3.3 MEASURES FOR INTERNAL LOADS REDUCTION

Basic ideas of measures for internal loads reduction are generally classified into two. One is to control static process (nutrient release from bottom sediment), and the other is to control dynamic process (resuspension of nutrient-rich sediment). Based on this, the following measures are selected and studied;

- Sediment removal (Dredging),
- Sediment cover, and
- Phosphorus inactivation.

(1) Sediment Removal (Dredging)

The governmental resolution 2100/1995 has required the dredging activities of the Keszthely basin to complete the planned area of 24 km^2 by the end of 1999. However, "the study of thin layer dredging of the Keszthely basin - mechanical studies of the sediment disposal possibilities (KDT VIZIG, 1995)" proposed a concrete plan for dredging considering capacity of dredger and disposal of dredged bottom sediment. It showed that the existing one dredger will complete about 70% of the planned total area by the year 2003, even if it works with the planned capacity of 210ha/year, and the work will be complete by the year 2002 if a set of pressure booster and one more dredger with a 4 km long sediment-carrying capacity come into operation from 1996.

It is generally said that the internal phosphorus load may equal or surpass the level of the external one in Lake Balaton and the thin-layer dredging may have effect to some extent. However, it is difficult to quantify the effect of dredging or to persuade the persons who have some doubts about its effect. Some experts say that it may be better to keep the present dredging capacity until its effect is clarified, and others say that the capacity should be increased, because too slow dredging pace would result in recontamination by neighboring undredged sediment.

Although a few years delay might be inevitable, the increase of dredging capacity is technically possible, and disposal sites have been already studied and defined. Remaining problems are to clarify the effect of dredging by frequent monitoring and to reach consensus on the dredging program.

(2) Sediment Cover

Sediment cover is one of alternatives for dredging of bottom sediment. In stead of being removed, bottom sediment is covered with thin-layer sand mat which has a thickness of 20~30 cm. The sand mat would prevent phosphorus in the bottom sediment from resuspending or releasing to the lake water. This technique will be able to solve the problem of dredged sediment disposal. The sand mat might be utilized as a part of sandy beach if it is spread over the lakeshore, which might give a variety to the lake shore view. Construction work of sediment cover is similar to that of dredging.

It is technically possible. However, materials should be transported from a sand/gravel pit in the catchment area and the materials for the sediment cover should be chosen taking nutrients content into account, which would result in raising the project cost.

As a major adverse impact, sand mat will make the basin shallow by 20~30 cm, which might affect the lake water management and physical conditions of the lake water. It may raise the water temperature, which provides favorable conditions for algal blooming. For those reasons, sand materials can not be supplied repeatedly even if the sand mat is partly removed by strong waves or covered by drifting nutrient-rich sediment.

(3) Phosphorous Inactivation

Phosphorous release from bottom sediment can be controlled by adding salts of aluminum to the lake water, which results in an aluminum hydroxide floc that settles to the sediment surface forming a barrier to further release.

It is said that inactivation of sediment phosphorus with salts of aluminum can retard phosphorus release. Trophic state in the shallow and continuously mixed lakes like Lake Balaton, which have a phosphorus cycle dominated by internal phosphorus load, can be improved, because the treatment affects the entire water column. Effectiveness was dramatic and long lasting (around 10 years) in some cases in the United States, and there were corresponding decreases in chlorophyll-a.

In the above-mentioned cases, negative environmental impacts of salts of aluminum were not observed. However, there have been insufficient studies of the impacts of salts of aluminum treatment on lake biota. Although no massive biotic changes, such as a fish kill, have been reported, increases of mortalities, decreases of species diversity, or increases and decreases of benthic invertebrate population were observed in many cases. As an alternative, iron or calcium salts might be used, where aerobic conditions can be maintained.

In general, unit cost (to treatment area of 1 hectare) of this technique is 600~2,600 USD/ha, which is lower than that of dredging (2,000~6,000 USD/ha). However effectiveness of this technique has not been sufficiently confirmed, or adverse impact by adding salts of aluminum can not be denied. Even if there is no adverse impact, adding chemicals to Lake Balaton may not be acceptable for the Hungarian.

(4) Evaluation of Internal Loads Reduction Measures

Internal load reduction measures should be taken with the highest priority to realize quick effect of water quality improvement of Lake Balaton. However, sediment removal by dredging seems to be an only possible measure for internal loads reduction, considering limnological conditions of Lake Balaton and people's acceptability.

There is a difficulty to quantify the internal load from bottom sediment, because mechanism of phosphorus release from the bottom sediment has several unknown factors. According to Hungarian experts, the internal load may attain or surpass the level of the external one, and the amount of exchangeable/mobile phosphorus in the uppermost 8 cm of the Keszthely basin and the Siófok basin is 7.8 gP/m^2 and 1.3 gP/m^2, respectively.

If the internal T-P load of Lake Balaton is equal to the external load from the whole catchment area, approximately 110 tons/year of T-P is released from the bottom sediment. A phosphorus release rate is estimated to be around 0.76 $mgP/m^2/day$ on average in the Study, though it was obtained from two times of short-period (15 days) measurements of samples taken from the lake bottom. This release rate shows that about 160 tons of phosphorus is released in a year, which does not contradict the above-mentioned value.

Additional dredging in 74 km^2 (14km^2 in the Keszthely basin and 60 km^2 in the Szigliget basin) is proposed as a possible measure in the Study. According to the experimental dredging prior to the implementation of existing dredging project, mobile phosphorus decreased by 40% after dredging. Based on this, T-P load released from bottom sediment would be reduced by 8.2 tons/year. The total project cost for 10 years is estimated to 6,816,070 thousand HUF. It means that cost efficiency of additional dredging project is 12 mgP/year/HUF.

3.4 PROPOSED STRUCTURAL MEASURES

(1) External Loads Reduction Measures

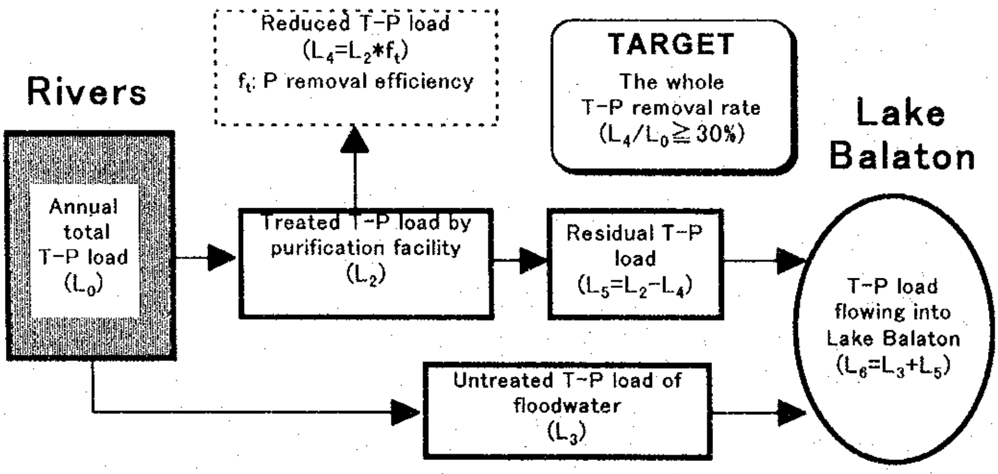
River purification systems have been selected as the most effective structural measures to be proposed in the Study. Since Kis-Balaton project is on-going project, structural measures are proposed for other rivers than Zala River.

Among three alternatives selected by initial screening, vegetation purification has been selected as an optimum method for river purification based on the following reasons.

- There are some examples in the catchment area of Lake Balaton, therefore this method would be technically adopted and would be accepted by residents or tourists.
- This is an environmental-friendly method, because this method uses not chemicals but a natural material such as reed growing around Lake Balaton.
- Cost efficiency of this method is higher than other methods.
- Sites for facilities are easy to find along the river courses or around the mouths of rivers where wetlands or farmlands spread.

Twenty nine (29) rivers and four (4) pumping stations have been selected as the target areas for which vegetation purification facilities should be constructed.

Their locations are shown in *Table 4.5.* Design capacities of the facilities are also shown in *Table 4.5.* The capacities were determined to meet the target as shown in the following conceptual figure, which requires that annual total phosphorous load flowing into Lake Balaton should be reduced at least by 30 % even if a certain level of floodwaters can not be treated to protect those facilities from damages.



Typical layout and cross sections of the river purification facility are shown in *Figures 4.9 and 4.10.* The facility should meet two requirements; to treat river water as much as possible, and to protect purification process from floodwaters. For that purpose, the facility is composed of the following components.

Water 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. According to examples in Japan, a rubber-made gate is proposed.

Inflow 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. Water flowrate in channel is assumed as 0.3 m/sec. To make a uniform water flow, overflow system is proposed at the entrance of the purification structure (reed pond).

Purification structure

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,

$$H = 0.20 \text{ m}$$

$$Q = 1.2 \times 0.50 \times (0.20)^{3/2} = 0.054 \text{ m}^3/\text{sec} = 2.84\ Q_d$$

Thus, the facility can treat a maximum water flow of about three times of design inflow (Q_d), even if the river water flow exceeds the design inflow of the facility. However, the purification efficiency does not meet the designed level under such condition.

The structure is set to keep the conditions; water depth of 10~20cm, water flow velocity of 0.5~1.0cm/sec, retention time of 4~5hours, and flow length of more than 100m.

Outflow channel

The structure is same as that of inflow channel. Water from purification structure flows into the inflow channel by overflow system and returns to the river course by open channel. A gate is set for maintenance of the facility.

(2) Internal Loads Reduction Measures

Dredging has been selected as a possible measure to reduce internal loads from bottom sediment.

According to the calculation of water quality simulation model, the reduction of internal load by dredging has an significant effects on water quality of Lake Balaton. It must be the most desirable alternative to dredge the whole basin of the lake. However, about 30 sets of dredging fleet will be necessary to dredge the whole basin of Lake Balaton (593 km^2) for 10 years, since the dredging ability of one set of dredging fleet is estimated to be 20 km^2/10 year. If the thickness of the dredging layer is 20cm and the dredged sediment is disposed to the disposal site with 1m thickness, a vast area of 119 km^2 will be necessary for disposal sites. It is hard to realize this alternative.

Possible dredging area for a decade is considered to be the western half area of the Szigliget basin as well as remaining part of the Keszthely basin to be dredged, for the following reasons:

- Based on hydraulic character of Lake Balaton, lake water flows slowly in the direction of north-east in general, namely from the Keszthely basin toward the Siófok basin. This hydraulic character suggests a clear answer that dredging of upstream area is more effective for the lake water quality improvement than that of downstream area.

- The water quality of the western half area of the Szigliget basin as well as the Keszthely basin appears to be worse comparing to other areas.

- The project cost is realistic.

To implement this dredging project, three more new dredgers and three more booster vessels including pipelines, pontoons, attached small boats are necessary. Existing dredger and one new booster vessel should be used for the dredging of the Keszthely basin and three new dredgers and two booster vessels will be used for the dredging of the Szigliget basin.

The dredging area will come up to about $14km^2$ in the Keszthely basin and $60km^2$ in the Szigliget basin shown in *Figure 4.11*.

It is very difficult to propose disposal sites because many problems will expect to be encountered directly depending on the ownership of the candidate land for the disposal sites. The potential disposal sites are shown in *Figures 4.12~ 4.14* which are draw up by using GIS. These figures show the areas which satisfy the three conditions; present land use, land height, and distance from the lake shore.

4. NON-STRUCTURAL MEASURES

4.1 POSSIBLE NON-STRUCTURAL APPROACHES

Non-structural measures aim to exploit direct actions of citizens and private sectors.

Citizens can contribute to maintain or restore river/lake water quality through following direct actions:

- Replacement of phosphate-based detergents by phosphorus-free ones
- Construction of sewerage house connection
- Installation of proper sewage treatment facility
- Proper waste disposal

Citizens' awareness for environmental improvement is a key for success of non-structural measures. Considering this fact, environmental education and campaigns should be base of non-structural measures. On this base, various non-structural measures could be effective as shown below.

Tools \ Purpose	Replacement of phosphate-based detergents	Construction of sewerage house connection	Installation of proper on-site sewage treatment facility	Proper waste disposal
Education and campaigns	◎	◎	◎	◎
Legal enforcement	△	◎	◎	△
Fines	×	○	○	△
Subsidies	×	◎	◎	×
Product charges	◎	×	×	×

note) ◎: suitable,○: applicable, △: not suitable, ×: not applicable

Private sectors, mainly industries, can mitigate their negative environmental impact through following direct actions:

- Installation of wastewater treatment facility
- Introducing cleaner production

Possible non-structural measures for private sectors are as shown below.

Tools \ Purpose	Installation of proper wastewater treatment facility	Promotion of cleaner production
Legal enforcement	◎	○
Fines	◎	△
Subsidies	◎	◎
Environmental labeling system	◎	◎
Product charges	○	○

note) ◎: suitable,○: applicable, △: not suitable, ×: not applicable

Effectiveness of environmental labeling system highly relies on citizens' awareness for environmental protection.

It is note that collection of fines and product charges themselves are classified not only into non-structural measures, but also into institutional measures, because collected fines and charges can be utilized for strengthening financial background of efforts for environmental improvement. In the catchment of Lake Balaton, discharge of some large factories are diverted outside the lake catchment, and in this case collection of effluent fines works only as institutional measures.

4.2 EVALUATION OF PRESENT SITUATION

(1) Environmental Education and Campaign

The fact that KDT-VIZIG has organized Balaton youth camp activity every summer for more than 10 years is highly valuable because accumulated experiences and knowledge of this activity enable to develop and disseminate environmental education further. Actually NyDT-VIZIG started similar activity around Kis-Balaton from this summer. The youth camp activity is well-designed and effective to learn how precious the lake is and how to manage and protect it, through clean-up activities as well as lectures, presentation of an introduction video and discussion on the lake management. On the other hand, the present capacity of human and financial resources results in limited number of participants, that is around 200 - 250 person a summer according to KDT-VIZIG. The effort for widening the target group of environmental education should be continued. Municipal governments are expected to play an important role for this purpose.

(2) Legal Enforcement, Fines, and Subsidies for House Connection and On-site Sewage Treatment Facility

Installation of sewerage house connection or adequate on-site sewage treatment facility put a financial burden on residents, and not a few residents have escaped from this burden. To motivate citizens to install house connection or proper on-site sewage treatment facility, legislation of legal enforcement, fines, and subsidies, or their combination are necessary. At present Hungarian legislation framework lacks this aspect.

(3) Product Charge for Promoting Phosphorus-free Detergents

Eutrophication of Lake Balaton is obviously phosphorus limited and use of phosphorus-based detergents might contribute to eutrophication process to some extent. For promotion of phosphorus-free detergents instead of phosphorus-based ones, levying higher product charge on phosphorus-base detergents is possible solution, however, at present phosphorus-based detergents are not subject of environmental product charges.

(4) Measures for Private Sectors

Basic tools of non-structural measures for private sectors have been established in Hungary. KÖFEs are responsible for monitoring effluent from factories and sewage treatment plants and for collection of fines from them. However, introduction of cleaner production concept is backward.

4.3 PROPOSED NON-STRUCTURAL MEASURES

Following measures are proposed as non-structural measures to motivate direct actions of citizens and private sectors.

- Promotion of the environmental education and campaigns.
- Establishment of legislative framework for the sewerage house connection and on-site sewage treatment.
- Introduction of product charge.

5. INSTITUTIONAL MEASURES

5.1 OBJECTIVES

(1) Establishment of Policy Making Process

One of the principal objectives of institutional measures is an establishment of leadership to integrate various efforts of various players. To build up this leadership, a governmental organization responsible for the lake environmental improvement should control following policy making process as its competence or by some means:

- Intensive accumulation of relevant data
- Information pool of activities and plans related to the lake environmental improvement
- Preparation of scenarios for the lake environmental improvement through analysis on collected data and information
- Selection of the optimal scenario
- Formulation (or revision) of a comprehensive plan which is technically, economically and financially feasible
- Implementation of the comprehensive plan

To establish above process and to enable the responsible organization to control the process are principal objectives of institutional measures.

(2) Promotion of Public Participation

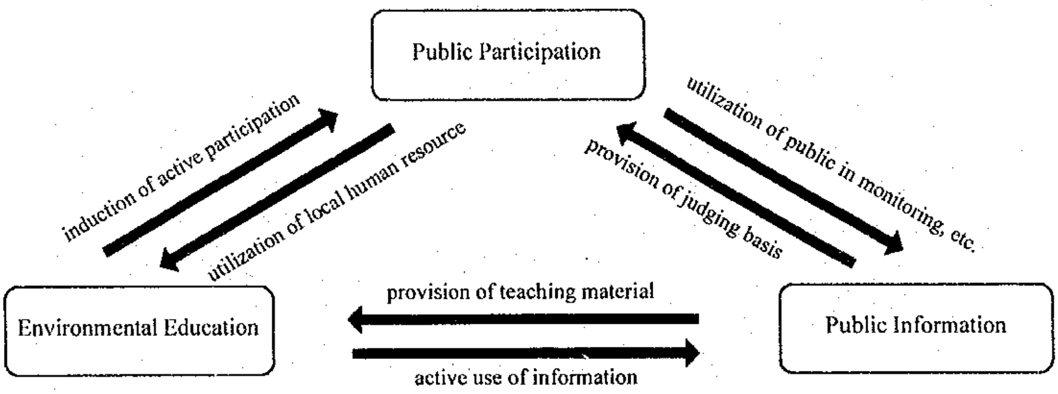
1) Necessity of Public Participation

The need for public participation in environmental improvement can be explained from two aspects. One is as a measure for redress of policy making process, and the other is as a measure for citizens involvement in operation and maintenance of structural measures. Public participation may enable to;

- reflect local conditions in policy making process,
- prompt the government to continuous and serious efforts even under political change, and
- involve inhabitants in operation and maintenance of structural measures.

2) Roles of Citizens and Administrative Side

Environmental issues are generally complicate and the first step to implement public participation is set of environmental education and public information. The task of administrative side is nothing but provision of knowledge, information, and preparation of proper framework. It is the citizens who exploit possibility of public participation. Relation among public participation, public information, and environmental education is shown below.



Potentially public participation is positive feedback process. Once a well designed framework succeeds to motivate citizens, then motivated citizens have a potential to improve the process. Water quality data monitored by NGO may greatly contribute for better policy making. In turn, the fact that citizens' active participation is established may motivate the government to introduce more advanced public participation instruments.

3) Referential Case of Lake Biwa in Japan

Lake Biwa, located in Shiga prefecture, is the largest lake in Japan with similar size of Lake Balaton. In the past time the lake was typically oligotrophic, however, recently eutrophication process has been proceeding and in 1977 first outbreak of red tide occurred. Riparian residents recognized that phosphate-based detergent was one of main causes of the lake eutrophication, and began a movement for using soap instead of phosphate-based detergent.

The movement resulted in the establishment of an association for promotion of soap usage for the sake of Lake Biwa in 1978, and this association played an important role in the enactment of a prefectural ordinance for preventing further eutrophication of Lake Biwa. In order to support such activities, Shiga prefectural government developed an easy-soluble powder soap for washing machine. After the enactment of the ordinance in 1984, the association was developed into the Citizens Forum for Conservation of Water Environment around Lake Biwa, which renders wider activities for the lake environmental protection.

The active public participation enabled Shiga prefectural government to allocate considerable budget in the lake environmental issue, and in 1996 Shiga prefecture opened the Lake Biwa Museum which now functions as a core of environmental education, as a research institute, and as an information center.

Hungarian citizens also have an experience of active public participation in the Danube Dam issue between Hungary and Slovakia. Proper public information will trigger citizen's active participation in environmental issues.

5.2 TASKS OF PROPOSED BALATON POLICY MAKING UNIT (BPMU)

(1) Overview of Policy Making Process

1) General Scheme of the Process

Balaton Policy Making Unit (BPMU) is assumed as a responsible organization for the lake environmental improvement, because reorganization of Hungarian government is in progress and it is difficult to show exact location or position of the responsible organization in the governmental structure.

Figure 4.15 shows a scheme of proposed policy making process. Some activities in *Figure 4.15* have been undertaken by some existing organizations. For example, KÖFEs collect sewerage fine and this is clearly regarded as fund raising activity. It is rational to utilize such efforts by existing players. BPMU can influence these players by having a hold on flow of information and money, and newly proposed activities in the process are covered by BPMU as its competence. Individual citizens are also important players, and promotion of public participation is one of main tasks of BPMU.

2) Development of Decision Making Tools

Figure 4.16 focuses a part of the process, that is, development of PLDB and WQSM. Development of these decision making tools has an important place in the policy making process because these tools can greatly contribute to evaluate various measures and scenarios. In addition, the development of these tools prompts accumulation of relevant data that should be attained through proper monitoring, researches, and studies.

3) Role of Balaton Development Council in the Process

Under the present legal framework, Balaton Development Council (BDC) is regarded as a local coordination agency in field of the lake environmental protection though it is established as a policy making agency in field of regional development of Balaton area. The reason is that development work like the road construction can be executed mainly by local governments but an initiative of environmental improvement projects are mainly taken by state organizations, and it seems difficult for BDC, judging from its legal position, to coordinate ministries. An expected role of BDC is to support the policy making process by coordinating local governments.

Such a role of BDC is envisaged based on the present legal framework. It is not denied that modification of the legislation enables BDC to cover the roles of BPMU.

(2) Intensive Accumulation of Relevant Data

1) Purpose of data accumulation

Operation and modification of the decision making tools require intensive and target oriented data accumulation.

To facilitate an operation and modification of WQSM, it is desirable to develop an input database (IPDB), which consists of monitoring data such as; meteorological data of the lake and its catchment; hydrological data of the lake and its tributaries; data concerning bottom sediment; and water quality data of the lake and its tributaries.

PLDB consists of spatial data (soil, geology, topography, land use, vegetation, erosion potential) and municipal data (population, population density, water supply service ratio, sewerage service ratio) as well as monitoring data of point sources and groundwater quality.

2) Data sources

Monitoring activities are done by KÖFEs (water quality data), VIZIGs (hydrological and bottom sediment data), OMSZ (meteorological data), and VITUKI Rt. (groundwater quality data). BPMU will design input data formats of PLDB and IPDB, and acquire necessary data based on the input data formats from those organizations on regular basis.

Basic spatial data are prepared by FÖMI (topography, CORINE land cover, land use, satellite images) and MTA-TAKI (soil, geology). BPMU will specify necessary spatial data for PLDB and acquire them from FÖMI and MTA-TAKI. Spatial data is not changed in short-term, and modification of these data might be needed quite seldom.

Concerning municipal data (population, population density, water supply service ratio, and sewerage service ratio), at present only local municipalities of settlements can provide them. BPMU will specify necessary municipal data and collect them from each local municipality or, more desirably, through county governments or BDC in processed form.

3) Necessary researches and studies

In addition to above data, researches and studies concerning following topics should be collected.

- Mechanism of algal bloom
- Phosphorus release from bottom sediment

- Run-off coefficient

One of great benefits of the decision making tools is that they can clarify deficient parts of data and knowledge related to the lake environmental improvement. BPMU should have an ability to commission additional monitoring or studies / researches which can complement such deficient parts.

(3) Information Pool of Activities and Plans for the Lake Environmental Improvement

As a first step of formulation or revision of the comprehensive plan, BPMU should prepare scenarios which consist of plans of executing agencies of structural measures, those of relevant municipalities, and BPMU's proposals.

Whether BPMU can prepare competitive scenarios or not depends on collected information of those plans. Information on the progress of the efforts for the lake environmental improvement also should be transferred to BPMU for present pollution load analysis, and information of revenues and expenditures of various funds is needed as a basis of economic and financial evaluation.

Information flow from ministries and state funds to BPMU can be established by obligating the former to report such information to the latter. In case of information of municipalities, a reasonable way is that county local governments or BDC bear the task to collect and process the information and transfer to BPMU.

(4) Revision or Formulation of the Comprehensive Plan

BPMU prepares scenarios based on pollution load analysis and collected information. Prepared scenarios are evaluated with PLDB and WQSM and the optimal scenario is selected. Feasibility of the optimal scenario should be verified with economic and financial evaluation. If the result of this evaluation is negative then second best scenario is regarded as the optimal one, and its feasibility be verified. This process is repeated until feasibility of the optimal scenario verified.

The feasible optimal scenario is a base of a draft of the comprehensive plan. BPMU prepares it and submit it to a coordination meeting chaired by BPMU. Participants are representatives of ministries nominated in the action program, and at least one representative of BDC, and representatives of county local governments. BPMU should do its best to coordinate participants' opinions, however, when BPMU deems adoption of some opinion results in impairment of the comprehensive plan, BPMU has the right to reject it. The record of discussion should be open to public for ensuring transparency of the process.

(5) Implementation of the Comprehensive Plan

1) Role of BPMU in the implementation stage

BPMU can propel implementation of the comprehensive plan in two ways, one is legislative way and the other is financial way.

The former is to provide biding authority to the comprehensive plan as a governmental resolution. To apply this way a position of BPMU in the governmental structure is very important. It means if BPMU is established outside the state government or under some executing ministry, it is quite difficult to apply this way.

The latter is to control budget allocation of the state budget and subsidies of the Ministry of Interior (BM) and relevant central funds. Concerning the state budget allocation, application possibility of this way depends on a position of BPMU. If BPMU is established in position to influence budget allocation, BPMU can efficiently pursue its responsibility as a policy maker.

2) Coordination of central subsidies

Concerning central subsidies, it is widely accepted that coordination among most central funds is quite poor, and in extreme case some 'good player' municipality can obtain even more than a total investment cost. Presently only VA tries to coordinate with BM by adjusting the amount of its subsidy based on total amount of targeted and addressed subsidies. BPMU should take the initiative in coordinating central funds and BM because BPMU will accumulate past records of central subsidies.

3) Balaton Environment Fund

Taking into consideration that main financial sources of local investment are central subsidies, it is desirable to earmark a certain part of central subsidies for the sake of environmental improvement of Lake Balaton and to allocate it in accordance with the comprehensive plan.

There are several options how BPMU participate in allocation of earmarked portion. Most ideal option for BPMU is to be handed over this portion from those funds to BPMU's own fund, 'Balaton Environment Fund'. If it is not acceptable for existing central funds then it is proposed that BPMU should take part in making application guidelines.

No matter whether earmarked portion of relevant state funds can be handed over or not, BPMU should have own fund to commission researches and additional monitoring as mentioned before. This fund also should function as a window for international financial sources.

4) Revenue sources

At least environmental load charge, which is mentioned in General Environment Act LIII/1995, should be at disposal of Balaton Environmental Fund. This would be applied to visitors to Lake Balaton for tourism. The charge is to be paid in compensation of use of the Lake Balaton environment. Careful consideration would be necessary in actual implementation of the environmental load charge, as it would weaken price competitiveness of the tourism around Lake Balaton.

For smooth implementation of the comprehensive plan, not only BPMU but also BDC should establish its stable revenue. In addition an appropriation from state budget as specified Regional Development Act XXI/1996, a part of corporate tax might be one of suitable revenue sources of BDC.

(6) Public Participation and Public Information

1) Public participation in policy making process

Basis of public participation is a set of public information and environmental education. Environmental education has been mentioned in previous section as one of non-structural measures.

The task of BPMU is a provision of free access to collected data and information for public. For the purpose Balaton Information Center should be founded under BPMU. The center operates IPDB and PLDB, and at least open IPDB and collected project information to public. Electric publication on Internet by having its own homepage or by utilizing the government's homepage is recommended. Moreover, the center should have library function.

In the course of formulation or revision of the comprehensive plan, BPMU should offer at least two opportunities for citizens to reflect their opinions in the process. At the beginning of the process BPMU should submit prepared scenarios for citizens' inspection for longer than two weeks, and when a draft comprehensive plan is formulated, BPMU should submit it to public inspection for longer than 30 days.

If BPMU would like to reject some citizen's opinion, BPMU should explain the reason why the opinion is rejected.

2) Public participation in maintenance activity

Another target of public participation is involvement of citizens in maintenance of river purification facilities. The work, cut of planted reeds and removal of dead ones, is enough easy to be rendered by students as a part of environmental education.

An important task, which might be assigned to BPMU, is market cultivation of collected reeds. Balaton region has a tradition to use reeds as roofing, however, it is getting rarer and rarer due to decrease of artisans and subsequent high cost. Set of advertisement and subsidy for craftsmanship training as well as construction cost might greatly contribute to promote reed roofing. Other usage of reeds, for example as fertilizer, is an important subject of research commissioned by BPMU. Cultivation of reed market must motivate citizens to take part in maintenance of the facility.

The fact that participation in the maintenance of environmental protection facilities yields a profit may contribute to better environmental education. One of important aspects of environmental education should be to make people understand that a sustainable development can be realized only with establishment of an eco-friendly economic system in which environmental protection activity makes a profit.

Clean settlement campaign is another idea to motivate public participation. The idea is to award settlements which show good performance in riparian cleaning, pollution loads reduction, maintenance of river purification facility, promotion of sewerage house connection, and so on. Linkage between the campaign and tourist information may enhance the effect of campaign to promote public participation.

5.3 ORGANIZATION OF BALATON POLICY MAKING UNIT

(1) General

A large portion of BPMU's tasks is related to formulation or revision of the comprehensive plan, and the frequency of revision is once a several years in general. Thus it is proposed to distinguish daily tasks from the tasks needed only at the revision of the comprehensive plan, and basically the latter are contracted out to consultants. Based on this principle, following tasks are listed as tasks performed by regular staff of BPMU.

- Intensive accumulation of relevant data
- Information pool of activities and plans for the lake improvement
- Public information
- Tasks related to Balaton Environmental Fund
- Tasks as a secretariat of the inter-ministerial meeting for Balaton issues
- Public relations

Among decision making tools databases, IPDB and PLDB, are subjects of public information and be owned by BPMU. On the other hand, WQSM is not a subject of public information because its operation requires specific knowledge and skill. Therefore it is recommendable that operation and modification of WQSM can be contracted out to one of academic institutes including universities.

(2) Staff Requirement

1) Balaton Information Center

This center is responsible for the tasks related to the collection of data and information including commissioning of researches and additional monitoring, and to public information. Required regular staff consists of;

- engineers for collecting data and information, and
- a database operator for IPDB and PLDB.

2) Planning department

This department is responsible for the tasks related to the formulation or revision of the comprehensive plan and monitoring the progress of its implementation. When the comprehensive plan is formulated or revised, this department is responsible for the whole subcontracting process. Except that period, this department functions as a secretariat of inter-ministerial meeting. Required regular staff consists of;

- engineers for coordination of ministries and technical advisory tasks for consultants,
- a legal profession for preparation of contract, and
- a document specialist for preparation of meeting resume.

3) Secretariat of Balaton Environment Fund

The fund functions not only as a subsidizer, but also as a coordinator of central funds and as a window of international financial source. Required regular staff consists of;

- a fund manager,
- engineers for preparation of own and other funds' subsidy guidelines,
- an accountant, and
- economists for coordination with international financial sources.

4) Public relations department

This department is responsible for public relations, especially related to promotion of public participation. The department receives public opinions on the draft scenarios and the draft comprehensive plan. All kinds of public campaigns, including promotion of reed roofing, are undertaken by the department. Required regular staff consists of;

- public relations specialists, and
- telephone clerks.

6. PROPOSED COMPREHENSIVE PLAN

6.1 COMPONENTS OF THE COMPREHENSIVE PLAN

The Comprehensive Plan has been prepared with a strategy;

i) to make people recognize the Lake Balaton environmental issues, support environmental policies for the improvement of the lake, and take actions to contribute to the improvement,

ii) to establish an institutional framework for the implementation of such environmental policies, and

iii) to materialize the policies by the established institutional framework.

Along the lines with the strategy, the Comprehensive Plan comprises following three approaches:

- Institutional approach to establish a system to execute program to contribute to the environmental improvement of Lake Balaton.
- Structural approach to improve the Lake Balaton environment by physical facilities.
- Non-structural approach to encourage public participation to the Lake Balaton environmental improvement.

Each approach consists of measures and activities in the table below:

Components of the Proposed Comprehensive Plan

Approach	Measures and Activities
Institutional	- Organization of Balaton Policy Making Unit, which is a responsible organization for the management of information, policy making and coordination of every organization related to Lake Balaton issues.
Structural	- Implementation of the present sewerage development plans in the catchment areas. - Early implementation of Kis-Balaton phase-II project. - Dredging of the bottom sediment in the Keszthely and the Szigliget basins. - Construction of the vegetation purification facilities in 33 proposed sites.
Non-structural	- Promotion of the environmental education and campaigns. - Introduction of product charge - Establishment of the legislative framework for the sewerage house connection and on-site sewage treatment.

More details of the dredging and the construction of the vegetation purification facility in the structural approach are as follows:

Dredging

Dredging area:	14 km² in the Keszthely basin and 60 km² in the Szigliget basin as shown in *Figure 4.11*.
Required equipment:	Additional two (2) dredgers and three (3) boosters.

Vegetation Purification Facility

Construction sites:	29 rivers and four (4) pumping stations in the northern and southern catchment. .
Major facilities:	Retractable water intake gate, Inlet channel, Purification structure, and Outlet channel.

6.2 PROJECT COSTS

Project costs are estimated for the structural measures in the proposed Comprehensive Plan except for the implementation of the sewerage development projects and Kis-Balaton phase-II project. The reason of eliminating these two projects from project costs is that they are now under preparation by the Hungarian side.

Cost estimates were carried out for the construction/procurement cost and operation cost of the dredging and the vegetation purification facilities. *Table 4.6* shows the procurement cost and operation cost of the dredging and *Tables 4.7* and *4.8* show construction cost and operation cost of the vegetation purification facilities.

Based on the estimated costs for the dredging and the vegetation purification facility, project costs are estimated as shown in the table below. Project costs consist of construction/procurement costs, an engineering service cost and a physical and price contingency. The engineering cost is assumed to be 5 % of the total construction cost but no engineering cost for the procurement. The physical contingency is assumed to be 5 % of a total of the construction/ procurement cost and the engineering cost.

Project Cost (Construction and Procurement)

(1000HUF)

A.	Construction Cost (Vegetation purification facility	3,537,434
B.	Procurement Cost (Dredging)	1,782,000
C.	Engineering Services ((5% of A)+Survey Cost)	191,698
D.	Contingency (5% of (A+B+C))	275,557
Total of Initial Cost		**5,786,688**

Project Cost (Operation)

(1000HUF/Year)

Vegetation purification facility	256,933
Dredging	494,497
Total of Operation Cost	751,430

6.3 IMPLEMENTATION PROGRAM

(1) Vegetation Purification

Implementation program for the vegetation purification was prepared based on the following assumption:

- The construction schedule is starting from year 2001 until year 2009.
- The engineering cost is divided into first three (3) years.
- The construction cost is divided into each year from 2002 to 2009.
- The facilities for the rivers flowing into the Keszthely basin or the Szigliget basin have higher priority.
- Each construction period of vegetation purification facility is one (1) year, except facilities with the width of over 500m, of which construction period is two (2) years.

(2) Dredging

Dredging has been designed so as the dredging of the planned area to be completed by 2010. Thus, dredging work is continued from 2001 to 2010.

(3) Implementation Program

The implementation program of the project is proposed as shown in *Table 4.9.*

6.4 FINANCIAL PLAN

Based on the project costs and the implementation program, yearly project cost is prepared as shown in *Table 4.10.*

In Hungary, environmental protection has been traditionally a matter of central government. Financial burdens of both capital costs and operational costs of major projects, such as Kis-Balaton Project, have been born solely by the central government, either through the central budget, or through various kinds of fund established for special purposes. Thus, there seems to be only one possible financial model to be assumed is the composition of foreign loan from international financial institution and own fund from budgets of central and/or local government, a public implementing body. Taking the substantial deficit in the central government budget, combined with the country's development needs in almost all sectors remaining at high level, this scenario appears to be the most practical.

It was assumed that out of the estimated total investment cost, US$ 27,303 thousand or HUF 5,786,688 thousand, US$ 8,191 thousand or 30% would be financed by the central government, and US$ 19,112 thousand or the remaining 70% would be financed by foreign loan granted by a international financial institution. Yearly financing plan is summarized in *Table 4.11*.

The World Bank would be a source of the foreign loan, considering the current Bank's contribution to the Hungarian environmental sector. Assuming the following loan terms and repayment conditions, financing and repayment schedule was calculated as shown *Table 4.12*.

Maturity:	15 years
Grace period:	5 years
Interest:	LIBOR (5.207% p.a. quoted on 1 October, 1998) plus 2%

6.5 PROJECT EVALUATION

(1) General

The Comprehensive Plan is a plan to aim the environmental improvement of Lake Balaton. Therefore, implementation of the structural projects proposed in the Plan could contribute to the improvement of the country's most valuable nature. In addition, the implementation of the proposed institutional and non-structural approaches could expedite the efficiency of the administration system of the state and local government and to raising people's awareness to the environmental issues, as well as to support the improvement of Lake Balaton.

Adjustment of the legislative framework of the environmental issues is one of the requirements for the affiliation to EU, which is the most urgent target of the country. Institutional strengthening and high people's awareness to the environment by the Comprehensive Plan may provide a basis of such adjustment.

(2) Environmental Improvement

The Comprehensive Plan set up the improvement targets by the trophic state of each sub-basin. However, the Study revealed that any possible measure can not achieve the targets completely. Current trophic level of the lake more depends on the climate conditions than the nutrient load level.

The climate conditions are a stochastic phenomenon, thus the trophic state is represented as a probability of the chlorophyll-a concentration, as shown in *Figure 2.4*. WQSM predicted a certain water quality improvement effects in the Keszthely and the Szigliget basins by the proposed dredging project as mentioned in the previous section of this chapter, however, no effects in the

Szemes and the Siófok basins. Based on the predicted improvement effects, in the Keszthely and the Szigliget basins the non-exceeding probability after the project can be assumed as shown *Figure 4.17*.

According to the non-exceeding probability shown in the figure, probabilities to achieve the targeted trophic state in the Keszthely and the Szigliget basins are improved as follows:

Sub-basin	Present Probability	Probability after Project	Improvement
Keszthely	23 %	35 %	12 %
Szigliget	43 %	58 %	15 %

(3) Economic Aspect

1) Estimation of the benefit of the Comprehensive Plan

The fact that water quality of the lake, as well as other environmental goods such as air quality or fauna and flora, does not have market prices make it almost impossible to apply traditional economic evaluation techniques in the Study. Therefore the monetary values of the lake environmental improvement estimated based on CVM (contingent valuation method) have been applied. This method is based on the use of questionnaires to create hypothetical market in which respondents are asked for their subjective valuation of specified environmental goods.

A study by Mourato in 1995 estimated the monetary values of environmental improvement of Lake Balaton based on CVM. Since this study well managed to translate the values of the lake environmental improvement through a CVM survey with carefully designed questionnaires, the result of the Mourato study, the annual willingness to pay (WTP) of Hungarian people for the environmental improvement was HUF 3,901.8 in 1995 price, is applied as a basis of economic evaluation of the Comprehensive Plan.

Based on the prospected water quality improvement and the WTP, the benefit of the Comprehensive Plan is estimated by following equation:

$$Annual\ Benefit = WTP \times n \times \Sigma(Ci \times Pi)$$

where WTP : WTP of Hungarian people (HUF 3908.1 in 1995 price)
n : the Hungarian population (20 - 65 year-old)
Ci : proportion of a sub-basin to the whole basin
Pi : improvement of non-exceeding probability in a sub-basin
i : sub-basin (1 = Keszthely, 2 = Szigliget)

2) Assumption of economic analysis

Following specific assumptions are applied for the economic evaluation.

- Water quality improvement process and the associated benefits have been envisaged with gradual process. The start value is 0 and it linearly increase to 2010 when the prospected improvement is attained first, then maintain throughout the project period.

- In case "without the project", no further degradation scenario of the water quality has been envisaged.

- All the costs and benefits are estimated in situations "with the project" and "without the project", in 1998 price.

- All the costs and benefits are measured for the first 39 years, including 30 years of operation and maintenance after completion of the construction. It should be noted, however, that the project would eventually lead to a larger benefit than indicated in this analysis as all activities and component envisaged would continue after 30 years of operation and maintenance of the project.

- All the financial costs quoted do not include Value Added Tax.

- No residual value of the booster and dredger at the time of completion of the dredging work has been accounted.

- Shadow prices are not applied to non-tradable goods, including labor.

- No sunk costs are accounted for the sake of simplification of the valuation.

- Foreign exchanges rates for major currencies applied when converted to US$ are as follows:

Currency	Ex. Rate/US$
Hungarian Forint (HUF)	211.945
Japanese Yen (J. Yen)	132.80
German Mark (DM)	1.8136

(Note) Average rate from January to June 1998.

Investment schedule is expected as below.

(1,000 US$)

Year	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*
Investment Cost	9,342	2,765	3,537	2,934	1,086	2,775

Year	*2007*	*2008*	*2009*	*Total*
Investment Cost	2,042	2,302	520	27,303

3) Results of analysis

The results of the analysis are summarized below; *Table 4.13* shows the details of calculation. As EIRR is over 12%, which is used as a norm for decision making of many World Bank projects, this project can be regarded as viable.

Indices	Result of Analysis
EIRR	12.62%
B/C	1.0394
NPV (12%)	1,724 thousand US$

The result of the sensitivity analysis shows that the project as a whole is sensitive to changes in economic conditions, especially the amount of WTP.

(4) Environmental Impact Aspect

The Comprehensive Plan will contribute to the environmental improvement, however, construction works and dredging operation may cause impacts to the environment. Possible impacts and their countermeasures taken into account in the plan are summarized below. As shown in the table all impacts is minor or temporary and to be controlled within acceptable levels.

Activities	Possible impacts	Evaluation and Countermeasures
Dredging in the lake	- Lake water pollution or impact on benthos caused by disturbing bottom sediment - Noise caused by sediment discharge pipe.	- Temporary or minor impact. - Operation control of dredgers. - particle size of sediment is very small and noise is not so serious - If necessary, night work should be restricted.
Disposal of dredged sediments	- Nutrient-rich water return to the lake. - Offensive odor or particulate matter affects the living condition.	- Embankment around the dredged sediment disposal site. - The disposal sites have been selected far from the residential area. - Quickly cover the surface with grass. - Reuse dried sediment for soil improvement.
Construction of vegetation purification facilities	- Temporarily may damage wetland and its sensitive ecosystem. - Excessively draining water may harm marshy ecosystem.	- Wetlands widely exist around the lake, which would recover soon if damages are controlled not spread over the construction site. - Monitoring the damages of emergent plant and control the work.
Operation of vegetation purification facilities	- Insufficient or inappropriate manner of maintenance makes the reed pond a source of nutrient, although it is expected to be a sink of it.	- Periodical monitoring of nutrient removal efficiency and maintenance (to remove withered reeds, or to replace the nutrient-accumulated bed soil) are necessary.

(5) Technical Aspect

The proposed dredging project is an extension and expansion of the current dredging project. The proposed vegetation purification is also a modification of the current measures for non-point source loads control. Therefore, there is no new technology in the proposed projects.

It should be noted that the vegetation purification method, not only this method but also most of methods for the non-point source load control, is not an established method. Since an importance of the non-point source load control in the pollution load control for lake environmental management has been recognized, there are many trials in the world. However, there is no method that is commonly accepted in its efficiency and effectiveness.

Therefore, the proposed vegetation purification should be considered as a pilot project to investigate more efficient and more effective methods. This will contribute to the environmental improvement of lakes in the world, as well as to Lake Balaton.

Table 4.1 List of Lake Environment Improve Methods with Its Applicability to Lake Balaton (Excluding methods aiming reduction of nutrients)

Aim of method	Methods	Comments	Applicability to Lake Balaton
Removal of Algae	Killing algae by algaecide	It was common in water source reservoirs for water supply. It is not preferable to dose chemicals to natural water at present.	Not applicable in its scale.
	Removal of algae by filtration of lake water	There were several trials to filtrate lake water by filtration facilities installed on a barge or located on the lake shore. Large scale operation would encounter difficulty in selecting proper filter media and treatment of removed algae sludge.	Not applicable in its scale.
Control of light	Spreading light shielding materials on water surface	It was common in water source reservoirs for water supply.(Activated carbon powder)	Not applicable in its scale. Not applicable because of its adverse effect to water uses
	Vertical circulation of lake water	Water is circulated by aeration or air lift pumps. Algae growth is controlled by passing deeper (dark) layer at certain intervals.	Not applicable because of its shallowness.
	Covering water surface by floating macrophyte.	This is observed in some tropical lakes which are covered by water hyacinth, causing difficulties in many water uses. Covering whole water surface may be difficult in the temperate and the sub-frigid zone	Not applicable because open surface is lost. Difficult due to its climate.
Control of retention time	Dilution water	To reduce retention time, dilution water is introduced. However, required time for algal growth is a few days, thus applicable case is limited.	Not applicable (longer retention time)
	Managing lake water level	To reduce retention time, water level is kept low. However, required time for algal growth is a few days, thus applicable case is limited.	Not applicable (longer retention time)
	Control of lake current	Causing change in lake currents by artificial methods, to reduce a retention time in limited zones in the lake.	Not applicable in its scale
Control of water temperature	Vertical circulation of lake water	Hypolimnion (low layer) water is supply to epilimnion (upper layer) to lower water temperature.	Not applicable. There is no thermal stratification.

Table 4.2 Methods of Nutrient Load Reduction

Load	Nature of Source	Point of Actions	Principals	Methods	Related activity or project in Lake Balaton catchment			Remarks
					Comple t-ed	On going	Propos-ed	
External	Point	Source	Reduction of load generation	Quantitative and qualitative regulation of industrial production				
				Encouraging phosphate free chemicals				
		Before reaching the lake	Reduction of load discharge	Development of sewerage system with phosphorous removal	x		x	
				Implementation of effluent regulations	x	x		Industrial wastewater and livestock discharge
				Diversion to other catchments	x			Diversion of sewage treatment plant effluent
	Non-point	Source	Erosion control	Landuse regulation	x	x		Protection of forest National park
				Covering exposed ground				
				Reduction of rainfall flush out	x			in Zanka
			Reduction of possible non-point sources	Control of illegal disposal of garbage and sewage				
				Control of storage of fertilizers				
		Before reaching the lake	Reduction of load discharge	Reduction of storm flush out by wetland or retention ponds	x		x	Kis-Balaton
				Reduction by sedimentation or other methods by construction of structural facilities	x		x	Kis Balaton and others sediment traps in small river
				Acceleration of natural purification functions by encouraging wetlands and macrophytes	x	x	x	Tapolca
Internal			Removing source	Dredging		x	x	Dredging of Keszthely bay
			Reduction of load from bottom sludge	Covering by inactive materials				

"x" indicates that activities or projects related to the method exist in the Balaton catchment in past, at present and in future.

Table 4.3 Summary of WQSM Calculation (Annual Maximum *Chla* Concentration)

Year	Case	Annual Max. Chlorophyll-a Concentration(μg/l)			
		Keszthely	Szeigliget	Szemes	Siofok
1994	Hindcast	222.3	151.3	137.4	112.7
	Case A1	219.0	151.1	137.4	112.7
	Case A2	222.1	151.3	137.4	112.7
	Case B1	185.7	125.4	120.4	95.1
	Case B2	189.8	149.8	137.4	112.7
1995	Hindcast	61.1	42.1	33.0	18.5
	Case A1	59.0	42.5	32.9	18.4
	Case A2	61.1	42.1	33.0	18.5
	Case B1	54.4	35.1	28.6	16.8
	Case B2	55.3	42.3	32.9	18.4

Legend:

Case A1: Phosphorus load reduction for all rivers

Case A2: Phosphorus load reduction for all direct runoff catchment areas

Case B1: Dredging of bottom sediment for all basins

Case B2: Dredging of bottom sediment for the Keszthely basins

Table 4.4 Comparative Evaluation of River Water Purification Methods

Method	Settling Reservoir Method	Coagulation Sedimentation Method	Anaerobic - aerobic Activated Sludge Method	Mixure of Coagulant and Activated Sludge Method	Soil Infiltration Method	Crystallization for Phosphorous Removal Method	Vegetation Purification Method
Principle of Purification	Lead river water to the settling reservoir and settle suspended solids by making very slow flow.	Remove phosphorous by chemical sedimentation; Mix a coagulant to river water and settle phosphorus.	Use nature of activated sludge activated sludge; in aerobic condition, activated sludge wants a lot of phosphorous in the cells.	To increase phosphorous removal efficiency, mix a coagulant to the aeration-tan of activated sludge method.	Infiltrate water through a soil to remove phosphorous by filtration and adsorption function of soil	Use a crystallization of hydro-oxi-apatite,which made from a reaction of phosphoric acid ion, calcium ion, and hydroxid ion.	Run water through reed pond to remove phosphorous by natural purification ability of emergent plants
Design Conditions	It is familiar in Europe as pre-settling reservoir of water purification plant, retention time is over 15 days.	Main system is composed of mixing coagulant pond, churning pond, settling pond, and sterilizer pond.	System is same as the activate sludge method.	System is same as the activate sludge method.	Example in Japan; infiltration velocity 3m/m2/day	Its need a pre-treatment system such as carbonic acid eliminati pond or sand infiltration pond. System is complex.	Example in Japan; water depth 0.1-0.2m velocity 0.5-1.0cm/sec lake length over 100m retention time 4-5hr
Removal Efficiency (%)	max 60 %	70-80%	60 -80%	90%	50%	60-80%	40-50%
Necessary Site Area	Large	Small	Small	Small	Smaller than vegetation purification method. but not so small as chemical method.	Small	Smaller than settling reservoir method. but not so small as chemical method.
Merits and Demerits	Simple system. Little impact to the environme Removal efficiency is lower than a chemical method. Regular removal of sediment sludge is necessary.	High removal efficiency. A lot of sludge is generated. Necessary site area is small.	It is difficult to make a good activated sludge by using river water.	Removal efficiency is high. It is rather difficult to make a good activated sludge by using river water. A lot of sludge is generated.	Efficiency strongly depends on a character of soil. It is necessary to experiment by using a soil around Lake Balaton.	Removal efficiency is not so high like a chemical method. There is no example to river water. Using no chemicals.	Simple system. No environmental impact Removal efficiency is not so high like a chemical method. It is necessary to cut and dispose a reed every year. It is necessary to remove sediment sludge regularly.
Construction Costs	Low	High	High	High	High	High	Low
O/M Costs	Low	High	High	High	Not so high like a chemical method. Almost same as vegetation purification method.	High	Medium
Applicability to Lake Balaton	Applicable because of using no chemicals and simple O/M, though a large site area is necessary.	Applicable because of higher removal efficiency and smaller site area though costs are higher and chemicals are used.	Not applicable because of higher costs and very few example applied to natural water bodies.	Not applicable because of higher costs and very few example applied to natural water bodies.	Probably Applicable But it is necessary to examine the efficiency by using soil around Lake Balaton.	Not applicable because of higher costs and very few example.	Applicable because of some examples around Lake Balaton Environmentally-friendly meth
Evaluation	○	○	×	×	△	×	○

Table 4.5 Design Water Flow and Design T-P Load of River Purification Facilities

Catchment Area	KOFE Code	River Name	Average Flow Rate (m^3/sec)	Design Flow (m^3/sec)	Design T-P load (mg/sec)	T-P load to be treated (kg/year)
North	E-1	Cinege patak	0.024	0.017	12.3	286.5
	E-2	Fuzfoi sed	0.018	0.070	4.3	100.4
	E-3	Vorosberenyi sed	0.052	0.370	21.2	476.7
		Lovasi sed	0.014	0.016	6.4	141.6
	E-4	Csopaki sed	0.006	0.007	3.7	89.2
		Aracsi sed	0.008	0.009	4.3	99.1
		Keki patak	0.032	0.170	7.4	161.2
		Szolosi sed	0.086	0.540	39.2	865.3
		Tavi(Aszofoi sed)	0.024	0.020	2.4	55.0
	E-5	Orvenyesi sed	0.056	0.060	4.4	97.7
	E-6	Csorszai patak	0.051	0.045	8.5	195.2
		Horogi sed	0.020	0.016	8.2	184.3
	E-7	Burnot patak	0.198	0.500	22.1	492.5
	E-8	Eger patak	0.156	0.350	23.6	548.8
	E-9	Tapolca patak	0.246	0.240	107.8	2,532.3
	E-10	Ketoles patak	0.018	0.016	7.3	162.8
		Vilagos patak	0.009	0.009	6.6	148.5
		Lesence patak	0.038	0.040	8.6	191.5
		Nemesvital ovarok	0.114	0.300	22.2	489.3
South	D-1	Endredi patak	0.054	0.070	8.7	203.3
	D-2	Koroshegyi sed	0.061	0.110	9.3	205.4
	D-3	Nagymetszes patak	0.188	0.500	95.8	1,954.0
	D-4	Tetves patak	0.171	0.720	84.2	1,817.5
		A-B-Ccsatorna	0.025	0.020	10.6	250.9
	D-5	Forro arok	0.014	0.012	13.1	300.2
		Jamai patak	0.080	0.135	6.6	148.4
	D-6	Keleti-Nyugati-Focsato	0.066	0.130	10.1	208.3
		Keleti bozot	0.482	1.130	836.3	17,447.9
	D-7	Nyugati ovcsatorna	0.428	1.010	643.6	13,222.0
	Pumping Station	Balatonfenyves	0.433	0.850	619.8	13,313.2
		Balatonlelle	0.100	0.263	14.6	423.1
		Ordacsehi	0.161	0.360	19.2	731.8
		Beletelep	0.037	0.230	32.8	219.6

Table 4.6 Cost Estimates for the Dredging

Procurement Cost

Basins	Equipment	Unit Price* (1000HUF)	Quantity	Amount (1000HUF)
Keszthely	Booster	205,500	1	205,500
Szigliget	Dredger	388,500	3	1,165,500
	Booster	205,500	2	411,000
Total				1,782,000

*: Price in 1998 and including pipeline to transfer dredged sediment to disposal site and other accessories

Operation Cost

Equipment	Items	Unit Price* (1000HUF/vessel)	Quantity**	Amount (1000HUF/year)
Dredger	Personnel	31136	4	124,544
	Fuel	34249	4	136,996
	Material	2768	4	11,072
	Others (inc. disposa	18401	4	73,604
Booster	Personnel	4670	3	14,010
	Fuel	34249	3	102,747
	Others (inc. disposa	10508	3	31,524
Total				494,497

*: Quantity of dredger includes one existing dredger.

**: Price in 1998

Table 4.7 Construction Cost for the Vegetation Purification Facility

KOFE Code	Name of River	Direct Construction Costs (1000 HUF)				
		Reed Pond	Gate and Screen	Retractable Gate	Inflow/Outflo Channel	Total
E-1	Cinege patak	4,472	33	6,390	140	11,034
E-2	Fuzfoi sed	17,886	65	6,390	515	24,856
E-3	Vorosberenyi sed	93,902	195	6,390	8,125	108,612
	Lovasi sed	4,065	33	8,520	140	12,758
E-4	Csopaki sed	1,829	33	6,390	94	8,345
	Aracsi sed	2,317	33	6,390	94	8,833
	Keki patak	43,496	98	21,300	2,080	66,973
	Szolosi sed	136,991	195	29,820	14,560	181,566
	Tavi(Aszofoi sed)	5,081	33	29,820	140	35,074
E-5	Orvenyesi sed	15,447	65	6,390	429	22,331
E-6	Csorszai patak	11,382	65	41,993	270	53,711
	Horogi sed	4,065	33	21,300	140	25,538
E-7	Burnot patak	126,828	195	6,390	13,728	147,141
E-8	Eger patak	89,024	195	29,820	8,125	127,164
E-9	Tapolca patak	60,975	130	29,820	2,704	93,629
E-10	Ketoles patak	4,065	33	8,520	140	12,758
	Vilagos patak	2,317	33	8,520	94	10,963
	Lesence patak	10,163	65	12,780	270	23,278
	Nemesvital ovarok	76,422	130	12,780	5,720	95,052
D-1	Endredi patak	17,886	65	12,780	515	31,246
D-2	Koroshegyi sed	28,049	98	21,300	1,105	50,551
D-3	Nagymetszes patak	126,828	195	21,300	13,728	162,051
D-4	Tetves patak	182,925	260	35,443	24,905	243,534
	A-B-Ccsatorna	5,081	33	6,390	140	11,644
D-5	Forro arok	3,049	33	6,390	94	9,565
	Jamai patak	34,553	98	37,594	1,664	73,908
D-6	Keleti-Nyugati-Focsator	33,333	98	21,300	1,664	56,395
	Keleti bozot	286,583	325	57,600	50,895	395,403
D-7	Nyugati ovcsatorna	256,095	325	68,600	42,926	367,946
Pumping Station	Balatonfenyves	215,852	325	68,600	31,460	316,236
	Balatonlelle	67,073	130	57,600	5,148	129,951
	Ordacsehi	91,463	195	62,442	7,800	161,900
	Beletelep	58,536	130	62,442	3,952	125,060
TOTAL		2,118,028	3,965	839,504	243,506	3,205,002

Table 4.8 Breakdown of Project Cost for the Vegetation Purification Facility

(× 1,000 HUF)

KOFE Code	Name of River	Land Acquisition Costs	Construction Costs			Operation Costs
			L/C portion		F/C portion	
			(1st year)	(2nd year)	(1st year)	(/year)
E-1	Cinege patak	1,440	8,484	0	2,550	805
E-2	Fuzfoi sed	4,320	22,306	0	2,550	2,290
E-3	Vorosberenyi sed	19,280	106,062	0	2,550	10,705
	Lovasi sed	1,360	9,358	0	3,400	760
E-4	Csopaki sed	920	5,795	0	2,550	513
	Aracsi sed	1,016	6,283	0	2,550	567
	Keki patak	9,360	58,473	0	8,500	5,125
	Szolosi sed	27,760	169,666	0	11,900	15,475
	Tavi(Aszofoi sed)	1,560	23,174	0	11,900	873
E-5	Orvenyesi sed	3,840	19,781	0	2,550	2,020
E-6	Csorszai patak	3,040	36,876	0	16,835	1,570
	Horogi sed	1,360	17,038	0	8,500	760
E-7	Burnot patak	25,760	144,591	0	2,550	14,350
E-8	Eger patak	18,320	115,264	0	11,900	10,165
E-9	Tapolca patak	12,800	81,729	0	11,900	7,060
E-10	Ketoles patak	1,360	9,358	0	3,400	760
	Vilagos patak	1,016	7,563	0	3,400	567
	Lesence patak	2,800	18,178	0	5,100	1,435
	Nemesvital ovarok	15,840	89,952	0	5,100	8,770
D-1	Endredi patak	4,320	26,146	0	5,100	2,290
D-2	Koroshegyi sed	6,320	42,051	0	8,500	3,415
D-3	Nagymetszes patak	25,760	153,551	0	8,500	14,350
D-4	Tetves patak	36,800	229,390	0	14,144	20,560
	A-B-Ccsatorna	1,560	9,094	0	2,550	873
D-5	Forro arok	1,160	7,015	0	2,550	648
	Jamai patak	7,600	58,885	0	15,023	4,135
D-6	Keleti-Nyugati-Focsator	7,360	47,895	0	8,500	4,000
	Keleti bozot	0	185,581	185,581	24,240	32,035
D-7	Nyugati ovcsatorna	0	168,773	168,773	30,400	28,660
Pumping Station	Balatonfenyves	43,280	142,918	142,918	30,400	24,205
	Balatonlelle	14,000	105,711	0	24,240	7,735
	Ordacsehi	18,800	135,300	0	26,600	10,435
	Beletelep	12,320	98,460	0	26,600	6,790
Subtotal		332,432	2,360,698	497,272	347,032	244,698
Engineering Service Cost		191,698				0
Contingency		186,457				12,235
Totoal Cost		3,915,588				256,933

Table 4.9 ImpNementation Schedule for Comprehensive Plan

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Vegetation Purificatio	Survey, Design, Contract Process	- - -	- - -	- - -								
	Cinege patak									———		
	Fuzfoi sed								———			
	Vorosberenyi sed			———								
	Lovasi sed				———							
	Csopaki sed						———					
	Aracsi sed					———						
	Keki patak						———					
	Szolosi sed					———						
	Tavi(Aszofoi sed)				———							
	Orvenyesi sed							———				
	Csorszai patak						———					
	Horogi sed							———				
	Burnot patak							———				
	Eger patak		———									
	Tapolca patak		———									
	Ketoles patak		———									
	Vilagos patak			———								
	Lesence patak			———								
	Nemesvital ovarok			———								
	Endredi patak									———		
	Koroshegyi sed									———		
	Nagymetszes patak				———							
	Tetves patak						———					
	A-B-Ccsatorna			———								
	Forro arok			———								
	Jamai patak								———			
	Keleti-Nyugati-Focsatorna		———									
	Keleti bozot			———	———							
	(Pogany volgyiviz)											
	Nyugati ovcsatorna		———	———								
	Balatonfenyves							———	———			
	Balatonlelle				———							
	Ordacsehi								———			
	Beletelep						———					
Dredging	Keszthely basin	———	———	———	———	———	———	———	- - -	- - -	- - -	
	Szigliget Basin	———	———	———	———	———	———	———	———	———	———	

Table 4.10 Project Costs by Year

(thousand USD)

Year	Investment Cost	Operation Cost
2001	9,342	1,348
2002	2,765	2,021
2003	3,537	2,561
2004	2,934	2,817
2005	1,086	3,093
2006	2,775	3,173
2007	2,042	3,344
2008	2,302	3,429
2009	520	3,632
2010		3,665

Table 4.11 Financing Plan by Year

(Thousand USD)

Year	Foreign Loan	Government of Hungary			Total		
		Investment Cost	OM Cost	Total	Investment Cost	OM Cost	Total
2001	8,828	514	1,348	1,861	9,342	1,348	10,689
2002	1,936	830	2,021	2,851	2,765	2,021	4,786
2003	2,476	1,061	2,561	3,623	3,537	2,561	6,098
2004	2,054	881	2,817	3,698	2,934	2,817	5,752
2005	760	326	3,093	3,419	1,086	3,093	4,179
2006	1,943	832	3,173	4,005	2,775	3,173	5,947
2007	1,116	926	3,344	4,270	2,042	3,344	5,386
2008	0	2,302	3,429	5,731	2,302	3,429	5,731
2009	0	520	3,632	4,152	520	3,632	4,152
Total	19,112	8,191	25,418	33,609	27,303	25,418	52,721

Table 4.12 Financing and Repayment Schedule

(Thousand US$)

Year	Borrowing[1]	Repayment[2]	Balance	Interest[4]	Debt Service
2001	8,828		8,828	318	318
2002	1,936		10,764	706	706
2003	2,476		13,239	865	865
2004	2,054		15,293	1,028	1,028
2005	760		16,053	1,130	1,130
2006	1,943	883	17,113	1,195	2,078
2007	1,116	1,076	17,153	1,235	2,311
2008		1,324	15,829	1,188	2,512
2009		1,529	14,299	1,086	2,615
2010		1,605	12,694	973	2,578
2011		1,800	10,895	850	2,650
2012		1,911	8,983	716	2,627
2013		1,911	7,072	579	2,490
2014		1,911	5,161	441	2,352
2015		1,911	3,250	303	2,214
2016		1,028	2,221	197	1,226
2017		835	1,387	130	965
2018		587	799	79	666
2019		382	417	44	426
2020		306	112	19	325
2021		112	0	4	116
2022		0	0	0	0
Total Amount	19,112	19,112	-	13,085	32,197

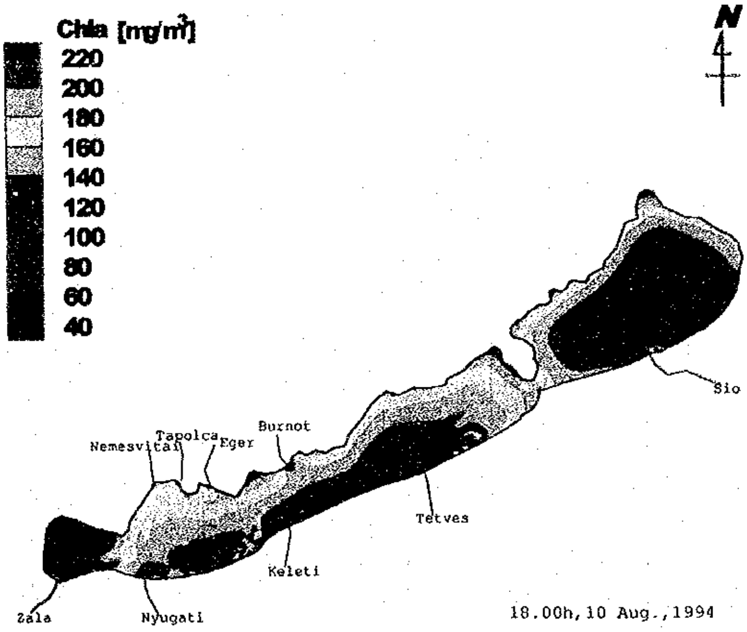
Assumptions: 1) Disbursement at middle of each year.
2) Starts after 5years of grace period. Repayment at middle of year.
3) Balance at the end of the year.
4) Semi-annually payment at 7.207% p.a.

Table 4.13 Cost Benefit Analysis (Base Case)

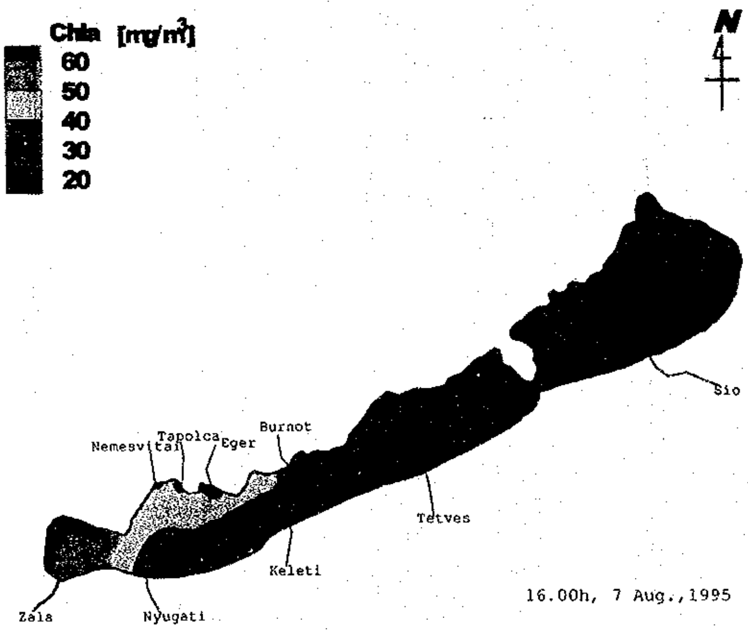
(Thousand US$)

(No.)	Year	Project Cost (C) Investment	Project Cost (C) Operation & Maintenance	Benefit (B) National WTP (Net)	Benefit - Cost (B) - (C)	Discounted Cash Flow (12%) Cost	Discounted Cash Flow (12%) Benefit
0	2001	9,342	1,348	0	-10,689	10,689	0
1	2002	2,765	2,021	932	-3,854	4,273	832
2	2003	3,537	2,561	1,865	-4,234	4,862	1,487
3	2004	2,934	2,817	2,797	-2,955	4,094	1,991
4	2005	1,086	3,093	3,729	-450	2,656	2,370
5	2006	2,775	3,173	4,662	-1,286	3,375	2,645
6	2007	2,042	3,344	5,594	208	2,729	2,834
7	2008	2,302	3,429	6,526	795	2,592	2,952
8	2009	520	3,632	7,459	3,307	1,677	3,012
9	2010	0	3,665	8,391	4,727	1,321	3,026
10	2011	0	1,886	8,400	6,514	607	2,704
11	2012	0	1,886	8,400	6,514	542	2,415
12	2013	0	1,886	8,400	6,514	484	2,156
13	2014	0	1,886	8,400	6,514	432	1,925
14	2015	0	1,886	8,400	6,514	386	1,719
15	2016	0	1,886	8,400	6,514	345	1,535
16	2017	0	1,886	8,400	6,514	308	1,370
17	2018	0	1,886	8,400	6,514	275	1,223
18	2019	0	1,886	8,400	6,514	245	1,092
19	2020	0	1,886	8,400	6,514	219	975
20	2021	0	1,886	8,400	6,514	196	871
21	2022	0	1,886	8,400	6,514	175	777
22	2023	0	1,886	8,400	6,514	156	694
23	2024	0	1,886	8,400	6,514	139	620
24	2025	0	1,886	8,400	6,514	124	553
25	2026	0	1,886	8,400	6,514	111	494
26	2027	0	1,886	8,400	6,514	99	441
27	2028	0	1,886	8,400	6,514	88	394
28	2029	0	1,886	8,400	6,514	79	352
29	2030	0	1,886	8,400	6,514	71	314
30	2031	0	1,886	8,400	6,514	63	280
31	2032	0	1,886	8,400	6,514	56	250
32	2033	0	1,886	8,400	6,514	50	224
33	2034	0	1,886	8,400	6,514	45	200
34	2035	0	1,886	8,400	6,514	40	178
35	2036	0	1,886	8,400	6,514	36	159
36	2037	0	1,886	8,400	6,514	32	142
37	2038	0	1,886	8,400	6,514	28	127
38	2039	0	1,886	8,400	6,514	25	113
	Total	27,303	83,778	285,544	174,463	43,724	45,448

EIRR 12.6150%
B/C 1.0394
NPV 1,724 thousand US$

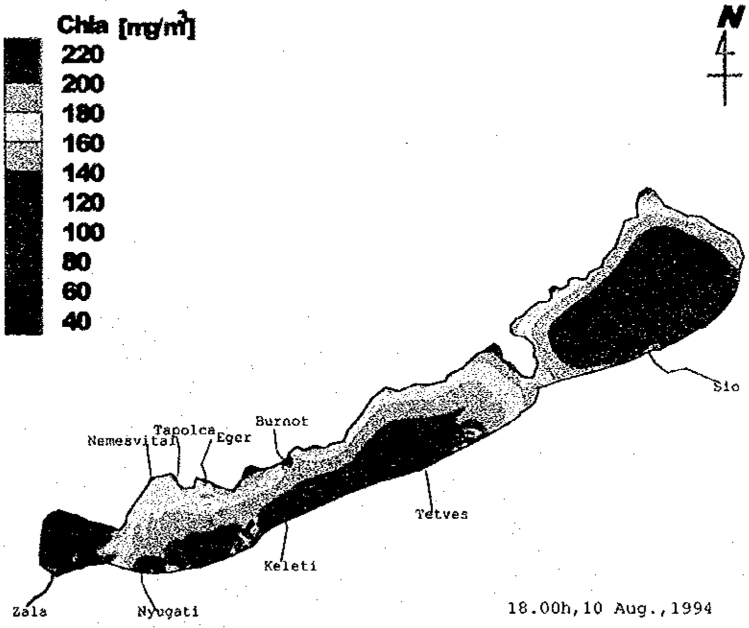


1994 Chla Hindcasting with 2-D Model

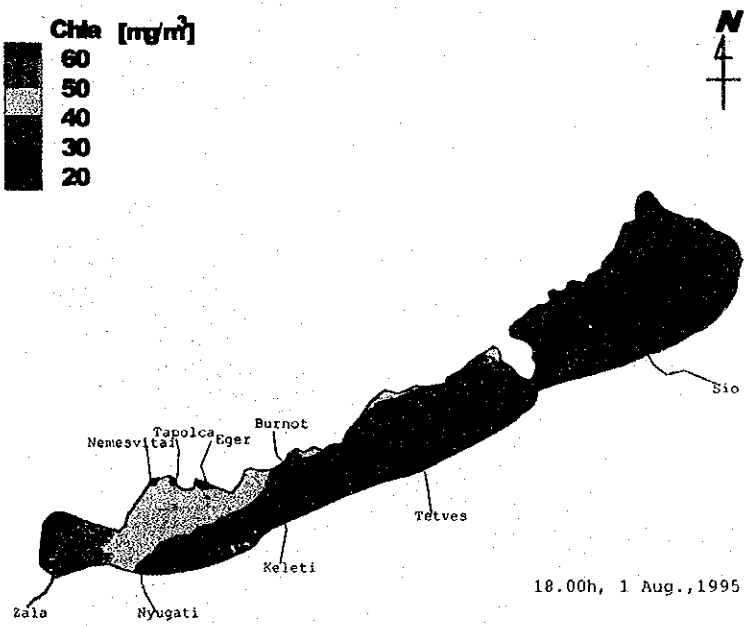


1995 Chla Hindcasting with 2-D Model

Figure 4.1 Hindcast of Annual Maximum *Chla* Concentration

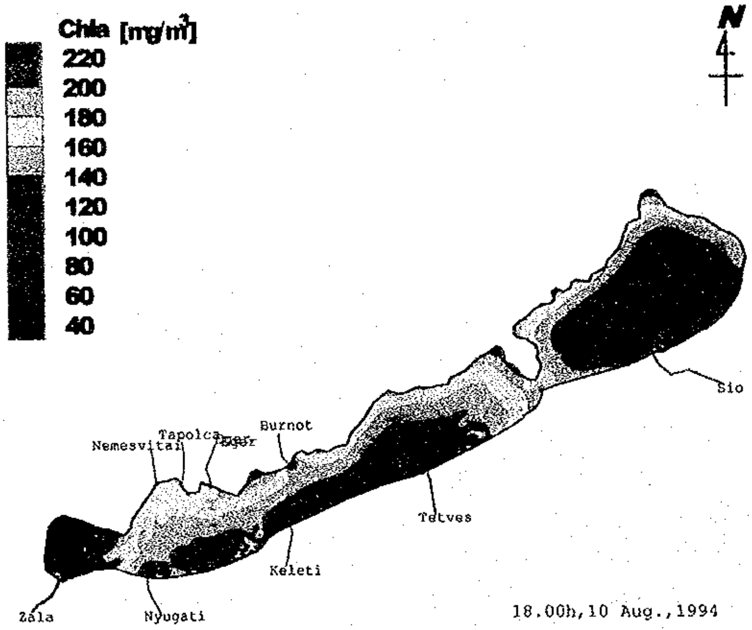


1994 Chla Response to 30% Reduction in River Loads

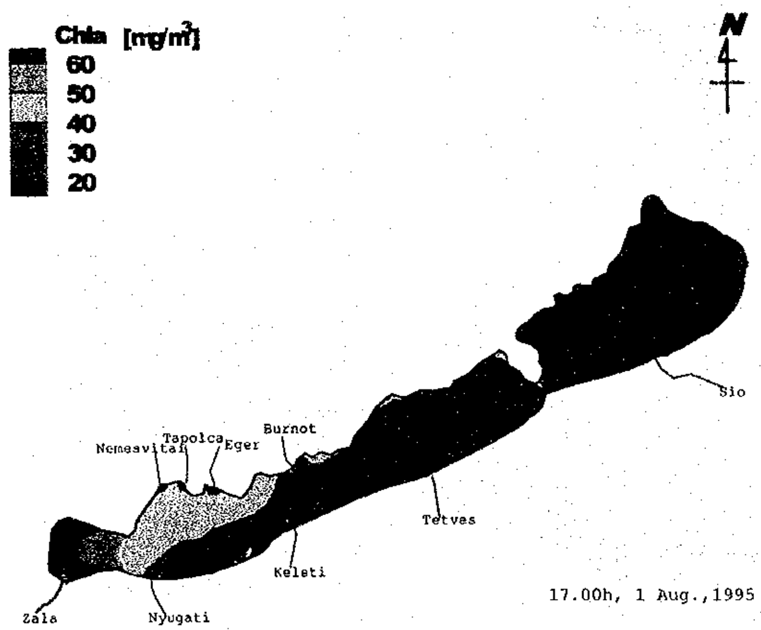


1995 Chla Response to 30 % Reduced Loads from Rivers

Figure 4.2 Prediction of Water Quality Improvement by Measures (Case A1)

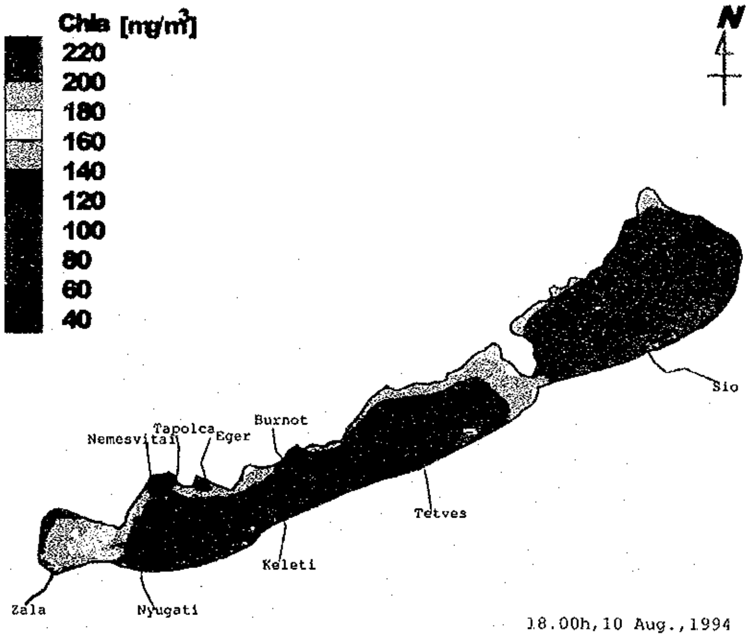


1994 Chla Response to 30% Reduction in Direct External Loads

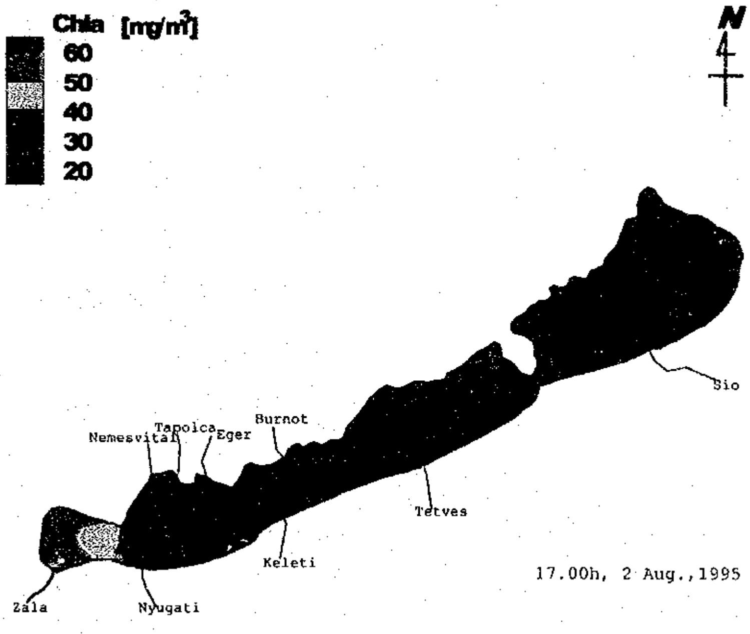


1995 Chla Response to 30 % Reduction in Direct External Loads

Figure 4.3 Prediction of Water Quality Improvement by Measures (Case A2)

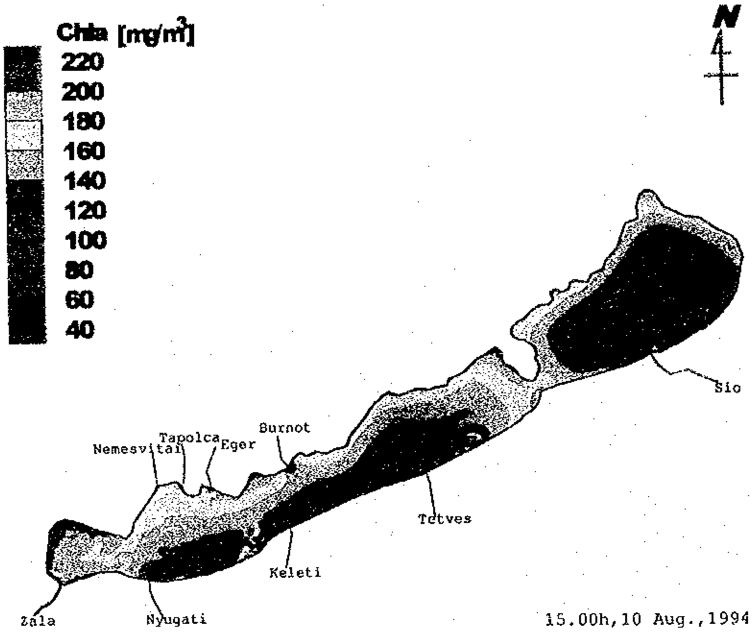


1994 Chla Response to 40% Reduced Internal Loads in All Basins

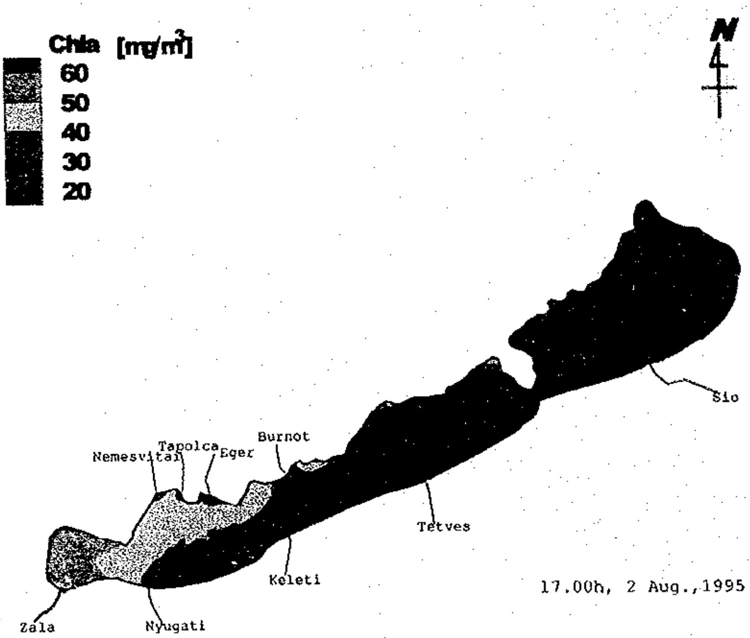


1995 Chla Response to 40% Reduced Internal Loads in All Basins

Figure 4.4 Prediction of Water Quality Improvement by Measures (Case B1)



1994 Chla Response to 40% Reduced Internal Loads



1995 Chla Response to 40% Reduced Internal Loads in Keszthely Basin

Figure 4.5 Prediction of Water Quality Improvement by Measures (Case B2)

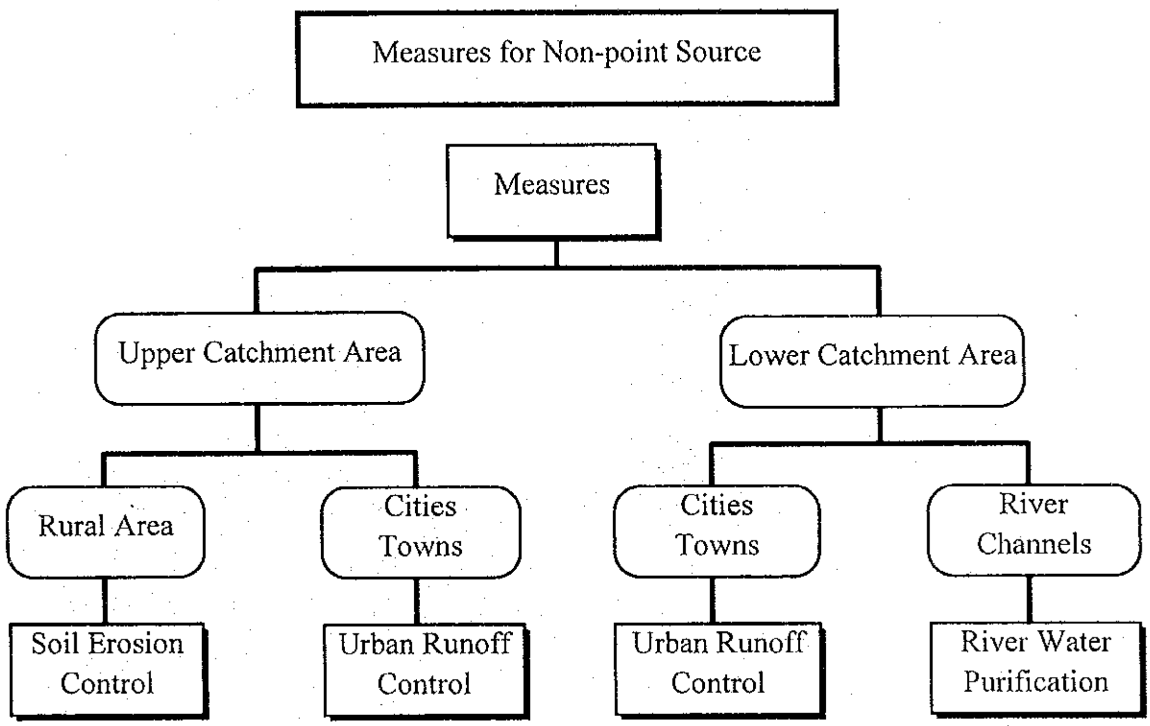


Figure 4.6 Classification of Measures for Non-point Pollution Sources

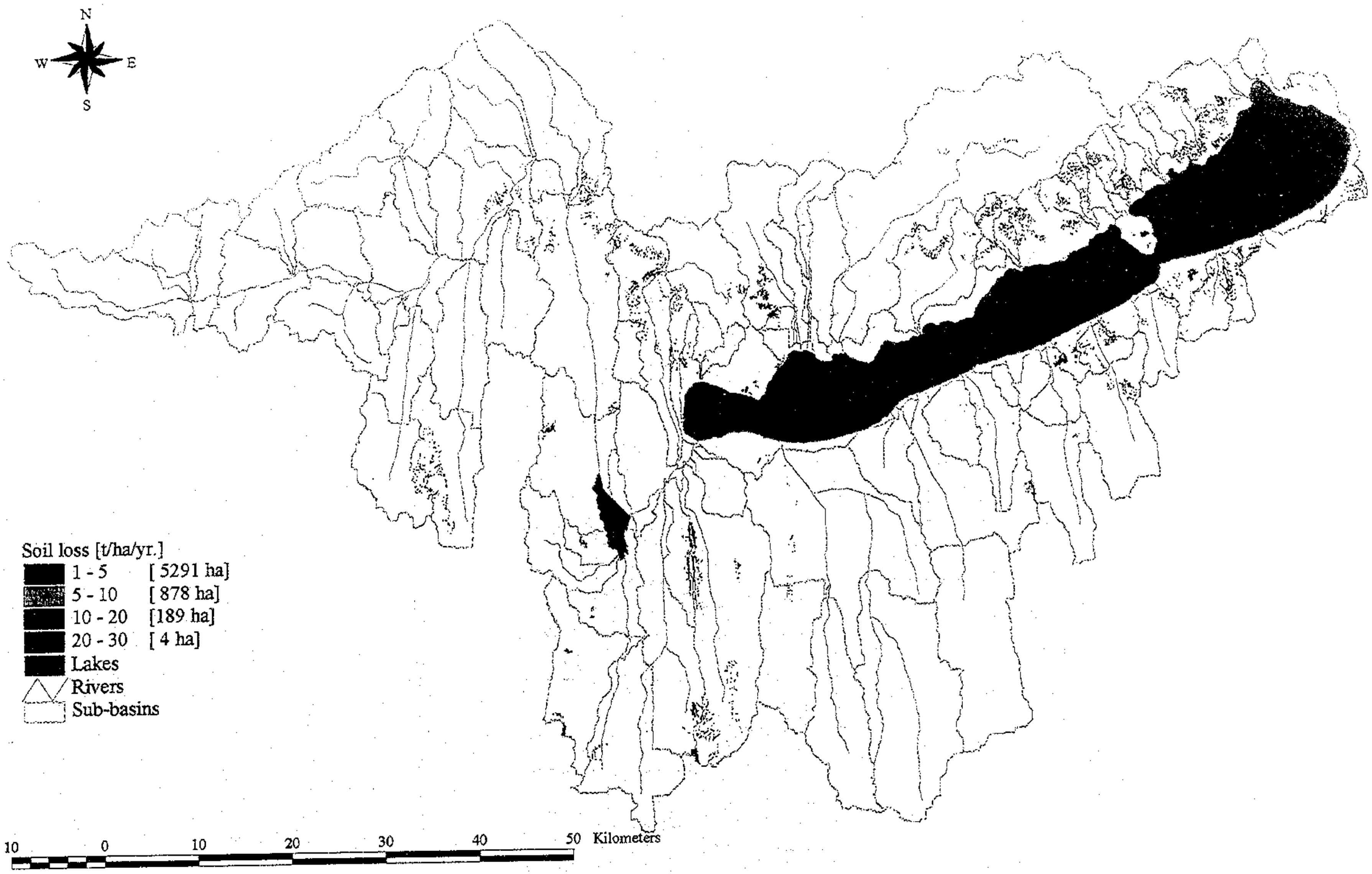
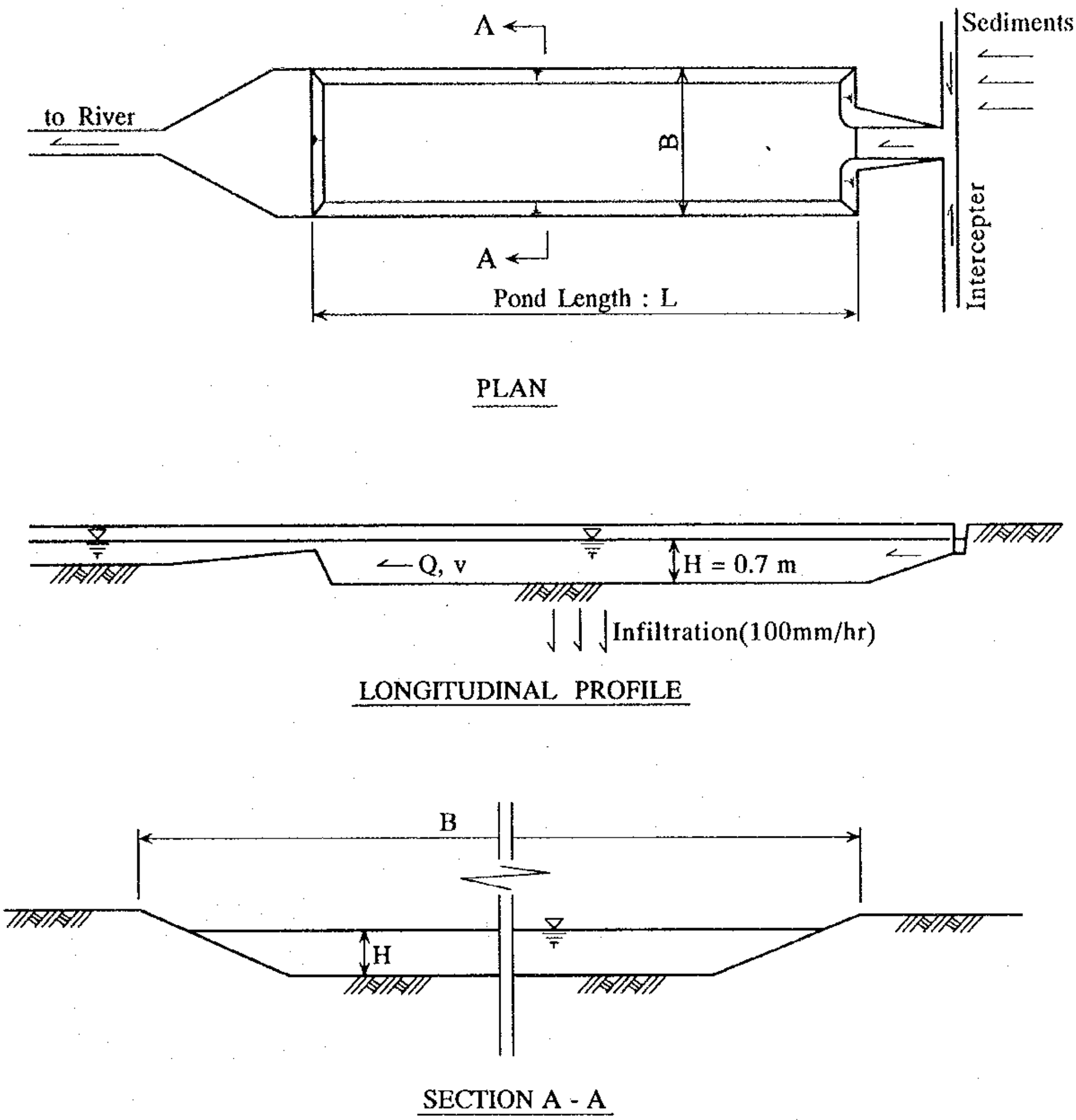


Figure 4.7 Proposed Erosion Control Areas

Source : Adapted from MTA-TAKI Data



Tentative calculation of the pond capacity :

Catchment area = 1 km², Rainfall intensity = 20 mm/hr, Q = 0.28 m³/s

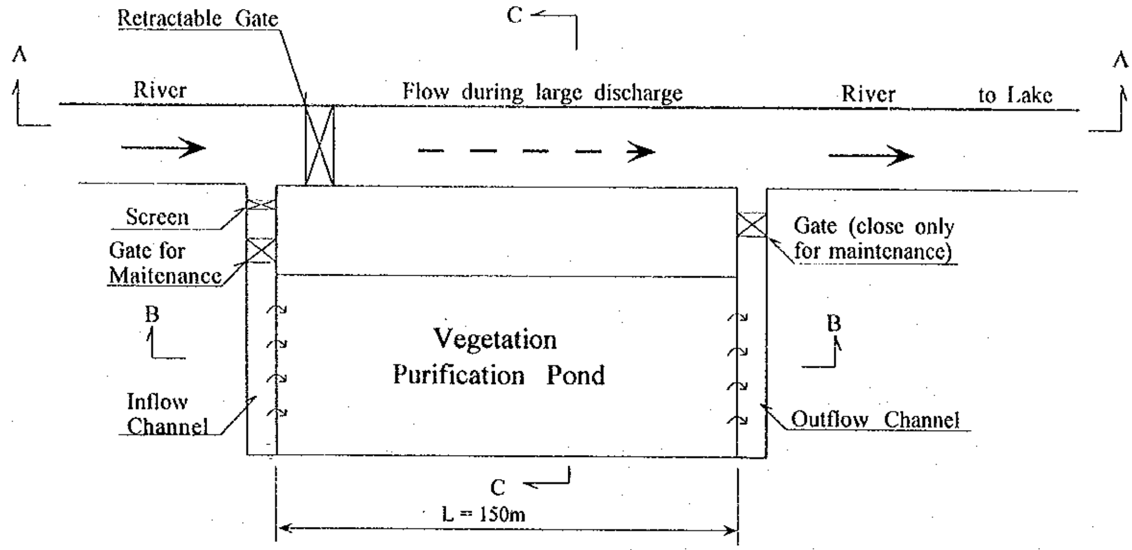
Run-off coefficient = 0.05, H = 0.7 m (assumed), B = 12.5 m (assumed),

Sedimentation rate = 0.07cm/s (d = 0.02 cm, 55% of sediment run-off), L = 40 m (v = 0.040 m/s),

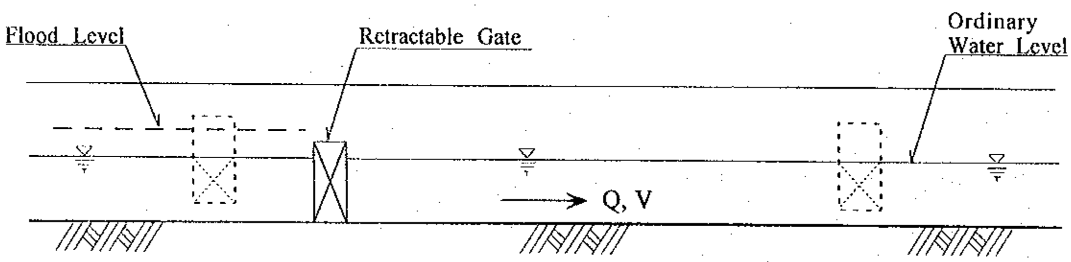
Infiltration = 100mm/hr x 10m x 40m = 40 m³/hr

Figure 4.8 Concept of the Soil Erosion Control Facility

Vegetation Purification Method

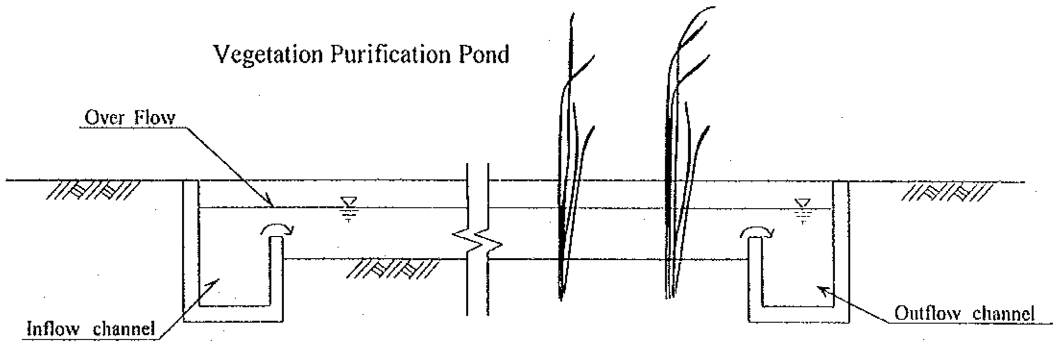


PLAN

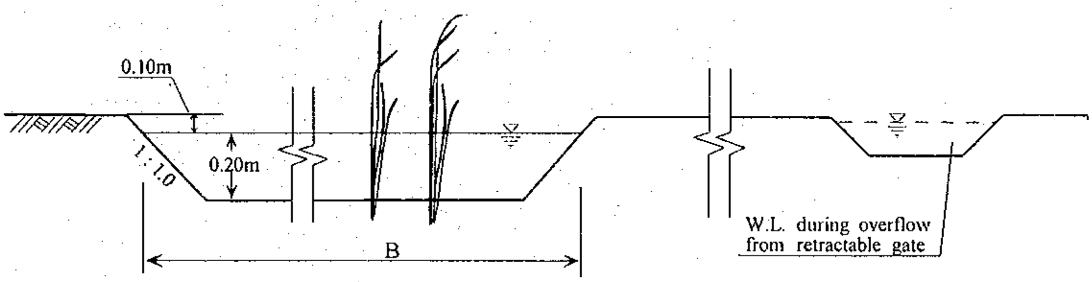


SECTION A - A

Figure 4.9 Typical Layout and Profiles of Vegetation Purification Facility (1)



SECTION B - B



SECTION C - C

Figure 4.10 Typical Layout and Profiles of Vegetation Purification Facility (2)

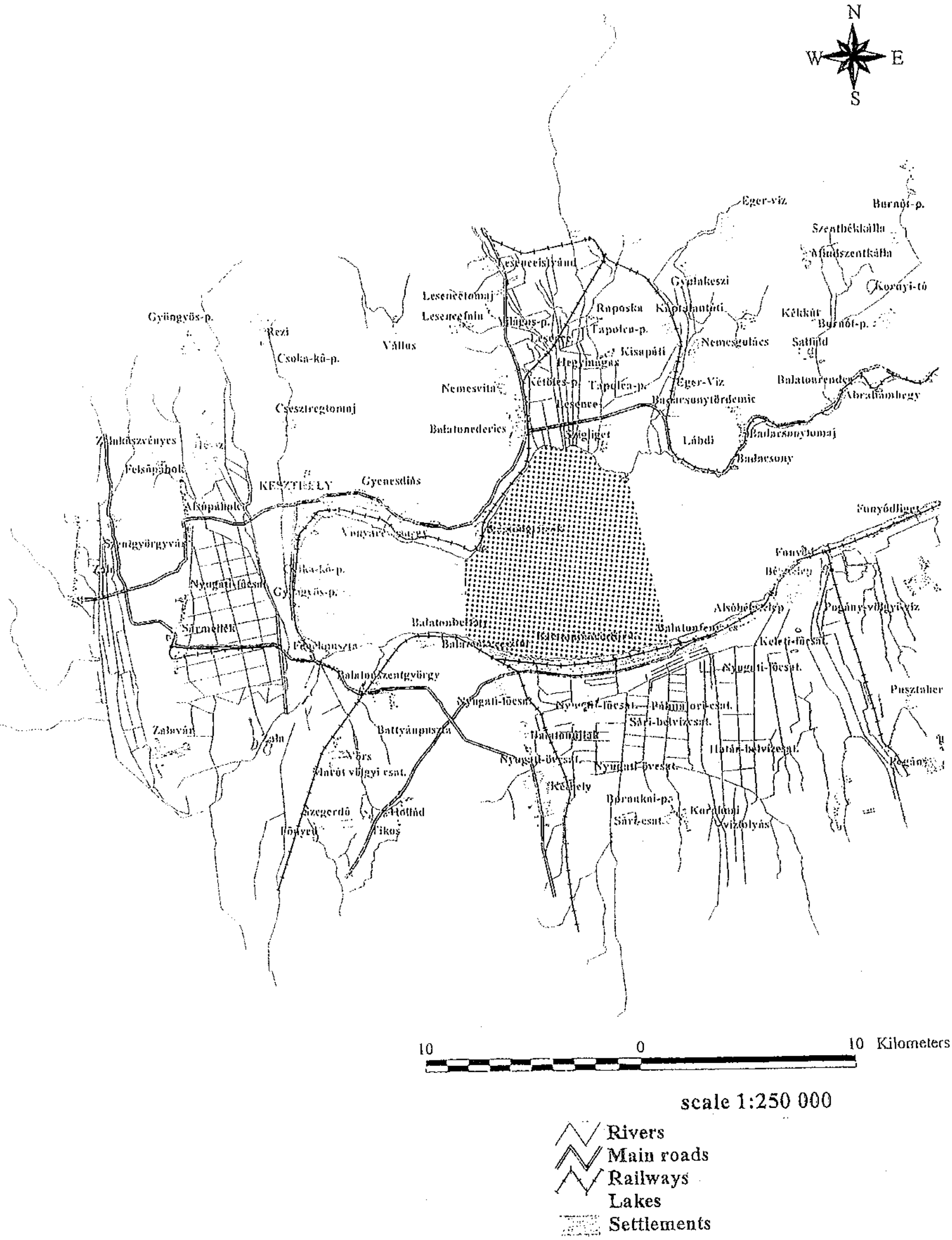


Figure 4.11 Planned Dredging Area from 2000 to 2010

CASE4 - wetlands; 3km; 106 - 115 m

ID-code	LU Code	Area (ha)
2	411	89.6
3	411	14.5
4	411	42.5
5	411	54.8
6	411	16.7
7	411	22.5
8	411	13.9
9	411	85.6
10	411	48.3
11	411	81.9
12	411	39.7
13	411	19.0
14	411	92.9
15	411	22.3
16	411	41.4
17	411	22.7
18	411	12.8
19	411	177.8
20	411	129.9
21	411	67.6
22	411	62.5
23	411	13.9
24	411	17.3
25	411	309.9
26	411	430.8
27	411	133.6
28	411	641.9
29	411	36.2
30	411	30.8
31	412	118.2
32	411	37.1
33	411	25.2
34	411	24.5

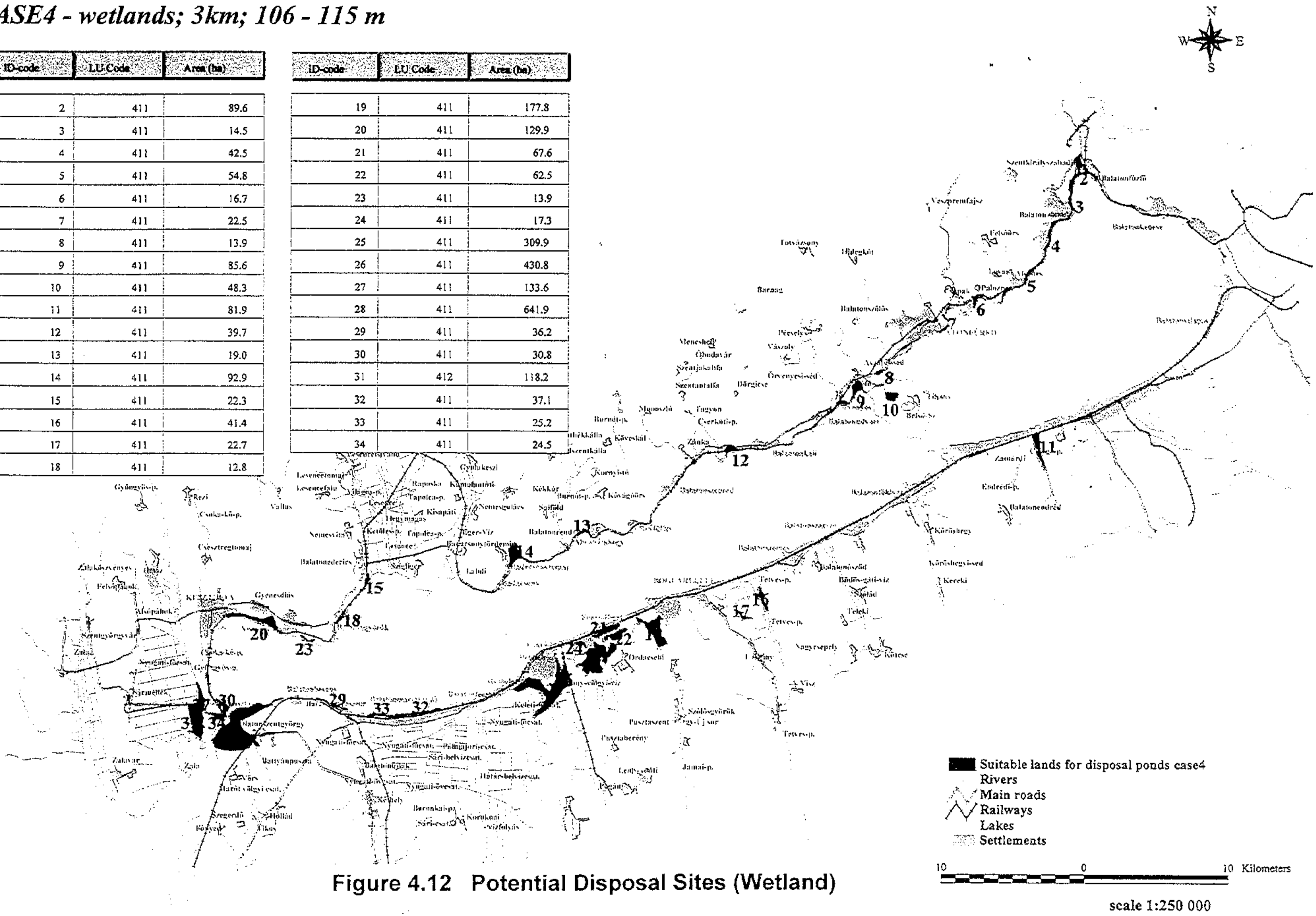


Figure 4.12 Potential Disposal Sites (Wetland)

CASE8 - agricultural area; 3km; 106 - 115 m

ID-code	LU Code	Area (ha)	ID-code	LU Code	Area (ha)	ID-code	LU Code	Area (ha)
2	211	18.7	33	231	177.7	64	211	41.0
3	221	9.1	34	221	42.3	65	231	26.0
4	211	75.1	35	211	10.9	66	211	524.8
5	221	41.9	36	211	9.1	67	211	34.1
6	242	40.6	37	221	64.9	68	242	12.0
7	221	19.0	38	231	146.5	69	231	303.5
8	211	16.8	39	211	10.7	70	231	305.0
9	211	94.4	40	221	19.1	71	211	73.3
10	211	64.6	41	221	36.8	72	211	328.1
11	221	35.5	42	211	18.0	73	221	26.2
12	231	148.1	43	221	146.2	74	211	88.7
13	211	75.8	44	231	779.7	75	231	29.3
14	231	41.2	45	211	30.5	76	211	168.0
15	231	28.7	46	211	70.5	77	211	11.0
16	211	50.1	47	231	209.0	78	231	13.8
17	211	66.9	48	221	35.9	79	231	27.2
18	221	22.5	49	231	22.0	80	231	14.8
19	231	36.2	50	231	169.1	81	243	49.0
20	222	81.2	51	211	108.9	82	231	144.2
21	221	17.3	52	211	64.5	83	231	31.2
22	231	142.1	53	211	24.0	84	231	32.3
23	211	92.1	54	221	132.2	85	211	50.9
24	231	12.8	55	221	18.3	86	231	206.9
25	211	26.4	56	231	24.6	87	231	728.9
26	221	32.8	57	211	46.9	88	211	57.8
27	231	36.9	58	211	96.8	89	211	13.5
28	231	30.2	59	231	425.0	90	211	293.1
29	211	40.8	60	242	51.5	91	211	27.2
30	231	17.5	61	231	119.3	92	221	13.8
31	231	9.8	62	231	25.2	93	211	87.4
32	211	17.4	63	211	15.1	94	211	60.3
						95	231	17.9
						96	211	9.3

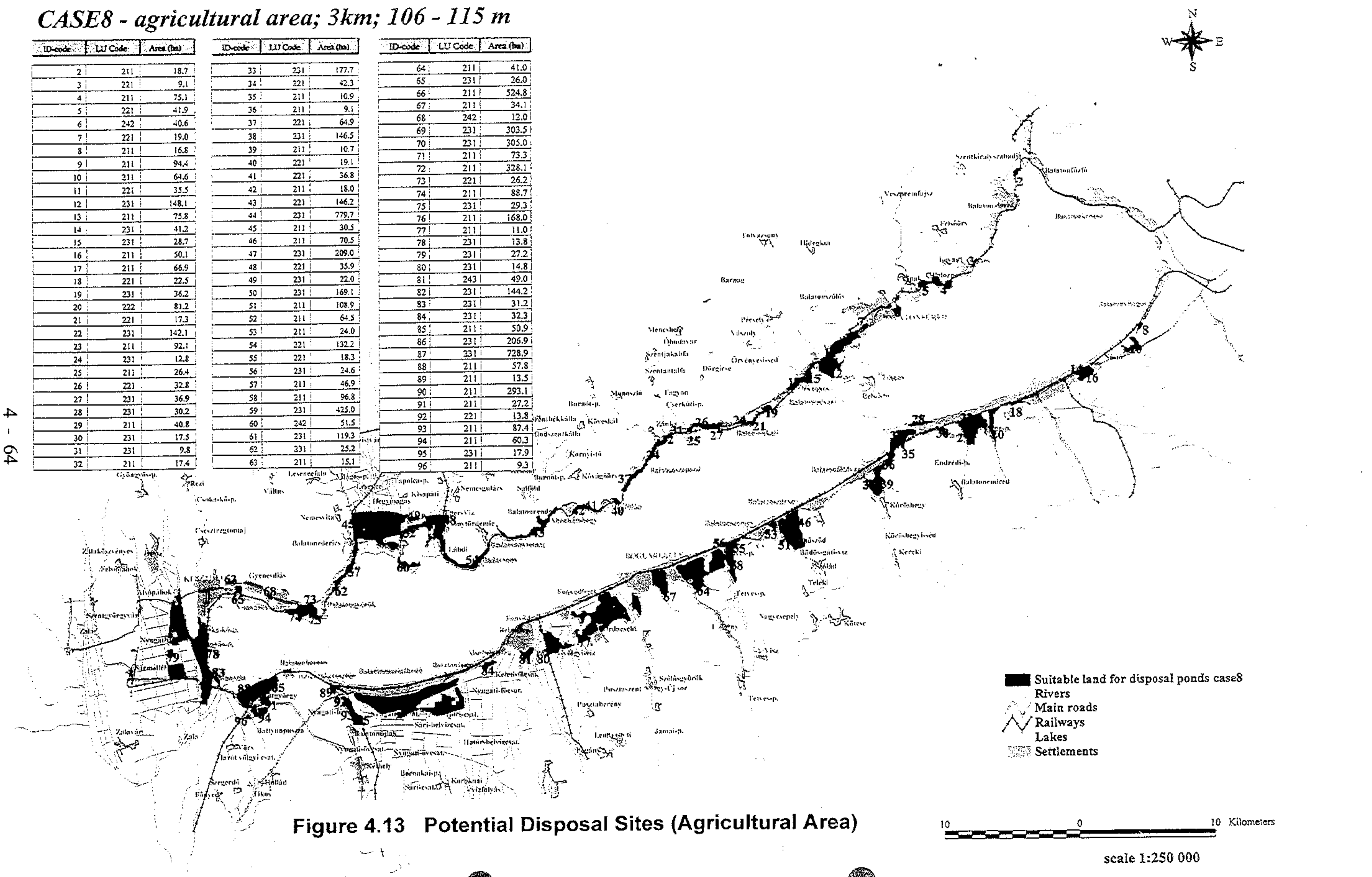


Figure 4.13 Potential Disposal Sites (Agricultural Area)

CASE12 - forest and sem-natural areas; 3km; 106 - 115 m

ID-code	LU Code	Area (ha)
2	311	13.1
3	324	24.6
4	311	19.1
5	324	141.5
6	311	17.8
7	311	14.0
8	311	412.3
9	311	30.6
10	311	167.2
11	311	192.6
12	311	21.7
13	311	43.0

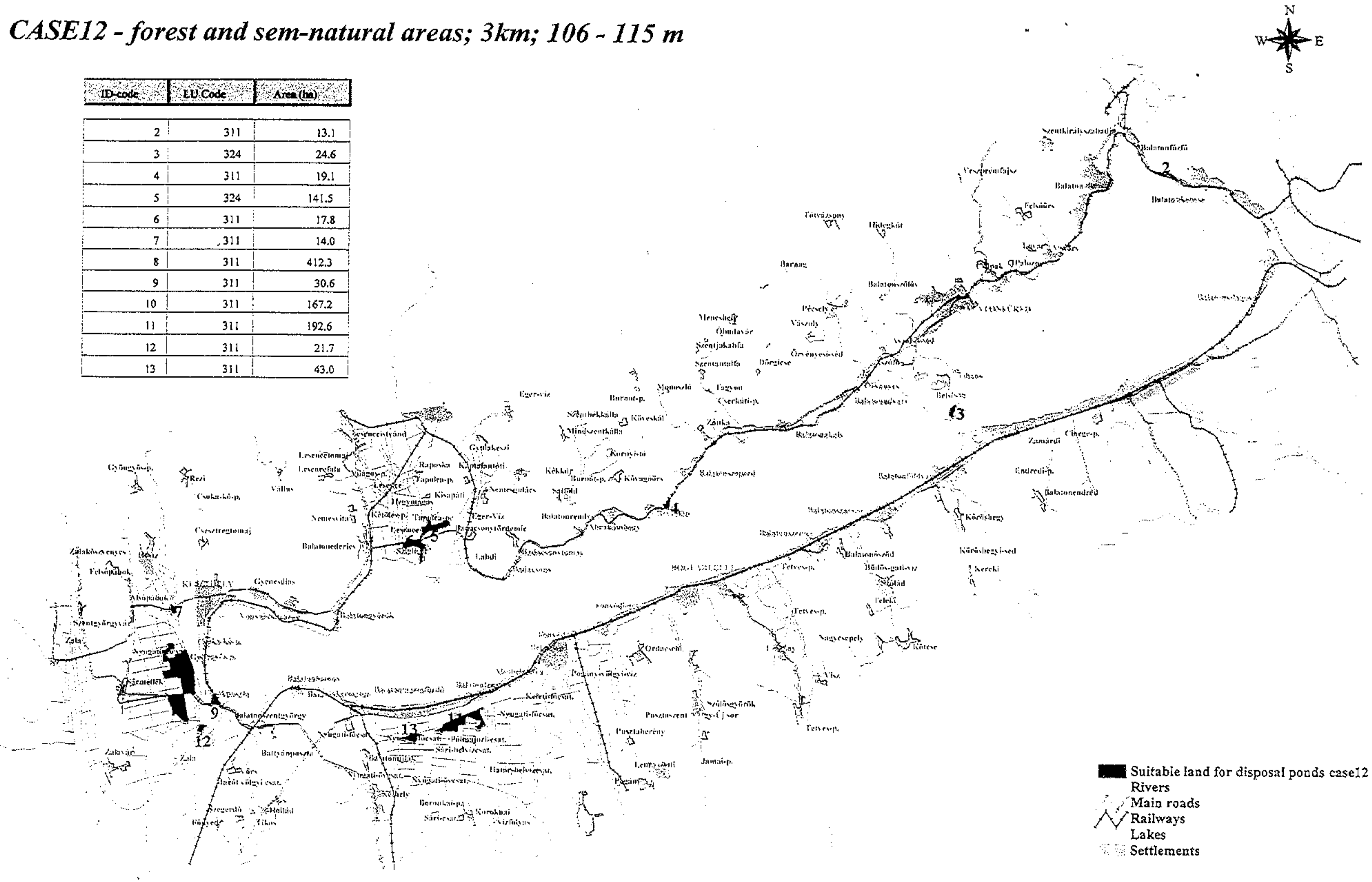


Figure 4.14 Potential Disposal Sites (Forest and Semi-natural Area)

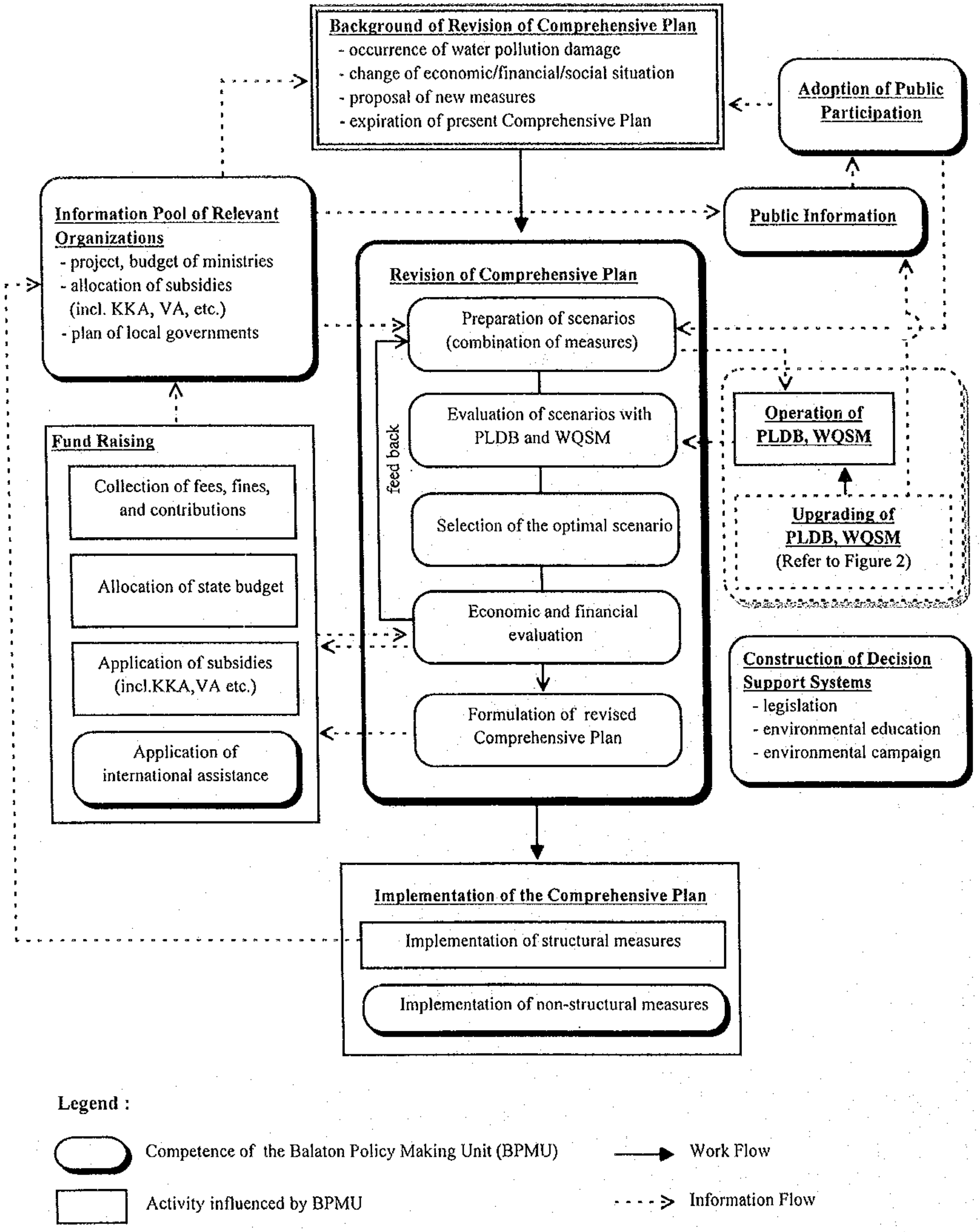


Figure 4.15 Schematic Diagram of Balaton Policy Making Process

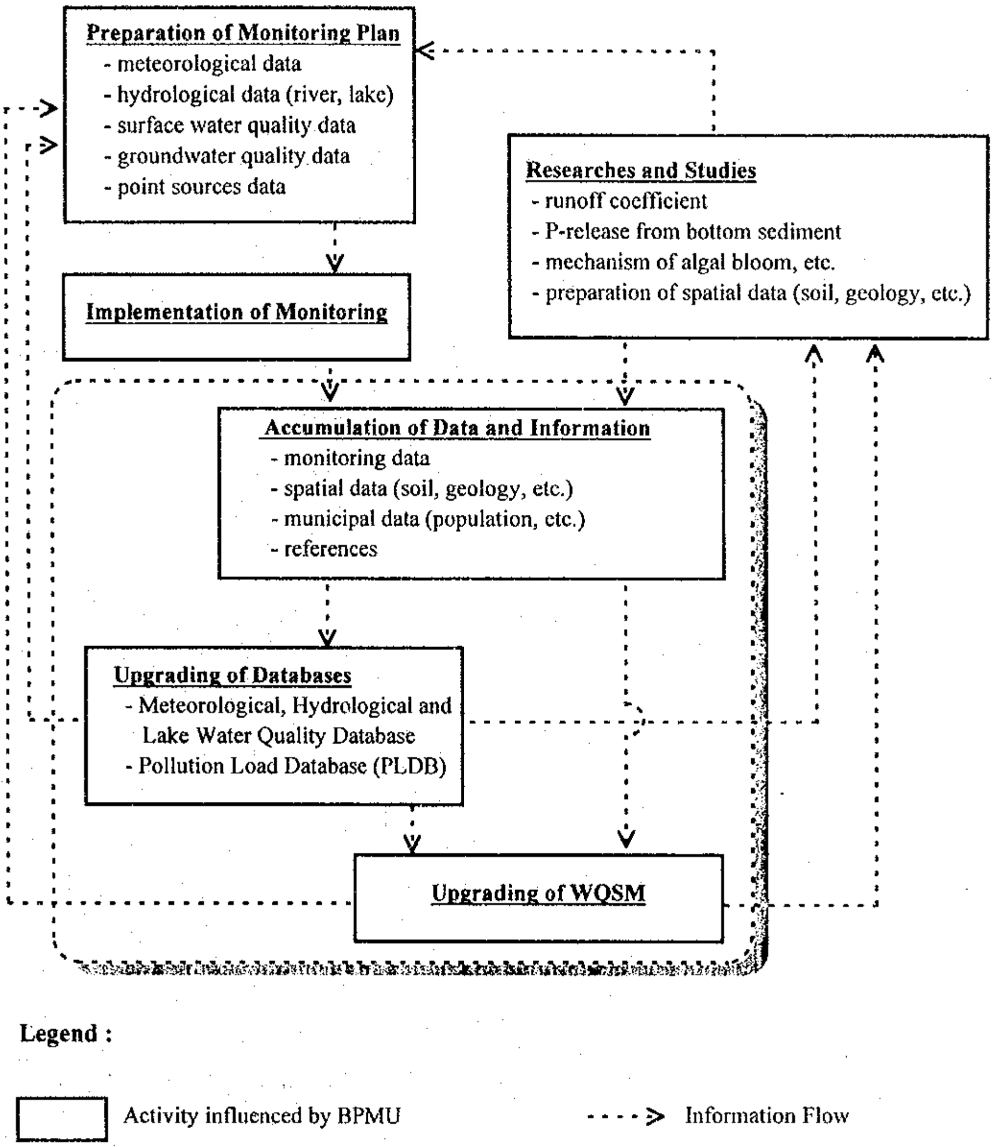
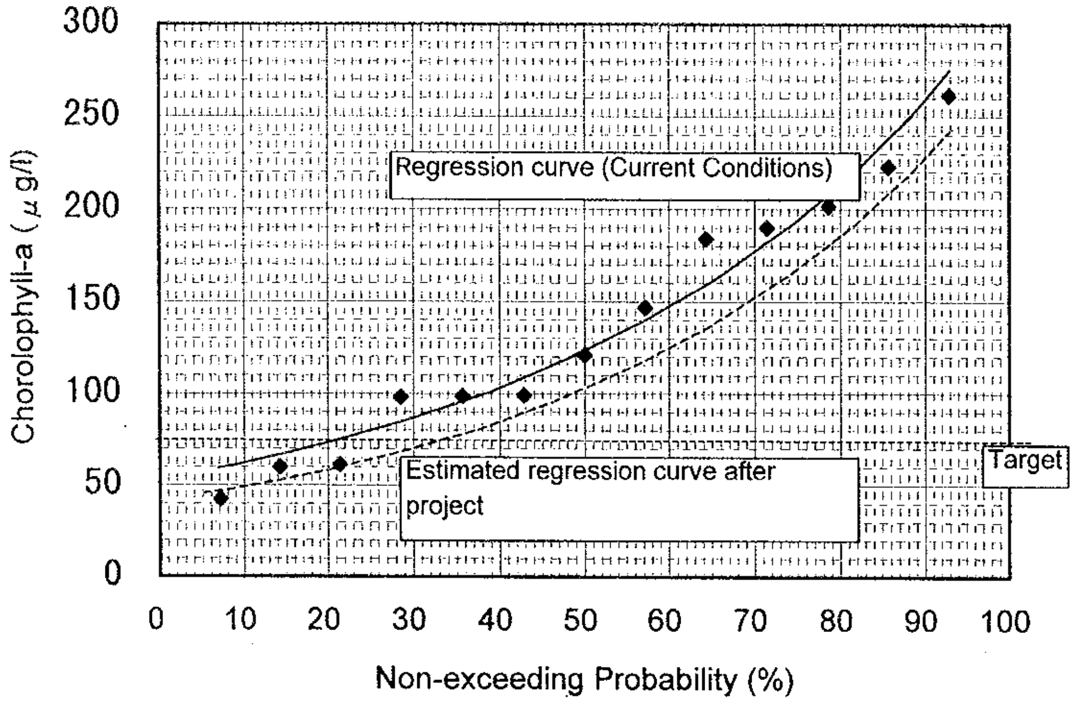
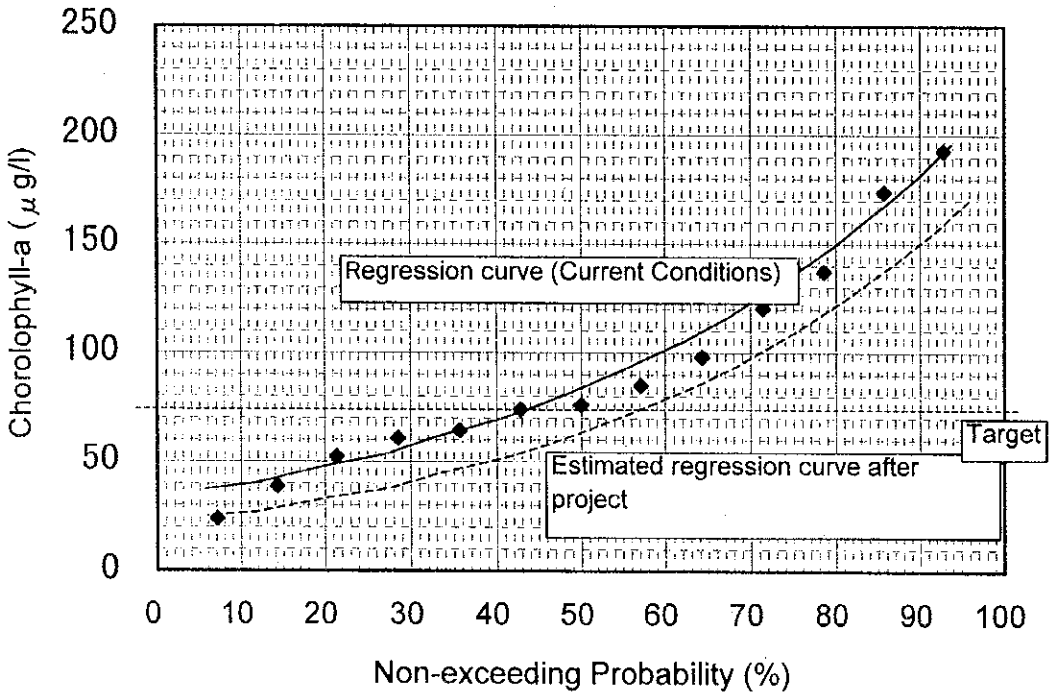


Figure 4.16 Flow Diagram of Operation of PLDB and WQSM



◆ Keszthely



◆ Szigliget

Figure 4.17 Water Quality Improvement Effect by the Project