SUPPORTING REPORT H
WASTEWATER TREATMENT FACILITIES

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUPPORTING REPORT H WASTEWATER TREATMENT FACILITIES

1. Introduction

In this part we set out the supporting material in respect of the Maritza Basin Wastewater Treatment Facilities.

Although the emphasis is on Municipal Wastewater Treatment, it is pointed out that the major numerical part of the Maritza Basin Institutions, and Commercial & Industrial Enterprises are located within the Municipal Boundaries.

2. Existing Situation

2.1 Incidence of Municipal Wastewater Systems

The 1,754,000 inhabitants within the Maritza River Basin live in 722 settlements. Of these 722, only 40 or so have a 'formal' Municipal Wastewater Collection system and only 5 have true Municipally Run Wastewater Treatment Works.

Fig. H.2.1 illustrates the 'incidence' of the Sewerage systems.

- Here a ranking of the largest 100 towns is made to illustrate incidence of Sewerage Systems and Sewage Treatment Works.
- The 'dashes' show unsewered towns
- The 'open circles' the sewered towns
- The 'Solid Rectangles' the wastewater treatment works (5)

Fig. H.2.2 presents a plan of the incidence of the formal wastewater systems with the respective populations and '% sewered' statistics: Table H.2.1 lists the towns and their statistics. Table H.2.2 briefly summarises the Maritza Basin Municipal Wastewater Treatment Works.

2.2 Existing Wastewater Systems and Treatment Plants

Data available relating to the "recorded" town sewer systems is shown in Table H.2.1.

There we tabulate the extent of the respective sewerage systems in each town. The table also states whether or not a municipal sewage works exists at the present or if a site is readily available for any proposed new wastewater treatment works.

(1) Systems Type

Almost all of the municipal drainage systems are of the 'combined type': I.e. The surface and domestic water drainage are combined together in the same reticulation system.

(2) Town & Village Wastewaters Disposal

Within the Maritza Basin, the various domestic drainage methods include:

1) Those parts of the larger settlements with organised "Blocks of Apartments" are with central drainage: Usually these are drained to a town sewage system or piped to a watercourse.
2) Individual properties in the larger town centres and the older planned developments are typically sewered to a town drainage system.
3) In the villages and in remaining undrained town sectors, the standard method of dealing with wastewater is to construct individual house soakaways.

These 'Unconnected' properties are of concern as they are discharging their sewerage direct to the groundwater.

(3) Soakaway Systems and Their Use

It is possible that of the 1,758,000 Maritza Basin Inhabitants, some 1,250,000 may have piped sewerage to a watercourse (totals around 1,000,000.'connected'). The balance of the population : possibly some 558,000 persons are using "Soakaways" to groundwater.

It is important to explain that these soakaways are typically simple excavated trenches (often stone filled into) which the house drain is fed. It is reported to us that the arrangement is NOT periodically de-sludged. It is usually extended/replaced when problems arise.

The physical process can be problematic. The cause of these problems are put down to this form of household drainage. The problems are regarded as having reached most serious proportions.

In no town visited, did any Municipality report having any system for cleaning out septic tanks: It seems that in the region no traditional 'proper-septic tank" systems are known of.

- The practice unfortunately has a severe impact on ground water quality and a detrimental influence on public health.
- It is of especial concern that many of these undrained areas are in rural villages and on the edge of some of the more "Agricultural Towns": These communities also accommodate a significant number of livestock within the house properties. These animals strengthen contamination of the ground waters and/or surface run-off & sewerage

2.3 Municipal Sewer Systems

Available Plans of the main town sewer systems are shown in the following Figures: Pazardjik (Fig. H.2.3), Panargyurishte (Fig. H.2.4), Stara Zagora (Fig. H.2.5), Plovdiv (Fig. H.2.6), Nova Zagora (Fig. H.2.7), Dimitrovgrad (Fig. H.2.8), Velingrad (Fig. H.2.9), Devin (Fig. H.2.10), Simeonograd (Fig. H.2.11), Hissarya (Fig. H.2.12).

Although the Table H.2.1 refers to some 37 "sewered" towns, it is clear from our research that many of the other "Villages" have some sewerage facility with typically 10 to 50 % house connection rates in some areas: Possibly more

E.g.

- The 8 Villages in the Panagyurishte Municipal Region are 10 to 15% sewered:
- Velingrad municipality has two notably sized almost fully sewered villages in its drainage area
- Of the 6 Stamboliyski's Regional Villages (pop. approx. 18,000), 2 are partially sewered with 5880 persons with full sewerage remote from the possibilities of central sewage treatment. The largest of these villages is Perushtitza with a population of 6124 and a reported connection rate of 80%.

In its Master Plan of 1998, Vodokanal reported a need for 24 "Packaged " WWT Plants. We believe that this number is quite insufficient and that, for communities too far from a Main sewerage Works, such a simple trickling filter plants, reed ponds or some suitable form of Package Plants (e.g. Settlers, Biodiscs + Grass Plots) should be planned to meet the communal needs. There is a need for many hundreds of Such Plants to be built over the next 20 to 50 years.

2.4 Municipal Treatment Works

Table H.2.2 sets out the basic characteristics of the 6 'Operational" Municipal Wastewater Treatment Plants Reported within the Basin.

(1) Water Company Works

Of these 6 only the two at Plovdiv, Nova Zagora, are in reality Operational Works run by the local Water Companies. The works at Hissarya and Radnevo were not really effective for purely operational reasons as explained below.

(2) Works Under Privatisation (Pamporovo)

A seventh Treatment plant is located at the watershed in a ski resort and we believe, discharges in the direction of the Maritza Basin. The Resort has a peak population of around 6000. Because it is now under 'privatisation' however, the Wastewater Works itself is no longer in the "public Domain" and accordingly not be dealt with further.

(3) Ihtiman Wastewater Treatment Plant

This works is currently owned by the local Cast Iron Foundry. It is operated and maintained by the Sofia District Water Company.

Currently the Water Company is negotiating to fully take over the works into the "public Domain": Accordingly, this works is included in our deliberations.

(4) The Peshtera Wastewater Treatment Plant

An industrial treatment plant at Peshtera handles around 15% of the Local town's wastewater. However as this works is "privately operated". It has not been considered as one of the Main Municipal Plants.

(5) Five Genuine Municipal Treatment Plants

We conclude therefore that there are only 5 Genuine Municipal treatment plants in the River Basin. They are Plovdiv, Hissarya, Nova Zagora, Radnevo and Ihtiman.

2.5 Condition of the Wastewater Systems, (State, Infiltration, etc)

Although most water companies and Municipalities report their sewers in operational order, there is evidence that they are not all necessarily in good condition. The type of pipework used in the past is generally inappropriate for an efficient and integral system.:

The bulk of the sewer systems seem to date back to the 1960's when many of the town expansions were commenced.

The almost 'universal' practice was to use precast concrete pipes laid to falls with ogee or Socket & Spigot joints plastered externally at the joint.

All Municipalities questioned confirm that their sewers are built with pipes joints with no jointing rings. This means that water can easily flow through the joints.

Infiltration and Exfiltration:

- The city wastewater can readily 'exfiltrate' to the Ground Water or vice-versa. Excessive *infiltration* means that the sewage can be costly and difficult to treat: Excessive *exfiltration* pollute the groundwater.

Surface Water Infiltration:

- Unwanted surface water penetration is a reported problem: Especially in the more mountainous regions where it seems the perimeters of the newer areas are still under development and the storm water run off from the hillsides often find their way into the sewers.

Manure & Solids Waste Problems in the Sewers:

- Problems with manure and solids waste infiltration into the sewers are well established.
- Some half of the Municipalities questioned report such problems with semi agricultural wastes in the sewers: Apparently the problem has worsened is some districts due to the increased incidence of larger animals in the Community.

2.6 O & M of Municipal Wastewater Systems

(1) Institutional Set Up

Institutionally, the respective 5 Municipal Water Works are operated by the following water Companies:

• Sofia District Water Co.:	Ihtiman WW Treatment Plant
• Plovdiv Water Co.:	Plovdiv WW Treatment Plant
	Hissarya WW Treatment Plant
• Sliven Water Co.:	Nova Zagora WW Treatment Plant
• Stara Zagora Co.:	Radnevo WW Treatment Plant

These works are all suffering from lack of funds, and especially in respect of the last three, an initiative to keep them in operational order. They just don't properly treat the sewage.

Following an initiative by the World Bank, the Water Companies are currently in the process of corporate re-organisation. It is anticipated that a new O&M set up for the management of water and wastewater systems will emerge in the near future.

The water companies also "operate" the sewer systems in their respective areas.

(2) Operational Aspects

As will be evident from the preceding sub-section, the main operational problem at the Treatment Works seems to be due to "Institutional System":

- Funds are low and there is little will to "supervise" and "police" operational efficiency: Much seems to depend on the individual operational management.
- The main treatment process operation may not improve until the "institutional" problems are solved: The operators have the ability: We believe they simply lack the resources they need and some encouragement from "The System".
- Although we understand drainage soakaways are "illegal", neither the REI nor the water Companies are Prime movers in any movement to improve the situation and feed these properties to the sewer for treatment (eventually), e.g., insist on proper Septic Tanks or Sewerage to drains.
- There is no record of Formal Water Co. or REI Prosecutions in Court for wastewater discharge offences.
- There is no real enforcement of the general requirement to maintain storm overflow discharges or prevent excessive exfiltration.

(3) Maintenance Aspects

In effect there is very little preventative maintenance in the treatment works, and possibly none at all in the sewer systems.

With the collapse of the economy all systems seen were run down, and suffering from lack of funds:

- At Ihtiman and at Plovdiv a degree of maintenance was obviously and probably the result of local managerial interest and care. Effort seemed to have been taken to keep the minimum of the plant "operational", but many of the standby units were out of action.
- At the other plants breakdowns and total process shut downs seem common.
- To date the REIs do not seem to 'prosecute' or "fine" these water companies for failing to keep the works in proper operation.

2.7 Other Treatment Plants (Industrial & Private)

Industrial Enterprises recorded with Treatment facilities shows that of a total of 172 Enterprises, 82 discharge into Surface water courses the balance of feeds the Water Company Sewers.

The respective water companies, charge for the sewered 'Wastewater Disposal Service" and, at most towns the Water Company either presumably:

- Discharge these effluents to the water course, (diluted with both town sewerage and/or leakage waters).

and/or

- Lose a portion of the effluents to the ground water due to the lack of integrity of their sewer systems.

3. Existing Development Plans for Improvement of the Wastewater Systems

3.1 Wastewater Collection

Existing plans to develop the existing wastewater collection systems are mainly locally sponsored and aimed at centralising sewerage collection and extending central Municipal

collection systems into unsewered urban areas or improving the waste drainage of surrounding villages by connecting them to the Central Municipal Networks.

Table H.3.1 lists the main town's collectors' programme with some $ 134,000,000 worth of main sewers referred to as being required. This work however can only progress when local funding permits and is consequently subject to severe constraints.

3.2 Municipal Treatment

(1) General Treatment Works Plans

The Ministry of Construction's long term 1989 plan for wastewater treatment are summarised in Table H.3.1. The Updated '1998' Treatment Budget would now be $175,000,000.

Since its inception very little has been done apart from IFI assisted work as mentioned below.

(2) Swiss Aid Assisted Work and the Work at Plovdiv WWTP

The Swiss Government has sponsored an 'Eco fund' which steers local 'eco-funds' and some IFI funds into Bulgarian environmental projects. (E.g. Related to the Pirdrop Privatisation related Eco-improvements)

As part of the Swiss – Bulgarian agreement, a scheme of improvements at the Plovdiv Treatment Works has been started and some progress made with the construction of 4 supplementary settling tanks.

Fig. H.3.1 presents a schematic of the improvement scheme and its proposed phasing.

(3) EC Funded Work

Some 4 to 5 years ago the MoE proposed that The Original Stara Zagora, Dimitrograd and Haskovo Treatment Plant Projects be updated and tendered with a view to EC x-Border Programme Funding. The Bulgarian PMU appointed Foreign Consultants (Dutch) appointed recognised that a radical change was needed and undertook a 'rapid' reassessment of the Technical requirement prior to issuing draft Turnkey Tender Documents for Primary treatment at all 3 sites.

This was followed by a more detailed Financial and Technical Review by a Brussels appointed EC Framework Consultancy Group. This Study Work completed in Dec 1998 and is currently under consideration by the EC in Brussels. So far no decisions as to funding availability or allocation is known.

The study team recommended full treatment for all 3 towns.

(4) IBRD Funded Proposals

In 1991 the World Bank commissioned a nation wide study as to how $100,000,000 could be rapidly injected into the Bulgarian Economy by completing 'unfinished' regional 'water and wastewater' projects for which designs were available and where work had started but had stopped due to lack of funds.

The loan agreement includes the condition that the associated Water Companies Borrow the Funds, that they be Privatised and the schemes funded be Self Sustaining.

An implementation programme set out contained several schemes within the Maritza Basin.

Of the original study programme has now altered and there has been little progress with the fund draw down. This appears to be principally due to the slow rate of the institutional changes needed before the Bulgarian Government and the water Con. can comply with the Loan Agreement Conditions. (E.g. Legislation for tariff increases and was needed, etc.)

3.3 Municipal Sludge Disposal

No municipality approached had any firm Treatment Works Sludge Disposal Plans other than to Stock pile it or dispose of to Landfill. One Municipal Official expressed the need for a study on the Market for Composted Sludge.

3.4 Industrial Treatment

Since de-socialisation there has been no co-ordinated plan for Industrial Wastewater Treatment.

The situation as seen is:

- Where an established industry discharging into a water course is privatised however, (and as appropriate), the State impose the requirement that the new owners update the Industrial Treatment Works. This appears to be working in principal but progress would be improved if were there effective mechanisms to impose a realistic discharge standard and deterring fines for failure to comply.
- Major industries such as the Agro-biohim and Neohim fertiliser plants have a declared intention of joining in the Municipal, Treatment Works and contributing to the cost. De-centralisation and a lack of funds for the State Companies has however meant that in reality there is little possibility of any guaranteed funds to enable any such project to proceed.

4. Municipal Treatment Planning Considerations

In this section, we summarise the main planning criteria and planning for the sewers, for the Municipal treatment and we discuss aspects of sludge disposal.

4.1 Planning Criteria

(1) Domestic Sewerage Systems

There are many deficiencies to be solved in the sewerage system (E.g. leaking sewers, industrial wastes, storm water control, overflows, rod and land drainage optimisation, resizing and the like). We have assumed that the Municipal Treatment Works should be planned assuming that the systems are 'normalised'. I.e. that the main problems (such as excess infiltration in the collection system) will be solved in parallel with the development of the respective Municipal sewerage works.

This will be an added burden for the detailed design stage and will inevitably mean that in parallel with the expenditure on wastewater treatment, many of the regions towns will also have to concentrate their efforts on rehabilitating their sewers and optimising the sewerage collection.

(2) Industrial Discharges

Many of the main towns have separate industrial estates and commercial activities that require careful consideration at the wastewater systems planning stage.

As this Plan is principally concerned with Municipal Wastewater Treatment we have concentrated solely on the Municipal domestic and commercial wastewater loading.

It is assumed, as a base plan premise of the plans developed herein, that all industrial estates are so sewered that the wastewaters are separated from the Municipal sewerage. Conjunctive treatment is, of course possible, but in view of the current uncertain economic climate in Bulgaria, and the state of flux in the regional industries, it is intended that the Municipal wastewater master planning should proceed on the basis that treatment works facilities should only be provided (funded) by the Towns for their own domestic and commercial loading. Both the old established and the newly emerging enterprises should be self sustaining; this is 'in line' with the 'polluter pays' principal.

(3) Animal Populations

In addition to the usual domestic and commercial design criteria we noted that many of the Rural Towns support notable supplementary animal populations.

4.2 Treatment Works Discharge Standards

Although regulation No 7 is often 'quoted' in relation to Treatment Works discharges, it cannot be strictly applied to the actual discharge from a treatment works.

The applicable standard is that of the EC Directive on Urban Wastewater Treatment as summarised in Table H.4.1.

As applied to the treatment works for the towns under consideration, it is generally an effluent standard equal to or better than:

BOD5	25 mg/l
COD	125 mg/l
SS	35 mg/l

4.3 Sewerage System Infiltration/Exfiltration Problems & Planning Considerations

We note that the past sewer laying practice has been to use ogee or S/S pipes without adopting fitted pipe joint material.

In consequence we find that many of the towns' domestic waste water collectors are showing signs of gross dilution of the sewerage with large quantities of 'unaccounted for' excess water.

Our study investigations showed evidence of

- Infiltration
- Exfiltration
- Seasonal Variation of night flows (possibly varying with the ground water table)

At Town after town, enquiries reported similar suspicions with notable dilute sewerage strengths and unaccounted-for BOD losses and high sewerage dilutions. Similar conditions exist in other East European Countries. The solution is to resewer/relay/repair as necessary.

Accordingly, we consider that extensive sewer system investigations need to be undertaken throughout the region to identify the full extent of the problems and optimise solutions.

It may well be worth investigating the option of totally re-sewering parts of the main towns.

4.4 Wastewater Treatment Plants

(1) Design Flow Rate of WWTP

One of the main parameters influencing the design of the initial stages of a normal Municipal WWTP is the flow rate. As a general rule, if there are no unusual factors such as Excessive infiltration a specific wastewater gencration rate of around 250 l/c/d can be assumed as a preliminary planning assumption

The assumed unit flow rate per capita includes water consumption of household, commercial, public facilities, and recreation.

(2) Design Population Equivalent PE

European Design Practice is to base the sizing of the Biological Elements of a Municipal Wastewater Treatment Plant design on an 'average' BOD loading calculated as a 'Population Equivalent (PE)'; one 'PE' representing a rate of loading of 54 grams[1] of BOD5 per day. The 'PE rating ' of a treatment works is the fundamental measure of its ability to handle biological loads, and is commonly used by the western European TW industry as an size indicator in cost models and preliminary & detailed TW planning/ component sizing for wastewaters of 'normal strength'.

This 'PE' measure is adopted in this study as the primary planning and cost criteria.

Based on similar East European Experience, we recommend that, for the "standard" Bulgarian Industrial Town in the Maritza river basin that the Budgetary Costs of the

provision of the Town Wastewater Treatment Plant be limited. We have adopted the upper limit of a PE (population equivalent) of 1.8 times the actual town population. This "Budgetary sizing" will, of course, have to be reassessed at the detailed design stage. (I.e. at the priority project or final feasibility study stages).

(3) Extent of Treatment

Normal Physical and 'BOD5' removal treatment processes are recommended.

Nutrient removal is not considered here, as we believe that such treatment refinements are unnecessary for any of the main towns considered. They are not required under the EC Urban Wastewater Treatment Directive. In all cases 'non-sensitive watercourses' are available as suitable recipient waters for effluent dilution and assimilation.

We consider that, in the foreseeable future, tertiary treatment is a needless and unaffordable requirement: The present river quality Regulation No 7 will not be breached if the normal (proper) dilution is achieved.

(4) Selection of Treatment Method

There is many treatment methods and extension process. For this study, the following design conditions are used.

- The process is either primary or secondary treatment.
- The treatment method is only considered to well-developed one.
- Small treatment plants are considered to simple maintenance facilities.

Referring to the specific wastewater capacity, potential treatment options are presented:

[1] Bulgarian practice 1 PE= 54 grams BOD5 per day

Design Flow Rate	Treatment Method
> 15,000 m3/d	CAS (Conventional Activated Sludge System)
3,000 – 15,000 m3/d	OD (Oxidation Ditch system)
500 – 3,000 m3/d	PF (Percolating Filter System)
< 500 m3/d	Pond Systems, Reid Beds, Lagoons, Biodiscs, etc

Schematic flow diagrams of examples of these general processes (CAS, OD, and PF) are shown Fig H.4.1.

(5) Facility Layout Plan

Fig H.4.2 shows general layout of CAS, OD, and PF systems. In order to extension process in the future, CAS method is kept enough space for nitrification/denitrification process.

4.5 Sludge Disposal

Sludge disposal is an essential part of the Municipal Wastewater Operational programme.

At the planning stage the economics and practicalities of the Treatment Works sludge separation, treatment, transit and disposal can have a profound influence on the Towns wastewater policy and treatment requirements. E.g. Certain Industrial discharges may render the wastewater sludges difficult to separate out, costly to treat and even very costly to dispose of.

Current Bulgarian wastewater planning seems to assume that all Municipal sludge can be 'landfilled' without full consideration of options such as forcing pre-treatment of toxic discharges, and the obvious solution of disposal to agricultural land or other recycling opportunities. Disposal to a modern properly organised landfill is expensive and the current movement for 'privatising' Bulgarian landfills will inevitably force the Municipalities to avoid land fill costs and seek 'recycling' solutions: E.g. Ensure toxics are eliminated and dispose to land.

In similar areas of Western Europe the gradual introduction of the various EC Directives has meant that around 55 % of all Municipal sludge is at present disposed of to agriculture and forecasts are that this will have to increase to at least 70 % with the current planning Horizons.

Particular Consideration has to be given to the Extent and type of Treatment required to 'stabilise' the sludge and render it sufficiently 'safe' for agricultural re-use:

Options include;

- Planning the main WW treatment process with consideration to the economics of the sludge disposal (E.g.. It may be cheaper to use 'extended aeration' or adopt 'bio-filters' rather that invest in more complex and 'modern' thermophilic[2] or mesophilic[3] processes promoted by specialist equipment suppliers/designers)
- Stabilisation with chemicals
- Soils injection of raw untreated sludge (Thus avoiding many of the complications of advanced sludge treatment and dewatering installations)
- Various 'pasteurisation' processes options prior to agricultural use (heating to 70deg for 1 hour)
- Variants such as 'Oven drying and pelletisation' (destroys germs and soil improving qualities (!), Mesophilic digestion and chemical treatment with quick lime, etc

Current European preference by some of the major water undertakers for major towns is to opt for land disposal and adopt thermophilic sludge processing to minimise risks to public health.

It is emphasised that no general rule can be applied, and that each 'town case' must be individually considered during the detailed design period. The end result may well be for each particular water company to set its own 'disposal & sludge treatment strategy' and for the treatment works designers to select the main treatment process and sludge processing accordingly.

[2] Treatment for several days at around 60 degrees
[3] Treatment for 4 to 5 weeks within range of 20 to 40 degrees

5. Municipal Wastewater Systems Cost Models

5.1 Scope and Basis

Municipal Sewerage Systems models were developed related to their current costs: For completed New Works built to International Standards. They are for:

- Sewers
- Pumping stations
- Wastewater treatment works (and their elements)
- Operation & maintenance Costs

Due to a lack of recent Bulgarian cost data in respect of similar major infrastructure projects, the models developed are based on similar work elsewhere in Eastern Europe (East Germany, Poland & Hungary).

(1) Target Accuracy

The models are targeted at a +/- 20% accuracy. They include allowances for all estimated costs to completion. They are adjusted for the current Bulgarian labour market and allow for using Bulgarian construction resources and using modern plant and construction techniques.

(2) Currency & Exchange Rates

All costs are estimated in US$. Related Exchange Rates Used during the work were:

- 1 US$ = 114 J Yen = 1730 Leva

(3) Economic Parameters

The respective economic parameters associated with the figures are:

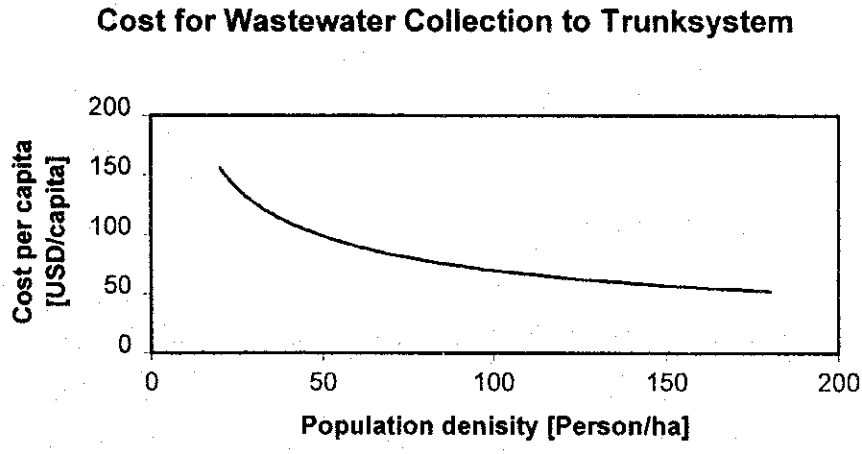
- Life of Civil works 40 years
- Life of Treatment & Pumping Plant 20 Years

- Life of Pumping Plant — 20 Years
- Life of Chemical plant: — 15 Years
- Civil Works: — Annually 0.2 % of Capital Cost
- Electro-Mechanical plant: — Annually 5 % of Capital Costs
- Insurance Costs — Annually 0.1% of Capital Costs

5.2 Sewerage Costs

(1) Sewerage Connection Costs

Costs for new connections to a Municipal sewerage scheme:



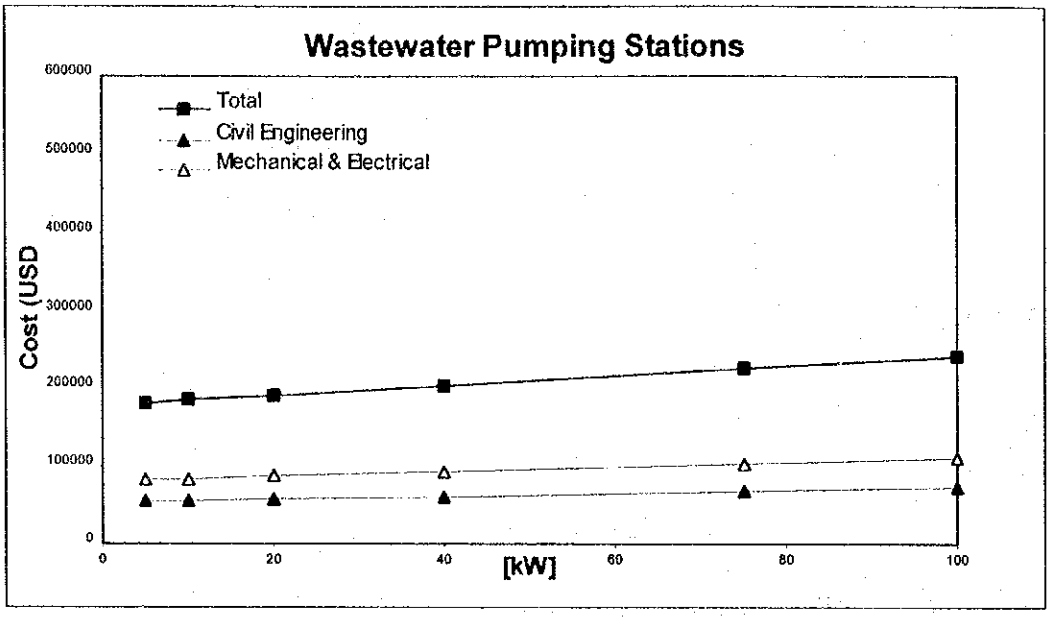
(2) Sewer Costs

Unit sewer runs/rising mains cost rates at 'average' depth are:

Dia. mm.	US $ Per m.	Dia. mm	US $ Per m.	Dia. mm	US $ Per m.	Dia. mm	US $ Per m.	Dia. mm	US $ Per m.
150	58	500	147	900	293	1500	655	2100	1141
200	74	600	162	1000	309	1600	662	2200	1229
300	88	700	218	1100	430	1700	717	2400	1472
400	110	800	250	1200	552	1800	773		

5.3 Pumping Station Costs

Pumping stations are modelled as follows in terms of Civil Works & Installed Power.



5.4 Treatment Costs

(1) Wastewater Treatment Works

For the larger treatment works built on 'green field sites, the most reliable data base has been constructed in tabular form from a model developed from German Experience applied to East Europe. The tabulation below, adjusted for Bulgaria, shows the cost range of individual unit processes and is constructed, to enable the table to be used for adjusting estimated for the 'non-Standard 'situation'.

TREATMENT WORKS COSTS:

The following Cost model tabulation gives net costs in US$ per PE (population Equivalent): Costs are exclusive of land costs, power supply and other services to the site, access roadways, inlet pumping, sludge treatment & the wastewater outfall aqueduct

Item	10,000 PE US $ Range		100,000 PE US $ Range		500,000 PE US $ Range	
Screening	6.44	6.44	4.29	4.29	1.07	1.07
Grit Removal	4.83	4.83	1.93	1.93	1.61	1.61
Primary Sedimentation	3.01	3.01	1.51	1.51	0.75	0.75
Activated Sludge	33.04	33.04	22.02	22.02	13.22	13.22

Final Clarification	10.85	10.85	4.52	4.52	3.62	3.62
Return Sludge Pumping	4.59	4.59	0.92	0.92	0.37	0.37
P-Precipitation	5.27	5.27	1.35	1.35	0.72	0.72
Interconnecting Services	5.27	12.05	3.76	7.53	2.71	6.03
Administration Buildings	5.47	5.47	1.64	1.64	0.55	0.55
Roads & Landscaping	0.85	3.73	0.68	2.97	0.51	1.69
Electric Serv. & Controls	25.63	51.25	13.98	25.63	9.32	13.98
Sludge Stabilisation	42.11	42.10	23.76	23.76	15.12	15.12
Others	18.38	36.76	9.89	18.38	6.69	9.89
General Items	12.21	16.02	6.58	8.52	4.06	5.03
Sub-Total	177.96	235.41	96.84	124.98	60.32	73.65
Engineering Etc.	6%	6%	6%	6%	5%	5%
Totals	188.64	249.53	102.66	132.48	63.34	77.33
Median Total (US $ / PE)	219.09		117.57		70.33	

(2) Smaller Treatment Works

Costs of recent smaller municipal wastewater treatment plants have been modelled in some detail the results, adjusted for Bulgaria, are set out in a series of cost curves in Fig. H.5.1. The 'points' marked on the curves themselves are those upon which a statistic was available for analysis in the original instance.

For flexibility, and to enable probable 'Foreign' and 'Local' budgets to be arrived at, the cost of civil works and the treatment 'plant' have been separated.

(3) Sludge Treatment Works

Costs of sludge treatment works are similarly set out in the curves of Fig. H.5.2.

(4) Extended Treatment (Nutrient Removal)

In the event that 'nutrient removal' is planned, initially or as a future planning option / financial contingency, Fig. H.5.3 shows costs generated for this or separate upgrading an existing works.

5.5 Running Costs

For running costs we adopted the World Bank Model prepared for use in Central Europe. This is reproduced in Table H.5.1.

6. Wastewater Treatment Facility Plan

6.1 Planning Targets

The general target of the Municipal Treatment Plan is to enable substantial parts the River Maritza (& tributaries) to recover from a past history of gross Municipal & Industrial Pollution and to achieve at least a consistent & sustainable Class I or II Surface Standard throughout by the year 2015.

The particular Municipal Treatment Targets are to

1) Transfer available Municipal wastewater to a Treatment Works Site.
2) Treat the Municipal Wastewater to facilitate individually discharges into the watercourses satisfying the EC Directive on Urban Treatment.
3) Process waste products for disposal

6.2 Approach

In our approach to the plan;

- We report long term strategic plan options in respect of the Ministry's plans, identifying a list of some 8 'first stage' towns and prioritising the others. At all of the 7 locations, we found that full treatment is necessary if river quality targets are to be met;

and,

- We appraise the measures necessary to provide Municipal Wastewater Treatment at the respective towns.

Using this appraisal, a priority project is selected for more detailed feasibility study.

6.3 Main Towns Compared on Historical Basis

The main towns' Wastewater review is based on the original 1989 Ministry of Construction Plan for listing Investments required in the sewerage collectors and treatment works. This is reproduced in Table H.3.1 (but with updated costs to allow for Bulgarian inflation in the interim period). The Ministry priorities are assumed 'weighted' on a regional basis and reflected in the incremental staging.

It is from this 1989 Table that we based our own comparison of priorities. In Table H.6.1 we have expanded the data to show various priority rankings.

6.4 Main Municipal Works Capacities (in Terms of PEs.)

In order to Size the respective Works, Population Equivalents have been calculated for each town adopting data referring to the 1992 populations, the applicable 'growth rates' and the like:

- Table H.6.2 lists these 'PEs' with relevant basis tabulated.
- For 'master planning purposes' it is assumed that that the municipal element of the treatment works will be that approximately 1.8 times that of the actual design population. In practice this PE will of course have to be re-appraised town-by-town at the feasibility study stage.
- We have adopted this approach so the work of comparing & prioritizing the actual municipal requirements will more reasonably reflect the Municipal obligation of providing treatment for its reasonably normal domestic & commercial wastewater. The assumption is that 'Big' industry will either pre-treat to a high standard or will independently fund the extra capital cost need to also treat its wastewater (without burden to the water operator).

It is reiterated that the actual 'PE' of the respective towns will have to be determined at the feasibility study stage.

6.5 Principal Criteria Applying in the First Stage 'Selection' Process

1) To have a high priority in the national & regional planning;
2) Bc a heavy discharger; affecting/influencing quality of the discharge on the Main Stream River Maritza,

and, by implication:

3) Have an effective impact in technical, socio-economic and environmental terms.

Additional factors which may well applying to those selected for further feasibility study & immediate implementation will be:

4) The relevant local Water Company/Municipality should 'apply' for and be prepared to actively support the project.
5) There should be no major institutional or physical impediments to implementation. e.g.:
   - The future works ownership & management should be clear;
   - Appropriate funding mechanisms should be approved in principal and & appropriate applications (local and external) should be instituted;
   - The future location of key construction sites for such as major river crossings, pumping stations, principal collectors and treatment works should be identifiable and it should be possible to proceed with preparatory work such as topographic & geotechnical surveys, EIAs, etc. all in the proper order and in time.

6.6 Prioritization of the Municipal Sewerage Collection & Treatment

Our prioritization of these listed towns is shown below. Staged for implementation in three groupings needed to meet a 15-year objective of the necessary river quality targets. Essentially the selection is 'catchment led' and based on the premise found that it is the Major Town Wastewater Treatment that is the Key to improving the surface water quality in the Maritza River Basin.

On the industrial side there is a clear 'hit list of some 10' industries to be targeted, but it is emphasized that:

1) It is by collecting and treating the Regular Municipal Effluent that will achieve the main impact
2) The mere imposition of tougher industrial discharge controls (essential themselves) will go a long way but it is the Municipal treatment that is the vital key.
3) That, generally the sewerage collection/interception should be completed with the Treatment works as should 'full conventional treatment' (with nitrification). Mechanical treatment as a planned first stage seems to have insufficient an impact to meet the River improvement objectives.
4) It is in this way that the Bulk of the Maritza Urban Municipal Wastewater Burden can be intercepted and properly treated.

6.7 Priority Project Wastewater Treatment Works Selection

We compiled the following list of First 'Priority Project Towns' where new or expanded Municipal Treatment Works are required.

Table H.6.3 sets out the adopted 'Priority-Order' listing, the catchments, basic preliminary design PE's, flow-rate data and some indicative (but conceptual) treatment process type possibilities.

The ***'First Priority Towns'*** are:

- Assenovgrad
- Dimitrovgrad
- Haskovo
- Pazardjik
- Plovdiv
- Stara Zagora
- Velingrad

With the exception of Plovdiv, these are all New Wastewater Treatment Works.

Some summary comments on the scope of the priority work, and considerations at these locations are as follows:

(1) Fast Tracking Action Needed

Up until now considerable delays have incurred in progressing Bulgarian wastewater projects since de-socialization[4]. Funds for wastewater treatment projects are/have been available from such as Swiss Aid (slow implementation), The EBRD, and The World Bank and (in the past 5 years) from the EC X-Border program[5]. This project makes it possible to apply for yet further assistance.

To take advantage of these current funding opportunities, and set up a system whereby the funds can be used (as and when they remain available); a new fast-tracking mechanism is necessary.

(2) General

It is not just sufficient to plan to build the 'planned treatment works': A proper updating feasibility study has to be expedited, the full sewage burden has to be collected (all or most of it). River crossings have to be planned and built, collector routes finalized, land availability confirmed for any needed pumping stations, holding tanks overflows, etc. and the Treatment Works themselves and & sludge disposal facilities built and commissioned. If these projects are to be properly expedited there is a lot to organize.

(3) At Stara Zagora, Dimitrovgrad and Haskovo

[4] Of the original 1991 US$ 100,000,000 World Bank offer to inject funds into suspended water & wastewater projects, very little has been spent as planned per the original loan agreement Program. In addition the Plovdiv Program is well behind Program and the intended 3 main EC X-Border WWT works are all 'years behind': Even now when tender documents are just ready, the most important construction site has still not been bought for implementation to proceed.

[5] A grant of 11,000,000 ECU has been in the un-spent budget for some time. The projected new allocation is around 30,000,000 ECU: A procedure to expedite fund draw down is needed: Lest the Funds be diverted

The wastewater systems at all 3 towns need urgent completion. These 3 towns are grouped together here because they are under consideration for funding under the EC X-Border program. As far as is known at the current time an original proposal for 3 primary treatment plants has been reviewed and a supplementary study was completed in Dec 1998. The budget available may be insufficient to meet all the needs for the 3 towns.

The Haskovo Treatment Works has been partially built but it is doubtful that any of the original Site-Works could be incorporated in any future IFI sponsored work.

The need at Stara Zagora is especially urgent and in recognition of this the town has recently bought the treatment works site and completed a 'Site EIA'.

- The Town is the single 'Worst Case' Municipal polluter of the Slazliyka Tributary
- From existing data there is strong evidence of both excessive infiltration and excessive exfiltration. Infiltration/'unaccounted for wastewater' seems to be as high as 3000 cubic meters per hour
- The Town's Industrial Base is a major contributor to the loading in the existing Municipal sewers: A major program of 'Pretreatment' or 'Separate treatment' or other 'Special Program' will have to be instituted if the municipality is to economically process its domestic wastewater.

(4) At Assenovgrad

At this town we include the adjacent villages of Dolny Vodyn & Gorny Vodyn. The main outstanding decisions at this town are related to

- Finalizing the treatment works site and size
- Finalizing the collectors
- River crossing(s)
- Finalizing the treatment process
- Past history of sewer blockages & storm water problems

(5) At Pazardjik & Septemvri

At Pazardjik the Treatment Works site is ready, previous work at the main site has 'prepared the way' but this stopped some time ago. The town collectors are designed and are partly complete. A river crossing has been finished (but as this is for 'industrial effluent' it has little municipal 'value').

A detailed and seemingly thorough Pazardjik wastewater quantity and quality study has recently been completed and is available, as are the results of past site surveys and investigations.

From existing data there is strong evidence of both excessive infiltration and excessive exfiltration. Infiltration on the domestic wastewater collector is around 1000 cu m per hour. An unacceptably high figure for economic wastewater processes.

At this town, the site has been prepared and some buildings erected, but none of the original admin facilities should be incorporated in any future IFI funded work.

The way is therefore open to:

- Up date the study determining the least cost economic remaining solution for Pazardjik and Septemvri. It should be noted however that Septembvri may be too far away to be economically served;
- Double check the existing system condition & hydraulics (especially in respect of the leaking sewers: The Vodokanal proposal needed US$ 25,000,000);
- Finalize the preliminary treatment process design;
- Finalize the proposals for the works sludges.

(6) At Velingrad

Velingrad is the center of a most important and relatively busy tourist town. The sewerage and wastewater treatment is of key economic and environmental importance. The town itself has some 90,000 beds occupied throughout the tourist season and nearby villages also attract business.

The main work to be undertaken here is that of a complete new feasibility study of the treatment needs and the existing sewers. This study so far has assumed that it will be economic to size the works at a PE level of around 180,000 and also to include Rakitovo, Dorkovop and Constantovo in the serviced. All these assumptions will have to be studied including the 'seasonal' nature of the towns' effluents.

In respect of the Velingrad sewers, we have collected data of their current overloading and this will have to be appraised, as will reports that the sewers are at present carrying thermal spring waters. The sewers date back to the 1960's and the town has many new developments.

(7) At Plovdiv

The Plovdiv Works are included on this 'first-priority' list mainly because it is one of the regional Key Towns. As such it contributes notably to the River Burden. This is no-doubt the reason why it was previously selected for the current Swiss Aid assistance.

As far as we can determine there may be a possibility that Further Treatment Capacity may be released/achievable at the present treatment works site if the sewerage quality was strengthened. At present the incoming Wastewater only averages some 91 mg/l of BOD, indicating the possibility of high levels of infiltration (Further study is urgently needed). In addition, the completion of the City collectors would notably improve the local river burden: Were the Northern Industrial Estate fed to the existing treatment works.

6.8 Municipal Treatment Costs

Based on the foregoing, preliminary 'budgetary' planning costs have been developed in respect of all the Main Listed Towns in the Maritza Basin: I.e. Maritza Basin towns of Tables H.3.1 & H.6.1.

The cost estimations were developed using the Treatment Plant and Pumping Models of Section 5; also the other Models as applicable on a case by case basis.

In respect of the cost of the main town collectors, we felt that the 'most authoritative' source of the financial needs was the original 1989 ministry data which was re-evaluated as Table H.3.1. This data was therefore used as the basis and amended as appropriate following site visits and desk studies. It is however pointed out that the figures generated are only sufficient for the present Budgetary Review. Further study and more detailed estimates, least cost solutions etc. are necessary on a town-by-town basis.

For the municipal treatment costs the main model that of the 'PE' table again individually reviewed the 'costs' on a case-by-case basis to reflect such as the existing site conditions, local requirements etc.

The estimated cost for wastewater treatment plants and necessary collectors are shown in Table H.6.1 and Table H.6.4.

In all cases:

- Treatment costs assume that standard conventional treatment will apply: The process priced by the above is that of an activated sludge plant but other process options should be considered at the more detailed planning stage.
- The discharge standard assumed is that which will apply when Bulgaria adopts the EC Urban Wastewater Directive.
- In our opinion none of these Municipal works could be regarded as discharging into 'sensitive' waters and hence it is quite unnecessary (and unaffordable) to treat to a higher standard. I.e. No nutrient removal measures are proposed.

For convenience, the following re-tabulates the first-stage budgetary costs in US$:

Town	Collectors	Full Treatment	Total
Assenovgrad	114,674	12,047,303	12,161,977
Dimitrovgrad	1,876,500	10,677,659	12,554,159
Haskovo	1,250,000	17,195,818	18,445,818
Pazardjik & Septemvri	5,854,000	19,923,835	25,777,835
Plovdiv	4,888,600	0	4,888,600
Stara Zagora	1,650,000	25,532,848	27,182,848
Velingrad	2,400,000	18,610,000	21,010,000
Totals	**18,063,774**	**103,987,463**	**122,021,237**

Notes:

The figures above include:

- At Plovdiv; the current costs of the treatment works improvements & The North Collector and Sewering the remainder of the Town.

TABLE H.2.1 SEWERED TOWNS

Location		Population			Treatment Plant		Sewers			
No.	Municipality	of town	connected to a sewer	unconnected	Existing WWTP	Firm Site for New WWTP Available	Collectors (km)	Sewers (km)	By Street %	Notes
1	Plovdiv	344,326	309,893	34,433	Yes		62	410.00	65.00	Only South City area connected to the sewers. TWks facilities currently under limited expansion & rehabilitation (Swiss Aid): Need to investigate reasons for dilute City Wastewater : Treatment Works Sludge system needs urgent attention.
2	Stara Zagora	149666	137692	11974	-	No	29	157	92	Proposed EC PHARE TWKS : But site unavailable
3	Haskovo	80959	76913	4046	-	Yes	25	94	73	Proposed EC PHARE Completion of Primary TWKS
4	Pazardjik	80921	72829	8092	-	Yes	3	65	55.2	Major Sewer Renovations needed. Proposals to Jointly treat wastewater with Septemvri
5	Asenovgrad	53,089	53,089	0	-	No	6	66.00	63.00	
6	Dimitrovgrad	50,413	50,413	0	-	Yes	9	65.00	68.00	Proposed EC PHARE Primary Treatment Works: New Collectors needed
7	Karlovo	26,582	26,582	0	-	Yes	3	43.00	96.00	
8	Nova Zagora	26658	24525	2133	Yes		7	24	31.3	Existing Treatment Works out of action : No sump drainage pumps
9	Velingrad	26,020	26,020	0	-	No	15	71.00	68.00	Additional 90,000 Tourist population: Joint wastewaer system with 4 local villages: Total PE 0f 130,000 : Town sewers grossly overloaded
10	Tchirpan	19,894	17,724	1,970	-	No	9	43.00	75.00	
11	Harmanli	21,559	17,247	4,312	-	No	1	30.00	56.00	
12	Panagjurishte	20,944	16,546	4,398	-	Yes	3	11.00	-	
13	Ihtiman	12,367	12,367	0	Yes		12	50.00	66.00	
14	Sopot	11,841	11,841	0	-	No	-	18.00	-	
15	Parmovai	16,690	10,041	6,649	-	Yes	8	46.00	59.00	
16	Peshtera	18,900	9,450	9,450	-	No	4	33.00	78.00	
17	Radnevo	14,203	9,232	4,971	Yes	Yes	7	26.00	47.00	Existing WWTWks not used: Pumps to be purchased. Town sewer renovations required
18	Kostenez	10,641	8,513	2,128	-	No	5	20.00	62.50	
19	Pirdop/Zlatitza	8,373	8,373	0	-	No	1	25.00	29.10	
20	Galabovo	9,473	8,336	1,137	-	No	1	11.00	15.00	
21	Septemvri	9,365	8,115	1,250	-	No	-	22.00	-	
22	Stamboliiski	13,155	7,893	5,262	-	No	3	22.00	50.00	
23	Svilengrad	16,496	7,423	9,073	-	No	1	13.00	19.00	
24	Hisaria	8,959	6,271	2,688	Yes	-	2	30.00	42.00	Existing TWKS Potential underused (no sludge removal)
25	Simeonovgrad	8,265	4,959	3,306	-	No	-	12.00	17.10	
26	Krichim	6,875	3,994	4,881	-	No	2	1.00	3.00	
27	Belovo	5,016	3,513	1,503	-	No	-	2.00	7.00	
28	Lubimetz	8,378	2,932	5,446	-	No	1	14.00	27.00	
29	Laki	3,437	2,750	687	-	No	-	5.00	21.40	
30	Rakitovo	8,672	2,601	6,071	-	No	-	23.00	42.30	
31	Devin	6,141	2,149	3,992	-	No	-	3.00	9.10	
32	Batak	4,466	1,787	2,681	-	No	6	66.00	63.00	
33	Streltcha	5,063	1,772	3,291	-	No	3	4.00	20.00	
34	Perustitza	5,535	1,661	3,874	-	No	-	14.00	50.00	
35	Tchepelare	6,083	1,217	4,866	-	No	4	9.00	25.00	
36	Bratzigovo	5,022	1,004	4,018	-	No	-	21.00	70.00	
37	Brezovo	2,174	450	1,724	-	No	1	-	2.00	
			968,119							

TABLE H.2.2 **OPERATIONAL MUNICIPAL WWTP INTHE MARITZA RIVER BASIN IN 1989**

Town	PE		Design parameters			Operation parameters			Treatment Process Units	
	Design	Present	Q m^3/d	BOD_5 mg/dm^3	SS mg/dm^3	Q m^3/d	BOD_5 mg/dm^3	SS mg/dm^3	Main Stream	Sludge
Plovdiv	870,000	470,000	294,000	168	323	175,800	145	105	Bar screen, PS, Grit chamber, Primary settling tanks, Aeration tanks, Secondary set. Tanks, Disinfection	Sludge thickeners, Thermophilic digestors, Mechanical dewatering
Hisarya	35,228	23,694	9,371	203	275	8,530	150	280	Screens, Grit chamber, Settling tanks, Rot.biocontactors, Secondary set. Tanks, Contact basins,	Drying beds
Nova Zagora	89,354	52,778	17,546	275	384	14,250	200	560	Screens, Grit chamber, Aeration, Primary settling tanks, Aeration tanks Secondary set. Tanks, Contact basins	Sludge thickeners, Open digestors, Drying beds
Radnevo	15,555	2,200	4,200	200	254	3300	36	88	Bar screen, Grit chamber, "Emsher" tanks, Bio-filters, Secondary set. tanks, Disinfection	Sludge thickeners, Drying beds
Ihtiman	72,000	35,904	28,512			14,256	136	102	Screens, Grit chamber, Primary settling tanks, Aeration tanks, Secondary set. tanks, Disinfection	Sludge thickeners, Open digestors, Drying beds
Pamporovo	14,800	13,600	3,197	250	80	2,938	250	80	Screen, Grit chamber, Aeration tank, Secondary set. tanks, Disinfection	Aerobic stabiliser Stone filterpress

TABLE H.3.1 WASTEWATER INVESTMENT PLAN OF MARITZA RIVER BASIN IN 1989

(Costs updated in US $ 1000s)

LOCATION	New Sewers			New or Extended Treatment Works		
	1995	2000	2010	1995	2000	2010
Sofia Area						
1 Ihtiman	1,440				1,000	
2 Dolna Banya (Samokov)			720			2,000
3 Kostenetz	2,160			2,500	1,000	
4 Srednogorie		2,400			1,500	
Plovdiv area						
1 Belovo		4,800			2,000	1,000
2 Septemvri		1,440			2,500	7,500
3 Pazardjik	1,440	2,400	2,400	10,000	2,500	2,500
4 Parvomay			1,920			2,000
5 Plovdiv	3,600	3,600	3,360	5,000		5,000
6 Karlovo	240			3,000		
7 Sopot		1,680		1,000	1,000	
8 Streltcha			1,440			1,000
9 Panagiurishte			7,200		2,500	4,500
10 Hisaria		2,400	2,640		1,000	1,000
11 Assenovgrad		7,200		2,500	2,500	
12 Velingrad	2,400			4,000	1,000	8,000
13 Rakitovo			1,200		1,000	1,000
14 Peshtera		960		4,000	2,000	
15 Batak			1,200		1,000	1,000
16 Bratzigovo			960		1,000	1,000
17 Devin		2,400	1,200		1,000	1,000
18 Borino village		960			500	
19 Tchepelare			1,690			
20 Lucky			1,200			1,000
21 Perushtitza		720			500	750
22 Kritchim		1,680	2,400		500	750
23 Stambolilski			1,200		1,000	1,000
24 Kaloyanovo village						1,000
25 2 modern waste water treatment facilities				1,000	500	1,000
Haskovo area						
1 Dimitrovgrad	1,200	1,200		7,500	1,500	
2 Harmanli			3,840			4,000
3 Radnevo						
4 Galabovo			7,200			3,500
5 Stara Zagora	720	720		7,500	5,000	7,500
6 Tchirpan			2,160		1,500	4,500
7 Simeonovgrad			6,000			1,500
8 4 modern waste water treatment facilities						500
9 Haskovo	720		720	2,500	5,000	12,500
1 StaroZagorski Bani				1,000		
Bourgas area						
1 Nova Zagora	3,360			1,000		
Totals in US$	21,800	37,800	74,450	52,500	41,000	82,000

TABLE H.4.1 EC DIRECTIVE FEDERAL STANDARD FOR EFFLUENT FROM URBAN TREATMENT WORKS

The 1991 European Community Council Directive Concerning Urban Wastewater Treatment
EXTRACT NOTES

General Standard for Effluent from Urban Treatment Works:

Parameters	**Concentration**	**Minimum percentage of Reduction in relation to the influent**
Biochemical oxygen Demand BOD5 at 20 deg.	25 mg/l of O2	70 - 90%
Chemical Oxygen Demand (COD)	125 mg/l	75%
Total Suspended Solids	35 mg/l 35 if more than 10,000 PE 60 if PE is for 2000 to 10000	90% 90% if more than 10,000 PE 70% if PE is for 2000 to 10000

And additionally for 'sensitive' waters:

Parameters	**Concentration**	**Minimum percentage of Reduction in relation to the influent**
Total phosphorous	2 mg/l P 10,000 - 100,000 PE 1 mg/l P more than 100,000 PE	80%
Total Nitrogen	15 mg/l N 10,000 - 100,000 PE 10 mg/l N more than 100,000 PE *An alternative seasonal "average compliance" standard of 20 mg/l applies see the directive*	70 to 80 %

NOTES:

- The foregoing is an indicative guide only : the actual directives them selves should be consulted before decisions are made in respect of the EC requirement.
- The directive requires that treated water shall be reused whenever appropriate
- The directive gives a transition time table for member states to achieve full compliance with the sewering requirements and some treatment needs: Different transition requirements may well be negotiable with new members.
- The 'sensitive' waters are defined by member states: Essentially sensitive waters are those at risk of eutrophication or undesirable biological imbalance.
- Sampling methods, analytical methods, QA standards and frequencies are defined in the EC directives. E.g. flow proportional or 24 hour composite sampling is required or equivalent.
- Extreme values for water quality can be ignored, if for example, they result from unusual situations : E.g. Heavy rain.

TABLE H.5.1 TREATMENT PLANT EFFICIENCIES AND OPERATIONAL COSTS

	WASTEWATER TREATMENT EFFICIENCIES AND COST									SLUDGE TREATMENT COSTS			
	BOD5		SS		Tot P		Tot N		Total costs	SP	Dewatering	Anaerobic Stab. +	Dewatering +
	%	g/m3	%	g/m3	%	g/m3	%	g/m3	US $/m3	g Ds/m3	US $/m3	US $/m3	US $/m3
RAW(WWTP influent)	0	250	0	250	0	12	0	48			0.192 US $/kg	0.267 US $/kg	0.509 US $/kg
1.MECHANICAL	30	175	60	100	15	10	15	40	0.16	125	0.02	0.03	0.06
2.CHEMICAL													
a.High load	50	125	80	50	70	3.6	25	36	0.19	250	0.05	0.07	0.13
b.Low load	70	75	90	25	90	1.2	30	34	0.22	350	0.07	0.09	0.18
3.BIOLOGICAL													
a.High load	70	75	80	50	30	8.4	25	36	0.23	185	0.04	0.05	0.09
b.Low load	~90	20	90	25	30	8.4	30	34	0.26	205	0.04	0.05	0.1
4.BIOLOGICAL / CHEMICAL													
a.Simultaneous precipitation	~90	20	~90	20	~90	1	35	31	0.29	250	0.05	0.07	0.13
b.Pre-precipitation	~95	10	~95	15	~95	0.5	35	31	0.29	380	0.07	0.1	0.19
5.BIOLOGICAL / CHEMICAL, N-REMOVAL													
a.Predenitrific./ simult. precip. Based on activated sludge	~95	10	~97	10	~90	1	70	15	0.44	275	0.05	0.07	0.14
b.Postdenitrific./ pre-precip. Based on biofilm process	~97	5	~97	10	~95	0.5	85	7.5	0.4	380	0.07	0.1	0.19

2a Chemical high load - Chemiccally enhanced mechanical

2b Chemical low load - Traditional chemical treatment - primary

3a Biological high load - activated sludge with sludge load = 0.5 kg BOD5

3b Biological normal load - activated sludgae with sludge load = 0.2 kg Bod5

4a Biological / chemical - Simultaneous precipitation in normally loaded activated

4b Biological / chemical - Pre-precipitaion followed by normally loaded activated

5a Biological / chemical incl. N-removal - Predenitrification/simultaneous precipitation in activated sludge plant with total

5b Biological / chemical incl. N-removal - Pre-precipitation followed by biofilm process with post-denitrification and external carbon

Source Document of the World Bank, "Municipal Wastewater in Central and Eastern Europe: Present situation and cost-effective development strategies", Part II/1

TABLE H.6.1 WASTEWATER TREATMENT SYSTEMS PRIORITIZATION RANKINGS FOR LISTED TOWNS

AREA	Initial Design P.E.s	River	Ranking Criteria								COSTS (US$)			IMPACT In terms of the BOD applied to the Watercourse			Total Project COSTS (US$)	
Town	Per Stated Criteria	Catchment	Ministry of Construction Programme of 1989 : New Wastewater Treatment, Modernisation & Extension			By Bulgarian Water Laboratory Analysts (On a 5 point scale)	JICA Interim Report (Dec 1997) Municipal Treatment Works Priorities			Treatment Works Site Immediately Available	Main Collectors	Primary Treatment Only	Secondary Treatment Only	BODs now put in the watercourse Kg. per day (90 g per PE)	BODs in Kg.per day Following Primary Treatment (@ 30% Removal Rate)	BODs in Kg per day Following Secondary Treatment (@ 90% Removal Rate)	Collection & Primary Treatment	Collection and Secondary Treatment
			5 Year	10 Year	15 Year		5 Year	10 Year	15 Year									
Sofia Area																		
1 Ihtiman	42,000	TOP-2		X		A			X	Yes	1,440,000	——	1,180,190	2,352	1,646	235	—	2,620,190
3 Kostenetz, (Town+Village)+Dolny Banya+Maritsa	19,152	MU 1 - 8 MU1 - 10	X	X						No	2,160,000	1,954,663	4,117,980	1,073	751	107	4,114,663	6,277,980
Plovdiv area																		
1 Belovo	9,036	MU1 - 3 MU 2 - 2		X	X				X	No	4,800,000	943,686	1,987,920	506	354	51	5,743,686	6,787,920
3 Pazardjik & Septemvri	161,482	MU1 - 2	X	X	X	A	X			Yes	5,854,000	8,189,185	19,923,835	9,043	6,330	904	15,043,185	25,777,835
4 Panomay	36,000	MM2 - 13			X	B		X		No	192,000	3,041,878	6,408,000	2,016	1,411	202	3,233,878	6,600,000
7 Sopot & Karlovo	70,308	STR - 3	X	X		B				No	2,500,000	4,654,054	9,804,200	3,937	2,756	394	7,154,054	12,304,200
8 Strelicha	9,106	LUD - 3			X	D				No	1,400,000	951,185	2,003,760	510	357	51	2,351,185	3,403,760
9 Panagiurishte	181,000	LUD - 2		X	X	B		X		Yes	400,000	3,137,948	6,202,579	10,136	7,095	1,014	3,537,948	6,602,579
10 Hisarla	30,000	STR - 1		X	X	A				No	0	2,705,790	5,700,000	1,680	1,176	168	2,705,790	5,700,000
11 Assenovgrad	95,562	CPE - 1	X	X		A	X			No	114,674	5,598,452	12,047,303	5,351	3,746	535	5,713,127	12,161,977
12 Vellingrad+Rakitovo+Dorkovo+Constantinov o	161,000	CPI - 3	X	X	X	A			X	No	2,400,000	8,583,241	18,610,036	10,136	7,095	1,014	10,983,241	21,010,036
14 Peshtera	11,504	STA	X	X		A			X	-	960,000	—	—	644	451	64	—	—
15 Batak	8,046	STA		X	X	C				No	120,000	847,915	1,786,212	451	315	45	967,915	1,906,212
16 Bratzigovo	9,000	STA		X	X	C				No	960,000	939,906	1,980,000	504	353	50	1,899,906	2,940,000
17 Devin	11,054	VAC - 4		X	X	A				No	3,600,000	1,101,043	2,319,450	619	433	62	4,701,043	5,919,450
18 Borino - village	5,202	VAC - 3		X		B				No	960,000			291	204	29	—	—
19 Tchepelare	11,268	CPE - 3			X	C				No	1,690,000	1,123,273	2,366,280	631	442	63	2,813,273	4,056,280
20 Lucky	6,228	CPE - 2			X					No	1,200,000	739,108	1,557,000	349	244	35	1,939,108	2,757,000
21 Perushtitza	10,080	VAC - 1		X	X	C				No	720,000	474,700	1,000,000	564	395	56	1,194,700	1,720,000
22 Krichim	15,770	VAC - 1		X	X	C			X	No	2,400,000	1,631,952	3,437,860	883	618	88	4,031,952	5,837,860
23 Stambolliski	25,200	MM1 - 12		X	X	B		X		No	1,200,000	2,213,051	4,662,000	1,411	988	141	3,413,051	5,862,000
24 Kaloyanovo - village	5,062	MM1 - 2			X	B				No				283	198	28		
25 20 packaged waste water treatment facilities			X	X	X					No								
Haskovo area																		
1 Dimitrovgrad	91,000	MM3-4	X	X		A	X			Yes	1,867,500	5,098,181	10,677,659	5,096	3,567	510	6,965,681	12,545,159
2 Harmanli	38,430	HAR- 1			X	B				No	3,840,000	3,192,476	6,725,250	2,152	1,506	215	7,032,476	10,565,250
3 Radnevo	27,000	SA2 - 6		X		R		X		Yes	0	2,435,211	5,130,000	1,512	1,058	151	2,435,211	5,130,000
4 Galabovo	17,100	SA2 - 4			X	C		X		No	7,200,000	1,686,413	3,556,800	958	670	96	8,886,413	10,756,800
5 Stara Zagora	270,000	SA2 - 7	X	X	X	A	X			No	1,650,000	12,061,699	25,532,646	15,120	10,584	1,512	13,711,699	27,182,646
6 Tchirpan	35,460	MM2 - 13		X	X	B	X			No	2,160,000	3,029,915	6,382,800	1,986	1,390	199	5,189,915	8,542,800
7 Simeonovgrad	14,940	MM3 - 1			X	C				No	6,000,000	1,560,244	3,286,800	837	586	84	7,560,244	9,286,800
8 4 module waste water treatment facilities					X					No								
9 Haskovo	150,000	HAR - 2	X	X	X	A	X			Yes	1,250,000	8,055,369	17,195,818	8,400	5,880	840	9,305,369	18,445,818
Bourgas area																		
1 Nova Zagora	.....	SA2 - 6	X	-	-	R		X		No	3,360,000		2,900,000	..			—	6,260,000

TABLE H.6.2 TREATMENT WORKS POPULATION EQUIVALENTS GENERATED FOR PRELIMINARY PLANNING PURPOSES

Municipality	Contributing Pupulation	Current Appraised Population Equivalent (PE)	Future Planning PE'	Basis
Sofia Area				
1 Ihtiman	15,000	42,000	N/a	Present works operating at 50% of units in service can cope with a average flow of 180 l/sec @ 75 mg/l of BOD.
3 Kostenetz & Dolny Banya	10,640	19,152	23,940	25% growth
4 Srednogorie	----	----		Not considered in detail
Plovdiv area				
1 Belovo	5,020	9,036		
3 Pazardjik and Septembrevi	89,712	161,482	193,778	pop = 80356+9356 =89712: Then factored by 1.8 and 20% growth applied
4 Parvomay	20,000	36,000	41,400	population to be connected taken from Towns data
5 Plovdiv	----	----	----	A budget for additional works capacity is not under consideration
7 Sopot & Karlovo	39,060	70,308	84,370	
8 Streltcha	5,060	9,108	10,930	
9 Panagiurishte	19,407	34,933	41,919	
10 Hisaria	10,000	30,000	34,500	Tourist town : PE estimated in consultation with the Mayor Future expansion also planned
11 Assenovgrad	53,090	95,562	114,674	
12 Velingrad+Rakitovo+Dorkovo+ Constantovo	50,500	91,000 Winter Time & 181,000 in Summer Season	181,000	Additional Summertime PE of 90000 Data all Based on Data collected during visit to Municipality
14 Peshtera	20,000	---	---	Town not considered as existing works is Industrial.
15 Batak	4,470	8,046	9,655	
16 Bratzigovo	5,000	9,000	10,800	
17 Devin	6,141	11,054	13,265	
18 Borino - village	2,890	5,202	6,242	
19 Tchepelare	6,260	11,268	13,522	
20 Lucky	3,460	6,228	7,474	
21 Perushtitza	5,600	10,080	12,096	Based on Data collected during visit to Municipality
22 Kritchim	8,761	15,770	18,924	
23 Stamboliiski	14,000	25,200	30,240	Based on Data collected during visit to Municipality
24 Kaloyanovo - village	2,812	5,062	6,074	20% growth
Haskovo area				
1 Dimitrovgrad	50,400	91,000	109,200	20% growth
2 Harmanli	21,350	38,430	48,038	25% growth
3 Radnevo	15,000	27,000	32,400	20% growth
4 Galabovo	9,500	17,100	20,520	20% growth
5 Stara Zagora	149,700	270,000	297,000	10% growth
6 Tchirpan	19,700	35,460	42,552	20% growth
7 Simeonovgrad	8,300	14,940	17,928	20% growth
9 Haskovo	80,960	150,000	165,000	10% growth
Bourgas area				
1 Nova Zagora	---------	---------		A budget for additional works capacity is not under consideration

NB: Future provision for Growth is generally in accordance with the data generated in Progress report I (Para 4.1).

TABLE H.6.3 DESIGN FLOWRATE AND TREATMENT PROCESS OF WWTP FOR THE PRIORITY TOWNS

River Basin		Catchment	Town	Present Pop	Future Pop	PE	Priority Order			WWTP Design Flowrate *1 (m^3/day)	Wastewater Treatment Process *2
							1st	2nd	3rd		
Maritza	Up-stream	MU2-2	Pazardjik /Septembvri	90,286	108,343	194,000	X			48,500	C.A.S
		MM1-9	Plovdiv	344,336	378,770	—	X			—	—
		CPE-1	Assenovgrad	52,360	57,596	115,000	X			28,800	C.A.S
		MM1-12	Stamboliiski	13,155	14,471	30,000		X		7,500	O.D
		MM1-2	Kaloyanovo - Village	2,812	3,374	6,000			X	1,500	P.F
		STA	Peshtera	18,900	20,790	—			X	—	—
		STA	Batak	4,468	4,915	10,000			X	2,500	P.F
		STA	Bratzigovo	5,022	5,524	11,000			X	2,800	P.F
	Mid-stream	MM3-9	Dimitrovgrad	50,977	61,172	109,000	X			27,300	C.A.S
		MM2-15	Sadovo	2,647	2,912	—		X		—	—
		MM2-13	Parvomai	16,690	18,359	41,000		X		10,300	O.D
		MM2-1	Chirpan	19,694	23,633	43,000		X		10,800	O.D
		MM3-1	Simeonovgrad	8,265	9,918	18,000			X	4,500	O.D
	Down-stream	HAR-2	Haskovo	80,959	89,055	165,000	X			41,300	C.A.S
		HAR-1	Harmanly	21,559	26,949	48,000		X		12,000	O.D
Sazlyka		SAZ-7	Stara Zagora	149,666	164,633	297,000	X			74,300	C.A.S
		SAZ-6	Radnevo	14,203	17,044	32,000		X		8,000	O.D
		SAZ-4	Galabovo	9,473	11,368	21,000		X		5,300	O.D
		SAZ-6	Nova Zagora	26,658	29,324	—			X	—	—
Other than Prioritized Region		CPE-2	Lukki	3,437	3,781	7,000			X	1,800	P.F
		CPE-3	Chepelare	6,085	6,694	14,000			X	3,500	P.F
		CPI-2	Rakitovo	8,672	9,539	—			X	—	—
		LUD-3	Streltcha	5,063	5,569	11,000			X	2,800	P.F
		MU1-3	Belovo	5,016	5,518	—			X	—	—
		MU1-8 /MU1-10	Kostinetz /Dolna Banya	15,667	19,584	24,000			X	6,000	O.D
		STR-3	Sopot/Karlovo	39,065	42,972	84,000			X	21,000	C.A.S
		TOP-2	Ihitman	12,860	14,146	—			X	—	—
		VAC-1	Perushtitza	5,535	6,089	12,000			X	3,000	P.F
		VAC-1	Kritchin	8,875	9,763	19,000			X	4,800	O.D
		VAC-3	Borino - Village	2,884	3,172	6,000			X	1,500	P.F
		VAC-4	Devin	6,141	6,755	13,000			X	3,300	P.F
			20 Packed Wastewater			—			X	—	—
			4 Module wastewater treatment facilities			—			X	—	—
Other		CPI-3	Velingrad	50,000	55,000	181,000	X			45,300	C.A.S
		STR-1	Hissarya	8,959	9,855	35,000		X		8,800	O.D
		LUD-2	Panagjurishte	20,944	23,038	42,000		X		10,500	O.D
		TOP-3	Pirdop/Zlatiza	14,008	15,409	—		X		—	—

*1 average design flow of 250 L/PE・day

*2 The treatment process is determined by the design flowrate

15,000m^3/d<flowrate C.A.S:conventional activated sludge system

3,000m^3/d<flowrate<15,000m^3/d O.D :oxidation ditch system

flowrate<3,000m^3/d P.F :percolating filter system

TABLE H.6.4 BUDGET ESTIMATES FOR WASTEWATER COLLECTION AND TREATMENT AT THE MAIN TOWNS

ITEM	Assenovgrad		Dimitrograd		Haskovo		Panagiuriste		Pazardjic & Septembrevi		Stara Zagora		Velingrad+Rakitovo+ Dorkovo+Constantovo	
	PRIMARY	PRIMARY & SECONDARY	PRIMARY	PRIMARY & SECONDARY	PRIMARY	PRIMARY & SECONDARY	PRIMARY	PRIMARY & SECONDARY	PRIMARY	PRIMARY & SECONDARY	PRIMARY	PRIMARY & SECONDARY	PRIMARY	PRIMARY & SECONDARY
UNIT RATES (US$ PER PE) FOR:														
Raw WW Pumping	1.2	1.2	0.88	0.88	1.2	1.2	1.2	1.2			1.00	1.00		
Screening	4.29	4.29	4.29	4.29	4.29	4.29	5.10	5.10	4.29	4.29	2.01	2.01	4.29	4.29
Grit removal	1.93	1.93	1.93	1.93	1.93	1.93	3.20	3.20	1.93	1.93	1.72	1.72	1.93	1.93
Primary sedimentation	1.51	1.51	1.34	1.34	1.51	1.51	2.40	2.40	1.51	1.51	1.20	1.20	1.51	1.51
Activated sludge		22.02		19.82		22.02		26.40		22.02		17.30		22.02
Final Clarification		4.52		4.07		3.80		7.10		3.80		3.90		3.80
Return Sludge		0.92		0.92		0.92		3.40		0.92		0.50		0.92
Interconnecting services	2.00	3.76	2.00	3.76	2.00	3.76	2.00	6.30	2.00	3.76	1.40	4.50	2.00	3.76
Admin Building	1.64	1.64	1.30	1.30	1.64	1.64	3.80	3.80	1.64	1.64	1.10	1.10	1.64	1.64
Roads & Landscaping	0.30	0.68	0.30	0.68	0.30	0.68	0.50	1.80	0.30	0.68	0.40	1.20	0.30	0.68
Electrical services	9.00	13.98	9.00	13.98	9.00	13.98	13.00	18.40	9.00	13.98	8.00	12.60	9.00	13.98
Sludge Stabilisation	16.00	23.76	15.00	21.00	16.00	23.76	27.00	32.80	16.00	23.76	15.00	18.90	16.00	23.76
Others	4.00	9.89	4.00	9.89	4.00	9.89	6.00	15.00	4.00	9.89	3.00	7.80	4.00	9.89
General items (10%)	4.19	9.01	4.00	8.39	4.19	8.94	6.42	12.69	4.07	8.82	3.48	7.37	4.07	8.82
Sub Total	46.06	99.11	44.04	92.25	46.06	98.32	70.62	139.59	44.74	97.00	38.31	81.10	44.74	97.00
Fees 6%	2.76	5.95	2.64	5.53	2.76	5.90	4.24	8.38	2.68	5.82	2.30	4.87	2.68	5.82
Total $ per PE	48.82	105.06	46.69	97.78	48.82	104.22	74.86	147.97	47.42	102.82	40.61	85.97	47.42	102.82

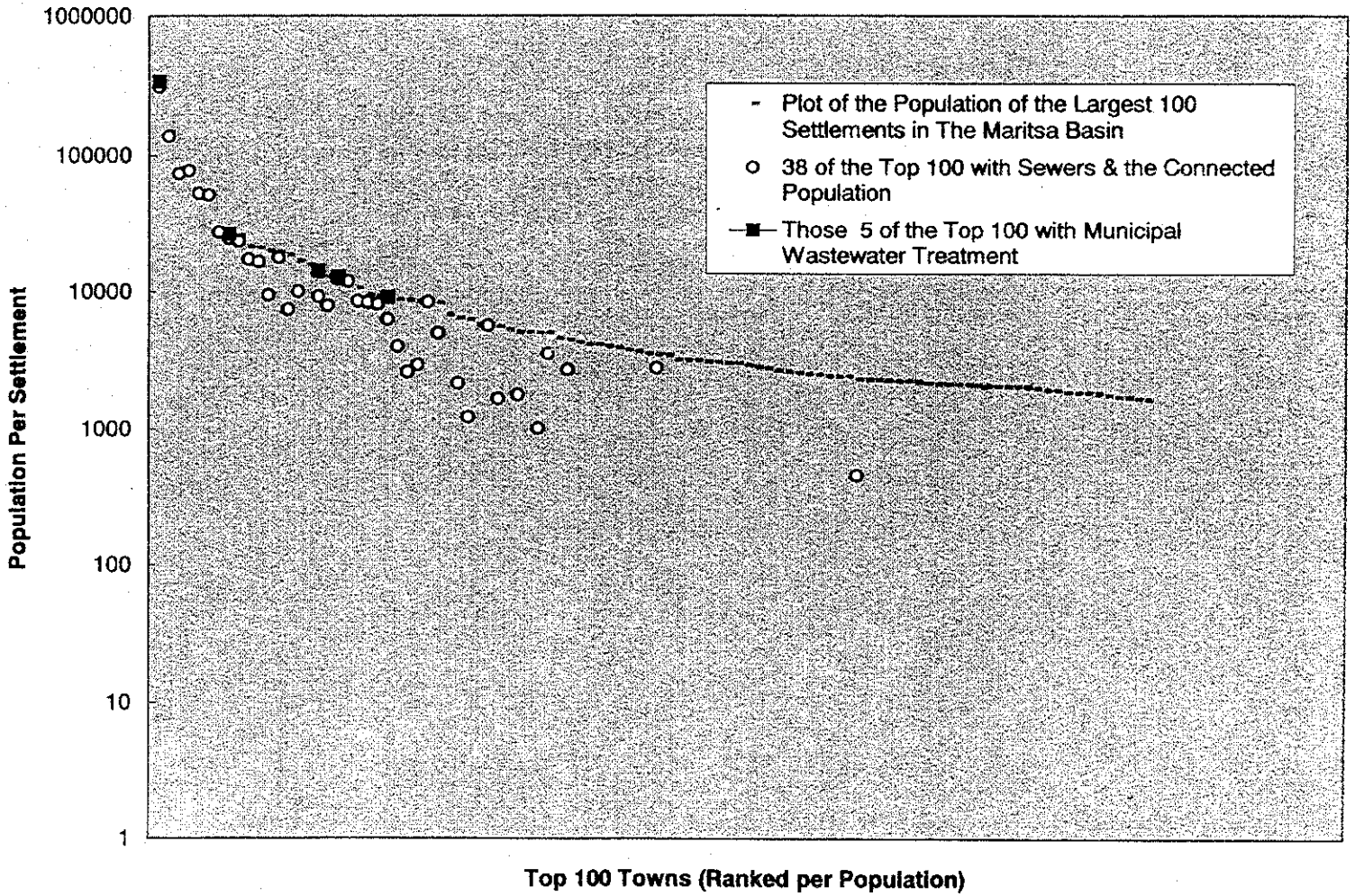
Population Equivalent	114,674		109,200		165,000		41,919		193,778		297,000		181,000	
Treatment Works Costs	5,598,452	12,047,303	5,098,181	10,677,659	8,055,369	17,195,818	3,137,948	6,202,579	9,189,185	19,923,835	12,061,699	25,532,846	8,583,241	18,610,036
Primary Collector Costs	7,200,000	7,200,000	1,867,500	1,867,500	1,250,000	1,250,000	400,000	400,000	5,854,000	5,854,000	1,650,000	1,650,000	2,400,000	2,400,000
Planning Budget (US $)	**12,798,452**	**19,247,303**	**6,965,681**	**12,545,159**	**9,305,369**	**18,445,818**	**3,537,948**	**6,602,579**	**15,043,185**	**25,777,835**	**13,711,699**	**27,182,846**	**10,983,241**	**21,010,036**

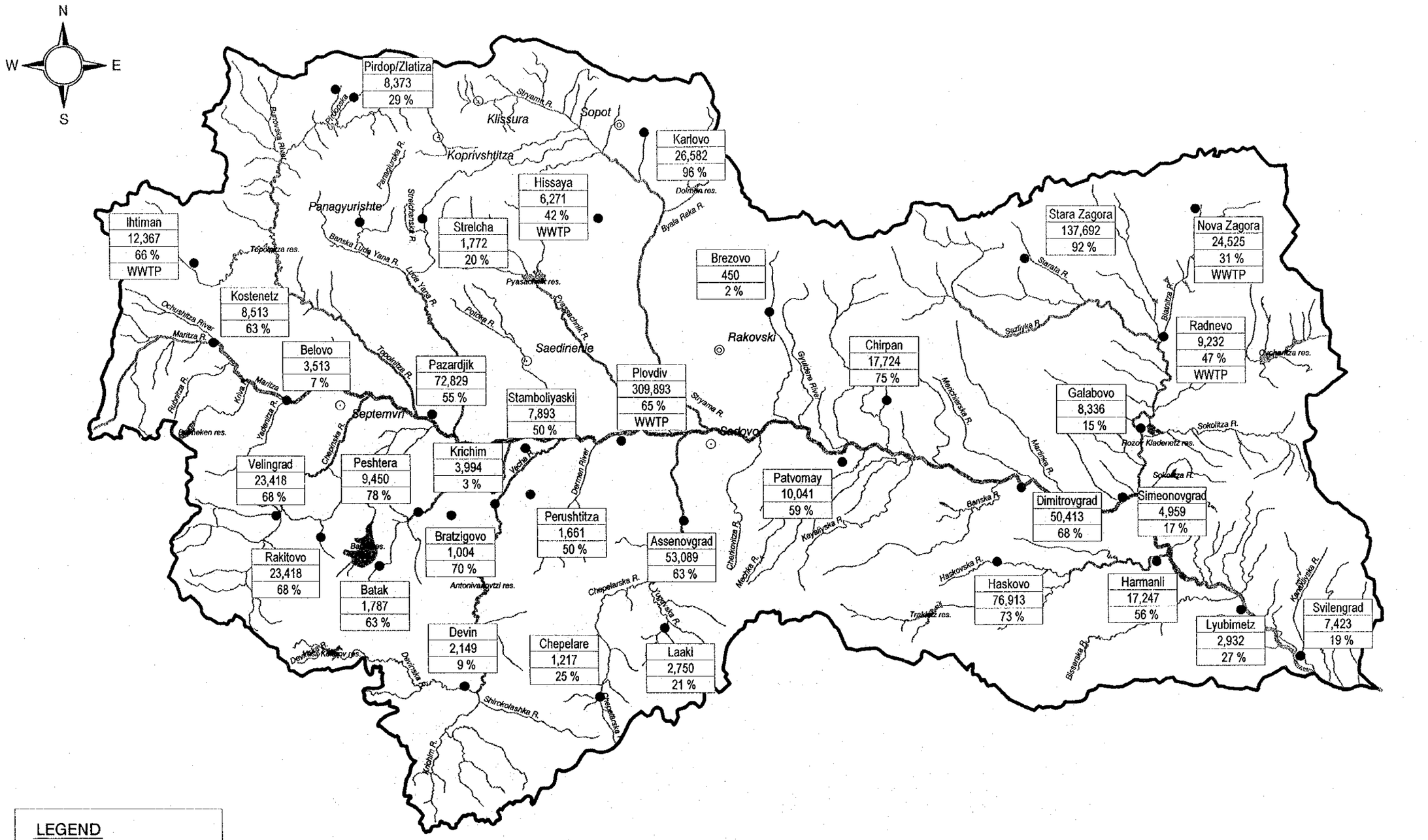
Budget costs:

Exclude land costs, site access roadways and external services such as power feeders, water services etc.
Include allowances for the main wastewater collectors from the respective centres of Municipal Development
Exclude Geotechnical Site investigations

Assume 'standard tender & construction site conditions' & typical prices @ international rates but after adjustment for Bulgarian conditions.

FIG.H.2.1 POPULATIONS CONNECTED, SEWERED & TREATED IN THE TOP 100 TOWNS & VILLAGES.





LEGEND

Plovdiv	Town
309,893	Population connected
65 %	Swewred by street %
WWTP	WWTP

SCALE 1 : 700000

10 0 10 20 km

FIG.H.2.2 TOWNS WITH SEWERAGE SYSTEMS

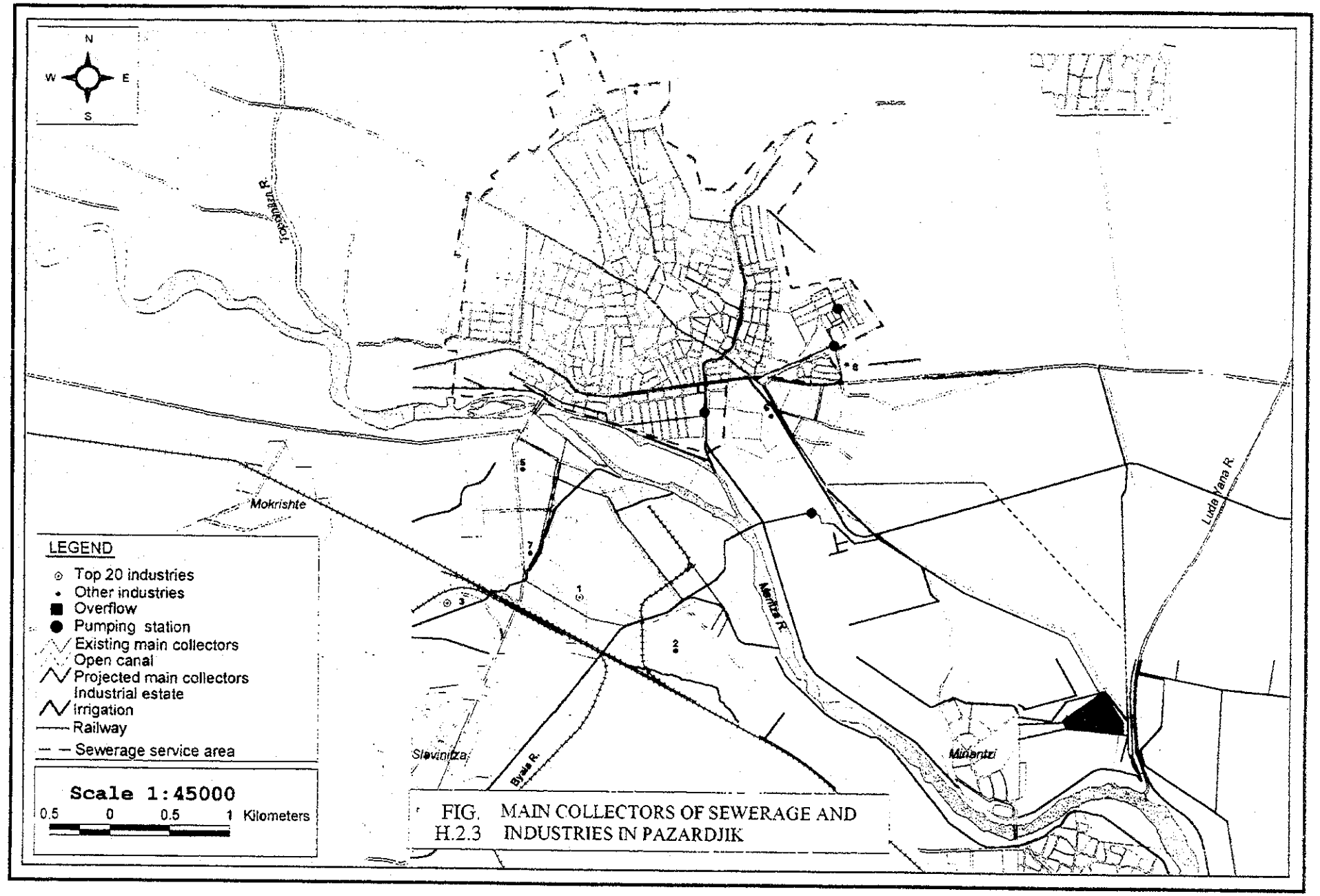


FIG. H.2.3 MAIN COLLECTORS OF SEWERAGE AND INDUSTRIES IN PAZARDJIK

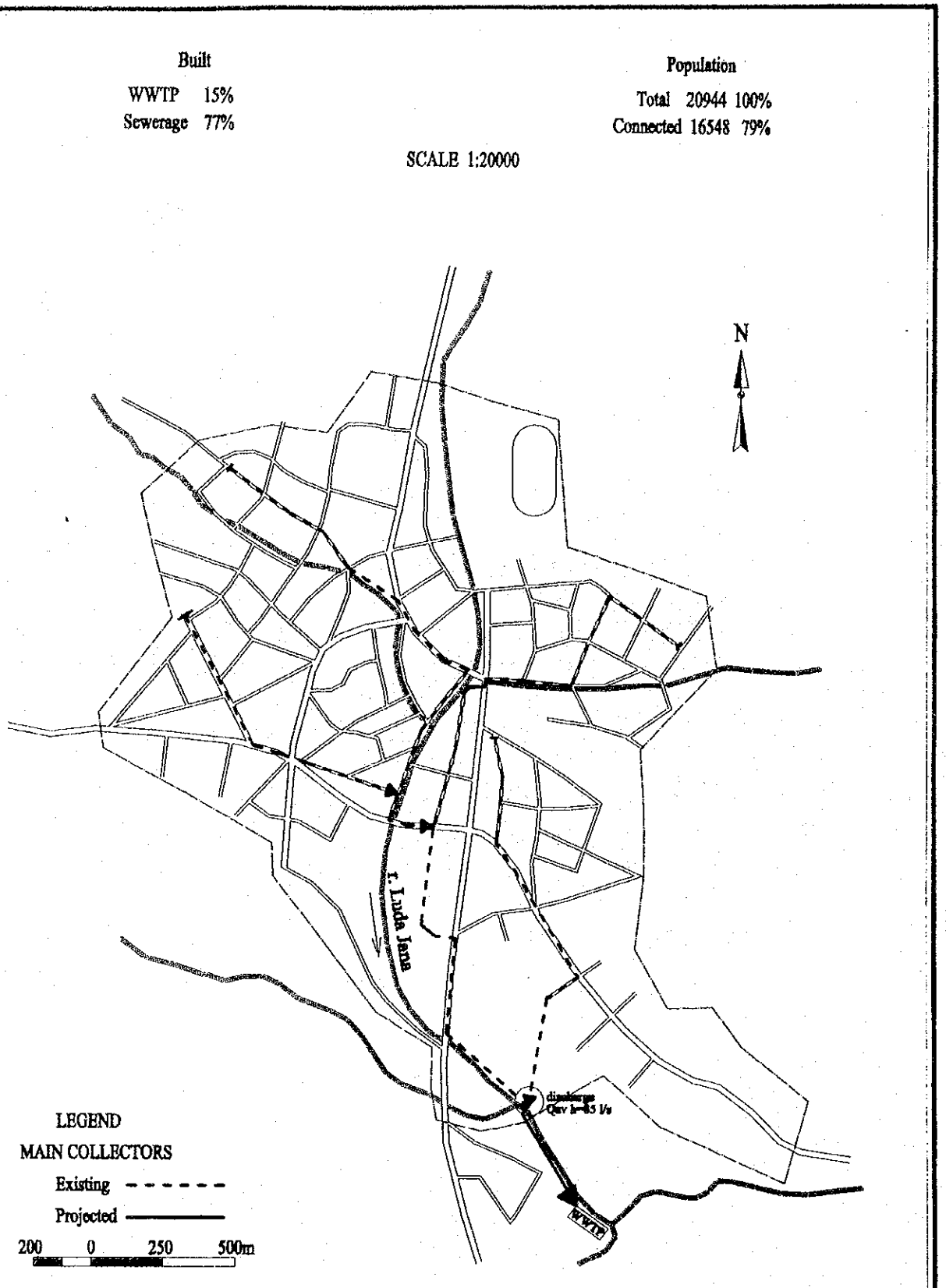


FIG.H.2.4 PANAGYURISHTE SEWERAGE SYSTEM

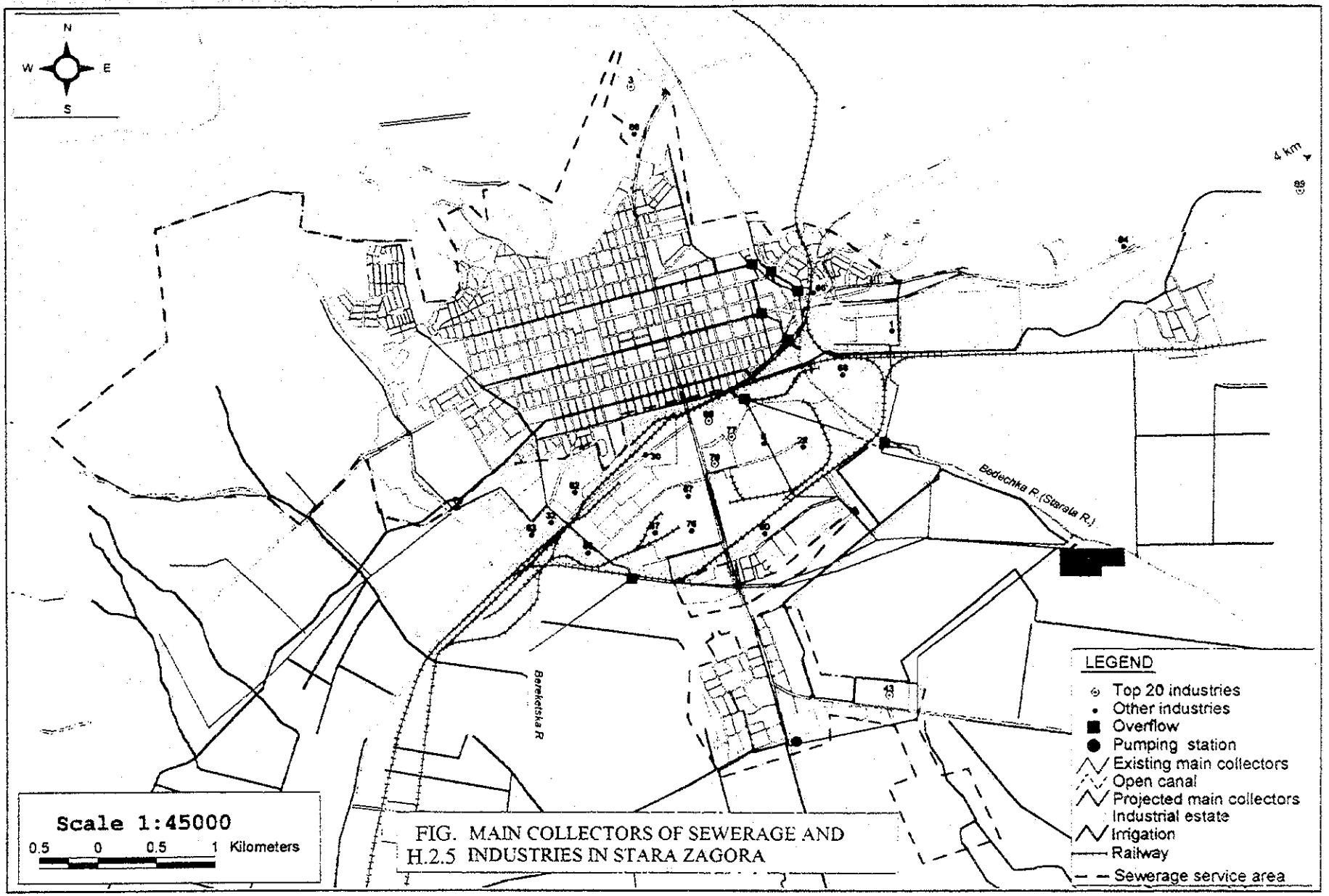


FIG. MAIN COLLECTORS OF SEWERAGE AND
H.2.5 INDUSTRIES IN STARA ZAGORA

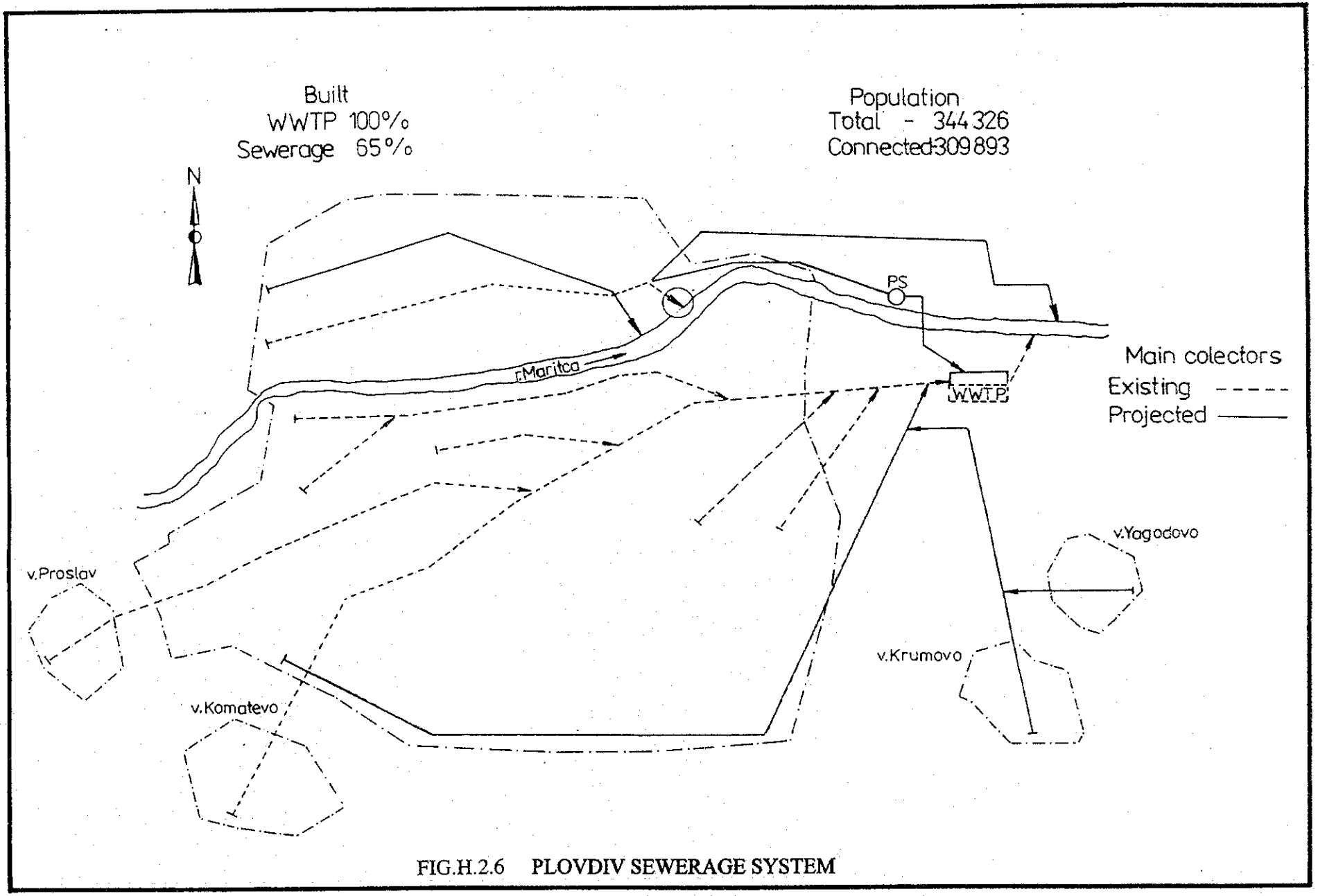


FIG.H.2.6 PLOVDIV SEWERAGE SYSTEM

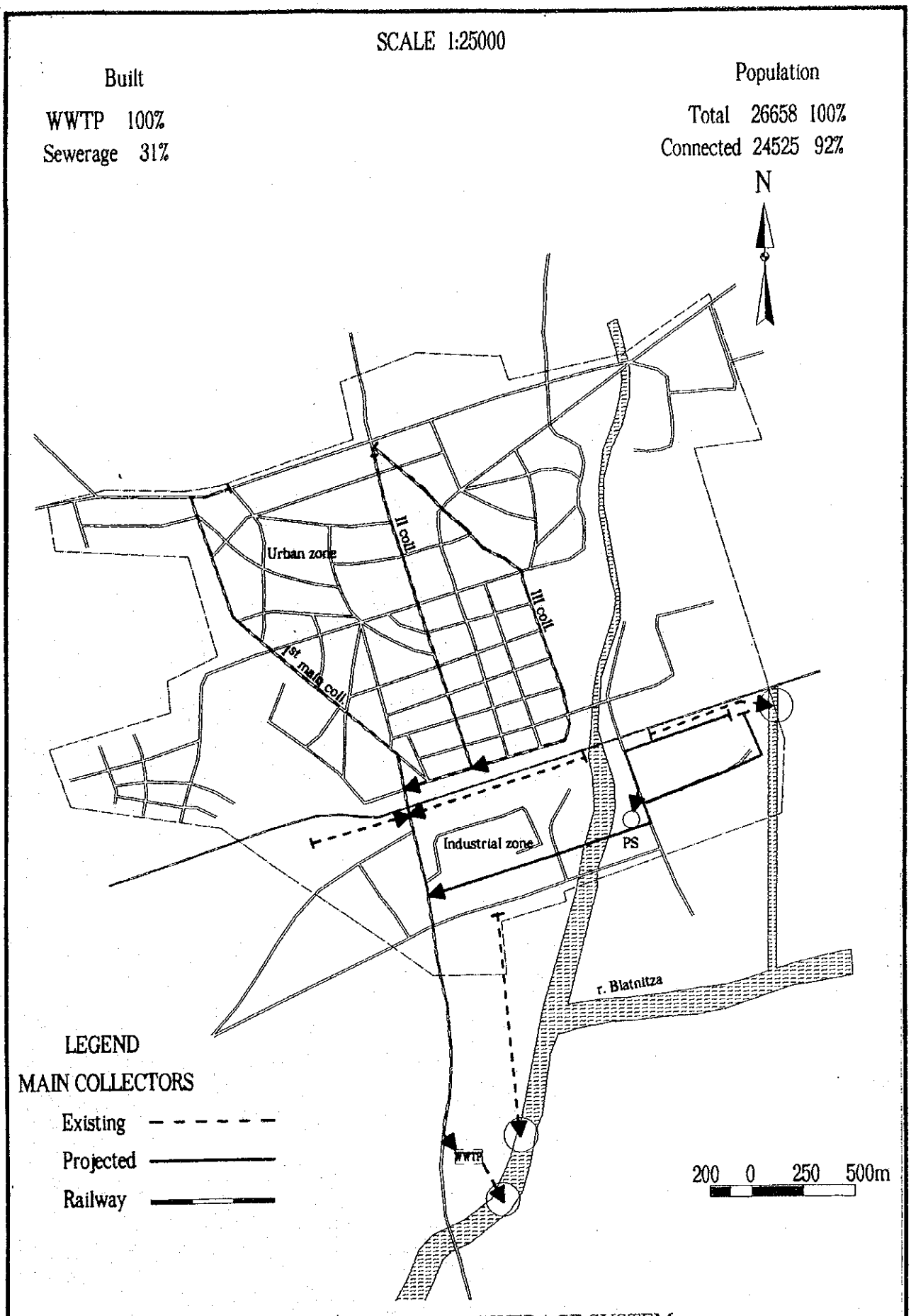


FIG.H.2.7 NOVA ZAGORA SEWERAGE SYSTEM

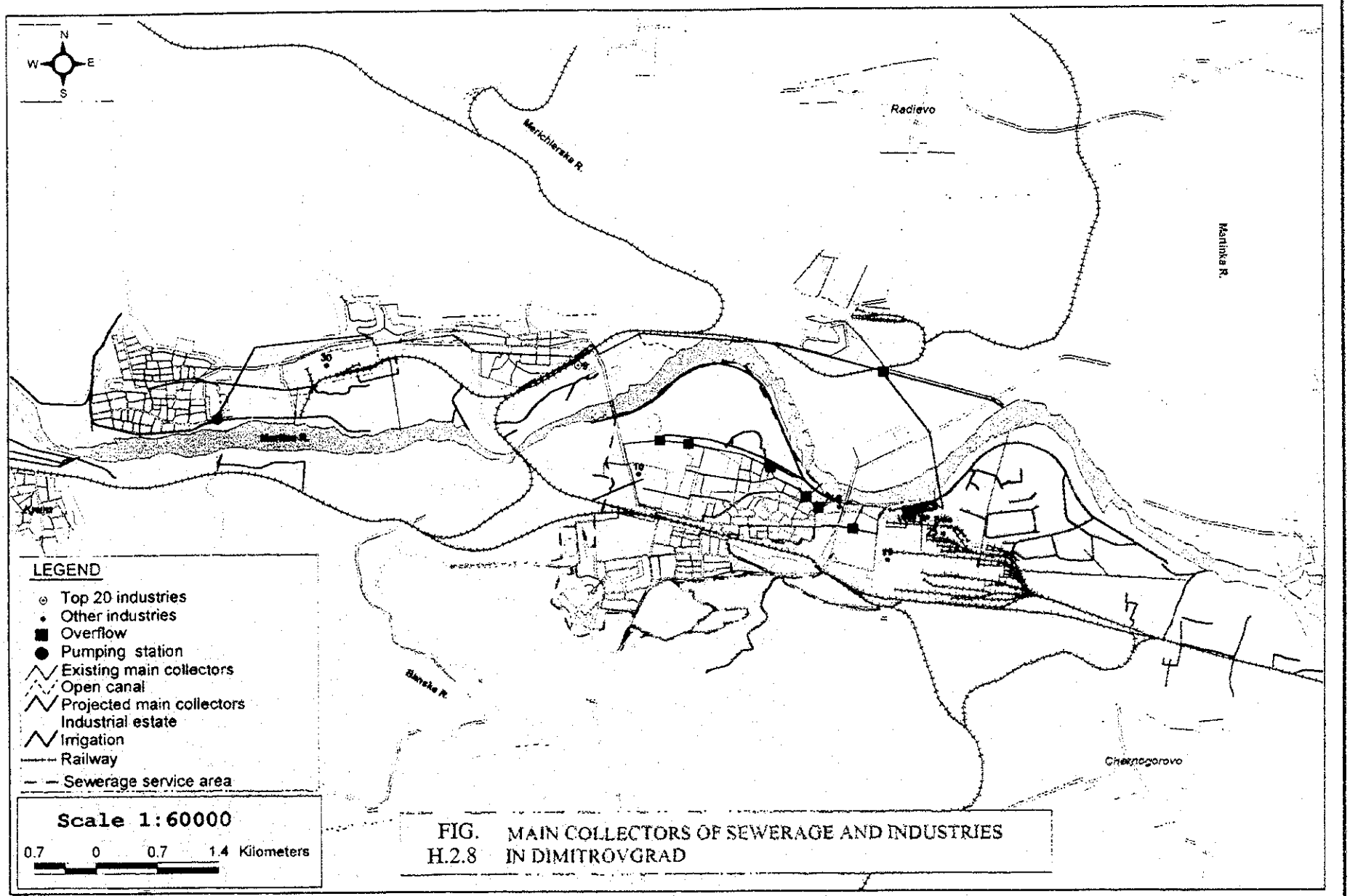


FIG. H.2.8 MAIN COLLECTORS OF SEWERAGE AND INDUSTRIES IN DIMITROVGRAD

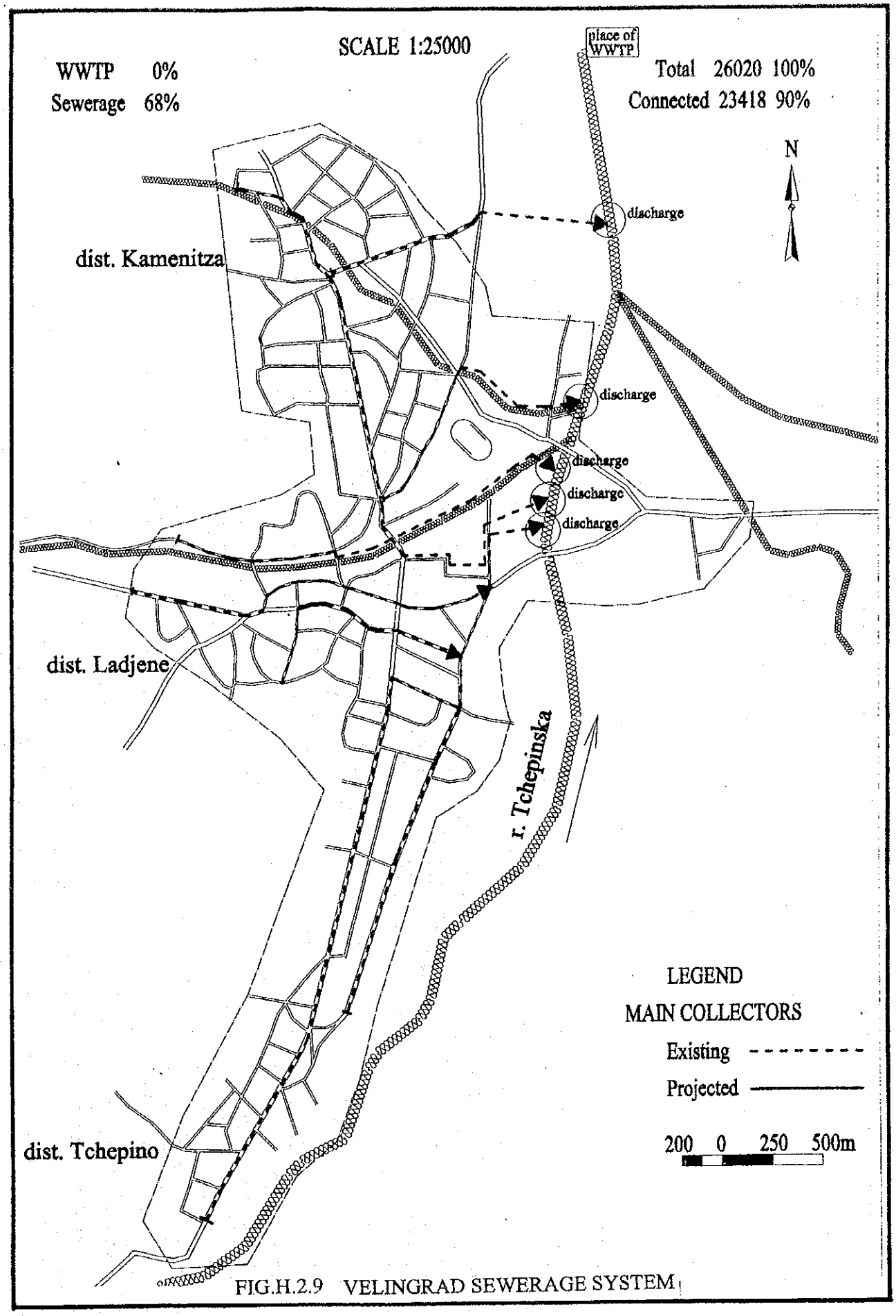


FIG.H.2.9 VELINGRAD SEWERAGE SYSTEM

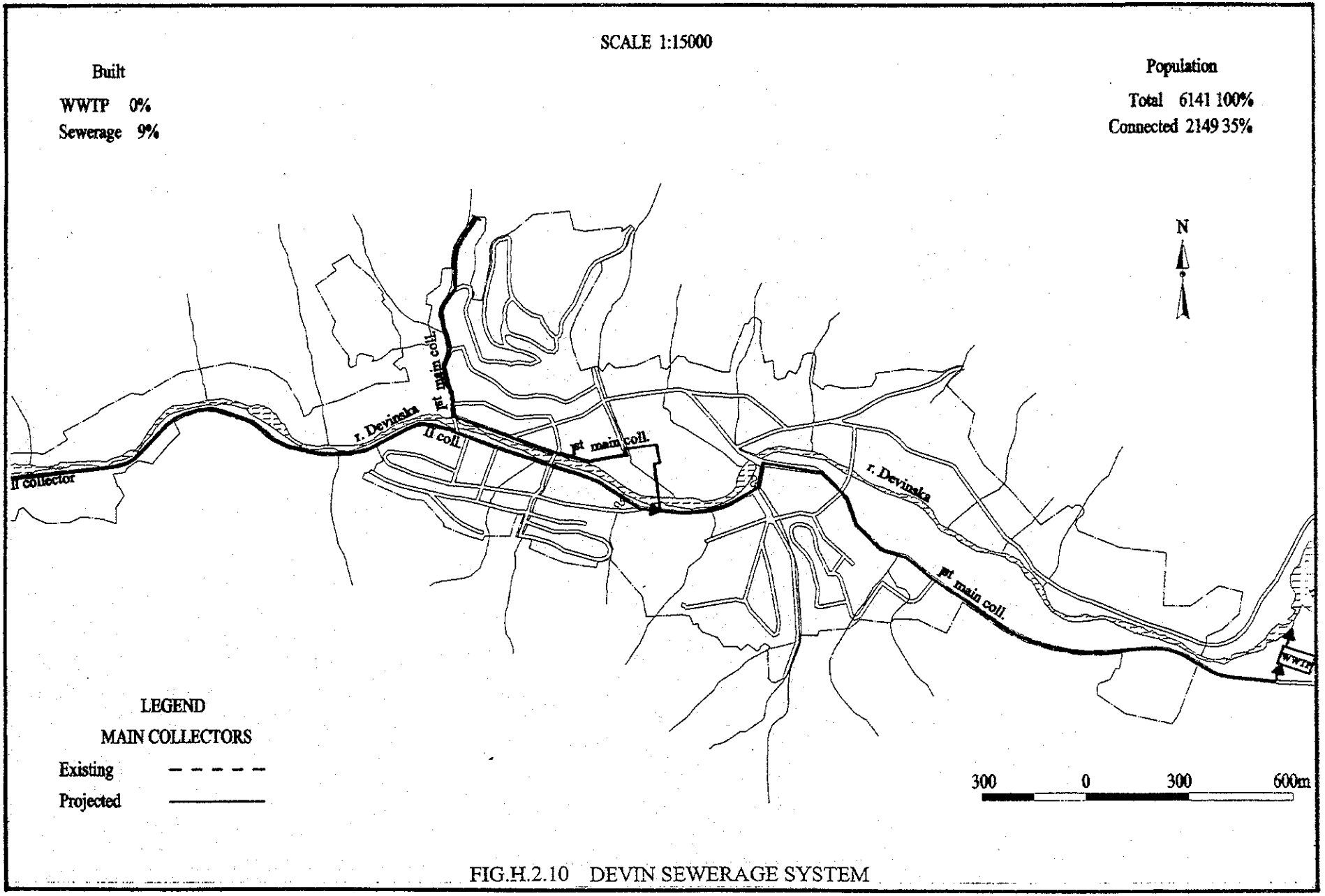


FIG.H.2.10 DEVIN SEWERAGE SYSTEM

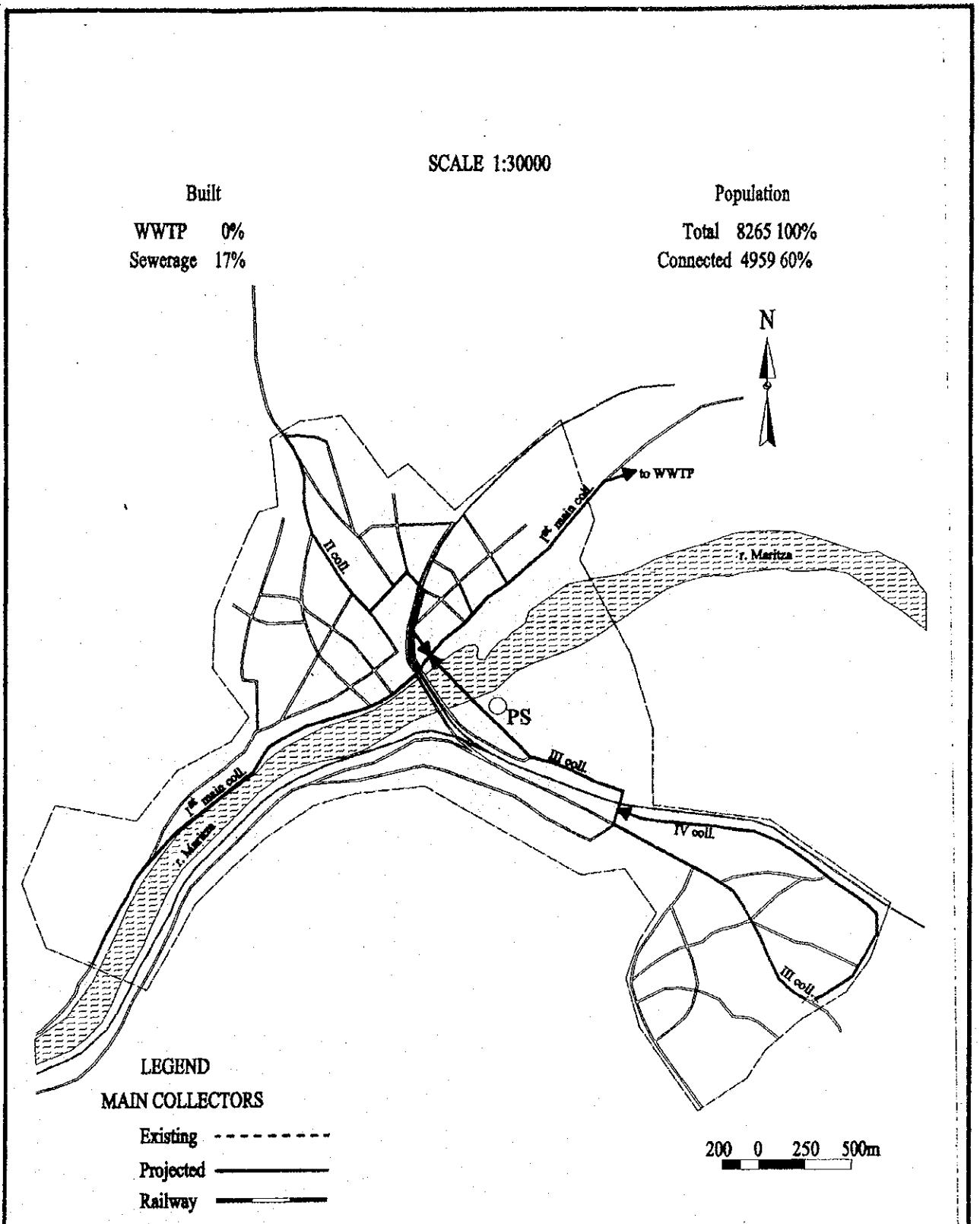


FIG.H.2.11 SIMEONOVGRAD SEWERAGE SYSTEM

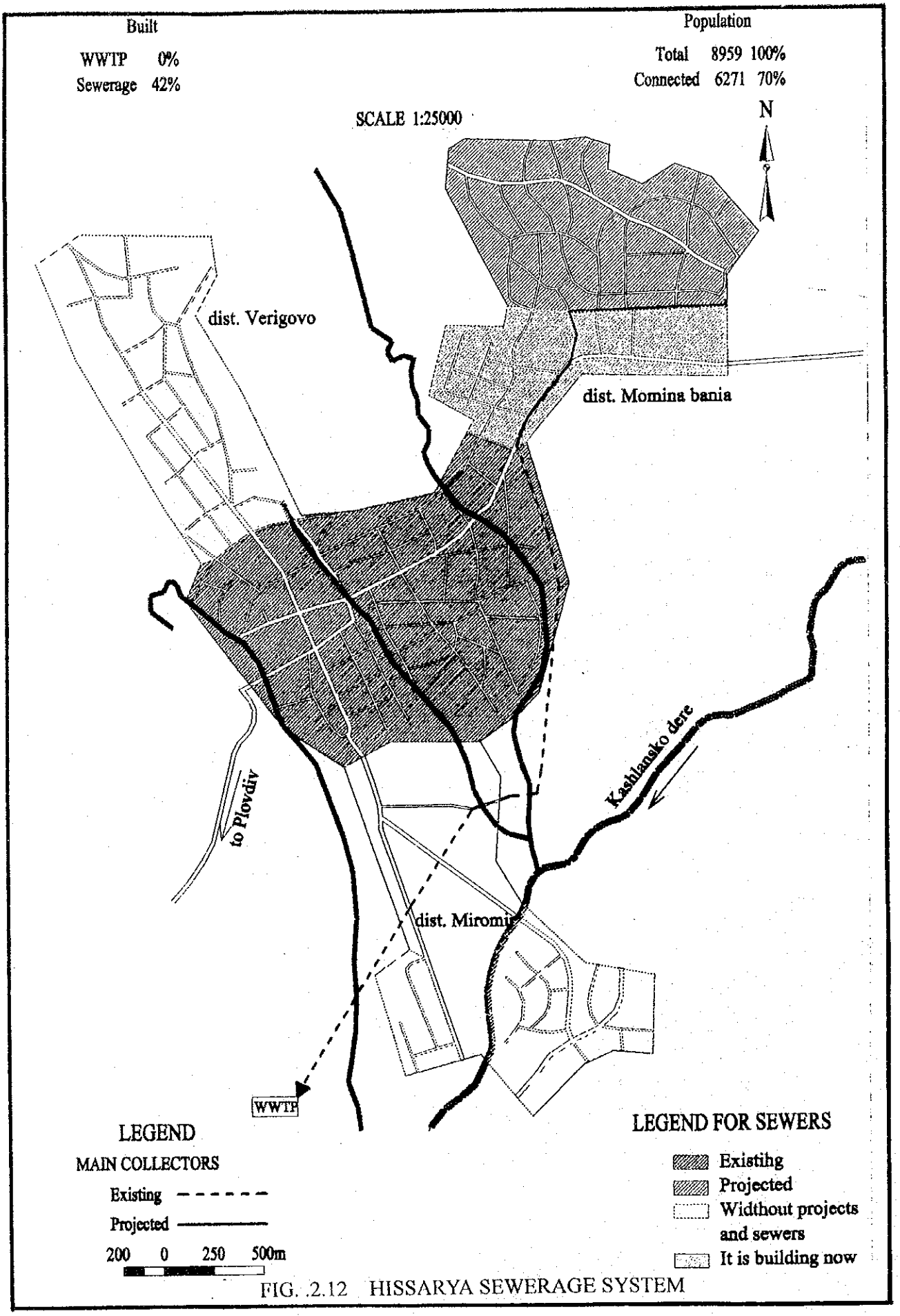


FIG. .2.12 HISSARYA SEWERAGE SYSTEM

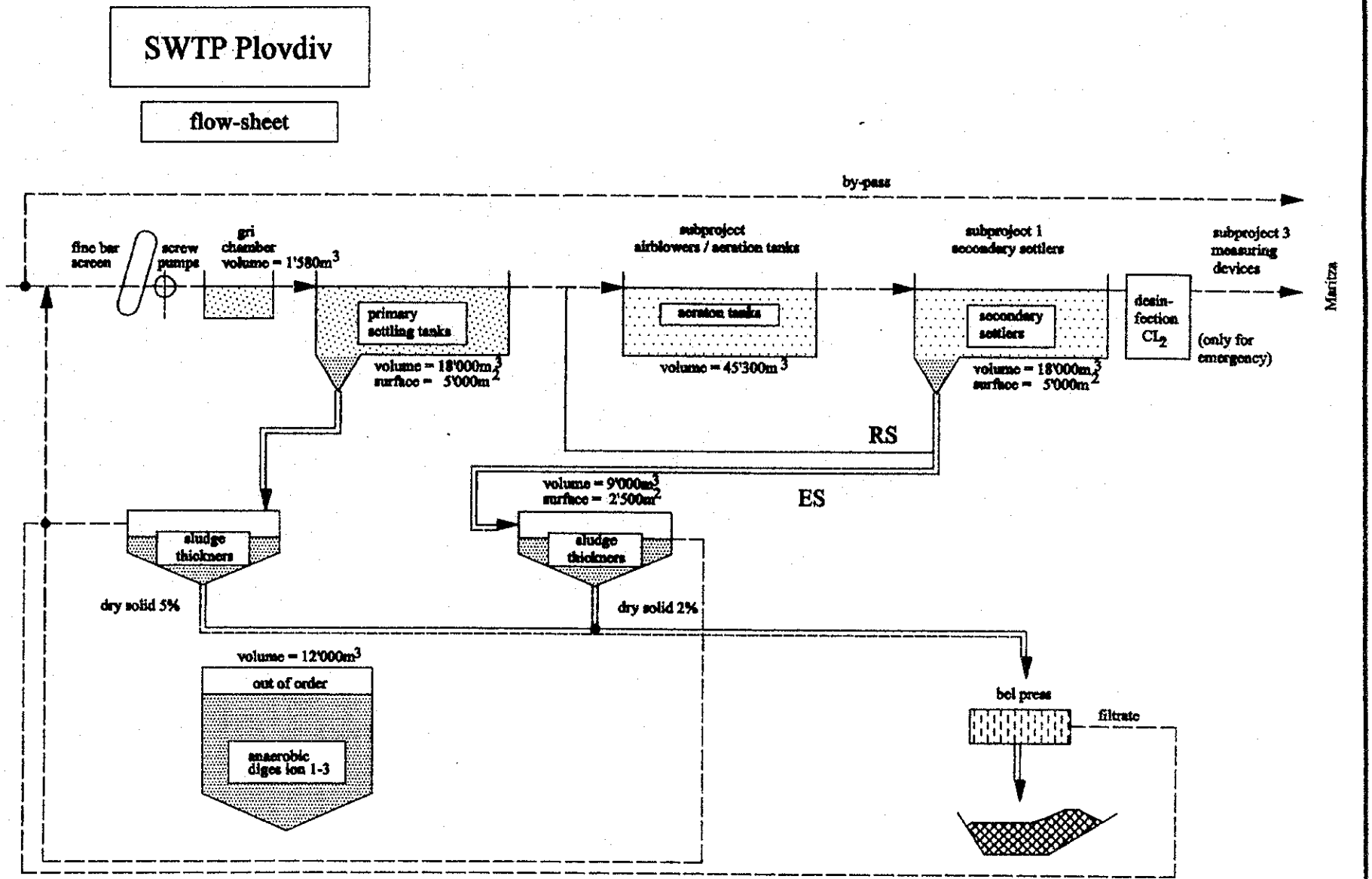
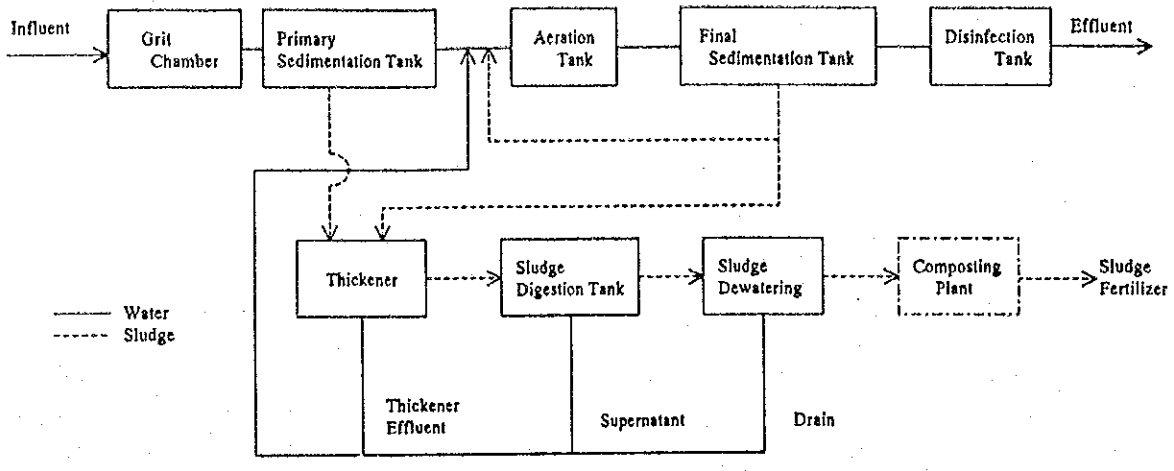
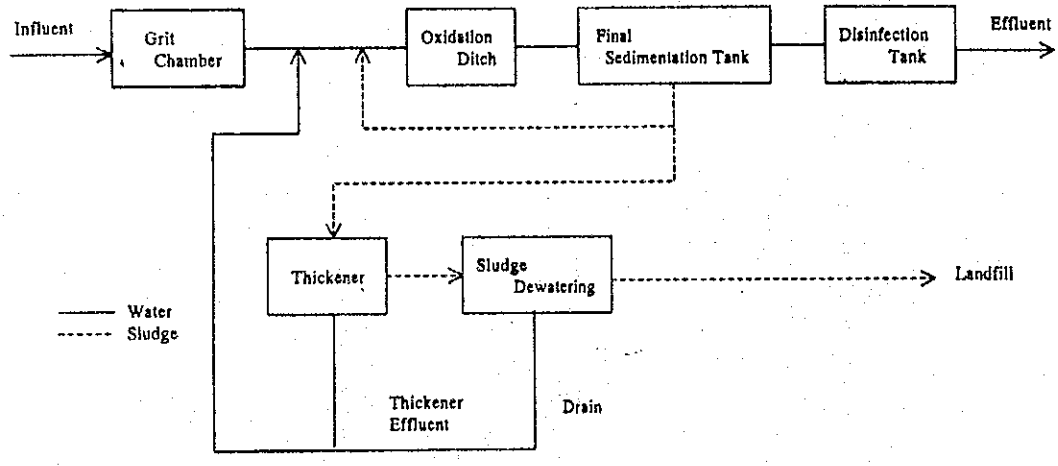


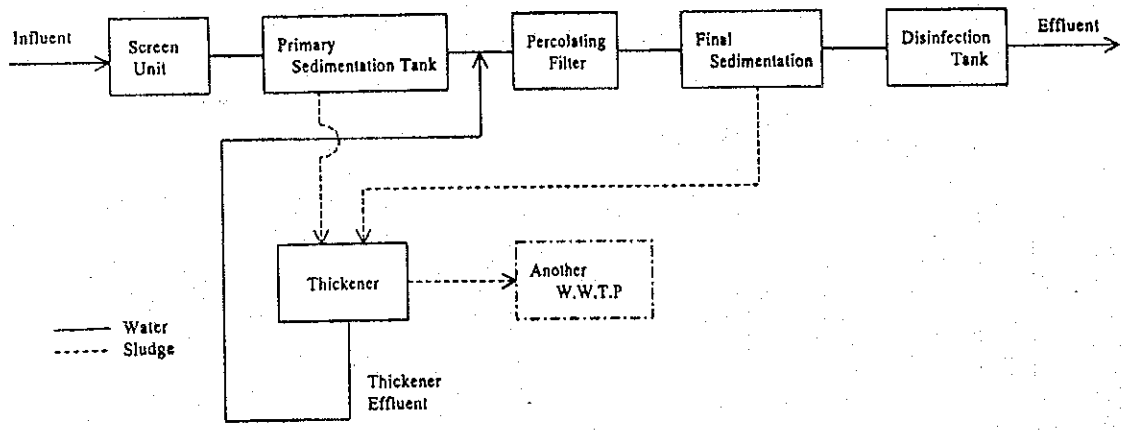
FIG.H.3.1 PROPOSED SUBPROJECTS



Conventional Activated Sludge System

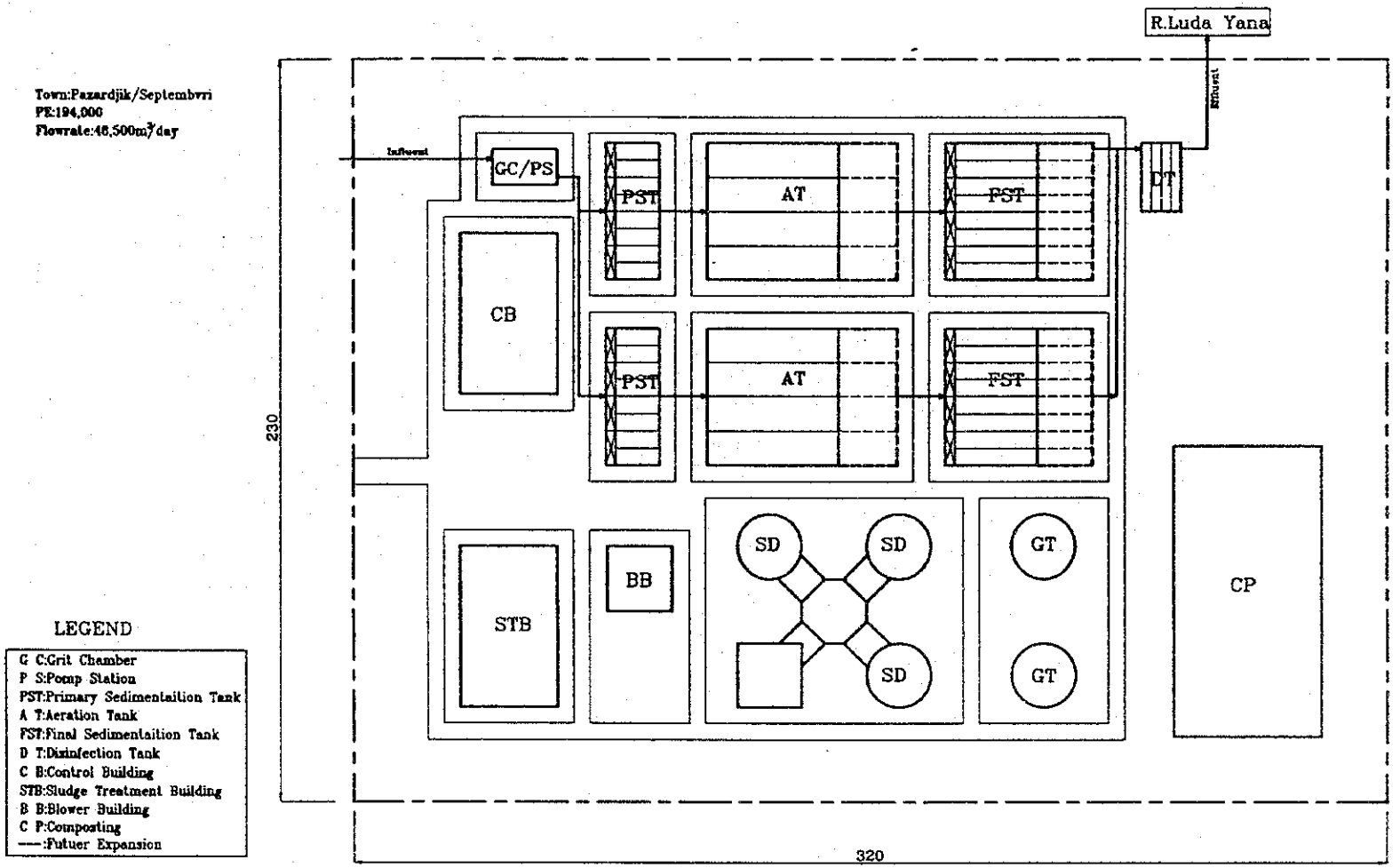


Oxidation Ditch System



Percolating Filter System

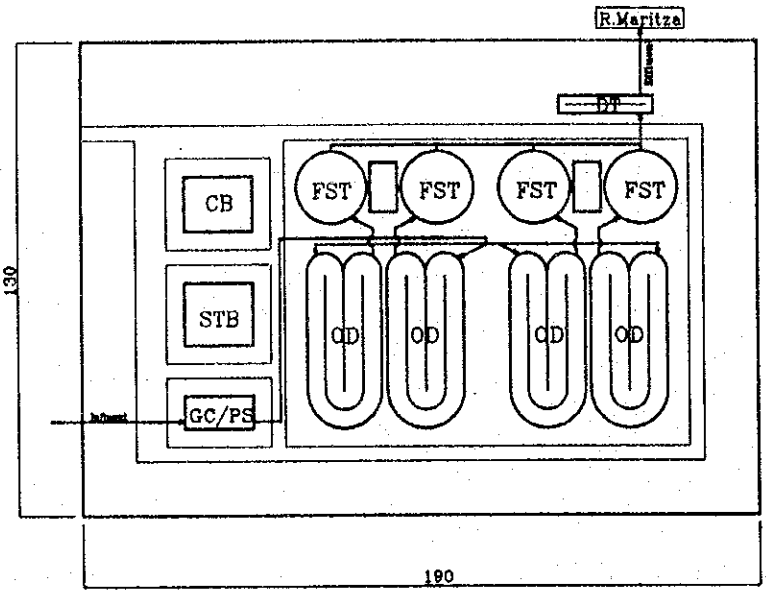
FIG.H.4.1 FLOW OF TREATMENT SYSTEMS



Conventional Activated Sludge System

FIG.H.4.2 LAYOUT OF TREATMENT PLANTS (1)

Town:Parvomai
PE:41,000
Flowrate:9,300m³/day

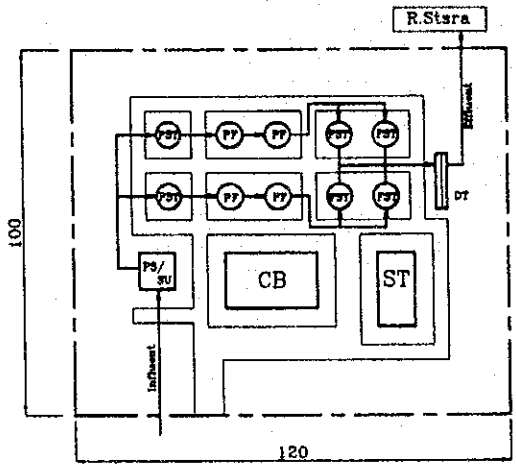


LEGEND

G	C:Grit Chamber
P	S:Pomp Station
O	D:Oxidaition Ditch
FST	:Final Sedimention Tank
D	T:Disinfection Tank
C	B:Control Building
STB	:Sludge Treatment Building

Oxidation Ditch System

Town:Batak
PE:10,000
Flowrate:2,500m³/day



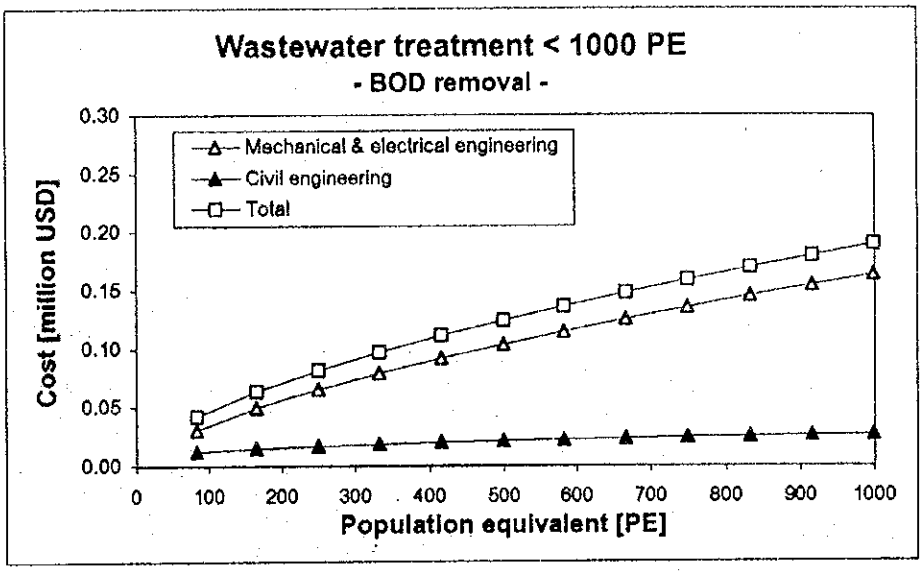
LEGEND

P	S:Pomp Station
S	U:Screen Unit
PST	:Praimary Sedimentation Tank
P	F:Percolating Filter
FST	:Final Sedimentaition Tank
D	T:Disinfection Tank
C	B:Control Building
S	T:Sludge Thickener

Percolating Filter System

FIG.H.4.2 LAYOUT OF TREATMENT PLANTS (2)

FIG.H.5.1 BASIC WASTEWATER TREATMENT WORKS COST (1/2)



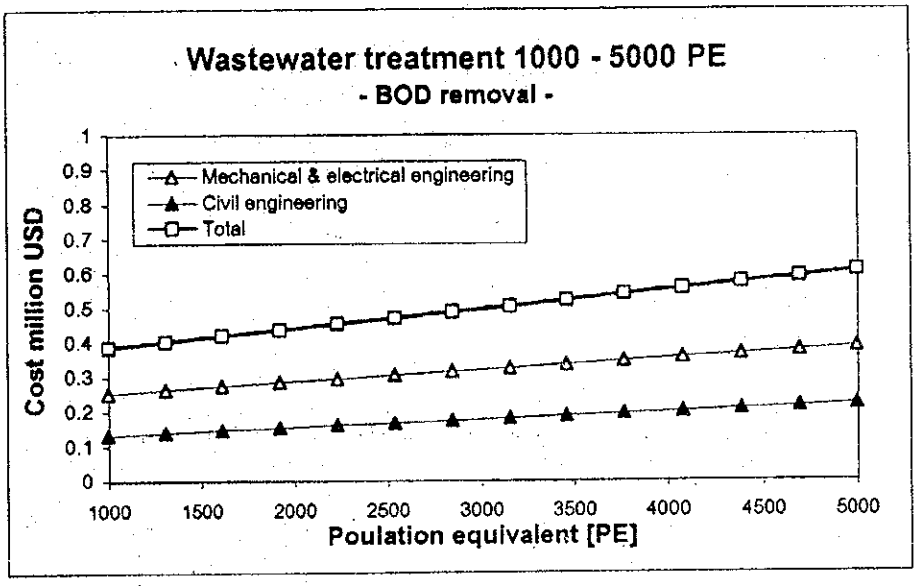
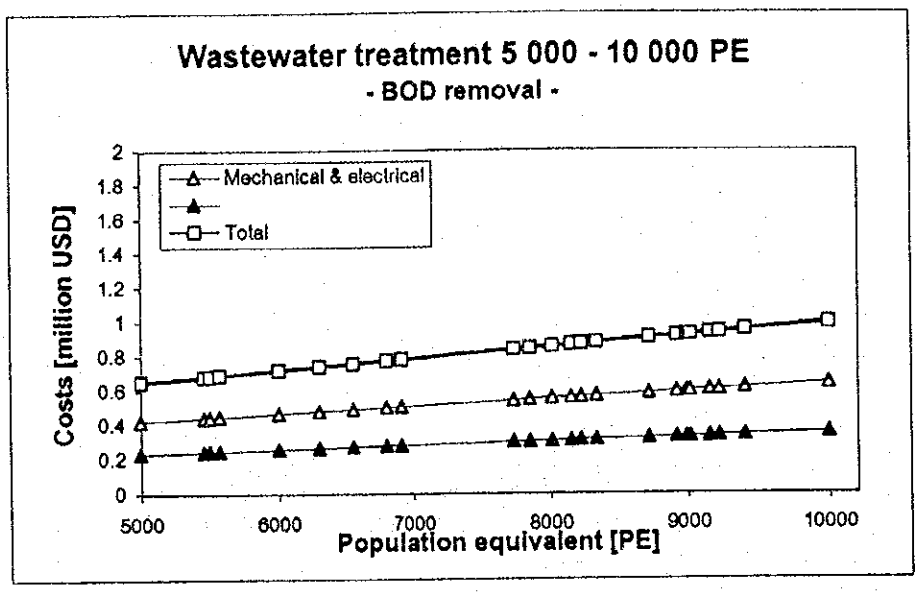


FIG.H.5.1 BASIC WASTEWATER TREATMENT WORKS COST (2/2)



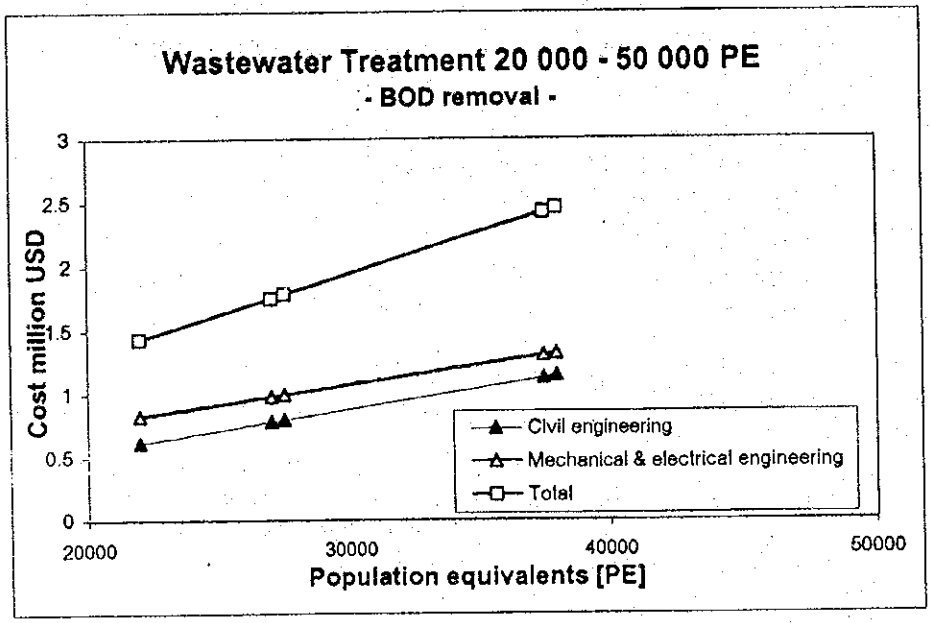
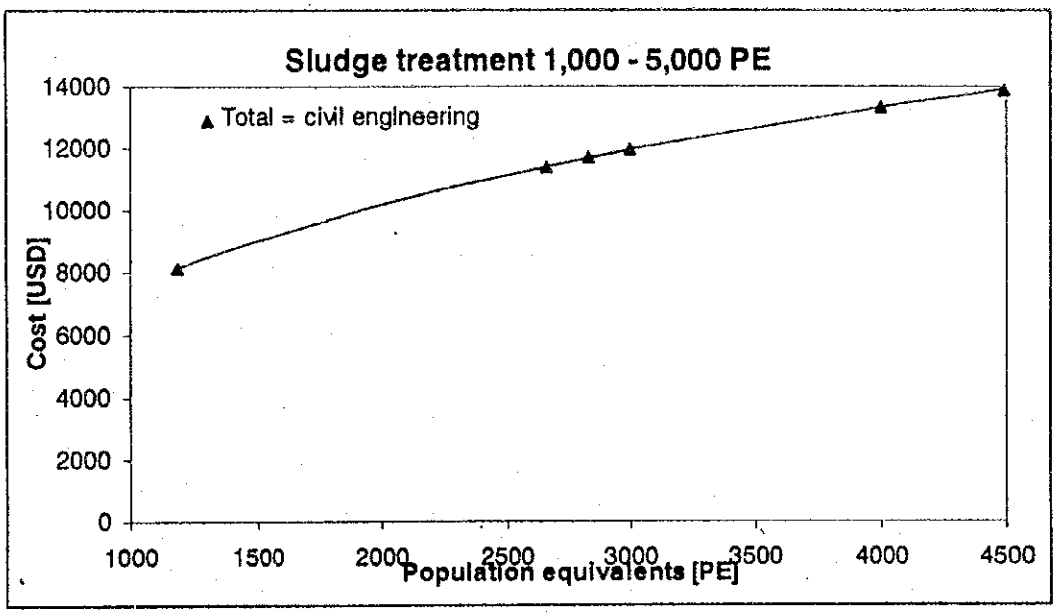


FIG.H.5.2 SLUDGE TREATMENT COST CURVES (1/2)



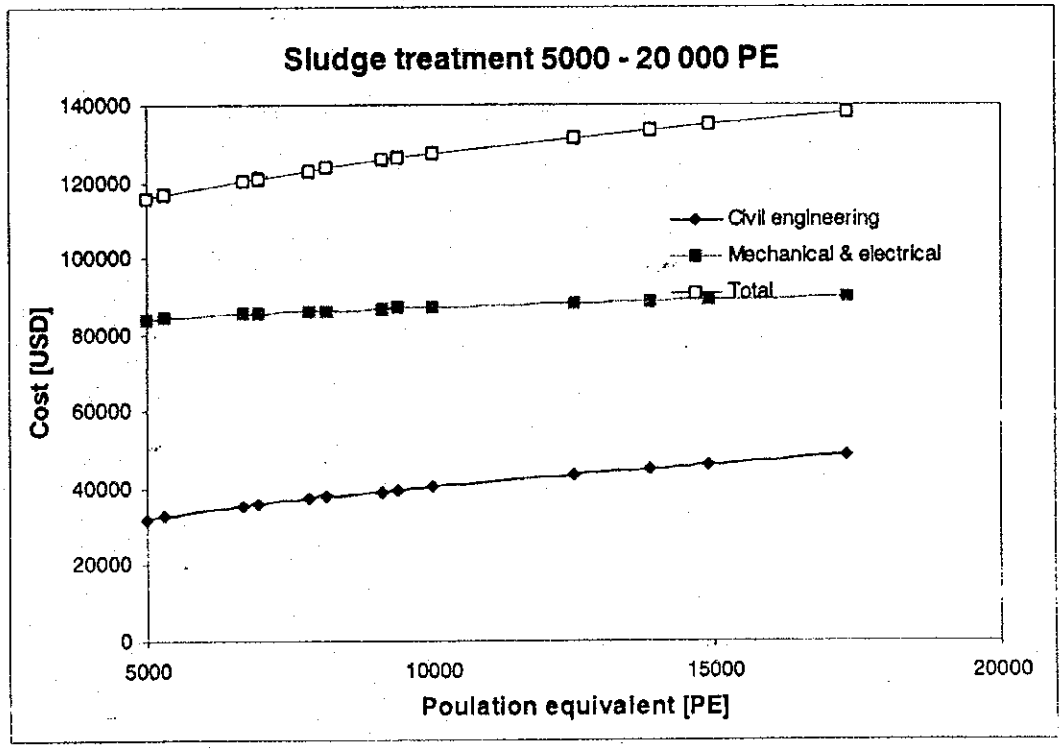


FIG.H.5.2 SLUDGE TREATMENT COST CURVES (2/2)

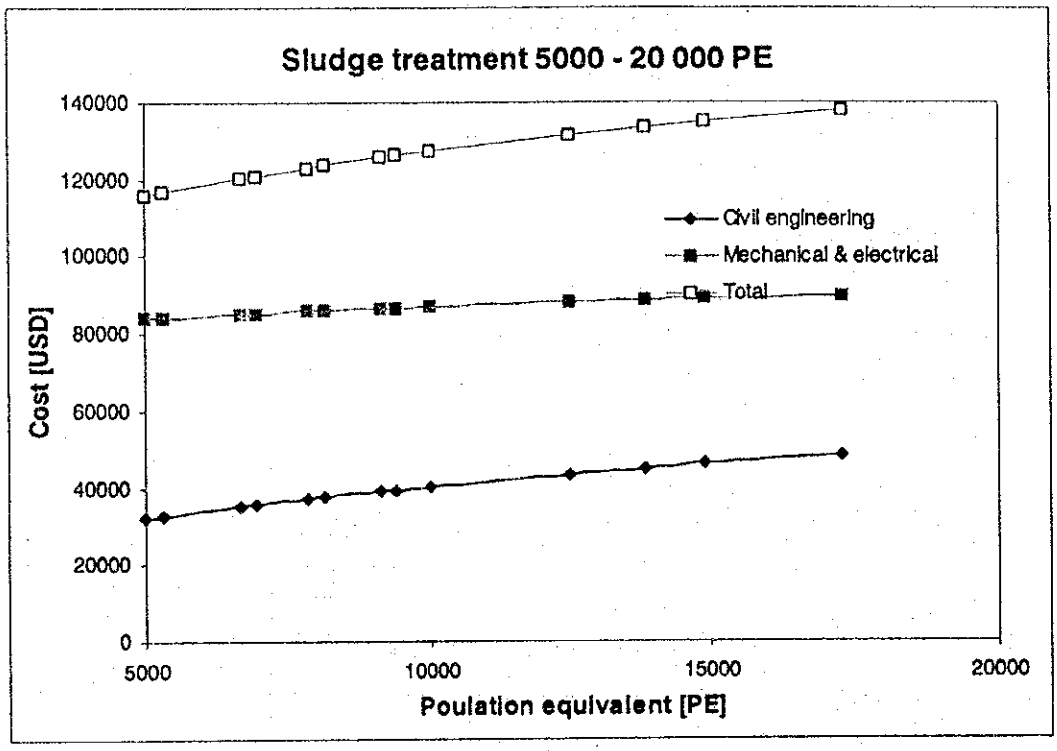
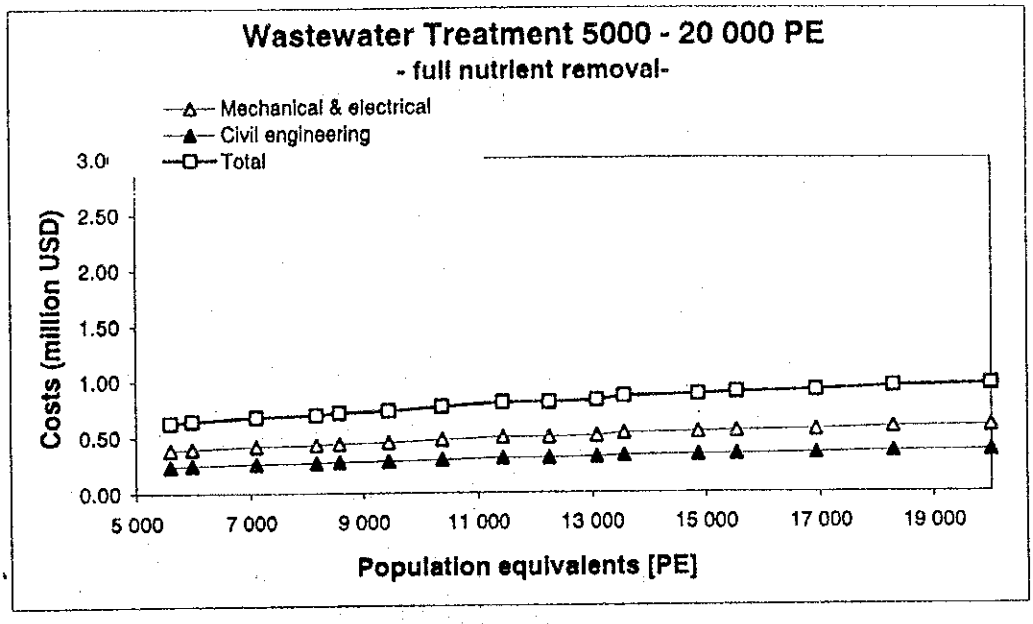


FIG.H.5.3 WASTEWATER TREATMENT COST CURVES (1/2)



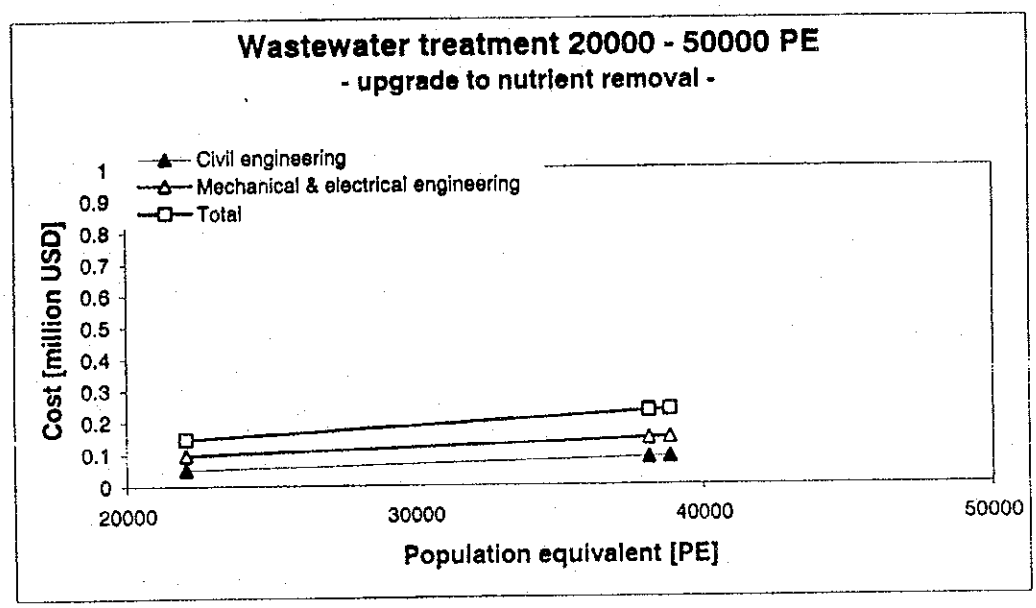


FIG.H.5.3 WASTEWATER TREATMENT COST CURVES (2/2)