system is very interlacing and poorly maintained.

(4) As for the rivers and main canals, natural and artificial, in HCMC, they are hydraulically interconnected and strongly influenced by the tidal effect. Therefore, with minimal gradients throughout this relatively lowland region, the tidal effect is found up to the northernmost area of HCMC. Besides, since there are no gates for sewer-outlets at

canals/rivers, this tidal effect is even found inside the city sewer network.

(5) For administration purposes, apart from the large waterways controlled by OWM (Ref. Table G.2.1: List of Waterways Controlled by Office of Waterway Management), the Government of HCMC has made a division of the urban drainage sewers into 4 grades being controlled by UDC for 3 grades (Grades 1, 2 and 3) and districts (District Public Service Enterprises) for only one grade (Grade 4) which details are as follows:

- Grade 1: Natural open canals used to collect domestic wastewater and run-off. Grade 1 channels are subdivided into types 1a and 1b. Type 1a canals are natural open channels, which will require only minor modifications. Type 1b natural channels have been targeted for major modification and will be channelized and/or enclosed to become a Grade 2 classification.

  According to UDC official, the total length of canals/channels (Grade 1) under UDC control is about 92 km.

- Grade 2: Underground sewers and canals used to collect water from Grade 3 sewers. Grade 2 sewers are relatively large, the diameter or channel width of which would be greater than one meter. These sewers are generally installed at a depth of 2 – 5 m. According to UDC official, the total length of Grade 2 sewers is about 100 km with 215 outlets connecting to canals/channels of Grade 1.

- Grade 3: Underground sewers installed along streets collecting wastewater from Grade 4 tributaries. Generally, Grade3 sewers are 600 – 800 mm diameter, 400 x 800 mm, or 600 x 800 mm. According to UDC official, the total length of Grade 3 sewers under UDC control is about 420 km in all 22 districts of HCMC.

- Grade 4: Underground sewers along streets which discharge water into Grade 3 sewers. Grade 4 sewers are usually less than 600 mm in diameter. This kind of sewer is controlled and recently constructed by districts themselves (mostly by District Public Service Enterprises). The total length of Grade 4 sewers in all 22 districts of HCMC is estimated at about 450 km.

(6) Structurally, the drainage sewer network was constructed in three types of cross-sections: semi-circular, circular, and box. These three types were installed during three different time periods. The specific characteristics of the three types of sewers are as follows:

- Semi-circular: These are brick structures, or a mix of bricks and concrete with dimensions of 400 mm x 600 mm (width x height) for sewers collecting stormwater and 1,400 mm x 1,800 mm for Grade 2 Sewers connecting to canals and channels. Most of these sewers are very old, mostly constructed during 1920 – 1930 and

some before 1954. They are mostly found in District 1 and 3. Most of them have good hydraulic gradients with little sludge sedimentation. Their old structure, however, is found very weak for being possibly damaged at any time.

- Circular: These sewers of reinforced concrete with diameters of 400 – 1,500 mm. were installed in the newer sections during the city development period. In Districts 1 and 3, and part of Ba Chieu – Lang Ong area), this type of sewer was constructed before 1954. In the northern Districts Tan Binh, Phu Nhuan, Binh Thanh, and Go Vap, and the southwest District 10, this type was built during the 1954 – 1975 period. For other remaining areas in HCMC this type was constructed after 1975. Most Grade 3 sewers have insufficient hydraulic slopes and poorly constructed joints. The insufficient slope directly contributes to sedimentation problems, especially in areas influenced by tides. According to UDC officials, 85 % of Grade 2 and 3 sewers have been reported in this type of cross section.

- Box: These Grade 2 sewers are reinforced concrete structures generally either 2 m x 2 m or two-2.5 m x 2.5 m. Most were built after 1975.

(7) Basically the sewer-distance between two culvert boxes/manholes is varied with the inclination, but most sewers have the distance of 30 –50 meters between two culvert boxes, causing basic difficulties in manual cleaning, particularly for the middle part of sewers with diameters less than 800 mm and/or in submerged conditions.

(8) There are also large drainage facilities passing through various important governmental compounds which are not under control of UDC, and some stone-lined open canals for drainage purposes existing near Tan Son Nhat airport.

2.2 Present Conditions of Facilities for Sewerage Treatment

(1) Regarding the facilities for sewerage treatment, apart from some separate installations in factories, hospitals etc., there are no existing sewerage treatment plants for public service at now. Septic tanks are subject to be installed at individual houses for primary treatment of the domestic sewerage including toilet water. In principle, after passing the septic tank, the effluent from this primary treatment will be permitted to connect to the city sewer system to be drained out into the nearby water bodies for a further treatment by natural cleansing.

(2) Despite the installation of septic tanks in housing constructions has been regulated as long as the installation of the city sewer network, at present, however, less than 60% of total households in HCMC are reportedly served by septic tanks. Some households have cesspools. And the remaining households (less than half of total households) have made illegal direct connection of their domestic sewerage to city sewer system or direct discharges of wastes into nearby canals/channels.

(3) The standard septic tank in HCMC is a concrete tank (capacity: 1-3 m3) consisting of one to three compartments, but mostly two compartments, installed beneath the floor slab of the building to collect the toilet water and the domestic sewage for firstly precipitating the sludge and finally draining out the effluent from this primary treatment into the city sewer network.

(4) Recent large commercial or apartment buildings such as international hotels etc., however, have been equipped with more sophisticated treatment systems rather than the normal septic tanks for even processing until the dried sludge cake for a conventional transportation and disposal.

(5) Team 2 of CITENCO with 3 vacuum-cars and private septic tank treatment companies (estimated at about 200 companies in all HCMC) with 1-2 vacuum-cars per unit have carried out the desludging from septic tanks for disposals in Tan Ky – Tan Qui compost plant, or Binh Chanh sludge dumping ground or nearby water bodies also.

3. Present Operation System

3.1 Present Operation System for Urban Drainage

(1) Administratively, OWM is in charge of the O/M of the assigned waterways, mainly for navigation purpose with minor functions on drainage and environmental controls. From this situation, OWM concerns about the drainage conditions when there is a serious problem reported on this aspect in their assigned waterways.

(2) UDC, therefore, is the organization in charge of the O/M for the main urban drainage network in HCMC (Grades 1, 2, and 3) consisting of about 92 km of canals and streams and about 500 km of closed conduits of the main drainage network (Ref. Table G.3.1: O/M System of UDC Drainage Network, Table G.3.2: Network of Drainage Canals/Channels handled by UDC and Table G.3.3: List Grade 2 Sewer in Ho Chi Minh City).

(3) The District Public Service Enterprises within each district, therefore, are in charge of the O/M for the remaining 450 km of sewers Grade 4 (Ref. Table G.3.4: O/M System of the Drainge Network controlled by Urban Districts).

(4) As for households in HCMC, the disposal of their domestic wastewater has been done in several ways. In the inner city, as mentioned in the above, a large number of households have disposed of their domestic wastewater through septic tanks in each individual household prior to connect the effluent from these septic tanks to the city drainage sewer network. Many residential areas, particularly in the outer city, have disposed their domestic wastewater including toilet water directly to the city drainage system or nearby canals/channels.

(5) On the aspect of drainage basins, as mentioned in the Chapter of Urban Drainage Improvement, the major part (581.51 km2) of the whole Study Area (650 km2) was proposed to divide into six (6) drainage zones as follows:

1) Central City Drainage Zone: This zone consists of 14 main Districts (1, 3, 4, 5, 6, 7, 8, 10, 11, Phu Nhuan, Go Vap, Binh Chanh, Binh Thanh and Tan Binh) with an area of 106.41 km2 but a present population of 3.19 million inhabitants (population density of about 30,000 persons/km2) or about 75 % population of the Study Area (4.5 million inhabitants).

The combined sewer network is mainly found in this Central City Drainage Zone. These sewers collect the stormwater also to mix with the domestic sewerage to drain into canals and rivers such as Doi, Te, Nhieu Loc – Thi Nghe, Tau Hu – Ben Nghe, Tan Hoa – Lo Gom etc. through 94 UDC outlets (about one half of 200 UDC outlet) to be finally drained out into Saigon River (Ref. Table G.3.5: List of Outlets Controlled by UDC).

Since this zone covers the area of utmost socio-economic activities in HCMC. But, due to the characteristic of uneven topographic surface and various social conditions, many places in this zone have been found in a malfunctioning drainage effect. The improvement works in urban drainage for this zone, therefore, should be considered in the highest priority.

For other zones, the situation is as follows:

2) Northern City Drainage Zone: This zone covers Districts 12, Go Vap, and some parts of Districts Tan Binh, Binh Chanh and Binh Thanh. There are a sewer pipe system for the right bank of Tham Luong – Ben Cat canal of Go Vap District, ditches and channels to the main canals such as Tham Luong – Ben Cat, Rach Dai Han, Rach Ben Da – Ba Hong etc.. This zone covers an area of 136.18 km2 with a population of 422.000 inhabitants (population density of 3,103.persons/km2) or about 10 % population of the Study Area.

Regarding the present socio-economic aspect, this is the second important zone in the Study Area. This zone, however, has a relatively high elevation, effectively making a good drainage effect.

3) Western City Drainage Zone: This is the westermost region of the Study Area, mostly covering the Rural District Binh Chanh and some parts of Districts 6, 8 and Tan Binh. There are some sewers being constructed for the newly urbanized areas in Binh Chanh District. The rainfall drainage has been mainly gone into the main canal of Rach Chua – Rach Nuoc Len through ditches and canals to drain into Ben

Luc River and discharged into Nha Be River through Can Giuoc River.
This zone covers an area of 72.91 km2 with a population of 176,000.inhabitants (population density of about 2,414 persons/km2) or about 4.1% population of the Study Area.. Despite its relatively low elevation, this zone is considered an area of outer city, the improvement in urban drainage, therefore, is considered not so important.

4) Southern City Drainage Zone: This zone is basically an agricultural land with some recent economic developments with some limited sewers for urban areas made by developers/ investors. Main rainfall drainage collected by small natural canals will be drained into the trunk canals such as Rach Ba Lao, Rach Xom Cui, Rach Cay Kho, Rach Dia, Muong Chuoi River etc. for finally discharging into Nha be River.

This area of a relatively high elevation covers partly Districts 7, Nha Be and Binh Chanh for an area of 81.74 km2 with a population of 127,000 inhabitants (population density of 1,554.persons/km2) or about 3% population of the Study Area. Concerning the future urban development plan for this region, this zone will be important for the development of urban drainage also.

5) North-Eastern City Drainage Zone: This zone has no sewers except a small part along National Road No.1. Rainfall drain has been gone into the western and eastern canals such as Rach Go Dua, Rach Nhum, Rach Cau, Rach Go Cong to be discharged to Saigon River and Dong nai River. This zone covers 64.91 km2 with the present population of about 174,000 inhabitants (population density of 2677 persons/km2) or 4.1% population of the Study Area.

As this zone consisting of Districts 9 and Thu Duc, it is considered important in future development. The urban drainage is presently performed through a dense canal network.

6) South Eastern City Drainage Zone: This zone has no UDC sewers but very dense canal network. Rainfall drain through ditches and channels into the trunk canals such as Rach Chiec, Rach Ong Hong, Rach Kieu, Rach Ong Nhieu, Rach Trau Trau, Tac River, Saigon River and Dong Nai River. This zone covers an area of 119.37 km2 with a present population of approximately 160,000 inhabitants (population density of 1350 persons/km2) or 3.8% population of the Study Area.

As this zone is considered a relatively remote zone with a dense canal network, the urban drainage is not important at the moment.

3.2 Present Operation System for Sewerage Treatment

(1) As mentioned in the above, in principle, the domestic wastewater including the washing

water (grey water) and the toilet water (black water) is, in principle, subjected to be passed through the septic tanks for making a primary treatment prior to be flown into the city sewer network (Ref. Fig. G.3.1: Operation Situation of Septic Tank)

(2) However, many houses in HHC City have dual grey water/sanitary wastewater discharge systems. Grey water from food preparation, washing, etc. is discharged directly to the city sewer network. Sanitary wastes from toilets are discharged to septic tank beneath the house. Solids accumulated as sludge in septic tanks and cesspools are subjected to be removed periodically for properly functioning this primary treatment. The overflow pipes from septic tanks and cesspools are basically connected to the city sewer network.

(3) In fact, only about one half of the existing septic tanks in HCMC are reportedly designed and constructed properly. Meanwhile, most septic tanks have not been regularly subjected to solids removal. Therefore, the primary treatment effect of the septic tanks is considered low, causing an equivalent black water flowing into the city sewer system.

(4) Besides, along with slump agglomerations and hang-on toilets, many houses have a direct connection of the sewage of both toilet wastes and grey water to the city sewer network or into nearby canals/channels, without a treatment by passing through corresponding septic tanks as regulated.

(5) Administratively, the organizations of OWM, UDC and District Public Service Enterprises, which are mainly in charge of urban drainage, are also responsible for the sewage treatment in their assigned facilities. On another hand, owners of individual houses are responsible for the operation of sewage treatment within their private premises.

(6) From our observation, most of the sludge collected by CITENCO and UDC contractors have been transported to the compost treatment plant in Tan Ky – Tan Qui (for septic tank sludge) or the sludge dumping site in Binh Chanh (for the sludge collected from sewers and canals). But most private septic tank treatment companies are reportedly dumping their collected sludge into nearby water bodies.

4. Present Maintenance System

4.1 Present Maintenance System for Urban Drainage

(1) In principle, the maintenance of the drainage facilities in HCMC has been carried out by the corresponding agencies mentioned in the above (OWM for the assigned waterways, UDC for the assigned canals/ channels and sewers of Grades 1, 2 and 3, and District Public Service Enterprises : for sewers of Grade 4 and inner canals/channels in each district).

(2) The maintenance works assigned to these organizations are to maintain the facilities in good conditions, repairing the damaged parts and assuring the good operation of these facilities.

(3) However, due to the present socio-economic conditions in HCMC and the consequences of the related systems, the dredging work of the subjected facilities is the main maintenance work for these organizations.

(4) During the 15-year period from 1975 to 1990, HCMC had serious neglects in maintenance works for the drainage system. As per consequent, the existing drainage system was presently found in a serious situation of deterioration in structure and operation. Most sewers and canals are presently found in a serious situation of hard sedimentation.

(5) Besides, since most of the equipment used for maintenance works was old and in poor conditions, the maintenance works of sewers and inner canals/ channels have been basically done manually with a low efficiency. Recently, the city administration began to realize the critical situation where high expenses have been used for funding the concerned organizations to operate these maintenance works.

(6) The present situation of maintenance works conducted by OWM, UDC and District Public Service Enterprises is as follows:

OWM: Due to its basic characteristics of a management organization, OWM has carried out the maintenance (mainly by dredging works) of its assigned waterways by annual bids to contractors. From the limitation of an annual budget provided from the Administration (PC HCMC), more or less 10 Billion VND per year, OWM could do the dredging for a limited part of its assigned waterways only. In these conditions, OWM task is to program a dredging schedule year by year for requesting budget and making bids for this dredging work which aims mainly at maintaining a good navigation at first and an acceptable drainage effect as the second purpose.

UDC: UDC, the national agency mainly in charge of urban drainage for HCMC established in 1980, has a large number of workers (about 600 persons) for the maintenance works of its controlled drainage network (Ref. Fig. G.4.1: Organization Chart of Urban Drainage Company). Due to the limitation of budget, more or less 30 billion VND per year, and the lack of sophisticated equipment, most UDC dredging works have been carried out manually throughout the city by groups of about 10 workers. Due to hard works, each group can clean the Grade 2 and 3 sewers for about 100 m per day only. From this situation, UDC cannot do the sufficient maintenance works for its whole assigned drainage network, particularly for the parts of hard sedimentation. Besides, the maintenance works for the canals/ channels (Grade 1) have been totally neglected up to now due to the lack of fund. Most outlets from Grade 2 sewers to

canals/channels have been found in deteriorated conditions and no gates to prevent the tidal effect.

District Public Service Enterprises: The District Public Service Enterprises established in urban districts in HCMC in the period of 1975-1985 have been carried out also the maintenance works (dredging and repairing) of sewers of Grade 4 and the inner canals/channels for maintaining a good drainage and hygienic environment in the districts. Depending on the costs estimated by these enterprises based on the lengths of sewers and dredging times, PC HCMC has provided an annual budget to each Enterprise for this aspect. This annual budget, therefore, is found very varied from one district to another, but its total for the whole HCMC is estimated at about 30 Billion VND per year. Due to financial insufficiency, the maintenance works in district drainage have been done for sewers of Grade 4 only, but not for the related inner canals and channels.

4.2 Present Maintenance System for Sewerage Treatment

(1) Apart from the dredging activities for the sludge sedimentation by OWM and UDC, the sampling and analysis of water quality in Saigon River and sludge characteristics in main canals/channels have been reportedly carried out times to times as part of the survey programs from the Environmental Committee. Strict measures for pollution prevention at sources, however, have been basically neglected.

(2) The Team 2 of CITENCO in District 11 has only 3 vaccum cars (one unit of 5 m3 and two units of 3 m3) and a staff of 8 skilled workers for mainly desluding the septic tanks in official compounds. Its daily collected volume of 20 m3 in average has been mainly transported to the compost plant in Tan Ky – Tan Qui of District Tan Binh (for an average distance of 30 km). The desludging charge of CITENCO is average 100,000 VND per m3. The maintenance of CITENCO equipment on this aspect has been observed properly done by its maintenance group stationed in its Team Station in District 11.

(3) For the desludging of septic tanks in private compounds, many private sludge treatment enterprises are reportedly in operation in HCMC. Each district has 10-20 units of this kind of enterprises. Their equipment (vaccum cars, sludge collecting carts etc.) were partly purchased from CITENCO and partly locally made. The desludging charge of previously sludge treatment enterprises is average 150,000 VND per m3, rather higher than the official charge of CITENCO. According to CITENCO officials, the collected sludge from private sludge treatment enterprises are estimated at about 200 m3 per day.

(4) For the maintenance of their equipment, CITENCO as well as the septic tank treatment enterprises have conducted a good daily maintenance for their vaccum cars, sludge collecting carts etc. after each operation.

(5) As for the maintenance of septic tank in each household premise, the periodical removal of sludge for assuring a proper effluent from this primary treatment has been found very neglected. The household owners will carry out this removal when really having problems with the working conditions of their septic tanks.

5. Actual Problems in Urban Drainage and Sewerage Treatment

5.1 General

(1) Firstly, from the findings mentioned above, the initial concept of urban drainage operation by gravity and the natural cleansing of collected waste water in nearby large waterstreams has been considered no more appropriate to the present conditions where the expanded inner city area of HCMC has different land configurations and a very high population density.

(2) The present administrative demarkation of O/M works on this aspect to the three agencies (OWM, UDC and District Public Service Enterprises) for being responsible for each category of drainage facilities has caused a total high budget allocation (about 70 billion VND per year) to these agencies in total. On another hand, due to this substantial system and no mutual coordination on O/M works among these agencies, the achievement of O/M for the whole urban drainage system has been observed largely insufficient.

(3) On the aspect of facilities, the present sewer system for drainage by gravity is found with various damages and malfunctioning places. For the aspect of sewage treatment, until nowadays, no sewage treatment plant of large scale is found in HCMC. On this basis, concerned officials have no experiences on pumping drainage and sewage treatment plants as well as the related O/M works. Besides, due to lack of sophisticated equipment, most O/M works have been basically relied on manual works, resulting in a very low efficiency, particularly in cleaning works for sewers/manholes.

(4) From their direct disposal of rubbish and domestic sewage into the water bodies, along with the presence of slump agglomerations on both sides of canals/channels in HCMC, this situation has caused the malfunctioning drainage and an adverse environment in these water bodies. With this consistent situation, the dredging works conducted by the responsible agencies have been found basically insufficient for the maintenance of these water bodies. Recently, due to no sufficient budgets, UDC and most districts in HCMC have not carried out the dredging works for their assigned canals/channels.

(5) The understanding of local inhabitants on the aspect of hygienic environmental conservation, particularly at public places like roads, markets, stations etc., has been found insufficient. The lack of basic environmental education on large scale and administrative measures for preventing the public pollution activities has been observed

also.

5.2 Actual Problems in Urban Drainage

5.2.1 General Problems

(1) The demarkation of O/M works in the drainage network has been clearly carried out but there is no permanent coordination and no mutual work operation program among OWM, UDC and the District Public Service Enterprises up to now.

(2) The urban drainage is basically operated by natural gravity, without mechanical means, through an old sewer network to drain out into the nearby waterstreams. The sewer network is mostly old with some places of insufficient drainage-capacity or hard sedimentation resulted in a bad flow of drainage.

(3) Most maintenance works for sewers (dredging of sedimentation) have been done manually, causing few progresses, low effects but high costs. Only a few sophisticated equipment have been recently introduced through foreign assistance for a limited utilization (Ref. Table G.5.1: Present Conditions of O/M Equipment of UDC).

(4) At now, there is no unified dredging schedule and tariff for equally providing O/M budgets to each District Public Service Enterprise. Besides, there are no periodical checks on the efficiencies of their maintenance works (Ref. Table G.5.2: O/M Works for Drainage carried out by Districts).

(5) For the inner canals/channels considered very necessary for functioning the local drainage effects, their maintenance works should be carried out properly also for improving the hygienic living environment for local inhabitants. Regulations on rubbish disposals and prevention of illegal dwelling on local public water bodies, therefore, should be strictly controlled by the corresponding local governments.

5.2.2 Problems of Facilities

(1) For the waterways of OWM and the canals/channels of UDC and districts, the necessary consolidated civil works for these facilities have been found basically insufficient for properly assuring a good O/M. The sewer outlets at these water bodies have been frequently found in bad operation or damaged due to frequent rubbish gathering, illegal dwelling, and the daily tidal effect.

(2) For the city sewer system, due to no sufficient maintenance and rehabilitation works up to now, many parts of its inside structure have been reportedly accumulated with hard sedimentation, resulted in degrading its operation capacities.

(3) For the combined sewer system, its coverage in the inner city is found not uniform. In

the area of city-center, particularly District 1, its density is relatively good, but for other areas its coverage is much less. Because of this non-uniform coverage and inadequate pipe capacity, a majority of the inhabitants living outside the city center, particularly in lowland areas, have problems of partial inundation and overflows of mixed sewage and stormwater onto the streets.

(4) Since most of the sewers Grade 2 were installed before 1980, the underground brick constructions are old and frequently collapsed, and along with the tidal effect through their open outlets, causing a malfunctioning drainage operation. Presently, UDC estimated that about 75 km (or about 75 %) of the Grade 2 sewers in HCMC need rehabilitation works (Ref. Table G.5.3: List of Outlets in priority project Area Controlled by UDC).

(5) The majority of Grade 3 sewers are in 400 mm and 600 mm diameters. Many new areas of HCMC are reportedly lacking of this type of sewers. The need to construct this type of sewers in these housing areas is considered necessary.

(6) As a result of the aforementioned situation of facilities, the whole present network of urban drainage system in HCMC has been reportedly malfunctioning over the years, causing numerous maintenance works, particularly during the rainy seasons. At present, localized floods lasting 1 – 2 days during the rainy season are reported in more than 50 flood-prone areas throughout the city. This situation implies the present malfunctioning conditions of urban drainage in the whole area of HCMC on one hand, and for the specific local places in this city on another hand.

5.2.3 Problems of Operation System

(1) Due to the large expansion of HCMC, the effective drainage operation by gravity for all areas of HCMC has been found impossible, particularly for lowland areas in rainy seasons when the water level of Saigon River raised up to the ground level of these areas.

(2) Besides, due to the old construction with various facilities in damages or insufficient capacities, and the consistent precipitation of rubbish in these facilities along with the unproper maintenance works throughout the whole urban drainage system, the urban drainage operation has been found inconsistent in its whole system.

(3) Under these existing conditions, the operation for the present drainage system in HCMC has been resulted in a very low efficiency but with a very high expense for O/M cost.

5.2.4 Problems of Maintenance System

(1) Due to the administrative demarkation of 3 organizations (OWM, UDC and Districts), the O/M budget of the whole drainage system has been resulted in a high cost in total,

approximately 70 Billion VND per year (or about 15,000 VND per capita per year).

(2) Despite of a high annual expense as aforementioned, the maintenance effectiveness of the drainage system has been found insufficient due to most maintenance works have been manually with low effects and only partial works have been carried out up to now. Each district has a different way of carrying out this work with different unit prices and different frequencies in a year, without any checks on the effectiveness of related works.

(3) Recently some new equipment and technologies have been introduced but still very limited (Ref. Table G.5.1: Present Conditions of O/M Equipment of UDC). These sophisticated equipment as well as the related working systems, therefore, are subjected to be largely introduced with training programs.

5.3 Actual Problems in Sewage Treatment

5.3.1 General Problems

(1) In principle, a new housing construction should install a septic tank. However, due to no official checks during/after the construction works, many housing constructions have direct connection of their domestic sewage to the city drainage system. Besides, a large number of septic tanks, due to manually constructed, have the inside liquid percolating through the floor and walls, causing a serious pollution problem into the soil and groundwater environments.

(2) Due to no strict regulations and controls at present, most septic tanks have no periodical removals of sludge, causing a similar black water flowing inside the city sewer system. Besides, most private septic tank treatment companies are reportedly dumping their collected untreated sludge into the nearby water bodies. In total, the present septic tank system is observed meaningless for its purpose.

(3) For the compost treatment plant in Tan Ky – Tan Qui as well as the national sludge dumping site in Binh Chanh, their receiving grounds have not been constructed in due form for preventing the spreading of nuisance and the infiltration of its leachate into the beneath soil, causing an adverse impact on the living environment of the surroundings.

5.3.2 Problems of Facilities

(1) Despite of a huge population for a major city, at present HCMC has no sewage treatment plants for operational purposes. The effect of natural cleansing in the surrounding water bodies has been found at limitation for the present socio-economic conditions of the city.

(2) The existing system of septic tanks and cesspools is found unproper for the development of a modern city. Particularly, more than half of these facilities have been reportedly

damaged or maleonstructed, causing leakage of the polluted liquid into the soil beneath.

(3) For the compost treatment plant in Tan Ky Tan Qui and the sludge dumping site in Binh Chanh, these compounds have not been constructed in due form for preventing the spreading of various nuisances and the infiltration of its leachate into the beneath soil.

5.3.3 Problems of Operation System

(1) From the present situation, the effect of sewage treatment by natural cleansing in the waterways and canals/channels surrounding HCMC, especially for Tauhu, Benghe, Doi , Te etc., has been observed very deteriorated due to the high sedimentation of sludge in these waterstreams. The desludging activities in these waterstreams are found substantially insufficient.

(2) For the operation of septic tanks, more than half of septic tanks/cesspools are reportedly damaged or maleonstructed, causing the percolation of the liquid into the soil and the underground water beneath. This would cause an adverse impact to the living environment of the local inhabitants.

(3) For the desludging of septic tanks, due to the policy of CITENCO, most private septic tank treatment companies are working illegally and dumping the collected sludge into nearby water bodies. This will cause an adverse effect to the living environment.

(4) Many houses, particularly for new residential areas in the outer city, have directly connected their waste water including the toilet wastes to the city sewer network or to nearby water bodies, without passing through an installation of septic tank for a preliminary sedimentation of sludge, causing a serious adverse impact in the environment of receiving water bodies.

5.3.4 Problems of Maintenance System

(1) Due to no official regulations on the maintenance of septic tanks, this aspect is found basically neglected up to now.

(2) The maintenance work for septic tanks is basically carried out by the sludge removal from septic tanks, usually made when there are problems with their working conditions.

(3) The average frequency of sludge removal from septic tanks is found varied with areas and individual installations, i.e. less than one year for low areas and 5-7 years for high places with good infiltration; but in average, the frequency is estimated at once per three years. The average cost for desludging is 200.000 VND per time which is totally paid by the premise owner/renter to the desluging Enterprises.