CHAPTER - 5

FEASIBILITY STUDY

CHAPTER - 5

FEASIBILITY STUDY

1. INTRODUCTION

As mentioned in *Chapter 4*, the Comprehensive Plan proposes the following main structural measures:

- Implementation of the present sewerage development in the catchment area of Lake Balaton

- Early implementation of Kis-Balaton phase-II project (Lower Reservoir)

- Dredging of bottom sediment in the Keszthely and the Szigliget basins

- Construction of the vegetation purification facilities for 33 rivers and storm water pumping stations

Among them, only the project for constructing the vegetation purification facilities is studied in this chapter. Other measures are excluded from the feasible study, although the priority of those measures is undoubtedly high or higher.

Because Kis-Balaton phase-II project has been considered in detail by the Hungarian side on the level of a feasible study, and has just been waiting the final decision of the central government. As for the sewerage development, it is an on-going project which has already materialized some facilities. It is not a question of engineering but financing whether the project will attain the goal or not. Dredging bottom sediment of the lake is also on-going project, and the target area and the depth to be dredged are to be reconsidered by the Hungarian side according to a precise study. Therefore the feasibility study on the dredging project should be carried out after the reconsideration.

By the following reasons, two (2) rivers among the above-mentioned 33 rivers and pumping stations have been selected.

- The river which flow volume is comparatively big and phosphorous load flowing into the lake is also big.

- The river flowing into the Keszthely basin or Szigliget basin which receives a large volume of nutrient loads from both external and internal sources and is suffering from eutrophication.

- The river where suitable land for facility site is easily found and acquired.

- The river which can be a model case to develop the river purification systems for other rivers.

Additionally, one (1) small river which is a storm water drainage of Keszthely town rather than a river has been selected. Because it is necessary to show a typical plan for urban runoff purification which should be a model case for further development of nutrient control in the direct runoff sub-catchment.

Selected project areas are as follows and their locations are shown in *Figure 5.1.*

- River purification facility (vegetation purification method)

  Nyugati-övcsatorna river

  Keleti-bozot river

- Urban runoff purification facility (coagulation sedimentation method)

  Keszthely urban runoff area (Szent Imre/Büdös river)

2. DESIGNING OF FACILITIES

2.1 RIVER PURIFICATION FACILITY

Considering technical, economical, and environmental acceptability and availability of land, the vegetation purification method is applied.

(1) Nyugati-övcsatorna Facility

The location of the project site is shown in *Figure5.2.* The proposed site area is owned by the central government. General layout of the facilities is shown in *Figure 5.3.*

1) Main purification facility

A reed pond is adopted for the main vegetation purification facility. The design capacities of vegetation purification facility are summarized below.

Water flow (Q) :	1.01 m^3/sec (87,264 m^3/day)
Water velocity :	0.8 cm/sec
Facility length (L) :	150 m
Water depth :	0.20 m
Retention time :	5.2 hours
Necessary width (B) :	630 m

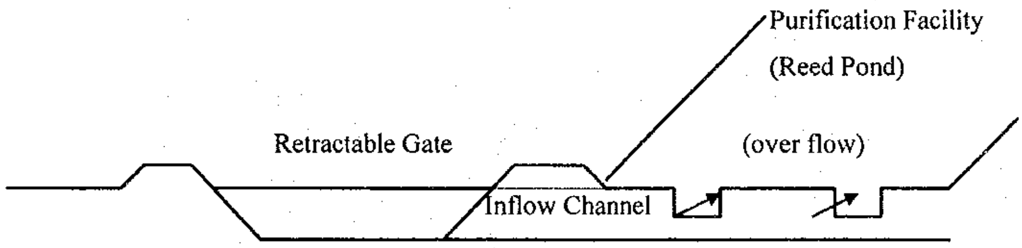
2) Intake gate

To lead river water to a purification facility, it is necessary to set an intake gate inside of the river course. When floodwater comes, the gate falls down (retractable gate) at a certain water level to lead the floodwater to main river course, and protect the purification facility from damages by the floodwater.

The certain water level is set over 10 cm higher than the top of the gate. As the gate does not fall down until the water level rises up to 10 cm higher than the top of the gate, the water level of the inflow channel (H) rises up to a maximum height of 0.20 m. When the water level of the inflow channel rises up to 0.20 m, the facility can treat a maximum water flow of about three times of design inflow (Q_d) according to hydraulic calculation. However, the purification efficiency does not meet the designed level under such condition.

Rubber-made retractable gate is proposed. The design capacities of the intake gate are summarized below.

Bottom width (B) :	15.0 m
Height (H) :	2.0 m



3) Inflow / outflow channel

From the intake gate to the purification facility, water flows into an open channel made by reinforced concrete, but a box culvert is used where intake water crosses the embankment of the river.

A set of screen and gate (flush board) is set at the entrance of the channel to shut the river water out when the purification facility is under maintenance. Overflow system is proposed at the entrance of the purification structure (reed pond) to make a uniform water flow and also to treat the runoff of the storm water as much as possible. The design capacities are summarized below.

Water Velocity :	0.3 m/sec
Channel width (B) :	1.90 m
Channel height (H) :	1.90 m

(2) Keleti-bozot Facility

The location of the project site is shown in *Figure5.4*. The proposed site area is owned by the central government. General layout of the facilities is shown in *Figure 5.5*.

1) Main purification facility

A reed pond is adopted for the main vegetation purification facility. The design capacities of vegetation purification facility are summarized below.

Water flow (Q) :	1.13 m^3/sec (97,632 m^3/day)
Water velocity :	0.8 cm/sec
Facility length (L) :	150 m
Water depth :	0.20 m
Retention time :	5.2 hours
Necessary width (B) :	705 m

2) Intake gate

Rubber-made retractable gate is adopted. The design capacities of the intake gate are summarized below.

Bottom width (B) :	8.0 m
Height (H) :	2.5 m

3) Inflow / outflow channel

Overflow system is adopted to treat the runoff of the storm as much as possible and to protect the main facility from damages by a certain level of floodwater. The design capacities are summarized below.

Water Velocity :	0.3 m/sec
Channel width (B) :	2.00 m
Channel height (H) :	2.00 m

2.2 URBAN RUNOFF PURIFICATION FACILITY

The location of the project site is shown in *Figure 5.6*. It is located near the river mouth and downstream of the confluence of Szent Imre river and Büdös river. The site area is the central government's land which was used for disposal site of the bottom sediment dredged in the Keszthely basin.

(1) Purification Method

Considering the limitation of available land for constructing the facility, the coagulation sedimentation is applied as the second best method. General layout of the facilities is shown in *Figure 5.7*.

(2) Designing of Facility

1) General design capacities

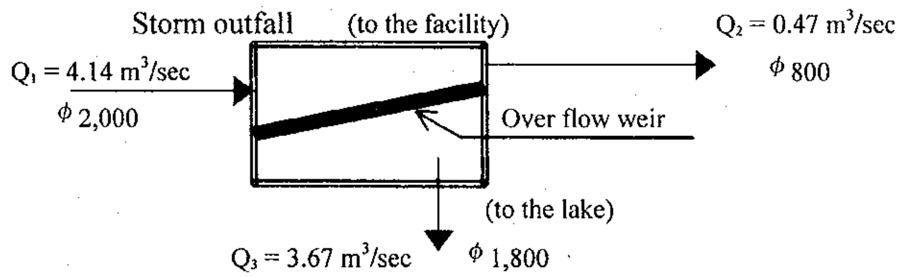
General design capacities are summarized below.

Water flow (Q) :	0.47 m^3/sec (40,600 m^3/day)
Inlet water quality :	T-P 1.1 mg/l
	SS 6.0 mg/l

2) Storm outfall

Storm outfall is adopted to treat the runoff of the storm as much as possible and to protect the main facility from damages by a certain level of floodwater. The design capacities of the storm outfall are summarized below.

Annual max flow rate (Q_1) :	4.14 m^3/sec
	(ϕ 2,000, water depth 1.46m)
Facility design capacity (Q_2) :	0.47 m^3/sec
	(ϕ 800 , water depth 0.52m)
Storm outfall volume (Q_3) :	$= Q_1 - Q_2 = 3.67$ m^3/sec (ϕ 1,800)
Overflow water depth (H) :	0.50 m
Overflow weir length (L) :	6.0 m



Conceptual figure of storm outfall

3) Intake gate

The design capacities of the intake gate are summarized below.

Size of the gate : 1.0 m (H) × 1.0 m (B)

Type of control :	manual operation
Quantity :	1 unit

4) Coarse screen

The design capacities of the coarse screen are summarized below.

Size of the screen :	3.50 m (H) × 1.0 m (B)
Mesh of the screen :	50 mm
Type of control :	automatic operation
Quantity :	2 units

5) Sand basin

The design capacities of the sand basin are summarized below.

Load of water surface area (a) :	1.800 $m^3/m^2/day$
Water velocity (V) :	0.1 m/sec
Retention time (T) :	128 sec
Useful depth (H) :	H = 2.0 m
Quantity :	2 units
Necessary water surface area (A) :	Q/a = 23 m^2
Width of sand basin (W) :	Q / H × V = 3.0 m
Length of sand basin (L) :	A / W = 10 m
Facility plan :	1.5m (W) × 10m (L) × 3.0m (H) × 2 units
Retention time (T) :	(W × L × H) / Q = 128 sec

6) Screen

The design capacities of the screen are summarized below.

Size of the screen :	3.50 m (L) × 0.8 m (B)
Mesh of the screen :	5 mm
Type of control :	automatic operation
Quantity :	2 units

7) Mixing basin

The design capacities of the mixing basin are summarized below.

Mixing time (T) :	5.1 min
Quantity :	2 units
Plan of the pond :	3.0m (W) × 6.0m (L) × 4.0m (H) (useful volume = 72m^3/ 1pond)

8) Flocculator

The design capacities of the flocculator are summarized below.

Flocculation time (T) :	20.9 min
Quantity :	4 units
Plan of the pond :	7.0 m (W) × 7.0 m (L) × 3.0 m (H) (useful volume = 147.0m^3/ 1pond)

9) Settling pond

Settling time :	5.05 hours
Quantity :	4 units
Plan of the pond :	7.0 m (W) × 41.0 m (L) × 4.5 m (H) (useful volume = 1,291.5m^3/ 1pond)

10) Coagulant storage tank

The design capacities are summarized below.

Chemicals (coagulant) :	Ferric chloride ($FeCl_3$, 37%)
Dosing volume :	950 ~ 1,426 (l / day)
Volume of tank :	10m^3 × 2units (max dosing volume × 10 days)

11) Sludge tank

The design capacities are summarized below.

Design of water quality :

	Inflow		Outflow
SS	60 mg/l	→	5 mg/l
T−P	1.1 mg/l	→	0.33 mg/l

Outbreak sludge concentration : 5 kg/m^3 (5,000 mg/l)

Outbreak sludge volume :

Sludge volume from SS :	2,233 kg-DS/day
Sludge volume from $FePO_4$:	152 kg-DS/day
Sludge volume from $Fe(OH)_3$:	108 kg-DS/day
Total volume =	2,493 kg-DS/day

Sludge volume :	2,493 (kg-DS/day) / 5 (kg / m^3) = 499 m^3
Storage time :	1 day
Plan of the sludge tank :	10 m (W) × 20 m (L) × 2.5 m (H) (useful volume = 500 m^3)

12) Sludge thickener

The design capacities are summarized below.

Outbreak sludge volume :	2,493 kg-DS/day
Solid load :	10 kg-DS/m^2/day
Necessary surface area :	249.3 m^2
Diameter of sludge thickener :	18m ϕ
Sludge depth :	3.0m (useful depth)
Plan of the sludge thickener :	18m (ϕ) × 3.5 m (H)
Concentration of the sludge thickener :	2.5 %
Outbreak sludge volume from the sludge thickener :	100 m^3

13) Sludge storage tank

The design capacities are summarized below.

Sludge volume :	100 m^3
Storage time :	1 day
Plan of the storage tank :	4.0 m (W) × 9.0 m (L) × 3.0 m (H) (useful volume 108 m^3)

14) Coagulation basin

The design capacities are summarized below.

Operation time of dehydrator :	10 hr
Inlet sludge volume :	10 m^3/hr
Storage time :	3 min
Necessary tank volume :	10 m^3/hr × (3/60) = 0.5 m^3
Plan of the coagulation basin :	0.8 m (W)×0.8 m (L)×0.8 m (H)

15) Dehydrator

Operation time of dehydrator :	10 hr/day
Outbreak sludge volume :	2,493 kg-DS/day
Volume for treatment :	249.3 kg-DS/hr
Dehydrate sludge :	9.23 m^3/day
water content :	$<$ 70%
density :	0.9 kg/l
volume of dehydrate sludge :	8,310 kg-WS/day

3. PROJECT COSTS

3.1 Basis of Cost Estimation

The project costs consist of the construction cost and the operation and maintenance (O/M) cost.

The construction cost consists of the following items.

- Direct construction cost
- Engineering service cost
- Physical contingency

The O/M cost consists of the following items.

- Facility operation cost
- Facility maintenance cost
- Water quality monitoring cost
- Personnel expenditure

Based on the facility plans, the project costs are estimated under the following conditions.

- The estimation is made on the assumption that all construction works will be contracted to Hungarian general contractors.
- Most costs are expressed under the economic conditions that prevailed in 1998.
- The construction cost is based on the data obtained from PMO/VATI, VIZITERV Kft, Várpalota region environmental improvement project, Tapolca town, and other sources.
- Engineering cost is assumed to be 5% of the total of construction cost.
- Physical contingency is assumed to be 5% of the total construction and engineering service costs.
- Price escalation is not counted.

3.2 Cost Estimation

(1) Direct Construction Cost and O/M Cost

The total direct construction costs and annual O/M costs are shown in *Table 5.1*.

(2) Project Costs

Breakdown of annual project costs is shown in *Table 5.2*. The total project costs are summarized as follows:

Total construction cost	:	1,247,644,000 HUF
Total operation cost	:	75,221,000 HUF/year

4. IMPLEMENTATION PROGRAM

4.1 GENERAL

The construction works for feasibility study projects consist of earth works, vegetation purification works, retractable gate works, concrete works, mechanical/electrical works for coagulation sedimentation facility, and other miscellaneous works.

Major works are planned to be carried out by mechanical power.

4.2 CONSTRUCTION PLAN

(1) Construction Plan

Construction plan of major works is expected as follows.

- Detail design and tendering process
- River purification facility
  Reed lake/pond
  Retractable gate
  Inlet and outlet channels
- Urban runoff purification facility
  Coagulant sedimentation facility
  Inlet and outlet channels

(2) Required Construction Period

Required construction period for each work is estimated as follows.

- Detail design period and tendering process are 12 months.
- Nyugati-övcsatorna and Keleti-bozot river purification facilities

Reed pond	15 months
Retractable gate	6 months
Channels and others	3 months

- Keszthely urban runoff purification facility

Earth works	3 months
Coagulant sedimentation facility including channels	9 months

The implementation schedule is shown in *Table 5.3.*

5. MANAGEMENT OF THE PROJECT

After completion of construction of the facilities, following system is proposed for operation and maintenance.

5.1 RIVER PURIFICATION FACILITY

This method uses the natural ability of the marsh reed, and mechanical system is only retractable gate.

So ordinary management is proposed as follows.

- Frequency of inspection is once a week by labor (skilled), and inspect a condition of the facility on the site, dispose a trash of screen, etc.

- The retractable gate falls down at a certain floodwater level to lead the floodwater to main course of the river, and protect the purification facility from damages by the floodwater.

- A water level monitoring system is necessary to send a signal of river water level to the office which is responsible for the operation and maintenance of the facility. When river water level exceeds a certain level, a worker has to go to the facility site and close the flush board of inlet and outlet channels.

- When the river water go down less than a certain level, a worker has to get up a retractable (rubber-made) gate by air power and take off the flush board of the inlet and outlet channels.

- It is necessary to cut and dispose reed plant once a year when reeds died, and it is convenient to do the work in winter season.

- To keep the phosphorous removal efficiency of the facility, it is necessary to replace sediment sludge and bottom soil with fresh soil, and plant a reed again at least once in a decade.

- For operation and maintenance, a working yard should be provided around the facility.

- To check the removal efficiency, a water quality monitoring is necessary at least once a month. Parameters to be analyzed are COD,SS, T-P and T-N.

5.2 Urban Runoff Purification Facility

This method is a mechanical system and sludge is always generated, therefore manpower is required for the operation and maintenance everyday.

Manpower necessary for this work is as follows:

Chief : 1

Workers : 2

- The eligibility of the chief is an engineer and can manage a all of the facility.
- Two (2) workers operate and maintain the mechanical/electrical systems and sludge disposal system..
- To check the phosphorous removal efficiency, water quality monitoring is necessary.
- For an adjustment of coagulant injection volume, T-P should be monitored once a week, and other parameters such as T-N, COD, or SS should be once a month..

6. PROJECT EVALUATION

6.1 Environmental Improvement

As discussed in the previous chapter, quick effect may not be expected from external load reduction. However, external load is undoubtedly an origin of internal load and the effect of its control may be slow but steady like preventive medicine.

The feasibility study in this chapter is not aiming to examine the feasibility of the most urgent or the highest priority project among Comprehensive Plan. The target of the study is to highlight the environmental improvement measures which are recognized as important but have been put aside.

River water purification is concluded that it is the most cost-effective measures among the conceivable external load control measures. The total amount of phosphorous load that these two rivers studied in this chapter discharge to Lake Balaton comes up to 50 % of all rivers except Zala river (29 rivers). Therefore it is strongly recommended to implement the project with these two rivers.

6.2 Technical Aspect

It must be a great challenge to tackle the water quality improvement in Lake Balaton. The important thing is to start with acceptable one which is easy to operate and maintain, cheap to materialize, and harmless to the environment. The vegetation purification method meets those requirements. This study prepares how to design the facility, how much it costs, and to what extent it contributes to phosphorous load reduction in Lake Balaton.

Remaining question is to make it clear how effective the facility functions, based on actually monitored data. Because this method utilizes natural purification effect by emergent plant, its efficiency strongly depends on a local condition and there are lots of unknown factors. For that reason, the project proposed here includes a periodical water quality monitoring as a component of operation and maintenance work.

6.3 FINANCIAL ASPECT

It is concluded in this study that the vegetation purification method is the most cost-effective, and the total investment cost of the feasibility study projects including one urban runoff purification facility is about 1,248 million HUF for six (6) years and annual O/M cost is 75.2million HUF. The amount of cost falls within the central government's budget and the Central Environmental Fund allocated for Lake Balaton area.

6.4 ENVIRONMENTAL IMPACT

The measure itself would contribute much to environmental improvement of Lake Balaton. Although the vegetation purification facility is in principle to be a sink of nutrients, it might be a source of nutrients if the facility is not well operated and maintained. Coagulation sedimentation method is to use chemicals as a coagulant. So an occasional water quality check would be necessary, though harmless coagulant is used.

During construction stage, it can not be denied that environmental impacts would be caused to some extent. However, most construction sites are located in wetlands or farmland. There would be no impacts on the residents.

Table 5.1 Breakdown of Project Cost (Feasibility Study Projects)

(x 1,000 HUF)

Name of River	Design Flow Rate (m^3/sec)	Land Acquisition Cost	Direct Construction Costs				Survey Cost	Operation Cost
			L/C portion		F/C portion	Subtotal		
			(1st year)	(2nd year)				
Nyugati ovcsatorna (Vegetation purification method)	1.01	0	150,545	223,074	30,280	403,898	1,506	27,760
Keleti bozot (Vegetation purification method)	1.13	0	155,392	232,320	24,260	411,972	1,676	31,022
Keszthely Urban Runoff (Coagulation sedimentation method)	0.47	0	312,621	0	0	312,621	135	12,857
Total	–	0	618,558	455,394	54,540	1,128,491	3,317	71,639

Table 5.2 Construction/Operation Costs by Year (Feasibility Study Projects)

(× 1,000 HUF)

Name of River and Water Purification Facilities	2001 Construction Cost L/C	2001 Construction Cost F/C	2001 O/M Costs	2002 Construction Cost L/C	2002 Construction Cost F/C	2002 O/M Costs	2003 Construction Cost L/C	2003 Construction Cost F/C	2003 O/M Costs	2004 Construction Cost L/C	2004 Construction Cost F/C	2004 O/M Costs	2005 Construction Cost L/C	2005 Construction Cost F/C	2005 O/M Costs	2006 Construction Cost L/C	2006 Construction Cost F/C	2006 O/M Costs	2007 Construction Cost L/C	2007 Construction Cost F/C	2007 O/M Costs	Total Project Cost Construction Costs L/C	Total Project Cost Construction Costs F/C	Total Project Cost O/M (per year)
Nyugati ovcsatorna																								
1.Purification Facility				150,545			150,545															301,089	0	
2.Retractable Gate							29,278	30,280														29,278	30,280	
3.Gate and Screen							325															325	0	
4.Inflow,Outflow Channel							42,926															42,926	0	
5.Operation Costs												27,760			27,760			27,760			27,760			27,760
Keleti bozot																								
1.Purification Facility										155,392			155,392									310,784	0	
2.Retractable Gate													26,059	24,260								26,059	24,260	
3.Gate and Screen													325									325	0	
4.Inflow,Outflow Channel													50,544									50,544	0	
5.Operation Costs																		31,022			31,022			31,022
Keszthely urban runoff																								
1.Purification Facility																306,681						306,681	0	
2.Inflow,Outflow Channel																5,940						5,940	0	
3.Operation Costs																					12,857			12,857
Sub Total	0	0	0	150,545	0	0	223,074	30,280	0	155,392	0	27,760	232,320	24,260	27,760	312,621	0	58,782	0	0	71,639	1,073,951	54,540	71,639
Engineering service cost (5% of Construction Cost + Survey Cost)	57,015	2,727																				57,015	2,727	0
Contingency (5%)	2,851	136		7,527			11,154	1,514		7,770		1,388	11,616	1,213	1,388	15,631		2,939	0		3,582	56,548	2,863	3,582
Total	59,865	2,863	0	158,072	0	0	234,227	31,794	0	163,162	0	29,148	243,936	25,473	29,148	328,252	0	61,721	0	0	75,221	1,187,514	60,130	75,221

L/C : local currency portion
F/C : foreign currency portion
O/M : operation and maintenance

Table 5.3 Implementation Schedule for Feasibility Study Projects

Name of River and Facilities	2001	2002	2003	2004	2005	2006	2007
Survey,Design							
Nyugati ovcsatorna							
1.Purification Facility							
2.Retractable Gate							
3.Gate and Screen							
4.Inflow,Outflow Channel							
5.Operation							
Keleti bozot							
1.Purification Facility							
2.Retractable Gate							
3.Gate and Screen							
4.Inflow,Outflow Channel							
5.Operation							
Keszthely urban runoff							
1.Purification Facility							
2.Inflow,Outflow Channel							
3.Operation							

Figure 5.1. Project Sites for Feasibility Study

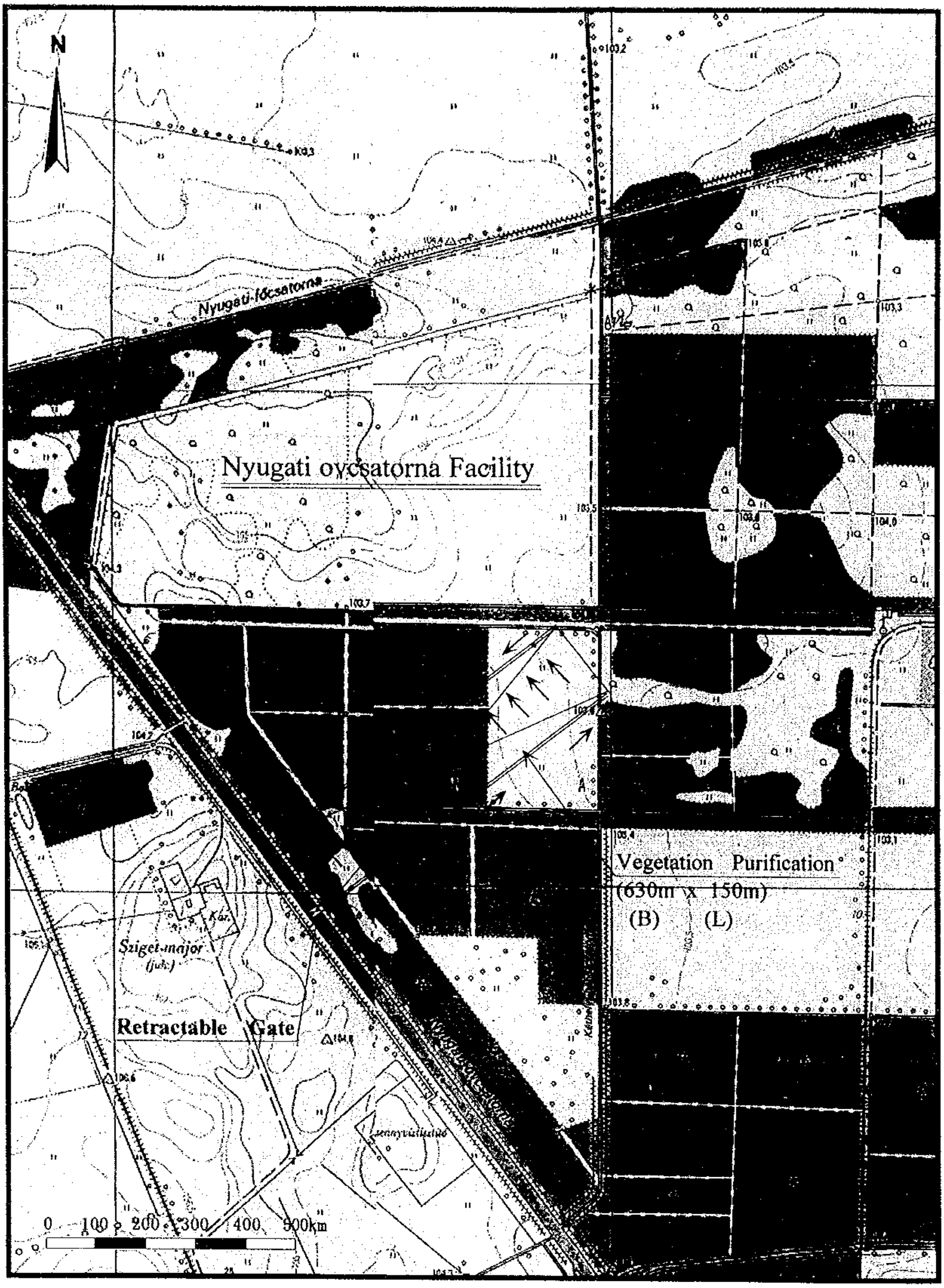


Figure 5.2 Location of Nyugati-ovcsatorna Facility

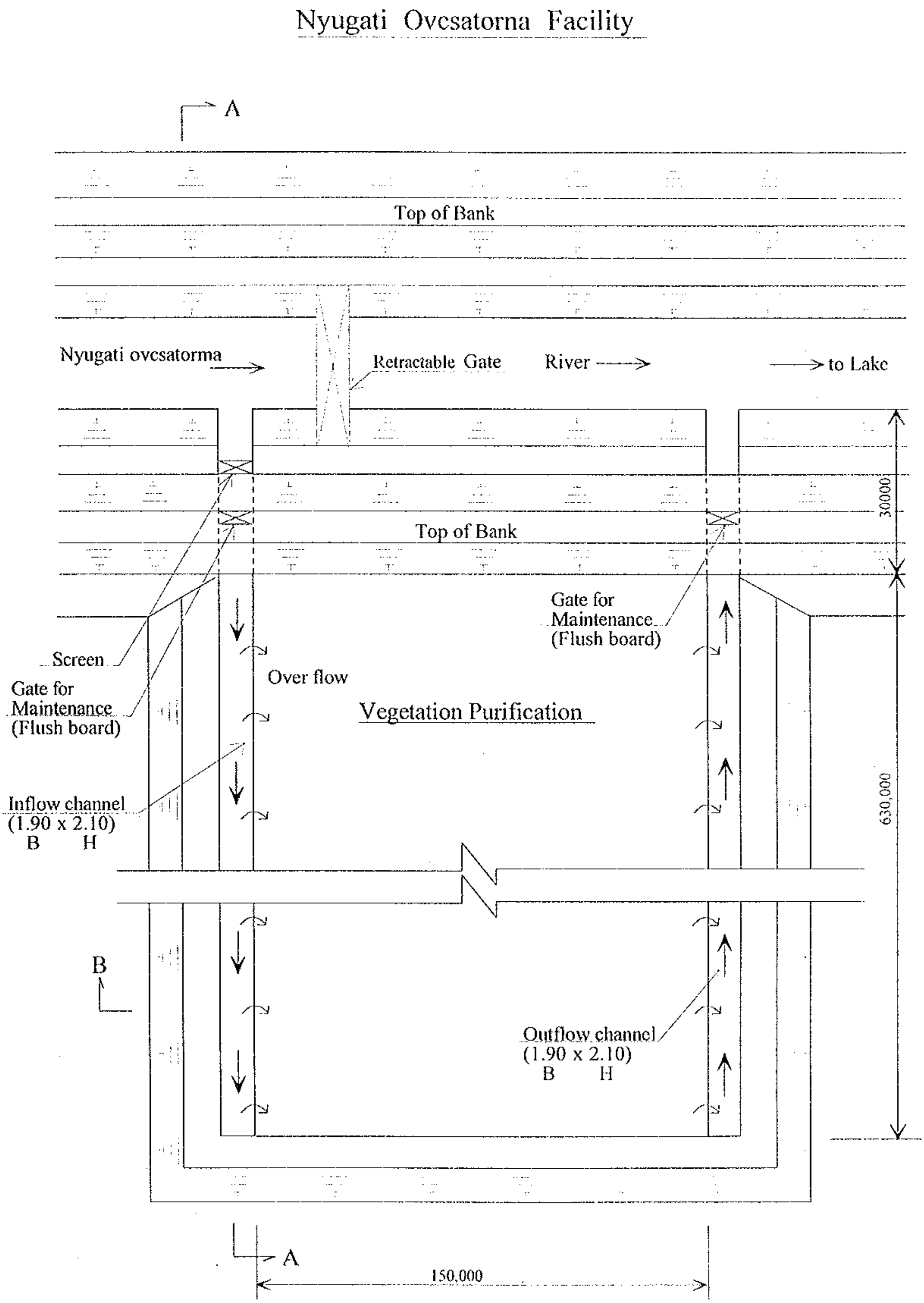


Figure 5.3 General Layout of Nyugati-ovcsatorna Facility

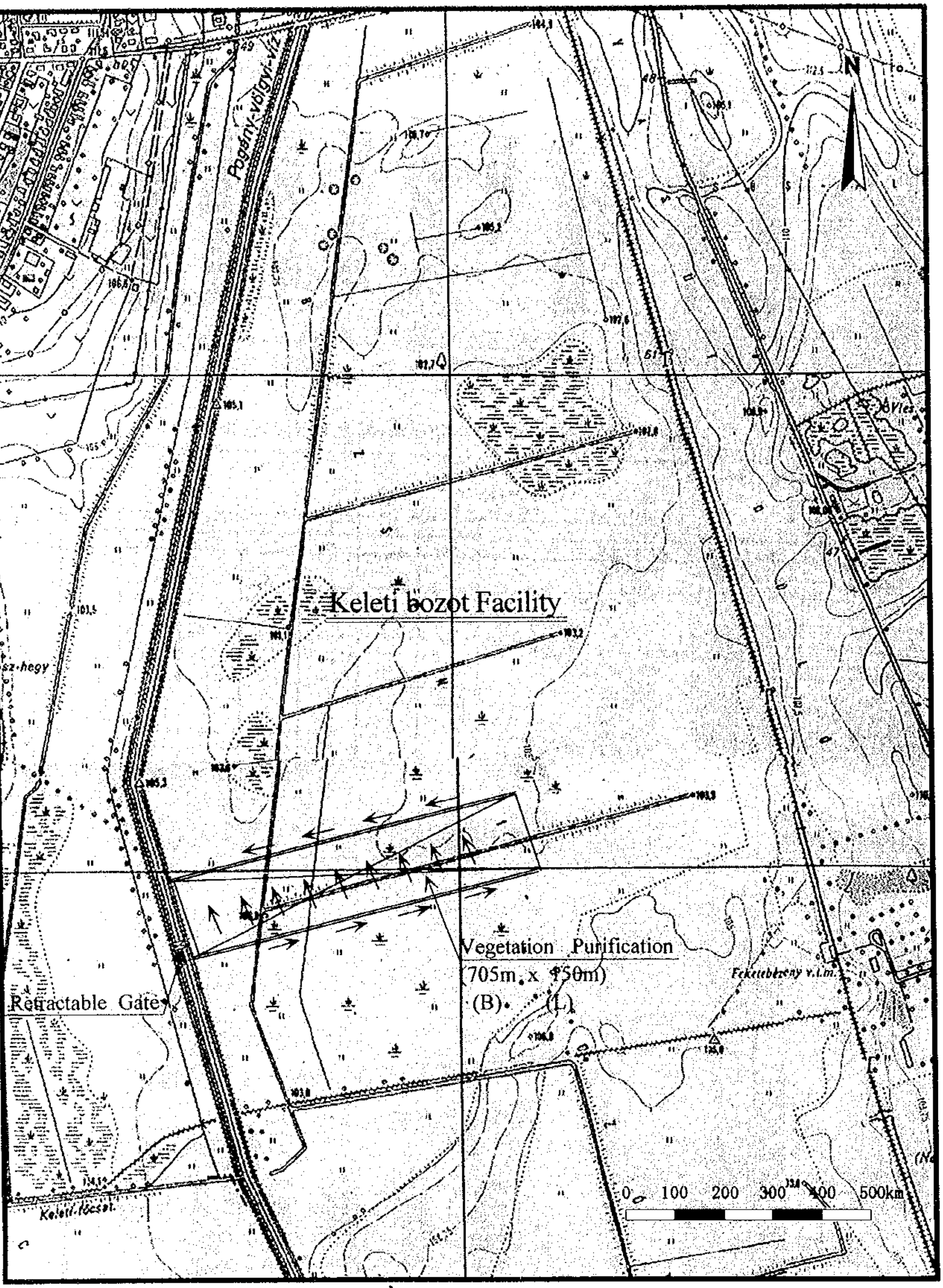


Figure 5.4 Location of Keleti-bozot Facility

Keleti Bozot Facility

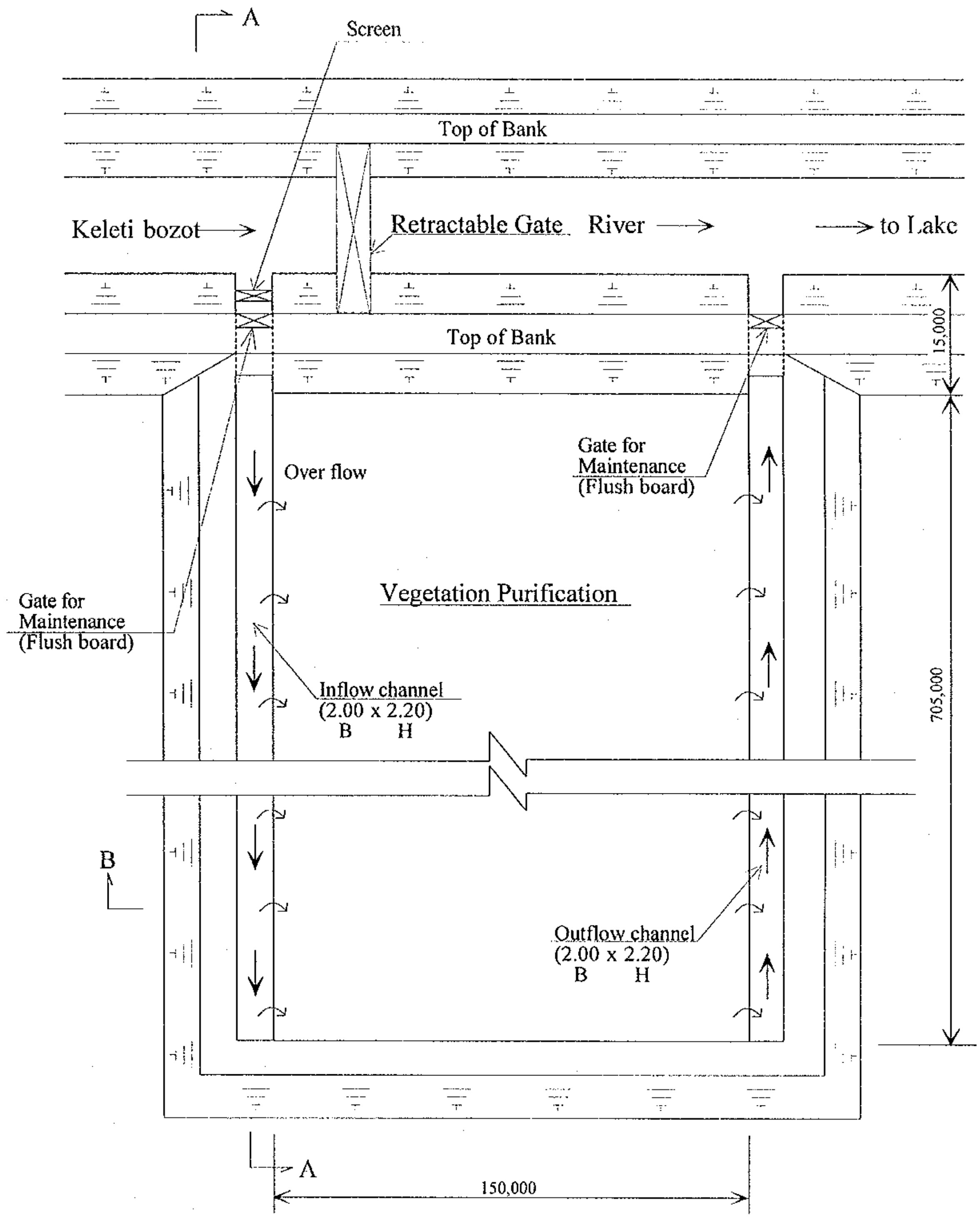


Figure 5.5 General Layout of Keleti-bozot Facility

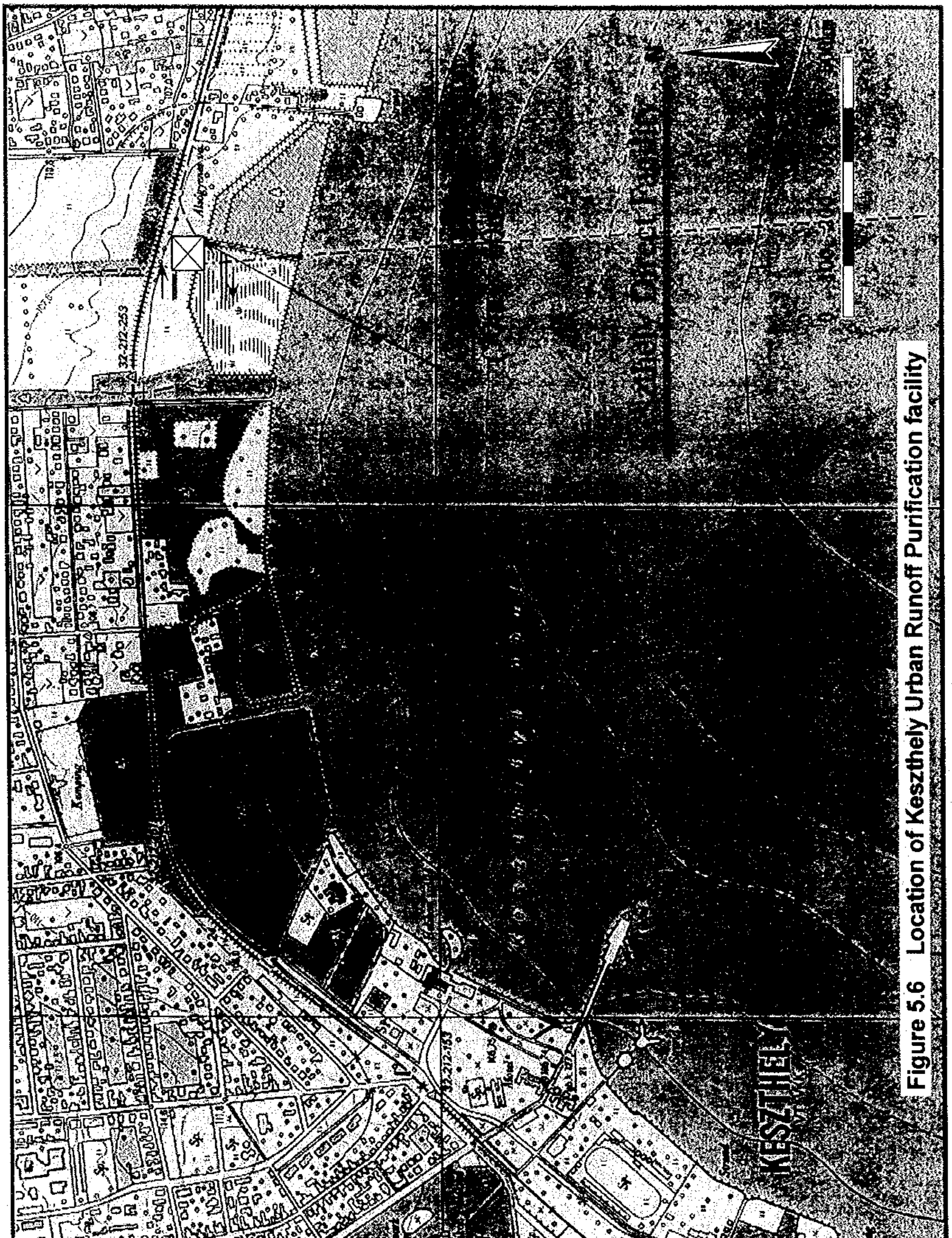


Figure 5.6 Location of Keszthely Urban Runoff Purification facility

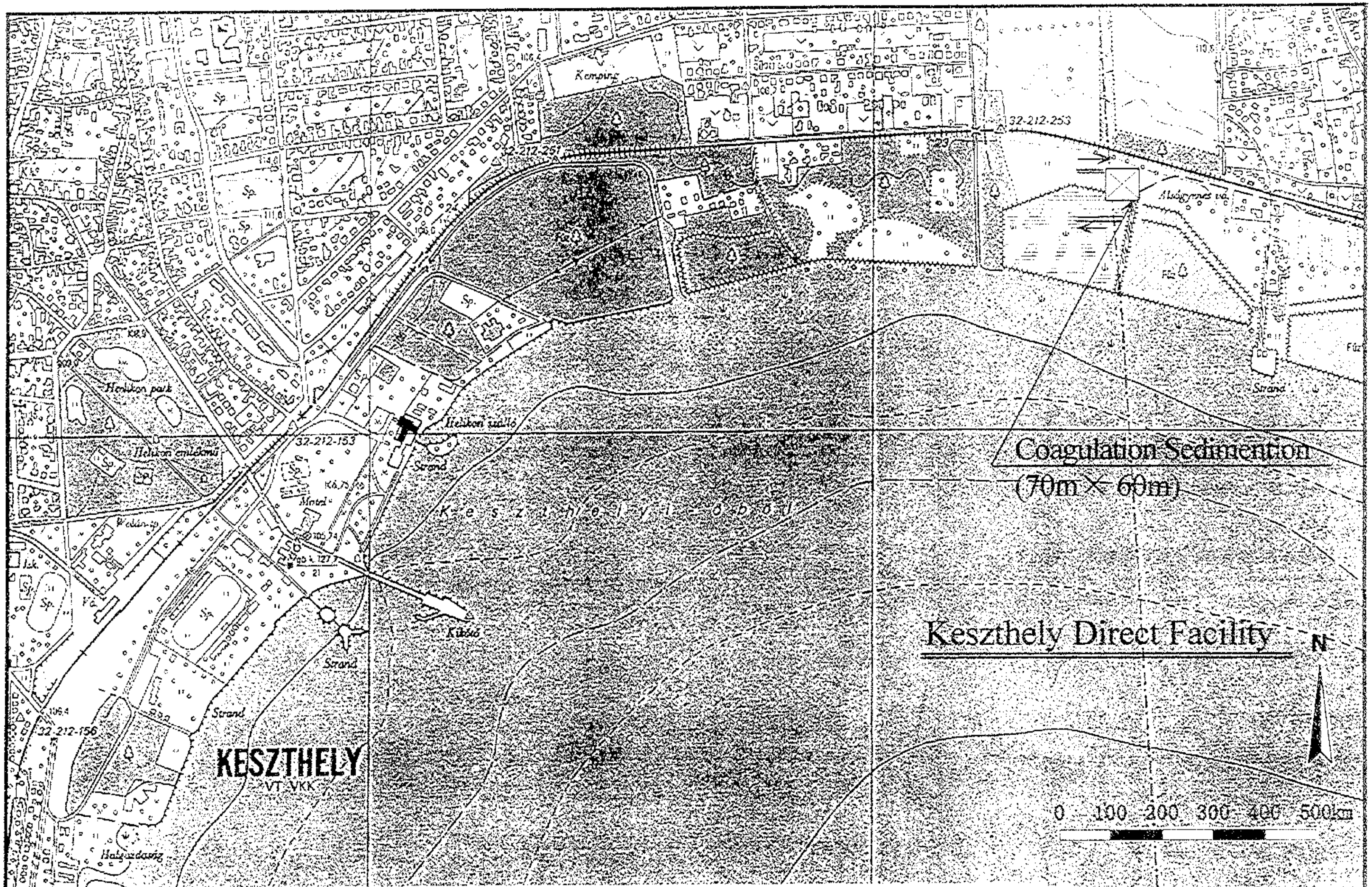
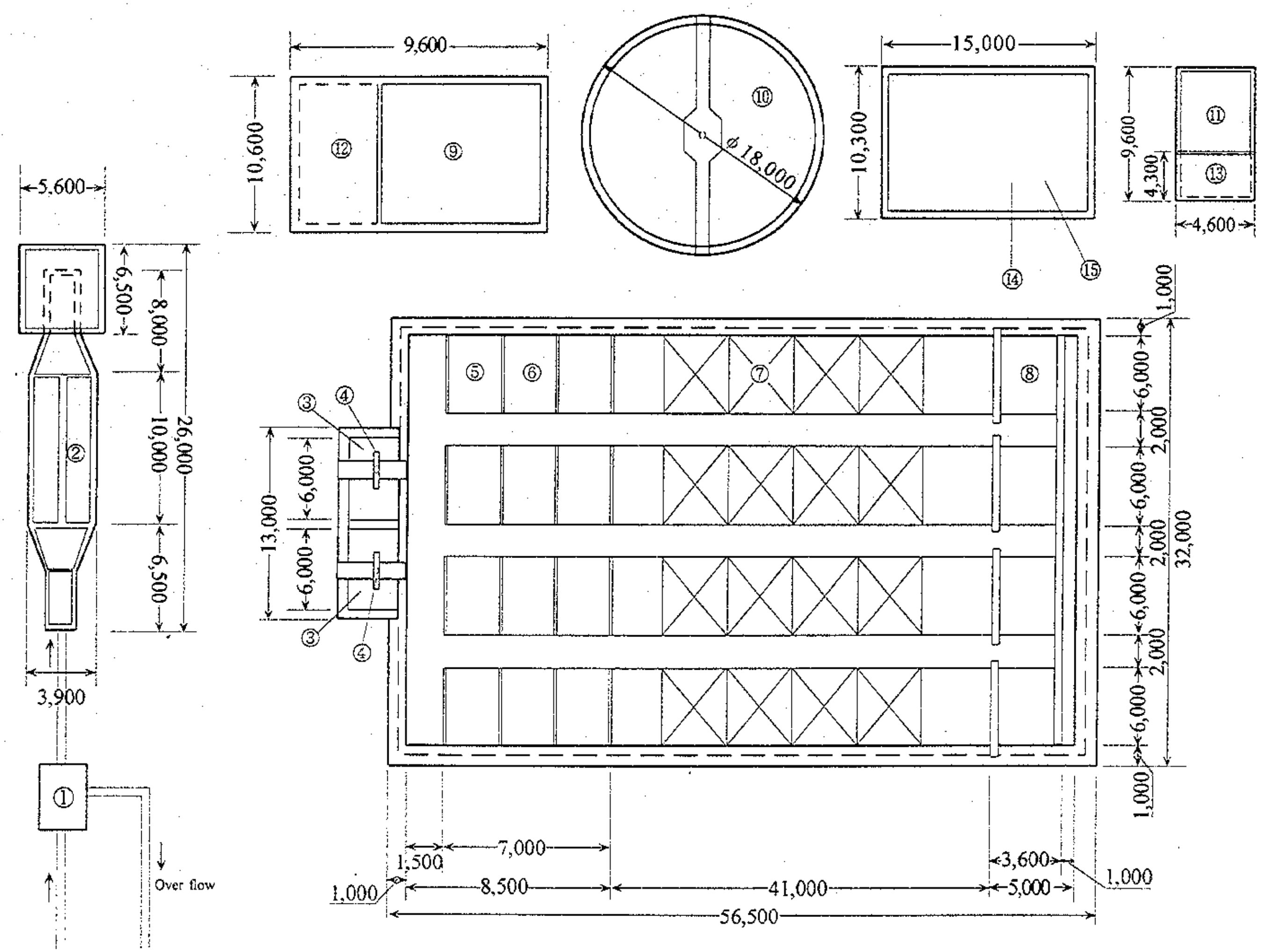


Figure 5.6 Location of Keszthely Urban Runoff Purification facility

Coagulation Sedimentation Facility



No	Name
1	Storm outfall
2	Sand basin
3	Mixing basin
4	Rapid mechanical aeration
5	Flocculator
6	Slow mechanical aeration
7	Settling pond
8	Overflow pond
9	Sludge tank
10	Sludge thickener
11	Sludge storage tank
12	Pumping station
13	Sludge pump
14	Coagulant storage tank
15	Dehydrator

Figure 5.7 General Layout of Coagulation Sedimentation Facility

CHAPTER - 6

CONCLUSION AND RECOMMENDATION

CHAPTER - 6

CONCLUSION AND RECOMMENDATION

1. GENERAL

The Study revealed that significant improvement of the trophic condition of Lake Balaton would not be expected by the reduction of external and internal pollution loads. However, it should be much stressed that the present lake conditions are a gift from every effort that has been made during these several decades by various organizations concerned to Lake Balaton. Lake Balaton is a shallow lake with an extremely small turn over rate. Furthermore, it has been exposed to tourism development of its shoreline since last century. Considering these severe conditions, it might be a miracle that Lake Balaton is providing an environment where people can swim there. If there was no past effort, Lake Balaton has lost most of the present values.

The eutrophication is an irreversible process of natural lakes. Although people may not be able to turn back or to stop the process, people could slow down the speed of the process. Therefore, it is necessary to continue the efforts, which have been made, to reduce the external and internal loads and outputs of the Study should be utilized to integrate the efforts efficiently and effectively.

2. INSTITUTIONAL FRAMEWORK

It was recognized through the Study that the eutrophication of Lake Balaton had been well acknowledged scientifically since its initial stage, since then many researchers and engineers in various organizations were involved in studies, researches and planning works. The government also took legislative actions for the prevention and improvement of Lake Balaton and not a few projects were materialized. Lake Balaton can be regarded as one of the most successful cases of lake environmental improvement in the world.

As a matter of fact, however, it was also recognized that outcome of the studies and researches spread over organizations and there is no core to manage those data and information. Moreover, while various improvement measures for the improvement under Action Program have been implemented by competent ministries, there seems no function to establish targets and coordinate them in order to accomplish the targets.

Apparently, former Balaton Office in PMO was established as a coordination body for every activity related to Lake Balaton. However, it failed to function as expected because it was not equipped with proper methodology and it did not have enough resources. Balaton Office was dissolved and the new government is under consideration of a new organization for the Lake Balaton management.

The Study provided Policy Making Process (PMP), which includes the management of relevant data and information, preparation of scenarios for the improvement and coordination to materialize the scenarios, and proposed

Balaton Policy Making Unit (BPMU) to implement Policy Making Process as a responsible organization for the improvement of Lake Balaton. Although BPMU was supposed to be established in or as a subordinate agency of Balaton Office, originally, concepts of PMP and BPMU can be taken over by any governmental organization or any other bodies to be organized for the Lake Balaton management. Therefore, it is recommended that an organization responsible for the Lake Balaton management be set up by incorporating the concepts of PMP and BPMU as much as possible.

3. STRUCTURAL MEASURES

Sewerage development and Kis-Balaton Project

The sewerage development and the implementation of Kis-Balaton Project Phase II are a basis of the Comprehensive Plan. The future conditions in the Comprehensive Plan are assumed on the conditions where both projects are to be implemented since they are considered to be an established policy.

The sewerage development should be appraised as not only a measure for the reduction of the pollution load, but also one of urban infrastructure development. Kis-Balaton Project was planned as a two-phase project. Phase I was already implemented and greatly contributed to the reduction of the pollution loads through Zala river. Phase II project was carefully reviewed from a viewpoint of a balance with nature conservation and the modified Phase II project is ready to be implemented. Phase II project is expected to further contribute to the pollution loads reduction and the flood control of the area. Therefore, these two projects should be implemented at the highest priority.

Dredging

The Comprehensive Plan proposes two structural measures; dredging and non-point source control. The reduction of the internal load by dredging of the bottom sediments in the Keszthely and Szigliget sub-basins was indicated more effective than the reduction of external load by results of the water quality simulation model. While the effect is not enough to achieve the improvement targets completely, the reduction of internal load indicated to reduce the frequency of occurrence of algal blooming. Since there is an on-going feasibility study on the dredging by the Hungarian side, a dredging project is not included in the feasibility of the Study. According to interim results of the on-going feasibility study, planned dredging works intends to extend and expand the current dredging activities, covering the Keszthely and Szigliget basins. Scope of the work seems almost same as the plan proposed in the Comprehensive Plan. Therefore, it is recommended the dredging projects by the on-going feasibility study be implemented as early as possible, expecting mitigation of algal blooming in summer season.

Non-point source control

The reduction of the external pollution loads hardly showed the effective improvement of water quality by calculation of the water quality simulation model. As long as the short or middle term water quality improvement is concerned, the reduction of the external load is less important. However, if an origin of the bottle sediments is thought of, and if a fact that the eutrophication process is irreversible is recognized, the reduction of the external load is yet important.

The Comprehensive Plan proposes measures for controlling the external load from non-point sources. Based on the assumption that the reduction of external loads from point sources is to be achieved by the upgrading/ improvement of sewage treatment level and the fact that more than 80% of the external load are originated from the non-point sources, the measures for the non-point sources were investigated in the feasibility study.

The measures investigated in the feasibility study require a large number of small-scale facilities to achieve significant effects. It might be a disadvantage of these measures, on the other hand, the fact that each facility can be constructed with less construction cost makes the partial implementation possible with small financial sources.

Methods applied are technically less established compared to methods for the point sources, such as wastewater or sewage treatment. It will require further research works to establish practical methods for the non-point source control. Therefore, it would be advisable to start with a pilot plant scale within an available budget, to improve and modify the methods through actual operations, and to generalize them over the whole catchment.

4. NON-STRUCTURAL MEASURES

Environmental Education and Campaigns

Citizens' awareness for environmental improvement is a key for non-structural measures. It works from two aspects. Citizens' awareness induces direct actions that contribute to the environmental improvement, such as replacement of phosphate-based detergents, proper waste disposal, acceptance of sewage treatment charge and so on. Moreover, environment-consciousness could affect citizens' support to governments. They may support the state or local governments that put a higher priority to the environmental policy.

As such, it is important to raise environmental consciousness of the citizens by education and campaigns. Youth camp in Balaton organized by KDT-VIZIG and other youth camps Kis-Balaton by other VIZIGs would be a good example of education. These activities should be encouraged over the catchment area. Incorporating into school curriculum in schools around Lake Balaton would be a practical method to encourage the environmental education.

Legal Enforcement, Fines and Subsidy

Whereas the environmental education and campaign expects citizens' actions caused by their own willing, legal enforcement, fines and subsidy lead citizens to take actions by motivation or forcing.

Generally, wastewater quality, landuse, and development and construction in specified areas are well controlled under the current legislative framework. One thing the Study found to be considered is a legislative framework for the encouragement of a sewerage house connection and an on-site sewage treatment facility. Their installation is obviously a financial burden for some people and not a few people have escaped from this burden. It causes not only insufficiency in the sewerage construction investment but also endangering of the wastewater management. Therefore, it is recommended to consider legal enforcement, fines and subsidies or their combination to motivate citizens to install sewerage house connection or on-site sewage treatment facility.

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