DANUBE POLLUTION REDUCTION PROGRAMME

NATIONAL REVIEWS 1998
SLOVAKIA

TECHNICAL REPORTS

Part C: **Water Quality**
Part D: **Water Environmental Engineering**

MINISTRY OF ENVIRONMENT

in cooperation with the

Programme Coordination Unit
UNDP/GEF Assistance

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Preface

The National Reviews were designed to produce basic data and information for the elaboration of the Pollution Reduction Programme (PRP), the Transboundary Analysis and the revision of the Strategic Action Plan of the International Commission for the Protection of the Danube River (ICPDR). Particular attention was also given to collect data and information for specific purposes concerning the development of the Danube Water Quality Model, the identification and evaluation of hot spots, the analysis of social and economic factors, the preparation of an investment portfolio and the development of financing mechanisms for the implementation of the ICPDR Action Plan.

For the elaboration of the National Reviews, a team of national experts was recruited in each of the participating countries for a period of one to four months covering the following positions:

- Socio-economist with knowledge in population studies,
- Financial expert (preferably from the Ministry of Finance),
- Water Quality Data expert/information specialist,
- Water Engineering expert with knowledge in project development.

Each of the experts had to organize his or her work under the supervision of the respective Country Programme Coordinator and with the guidance of a team of International Consultants. The tasks were laid out in specific Terms of Reference.

At a Regional Workshop in Budapest from 27 to 29 January 1998, the national teams and the group of international consultants discussed in detail the methodological approach and the content of the National Reviews to assure coherence of results. Practical work at the national level started in March/April 1998 and results were submitted between May and October 1998. After revision by the international expert team, the different reports have been finalized and are now presented in the following volumes:

Volume 1:	Summary Report
Volume 2:	Project Files
Volume 3 and 4:	Technical reports containing: - Part A : Social and Economic Analysis - Part B : Financing Mechanisms - Part C : Water Quality - Part D : Water Environmental Engineering

In the frame of national planning activities of the Pollution Reduction Programme, the results of the National Reviews provided adequate documentation for the conducting of National Planning Workshops and actually constitute a base of information for the national planning and decision making process.

Further, the basic data, as collected and analyzed in the frame of the National Reviews, will be compiled and integrated into the ICPDR Information System, which should be operational by the end of 1999. This will improve the ability to further update and access National Reviews data which are expected to be collected periodically by the participating countries, thereby constituting a consistently updated planning and decision making tool for the ICPDR.

UNDP/GEF provided technical and financial support to elaborate the National Reviews. Governments of participating Countries in the Danube River basin have actively participated with professional expertise, compiling and analyzing essential data and information, and by providing financial contributions to reach the achieved results.

The National Reviews Reports were prepared under the guidance of the UNDP/GEF team of experts and consultants of the Danube Programme Coordination Unit (DPCU) in Vienna, Austria. The conceptual preparation and organization of activities was carried out by **Mr. Joachim Bendow**, UNDP/GEF Project Manager, and special tasks were assigned to the following staff members:

- Social and Economic Analysis and Financing Mechanisms:	**Reinhard Wanninger**, Consultant
- Water Quality Data:	**Donald Graybill**, Consultant,
- Water Engineering and Project Files:	**Rolf Niemeyer**, Consultant
- Coordination and follow up:	**Andy Garner**, UNDP/GEF Environmental Specialist

The **Slovakian National Reviews** were prepared under the supervision of the National Focal Point Coordinator, **Mr. Boris Minarik**. The authors of the respective parts of the report are:

- Part A: Social and Economic Analysis:	**Ms. M. A. Petrikova**
- Part B: Financing Mechanisms:	**Mr. David Luptak**
- Part C: Water Quality:	**Ms. Anna Zekeova**
- Part D: Water Environmental Engineering:	**Mr. Juraj Namer**

The Ministry of Environment

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Part C

Water Quality

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List of Abbreviations
on Water Quality and Quantity

BOD 5	Biochemical Oxygen Demands after 5 days
COD Cr	Chemical Oxygen Demand with Potassium Dichromate
COD Mn	Chemical Oxygen Demands with Manganese
DAS	Dissolved Anorganic Substances
DS	Dissolved Substances
NES	Non-Polar Extractable Substances
SS	Suspended Solids
TOC	Total Organic Carbon
Qa	Long Time Average Year Discharge
Qg	Guarantee Discharge
Q355	Water Discharge Guaranteed for 355 days in year
Qokamž	Instantaneous Discharge
DWQM	Danube Water Quality Model
PE	Population Equivalent
QA/QC	Quality Assurance and Quality Control
STN	Slovak Technical Standards
TNMN	Trans National Monitoring Network
VK	Public Sewage System
WWTP	Wastewater Treatment Plant
MB WWTP	Mechanical-Biological WWTP

List of Institutions
Dealing with Water Management Issues

Environmental Programme for the Danube River Basin
Programme Coordination Unit, Vienna International Center, Vienna, Austria

Ministry of Economy of the Slovak Republic
Mierova 19, Bratislava

Ministry of Environment of the Slovak Republic
Nám. Ľ. Štura 1, Bratislava

Ministry of Health of the Slovak Republic
Limbova 2, Bratislava

Ministry of Soil Management of the Slovak Republic
Dobrovičova 12, Bratislava

National Reference Laboratory for Water in the SR
Water Research Institute
Nábr. arm. gen. L. Svobodu 5, Bratislava

Research Institute of Soil Fertility
Gagarinova 10, Bratislava

River Basin Authorities:
for Danube River Basin – Bratislava
Váh River Basin - Piešťany
Hron - Banská Bystrica
Bodrog and Hornád – Košice

Slovak Hydrological Institute
Jeséniova 17, Bratislava

Slovak Water Management Enterprices
Banská Štiavnica

Slovak Water Management Inspection, Head Office
Novomestského 2, Bratislava

Water Research Institute
Nábr. arm. gen. L. Svobodu 5, Bratislava

1. Summary

1.1. Updating, Evaluation and Ranking of Hot Spots

Before the elaboration of the List of hot spots, the review of relevant documents, studies and projects performed up to now in the framework of the Danube Environmental Programme, such as National Review, Strategic Action Plan (SAP), Strategic Action Plan Implementation (SIP), Slovak National Action Plan (NAP) was carried out.

The List of „hot spots“ sites established in the framework of SAP includes 22 sites from the Slovak Republic (municipal agglomerations, industrial pollution sources and landfills). For 21 of them pre-investment studies were prepared. For SIP projects proposals were suggested in two stages (SIP1 and SIP2) and four of them were selected to a short list. Two of them were focused on the solution of point sources of pollution.

The Ministry of Environment of the Slovak Republic (MoE) included in the NAP a study focused on the pollution reduction in discharged wastewater. The „hot spots“ are ranked into 2 categories. The first category includes 19 pollution sources in the Danube River basin and takes into account national requirements as well. In the second category the highest priority is given to transboundary impact and it includes 17 pollution sources.

The Ministry of Soil Management of the Slovak Republic, which is responsible for the scope of activities in regard with municipal pollution sources, proposed to solve preferentially new sewerage and wastewater treatment plants (WWTPs) and WWTPs under construction in 13 cities. The majority of them are also on the List of MoE.

The Ministry of Economy of the Slovak Republic proposed to solve pollution sources considered as preferential.

The pollution sources in above-mentioned documents are listed in relevant chapters.

On the basis of data analysis and comparison, information and proposals included in the above-mentioned documents, it can be concluded, that they were selected on the basis of different criteria, application of which was not unified and systematic. It was quite difficult to rank a priority sequence. It is important to mention, that the National Review, the Strategic Action Plan have been elaborated several years ago and although the way of evaluation of point sources of pollution has not been altered significantly, part of the pollution sources is not included in the currently presented priority setting. One of the reasons is transformation of production programme in some factories and subsequently also alteration of discharged pollution. In the meantime, some of the pollution sources meet the Governmental Decree No. 242/1993 or are going to meet the Governmental Degree in a short time.

In order to exclude subjective aspect of pollution sources evaluation, the following approach to pollution sources selection in the Danube River basin was taken:

The initial database for updating of hot spots was created by using data on point sources of pollution during years 1990-96, which were registered in the State Water Management Balance (SWMB). In 1996 year 428 point sources of pollution were registered in SWMB, wastewater from which was discharged into rivers belonging to Danube River basin:

190 pollution sources from cities and municipalities
225 industrial sources of pollution
13 agricultural sources of pollution

It represented 1.102.465 mil. m^3 of wastewater, 25.074,3 $t.y^{-1}$ of BOD_5, 70.935,5 $t.y^{-1}$ of COD_{Cr}, 38.579,4 $t.y^{-1}$ of suspended solids, 580,9 $t.y^{-1}$ of NES (non-polar extractable substances) and 5490,1 $t.y^{-1}$ of $N\text{-}NH_4$. It is not possible to make balance of pollution from sources registered in SWMB because of incompleteness of data on total N, total P, heavy metals and specific organic pollutants. The database of pollution sources from SWMB was analyzed in accordance with amount of emissions to define introductory group of point sources of pollution. In the introductory group were included sewerage of cities and municipalities under administration of waterworks, industrial and agricultural sources with emissions larger than 40 $t.y^{-1}$ of BOD_5 and also industrial and agricultural sources, which affect receiving water body significantly by specific pollution (heavy metals, etc.) in spite of emissions lower than 40 $t.y^{-1}$ of BOD_5. Apart from that, each pollution source was evaluated from the point of view of water management permission, which is issued in compliance with the Governmental Decree No. 242/1993. If the pollution is in compliance with the Governmental Decree, the source of pollution was excluded from the list. Also small effluents lower than 10 $t.y^{-1}$ of BOD_5 were excluded. Pollution sources, which were temporarily discharging higher pollution (so called exceptions), were evaluated individually. This way the introductory group of 184 pollution sources was reduced to 82 sources of pollution. They were used in the priority setting by using multi-criteria analysis, illustrated in the Annex 2.1. *„Criteria for evaluation of the urgency of WWTP construction“*, which is based on a score system. The pollution sources were ranked on the basis of a score number into priority sequence, which is increasing with increasing score number. The summaries are in the tables *„Order of Urgency for Solution of Municipal Hot Spots”* and *“Order of Urgency for Solution of Industrial Hot Spots”* (Table 2.5. and Table 2.6.). Including some of the pollution sources covered by SAP is out-of-date either because they were already solved, or their solution is under process in present e.g. Re-loading Railway Station Čierna n. Tisou, Sliac Airfield, Red Mud Deposit from the “ZSNP“ Aluminium Factory in Žiar nad Hronom.

On the basis of described procedure agricultural point sources did not fall into reduced group of 82 pollution sources.

The list of „hot spots“ in Slovak Republic in the Danube River basin includes top 10 from the list of municipal sources of pollution and top 10 from the list of industrial pollution sources (Table 2.16. and Table 2.17.). They represent emission sources, which should have been solved preferentially in dependence on accessible technical and financial sources because they are important pollution sources from both, the national and transboundary impacts on the water quality. Based on this top list the analyses of impact on rivers and use of water, data on wastewater treatment and current issues with proposal of necessary measures were elaborated. The processed data are in relevant tables.

1.2. Updating, Analysis and Validation of Water Quality Data

Surface water quality monitoring was set up in 1963 year. With increasing number of substances of interest and analytical methods development also number of monitored water quality determinants was gradually increasing. The surface and groundwater quality and quantity monitoring is in the scope of activities covered by the Ministry of Environment of the Slovak Republic. Nowadays, surface water quality is monitored in 243 sampling sites belonging to the Danube River basin (1997 y.). The surface water quality is evaluated in accordance with Slovak Technical Standard STN 75 7221 *„Classification of Surface Water Quality“*. The data are evaluated on a yearly basis and published in a yearbook *„Surface Water Quality in Slovak Republic“*.

The Slovak Hydrometeorological Institute (SHMI) is responsible for the surface water quality monitoring in the Slovak Republic. Sampling and analytical measurements are realized on the basis of contract between SHMI and Slovak Water Management Authority, actually by its four river basin authorities.

Slovak Hydrometeorological Institute defines to the laboratories requirements on the detection limit values for water quality determinants (which should correspond to 10% of limit value set up for I. class of water quality in accordance with Slovak classification system) and requirements on using of the standardized methods. The laboratories have also an obligation to provide information about quality system established in laboratory.

The laboratories send data to SHMI in defined structure and units (codes of river basins, rivers, sampling sites, determinants and analytical methods are unified). Apart of data control by laboratories, control is also performed by SHMI. Data needed to be checked (outliners, data which don’t conform to general pattern of a data set) are consulted with representatives of the laboratories. After checking the data are recorded into database system MAGIC and are archived. Also secondary data concerns sampling location, time and date of sampling, analysis methods, etc. are stored. Statistical analyze of data is performed by computerized processing. Limit of detection value is used for statistical treatment in cases when value below detection limit was measured.

The laboratories of River Basin Authorities have developed their internal QA/QC system. Except for the Hron River Basin Authority, the laboratories are under the accreditation process, realized by Slovak National Accreditation System. The Hron River Basin Authority is planning to start with this process during a year 1998. In the Danube River Basin Authority and the Vah River Basin Authority persons responsible for quality management are already set up. Quality manuals are under preparation process in the Danube River Basin Authority, the Vah River Basin Authority and the Bodrog and Hornád River Basin Authority.

Standardized methods are used exclusively to analytical measurements of surface water samples in each laboratory. The results are well documented and archived. Documentation on maintenance of equipment and calibration is registered in logbooks. Principles of storage and maintenance of used chemicals are set up by each laboratory. Control and documentation in regard with the chemicals are performed by responsible persons.

Surface water sampling, transport conditions, sample conservation and storage before analytical measurements are in accordance with Slovak Technical Standard STN 83 0530. Standardized sampling protocols are filled in during the sampling process.

The type of sampling bottle and cleaning procedure is set up for different types of analyses.

Internal quality control is ensured using control charts and analysis of control samples (blanks, spiked samples, replicates) in participating laboratories.

External quality control is realized by participating of laboratories in between-laboratory performance testing, which is organized mainly by National Reference Laboratory for Water in the Slovak Republic. The National Reference Laboratory for Water is also the methodological center for quality assurance of water and water related media analyses and is a part of Water Research Institute in Bratislava. Between-laboratory performance testing is organized in accordance with standards valid in European Union.

Great importance is given to continuous increasing of staff qualification in laboratories. The information on completed training courses or studies creates a part of personal documentation of the laboratory staff.

In addition to national surface water quality monitoring network monitoring of transboundary rivers with neighboring countries is realized. The selection of sampling sites, sampling frequency, analytical methods used and method of evaluation depend on the common agreement of country representatives. The data on water quality in transboundary sampling sites are also accessible. If they are required, it will be necessary to take into account its specific character in the data assessment process. Their use should have been bound to agreement of both involved countries.

With purpose to get information on human activities impact on environment and on quality of human living „Danube Water Quality Model“ is under preparation, which is to be served for assessment of transboundary pollution impact and also as a tool for water management planning.

With purpose to municipal and industrial hot spots impact assessment and for water quality management by using this model data on surface water quality from sampling sites situated above and below pollution sources in years 1994-96 (in some cases in 1997 y.) can be used. These sampling sites are listed in relevant tables of chapter 2.

For evaluation and balance of pollution out flowing from the Slovak Republic by using this model the water quality data of the Danube River entering and flowing off the Slovak Republic and its tributaries are accessible for years 1994-97. Selected water quality determinants are in Tables Water Quality in the Main Check Points in 1994-1997 as the minimum, maximum and mean values.

As one of the activities of the Danube Environmental Programme TNMN (Trans National Monitoring Network) was established, in the framework of which the water quality data from selected sampling sites in Danube River basin countries are collecting. The data are sent from involved countries in agreed extent and in the defined structure. This activity is coordinated by the same Programme and with purpose to avoid the duplicity it is therefore not mentioned in this section in a larger extent.

GEF - Danube River Basin Pollution Reduction Programme is focused on the pollution reduction in the Danube River Basin and on reduction of its negative impact on both the Danube Delta and Black Sea. One of its main purposes is reduction of eutrophication processes in Black Sea. In regard to these purposes determinants of interest such as BOD5, CODCr, total nitrogen (or other nitrogen forms), total phosphorus, heavy metals, oil and other hazardous chemicals were selected.

It is necessary to say that the frequency of surface water analyses on heavy metals, organic pollutants, total N, total P and some other determinants content is lower in some cases, and evaluation in accordance with STN 75 7221 is therefore not possible. It is supposed to be a disadvantage in the process of water quality simulation.

Another important disadvantage regarding the input of the data for water quality simulation is the lack of information concerning discharged nutrients amount from point sources of pollution, such as total N and total P. The current legislation does not require its monitoring. The New Water Act with related regulations are under preparation process now. They are preparing in accordance with EU Directives, in which monitoring of discharged nutrient is required.

Information concerning nutrient balance in Danube region was published in Final Report “Nutrient Balances for Danube Countries“, which was elaborated in the frame of the Danube Environmental Programme - Applied Research Programme. To obtain more exact data was not possible, because of lack of information about effluent discharges from the point of view of nutrients. Data concerning diffusion pollution are not available on better basis than published in this report. Emissions of Slovakia into Danube River Basin were estimated as follows: 59 kt/y N and 5 kt/y P. The statement concerning estimation of nutrient emissions in this report was prepared on the basis of information of the experts from wastewater treatment branch and research institutions.

2. Updating of Hot Spots

The Environmental Programme for the Danube River Basin (EPDRB) conceived in Sofia in September 1991 and started in 1992, following agreement between its parties, Danubian countries and European Union.

Programme consists of two parts:

- first one is focused on collection of data and information, which monitors environment state
- second one is oriented to realization of the measures, which will lead to improvement of environment, mainly Danube water quality and following Danube Delta and Black Sea.

The first document in the frame of the EPDRB in Slovakia was “The National Review”, March 1994. It is focused on data and information about individual components of environment in the Slovak Republic according to river basins.

Chapter III proves by evidence point sources of pollution, nutrient outflow from arable agricultural land by wind and water erosion, waste disposals and water structures. Data are valid for the time of “The National Report” preparation, maximum till year 1991. In consequence of cogent changes ensued from the transformation of economy, substantial part of data does not represent reality.

“The Strategic Action Plan“ (SAP) elaborated in December 1994, sets up common objectives, policy and strategy for solution of main environmental problems in the Danube River basin, its Delta and Black Sea.

On the SAP’ list of the “hot spots”, that means critical loaded areas, 22 localities from Slovakia are mentioned. Pre-investments studies were worked out for 21 of them.

List of proposed Slovak hot spots is in SAP (page 47) and consists of:

7 municipalities
10 industrial point sources of pollution
5 industrial localities like landfills of hazardous waste, respectively area with contaminated land and penetration of harmful substances into surface and ground water

SAP contents list of wetlands and other ecological sensitive areas as well. Their protection and renaturation is important from point of view of biodiversity, restoration of selfpurification etc. On this list are mentioned 6 localities from Slovakia (SAP, page 31).

“The Strategic Action Plan Implementation” (SIP) started in year 1996. On May 1996 “List of Project Proposals for the Danube Environmental Programme” was elaborated, called “SIP Projects“ (SIP 1 and SIP 2). Projects were prepared for Morava, Vah and Tisa River basins, and were specially focused on hot spots with transboundary impact to Danube water quality. List of hot spots was prepared on the basis of report of an expert from the Water Research Institute named *“Order of Urgency of Construction of the WWTPs with Transboundary Effect to Water Quality”*. Report was prepared specially for SIP Projects and used latest available data. Criteria for project proposals were following:

- incorporation in the SAP
- order of urgency for solution of point sources of pollution (updated information)
- position on list of sources of pollution with regard to transboundary impact to water quality
- nature protection priorities

During the second phase project proposals were chosen:

Morava River basin:

- Reduction of the Pollution from WWTP in the Company Slovhodvab Senica nad Myjavou
- Renaturation of the River System in the Morava River basin

Vah River basin:

- The International Training Center for the Education of Wastewater Treatment Plant Staff in Central and Eastern European and Developing Countries - Town Sladkovicovo

Tisa River basin:

- Management of the Senne Rybniky

Strategic Action Plan is a tool of the EPDRB for improvement of environment in the Danube River basin, focused mainly to water protection. Each of Danubian countries prepared (or prepares) own Strategic Action Plan called National Action Plan.

“National Action Plan for Danube River Basin” (NAP) was submitted to Slovak Government on June 1997. Important part of NAP is chapter 2, in which are summarized main environmental problems including their influence on water regime and quality, causes and proposals of the measures with regard to local and regional level and level of the main river basins and whole Danube River system and Black Sea as well.

In chapter 4 “Measures” is improvement of water quality focused on the solution of important point sources of pollution and to measures in agricultural sector as well.

In the study of the Ministry of Environment of the Slovak Republic (MoE) which is focused on pollution reduction in wastewater up to limit values, order of hot spots is listed for two categories.

In the first category national criteria are set up and it includes 19 point sources in the Danube River Basin, from which 17 are municipalities and 2 industrial complexes. List of these point sources is in NAP (page 38). The second category gives the highest priority to transboundary impact and includes 17 point sources, of which 10 are municipalities and 7 industrial sources. Point sources are listed in NAP as well (page 38).

Ministry of Soil Management of the Slovak Republic, responsible for municipal sources of pollution (public sewerage and WWTPs), proposes prior solution of 13 new sewerage and WWTPs, respectively those, which construction started before. Eight of them are mentioned in the list of Ministry of Environment of the Slovak Republic in the first category, what means from the point of view of national interests.

On the programme of the Ministry of Economy of the Slovak Republic are listed point sources of pollution, which have priority from both point of view of the MoE - from national and transboundary aspect. For eight proposed hot-spots investment should be ensured from own sources of the factories and the enterprises and as loans from national and foreign financial institutions.

Point sources proposed for solution by the Ministry of Soil Management of the Slovak Republic and the Ministry of Economy of the Slovak Republic are listed in NAP (pages 38 and 39).

Analysis and comparison of data, information and proposals listed in above mentioned documents shows that the selection of hot spots and their order of urgency is designated by different criteria, application of which is not unified and systematic.

For mentioned reason it is problematic to set up order of urgency for solution of hot spots. That is why in the summary are point sources proposed till now, distributed to municipal and industrial. But order of urgency is not identical with the digit.

NOTES TO FOLLOWING TABLES:

SAP	*Strategic Action Plan*
SIP (1)	*Strategic Action Plan Implementation, the first List of Project Proposals*
SIP (2)	*Strategic Action Plan Implementation, the second (final) List of Project Proposals (transboundary effect)*
NAP (1)	*National Action Plan - national point of view*
NAP (2)	*National Action Plan - transboundary point of view*
MP SR	*Ministry of Soil Management of the Slovak Republic*
MH SR	*Ministry of Economy of the Slovak Republic*
VK	*Public Sewage System*

Table 2.1. Municipal hot spots

No.	Locality	Proposed in
1	VK Banska Bystrica	SAP, NAP (1), MP SR
2	VK Hlohovec	SAP **D**
3	VK Kosice	SAP, SIP (1), NAP (1), NAP (2), MP SR
4	VK Krompachy	SAP, SIP (2), MP SR
5	VK Nitra	SAP, NAP (1), MP SR
6	VK Nove Zamky	SAP
7	VK Ziar nad Hronom	SAP **D**
8	VK Malacky	SIP (1), NAP (1) NAP (2)
9	VK Komarno	SIP (1)
10	VK Kralovsky Chlmec	SIP (1), NAP (2)
11	VK Slovenske Nove Mesto	SIP (1), NAP (2)
12	VK Devinska Nova Ves	SIP (1), NAP (2)
13	VK Humenne	NAP (1), MP SR
14	VK Presov	NAP (1), MP SR
15	VK Svidnik	NAP (1), MP SR
16	VK Trencin, right bank	NAP (1)
17	VK Michalovce	NAP (1), MP SR
18	VK Trnava	NAP (1)
19	VK Bardejov	NAP (1)
20	VK Hnusta	NAP (1)
21	VK Svabovce	NAP (1)
22	VK Kisovce – Horka	NAP (1)
23	VK Roznava	NAP (1)
24	VK Rimavska Sobota	NAP (1)
25	VK Banska Stiavnica	NAP (1), MP SR
26	VK Lucenec	NAP (2)
27	VK Sturovo	NAP (2)
28	VK Samorin	NAP (2)
29	VK Sahy	NAP (2)
30	VK Cadca	MP SR
31	VK Safarikovo	MP SR
32	VK Zvolen	MP SR
33	VK Kovacova	MP SR

Table 2.2. Industrial hot spots

No.	Name / Locality	Proposed in:
1	Tannery factory-Bosany	SAP
2	Istrochem-Bratislava (chemical plant)	SAP, NAP(2)
3	Copper Smelting Works-Krompachy	SAP, SIP(2) **D**
4	Biopo-Leopoldov (food industry)	SAP **D**
5	Novaky Chemical Plants-Novaky	SAP, NAP(1)
6	North Slovak Pulp and Paper Plants-Ruzomberok	SAP
7	Sugar Factory-Sladkovicovo	SAP **D**
8	Chemko-Strazske (chemical plant)	SAP, SIP(1), NAP(2)
9	Sugar Factory-Surany	SAP **D**
10	Povazske Chemical Plants-Zilina	SAP
11	Re-loading station-Cierna nad Tisou	SAP **D**
12	Municipal waste dump-Krompachy	SAP **D**
13	Fly-ash dump-Zemianske Kostolany	SAP **D**
14	Airfield-Sliac	SAP **D**
15	Dump of the ZSNP Plants-Ziar nad Hronom (aluminium factory)	SAP **D**
16	Bukocel Hencovce	SIP(1), NAP(1), NAP(2)
17	Slovhodvab-Senica nad Myjavou	SIP(1), SIP(2), NAP(2)
18	Antifriction bearing Plant-Skalica	SIP(1), NAP(2)
19	East Slovak Ironworks-Kosice	SIP(1), NAP(2)
20	Old Herold Ferm-Trencin (spirit and yeast production)	SIP(1)
21	ASSI DOMAN Sturovo {pulp and paper ind.)	NAP(2)
22	Feasibility study for Training Center for WWTP Operators-Sladkovicovo	SIP(2)

*NOTE:“**D**” /deleted/ - that means hot spots which are listed in the Strategic Action Plan, but present are solved, or under solution.*

Table 2.3. Agricultural hot spots

No.	Name/Locality	Proposed in :
1	Reduction of Nutrient Load to the Black Sea by Improvement Agricultural Management Practices (Proposal for PHARE Cross Border Project)-selected localities within one or more of the three Slovak river basins	SIP(1)

2.1. General Approach and Methodology

Starting point database for realization of requirement objective is: “up-dating of hot spots”, are data concerning point sources of pollution from years 1990-1996, which are recorded in “The State Water Management Balance”(SWMB). Criteria for record keeping in SWMB are following:

Annual pollution higher than

15,000 m^3 discharged wastewater
3 t BOD -
6 t COD - Cr
5 t suspended solids (SS)
0.5 t non-polar extractable substances (NES)
10 t dissolved anorganic substances (DAS)

NOTE: for record keeping is enough fulfillment one of mentioned criteria

In Danube River Basin were recorded 428 point sources of pollution in SWMB in year 1996. Wastewater discharges were as follows:

190 from cities, towns and villages
225 from industry
13 from agriculture

Total volume of wastewater discharged in the Danube River basin was 1.102.456 mil. m^3/year and pollution expressed by special indices was the following:

BOD – 5	25.074,3 t/year
COD – Cr	70.935,5 t/year
SS	38.579,4 t/year
NES	580,9 t/year
N-NH	4.5 490,1 t/year

In the frame of the SWMB it is not possible to calculate the balance discharged pollution from point sources for total N, total P, TOC, heavy metals and specific organic pollutants, because of the lack of the data. Existing legislation does not require those data. New legislation is under preparation now.

Database of pollution sources in the State Water Management Balance was submitted to analysis with regard to the greatness of emissions, with aim to set up most important points of pollution and to work out order of urgency for their solution. This way input file for point sources of pollution was established, in which were included:

- public sewerage of towns and villages, which are under control of the waterworks
- industrial and agricultural sources with emissions higher than 40 t BOD5/year
- industrial and agricultural sources with emissions lower than 40 t BOD5/year, but with significant impact to water quality downstream of source with specific pollutants (heavy metals, organic pollutants etc.)

Each point source is assessed from point of view of discharging permit issued by the Water Management Authority as well. In this permit is regarded the Government Degree No. 242/1993 Coll., which sets up limit values for chosen parameters in wastewater. More details are in Annex of the Chapter 5.

Only 32 % of input files meet conditions in accordance with water management permit. Point sources in harmony with permit were deleted from file. Sources with temporary higher values than limit values, but discharging with permit of the water management authority (so called “exceptions”) were evaluated individually. Each of those exceptions has determined the date when they must meet the Government Degree No. 242/1993 criteria. Public sewerages with small discharged pollution (lower than 10 t BOD-5/year) were deleted from the list.

Using this procedure number of point sources has been decreased to 82.

The order of urgency for solution of mentioned 82 sources have been established by the method of multicriteria analysis. The principle is system of evaluation by points for 11 criteria. Each criterion has the scope from 1 to 5 and depends on the cogency. The signification of the criteria is evaluated by numbers as well and is called “weight of the criterion”. The highest weight has criterion for discharged pollution in relationship to the deterioration of downstream water quality (for flow discharge Q 355). Following are criteria intakes of water for drinking water supply, state of wastewater treatment etc. More details in Annex 2-1.

The order of pollution sources established on the basis of points evaluation is articulated into municipal and industrial sources as follows:

Table 2.5. Order of urgency for solution of municipal hot spots

No.	Name/Locality	E	Outlet into receiving water		
			Name of recipient	r.km	Q_{355} (m^3/s)
1	VK Kosice	241	Hornad	24,3	6,23
2	VK Nitra	224	Nitra	52,5	3,46
3	VK Malacky	223	branch of Malina	1,6	0,001
4	VK Banska Bystrica	222	Hron	168,4	7,93
5	VK Michalovce	219	Laborec	34,2	1,474
6	VK Svidnik	217	Ondava	117,2 115,3	0,28
7	VK Trencin right bank	215	Zlatovsky creek	2,8	0,03
8	VK Humenne	210	Laborec	63,4	1,13
9	VK Ruzomberok	198	Vah	314,8	12,1
10	VK Topolcany	195	Nitra	93,4	2,78
11	VK Svabovce	194	Ganovsky creek	5,7	0,034
12	VK Kisovce-Horka	194	Tarnocky creek Kisovsky creek	1,5 0,05	0,034
13	VK Roznava	190	Slana, Roznavsky creek	50,2	0,951
14	VK Liptov. Mikulas	190	Vah	357,6	4,473
15	VK Banska Stiavnica	186	Stiavnica	51,0 51,6	0,017
16	VK Krompachy	181	Hornad Slovinsky creek	96,5 and 98,9 0,096	1,48
17	VK Ilava	174	Nosicky channel	18	Qg
18	VK Hlohovec	172	Vah	98,9	Qg: 6,4
19	VK Zvolen	172	Hron Slatina	153,3 152,7	9,79
20	VK Lucenec	172	Krivansky creek	4,4	0,116
21	VK Sala nad Vahom	169	Kolarovsky channel	27,9	0,3
22	VK Secovce	168	Trnavka	14	Qg: 0,32
23	VK Levice	168	Podluzianka	2,2	0,03
24	VK Myjava	167	Myjava	62,3	0,055
25	VK Galanta	167	Sard	10,4	0,006
26	VK Slov. Lucobne zavody-Hnusta	166	Rimava	59,9	0,478
27	VK Pezinok	163	Blatina	1,2	0,035
28	VK Holic	162	Kystor	4,1	0,001
29	VK Piestany	162	Dubova	2,6	0,04
30	VK Spisske Podhradie	162	Margecianka	5,0	0,06
31	VK Velky Meder	161	chan. Velky Meder -Holiare	2,8	0,001
32	VK Komarno	161	Vah	1,7	40
33	VK Sturovo	160	Dunaj	1718,1	890
34	VK Prievidza	159	Handlovka	4,8	0,249
35	VK Nove Zamky	159	Nitra	8,8	4,27
36	VK Kosice-Saca	155	Hornad	24,3	Qg: 6,23
37	VK Kralovsky Chlmec	154	Chlmecky channel	1,1	0,001
38	VK Cadca	153	Kysuca	28,1	0,785
39	VK Senec	150	Cierna Voda	30,7	1,03
40	VK Krupina	149	Krupinica	40,7	0,005
41	VK Petrzalka	148	Dunaj	1862	800
42	VK Bratislava (central WWTP)	148	Maly Dunaj	123,4	Qg:
43	VK Spis.Nova Ves	147	Hornad	127,4	0,54
44	VK Stropkov	147	Ondava	100,8 101,5	0,45

Table 2.5. continued

No.	Name/Locality	E	Outlet into receiving water		
			Name of recipient	**r.km**	**Q_{355} (m^3/s)**
45	VK Samorin	144	Dunaj	1843	800
46	VK Skalica	142	Kopciansky channel	7,4	ponds system
47	VK Velke Kapusany	142	Udoc	3,8	0,017
48	VK Vranov nad Toplou	141	Topla	17,5	1,58
49	VK Kysuc.Nove Mesto	139	Kysuca	7,1	1,53
50	VK Modra	139	Stolicny creek	21,3	0,019
51	VK Bernolakovo	138	Cierna Voda	41,1	0,02
52	VK Filakovo	138	Belina	1,6	0,017
53	VK Sahy	133	Ipel	54,7	0,61
54	VK and Ozeta Tornala	133	Slana	15,8 17,4 17,8	2,64
55	VK Svaty Jur	130	Sursky channel	11,2	0,035
56	VK Kremnica	130	Kremnicky creek	15,0 15,5 10,6	0,077
57	VK Liptov.Hradok	129	Vah	357,6	Qg: 4,473
58	VK Vrable	127	Zitava	19,9	0,32
59	VK Dolny Kubin	126	Orava	15,6	6,26
60	VK Levoca	125	Levocsky creek	15,0	0,09
61	VK Jablonov	125	Vavrincov creek	3,0	0,03
62	VK Brezno	125	Hron Brezenec	218,8-232-224 0,8	1,77
63	VK Dudince	125	Stiavnica	10,0	0,147
64	VK Banovce n. Bebr.	120	Bebrava	19,8	0,485
65	VK Gelnica	120	Hnilec	7,0	1,242
66	VK Slovenske Nove Mesto	117	Ronava	1,1	0,25
67	VK Jelsava	111	Muran	20,9	0,438
68	VK Devinska NovaVes	106	Mlaka	1,0	0,055
69	VK Medzilaborce	100	Laborec	110,6	0,16
70	VK Snina	93	Cirocha	22,1 22,5	0,28

*NOTE: **Qg** - guarantee discharge*

Table 2.6. Order of urgency for solution of industrial hot spots

No.	Name/Locality	Evaluation
1	Novaky Chemical Plants-Novaky	207
2	Bukocel Hencovce	198
3	Povazske Chemical Plants-Zilina	186
4	Istrochem Bratislava	185
5	Slovhodvab-Senica nad Myjavou	179
6	Chemko Strazske	175
7	ASSI DOMAN Sturovo	168
8	Biotika Slovenska Lupca	161
9	Bucina Zvolen	157
10	Tanner Tactory-Bosany	148
11	Harmanec Paper Factory-Harmanec	121
12	East Slovak Ironworks-Kosice	120

Note: E - evaluation expressed by points assessment (municipal and industrial sources)

By using multicriteria analysis evaluation, agricultural point sources are not in narrow down file of 82 sources. Those sources are essentially pig and poultry farms and improvement of the sanitary conditions of veterinary facilities.

2.1.1. Evaluation of Existing Hot Spots

Data and information concerning sources of pollution, existing in individual documents (the National Review, SAP, SIP, NAP), are not possible to compare and evaluate, because of their insufficient scope and heterogeneous assessment criteria.

List worked out on the basis of multicriteria analysis sets up the order of urgency for the solution of pollution sources.

The first 10 sources were chosen from the list of municipal hot spots. For those latest available data were assessed, mainly the size of emission source, impact on downstream water quality in the relationship to pollution source and state of wastewater treatment.

Eight from mentioned 10 hot spots are proposed in the Strategic Action Plan, the National Action Plan or SIP. Six of them as well were chosen by the Ministry of Soil Management of the Slovak Republic as sources with priority solution.

Latest data about point sources emission are available from year 1996 (data of year 1997 are being worked up) and for 10 chosen municipal hot spots in Table 2.7.

Data about influence pollution source on recipient shows Table 2.8. There are average values of chosen water quality indices in the recipient of years 1995-1996, in profiles up and downstream of pollution source. Surface water quality is classified by class as well (standard STN 75 7221). Check profile localities for evaluated hot spots are in Table 2.9. and on map (Figure 2.1.).

More detailed data concerning water quality in check qualitative profiles for years 1994-1997 are in the Slovak Hydrometeorological Institute database. They are available in the yearbooks “Surface Water Quality in SR”.

Quantity of emissions and their impact on recipient depends largely on state of wastewater treatment. For this reason key measures are focused to this problem. The present wastewater treatment state in chosen hot spots and realization proposed measures is listed in Table 2.10.

Other available information characteristic of pollution source and recipient, above all from point of view of its utilization is noted in Table 2.11.

Similarly as for municipal hot spots, industrial hot spots data are handled for year 1996. Characteristic indices of effluent discharges for the first 10 hot spots shows Table 2.12. The influence to water quality in check point downstream of point source is proved by average values of measured data in years 1995-1996 and completed by class of quality (standard STN 75 7221). Results are in Table 2.13. Industrial hot spots check river points of receiving water are listed in Table 2.14. The present wastewater treatment state in hot spots and proposed measures shows Table 2.15.

Water quality data in qualitative checkpoints during years 1994-1997 are in the yearbook “Surface Water Quality in SR” at SHMI.

Map “Significant Pollution Sources and main Profiles of the State Water Management Balance” shows municipal and industrial hot spots including checkpoints of water quality (Figure 2.1.).

2.1.2. Deletion of Existing Hot Spots

All pollution sources proposed in SAP, SIP and NAP or in the proposals of the Ministry of Soil Management and the Ministry of Economy are found in more narrow pollution sources file. The order of urgency for their solution is worked out on the basis of multicriteria analysis. The changes in the order of urgency ensue from the methodic of individual criteria evaluation.

On the basis of comparison of lists of hot spots in SAP, NAP, SIP, or other relevant documents, with list of hot spots prepared by multicriteria analysis, it is possible to state:

8 municipal hot spots localities, 7 industrial point sources and 5 areal polluted places are missing. They are listed below:

- **Municipal hot spots**

  ZIAR NAD HRONOM

  WWTP fulfills criteria for wastewater discharges in the wording of Governmental Decree No. 242/1993. In 1994 started MB WWTP where removal of N is included in the treatment process. In the future is planned removal P as well.

  PRESOV

  WWTP after finalization of new MB WWTP in 1997 fulfills required emissions limits and other conditions as set up in Governmental Decree No. 242/1998. Testing operation a new WWTP should be finished in June 1998. By end of the year 1998 finalization IV construction of sewerage Presov-Sekcov is planned. Outflow DEPO has been canceled.

  TRNAVA

  WWTP was finished in year 1997, now is in testing operation.

  BARDEJOV

  Upgrading of WWTP was completed in 1997.

  RIMAVSKA SOBOTA

  Extended WWTP including nutrients removal is in testing operation since 1997 and fulfills required limit values.

  TORNALA

  Sewerage and WWTP should be finished in 1998. Common treatment for municipal and industrial (OZETA) wastewater.

  KOVACOVA

  During years 1996 - 97 sewerage and main sewerage collector were built. Finalization is planned in year 1999.

  HLOHOVEC

  WWTP finalization in year 1998

- **Industrial hot spots**

  KOVOHUTY KROMPACHY

  The reconstruction and changes of technology are planned till year 2000.

  BIOPO LEOPOLDOV

  Change in the production structure and establishing of low - waste technology are reason for decreasing of organic pollution discharged into recipient (from 1879 t BOD-5 in year 1991 to 130 t BOD-5 in year 1996). Decrease of N-NH4 is registered as well. Effluent discharges fulfill limit values.

  SCP RUZOMBEROK (pulp and paper industry)

  Installation of a new paper machine and mechanical-chemical treatment of wastewater are the causes of suspended solids lowering. By introducing of new bleaching technology for pulp, content of COD decreased about 35 % in wastewater. Other parameters were improved as well (color, sulphur compounds) and limit values for discharged pollution were fulfilled, except COD values.

  Change of ownership is presupposed.

  SUGAR FACTORY SLADKOVICOVO (CUKOS Ltd.)

  Upgrading of MB WWTP was finished in year 1997.

SUGAR FACTORY SURANY

On the basis of changes in production process, MB WWTP fulfills required criteria.

ANTIFRICTION BEARING PLANT SKALICA

WWTP was built and since 1997 is in testing operation

OLD HEROLD FERM TRENCIN

WWTP built and treatment process started in 1997.

- **Critical sides**

Contemporary list of industrial point sources does not include the environmentally critical sites that are mentioned in the Strategic Action Plan. Their total number is 5, but for all of them during years 1993-1994 pre-investment studies were elaborated, in which and measures for solution are proposed.

Actual data and information concerning progress in environmental problems solution in those localities it is possible obtain usually from interested institutions. Character and extent of relevant questions of those areas as mentioned in the pre-investments studies including present situation is as follows:

RE-LOADING RAILWAY BORDER STATION “ČIERNA NAD TISOU”

Identified environmental problems are concentrated on the ground water pollution of oil components derived from spills leaching of oil from oil tanks and waste reservoirs due to the re-loading of oil and oil products from Ukraine and other eastern countries.

More than 450.000 m^3 of soil and 70.000 m^3 of ground water aquifer are heavily contaminated. The contamination seriously threatens a nearby drinking water reservoirs for approx. 20.000 inhabitants.

Projects listed by the company included a great number of measures concentrated to two locations:

a. the pumping area and storage tanks

b. a lake area (7 ha), into which all wastewater from the drainage/sewage system were pumped for many years resulting in a thick layer of accumulated oil at the bottom (now removed)

Present situation:

Oil products accumulated in lake area were removed. Hydraulic shield for groundwater sources protection was proposed, and start of its operation is planned on May 1998. Former oil products pipe should be liquidated soon and the improvement of sanitary condition will start as well.

Solution of these hot spots is under auspices of the Slovak Railway and depends on available budget.

“SLIAČ” AIRFIELD

During its use as a military airfield by the Russians until 1989, the sub-soil and ground water at the Sliac airfield have been polluted by leakage of oil from storage tanks and pipelines. The total polluted area is about 3,6 ha. The pollution was thought to endanger the water quality of the Hron River and two nearby spas (Sliac and Kovacova). However, in view of the hydro-geological condition this danger seems minor. The situation with regard to micro-pollution is not clear.

After 1989 a number of sanitation measures were taken. Biodegradation of polluted soil seems to be effective. This has been done in the past but was discontinued.

Present situation:

Cleaning process in this area continues under the auspices of the Ministry of Defense of the Slovak Republic, which is responsible body for it now. That means biodegradation of oil products in polluted soil and treatment of polluted ground water.

RED MUD DEPOSIT FROM THE “ZSNP” ALUMINIUM FACTORY AT ZIAR NAD HRONOM

The red and brown mud is waste product from the production of aluminium (raw material bauxide). The fluid mud is transported by pipeline to a storage site of about 50 ha where it is piled up to a high of some 40 to 50 meters. The water leaching from this dumping site is high alkalinity (pH about 12) with high concentrations of chromium, arsenic, vanadium and molybdenium. At the upstream side of the storage site a bentonite wall has been constructed. This wall was intended as a barrier to prevent the flow of percolate and polluted (arsenic especially) ground water to the Hron River.

The bentonite wall has been not satisfactorily effective. The ground water flows to the Hron contain an estimated arsenic load 750-3500 kg/y, which will rise the average arsenic concentration of the Hron by 0.7 to 3.8 microgram/l.

To avoid the flow of polluted ground water towards the river it was prepared a project of extension the bentonite wall around the entire dumping area. In addition it is planned to evaluate the drain from the dumping site, to prevent the build up of a high hydraulic pressure on the bentonite wall. This water can be reused in the factory.

Present situation:

Planned wall was built up, now continues process of afforestation, which depends of financial sources.

MUNICIPAL SOLID WASTE IN TOWN KROMPACHY

Main problem of these hot spots was leaching of heavy metals and nutrients into drinking water supplies.

Present situation:

Municipal solid waste should be closed during year 1998 and it is part of complex solution together with dump of factory “Kovohuty” in Krompachy, dump “Halna” and fly-ash dump of “Foundry” in Krompachy. Responsible bodies for closing of dumps and their cleaning up are mentioned enterprises together with Municipal Office Krompachy.

Note: Changes are intended in technology of production process in “Kovohuty” Krompachy

“ENO” (THERMAL POWER PLANT) ZEMIANSKE KOSTOLANY

Main problems - arsenic ashes stored at riverside

Present situation:

The enlargement of existing ashes dump is under construction and is realized on the basis of valid orders.

In future changes are planned in technology and for this reason character of waste will be changed. There are planned changes in fuel base as well.

2.1.3. Addition of Hot Spots

On the basis of the consultation with the representatives of the Slovak Water Management Inspection, what is felt from their viewpoint as a problem, which should be solved as important, we have received next proposal.

There is a problem with discharged pollution from vessels in Slovak Danube River stretch and water pollution by oil products from vessels as well. This problem is necessary to solve from technical and institutional point of view. With regard to transboundary character of the Danube River, process of solution must be in accordance with existing relevant bilateral and multilateral agreements.

For above-mentioned reason this project was not put on the list of hot spots at present. But later on, after preparation of the common work plans with other Danube countries, supporting project could be useful. Now, this hot spot is assessed as POTENTIAL HOT SPOT. Moreover, in year 1997 project focused to solution of such problem was intended to be solved in the frame of the Danube Environmental Programme.

Diffuse sources of pollution as proposed to be mentioned in this part, are topic of the Chapter 3. Except of difficult clarification of diffusion source it is not possible to find polluter - owner of the project. At present to solve this problem in the frame of this Programme seems to be unrealistic.

2.1.4. Ranking of Hot Spots

Regarding to the previous text and relevant tables ranking lists for municipal and industrial hot spots were prepared.

Table 2.17. Selected municipal hot spots

No.	Locality	Priority
1	WWTP Kosice	**high**
2	WWTP Nitra	**high**
3	WWTP Malacky	medium
4	WWTP Banska Bystrica	medium
5	WWTP Humenne	medium
6	WWTP Michalovce	medium
7	WWTP Svidnik	medium
8	Sewerage Trencin, right side	medium
9	WWTP Ruzomberok	low
10	WWTP Topolcany	low

From above mentioned municipal hot spots two pollution sources have transboundary impact to water quality: WWTP Kosice and WWTP Malacky

Table 2.18. Selected industrial hot spots

No.	Locality	Priority
1	Novaky Chemical Plants Novaky	**high**
2	Bukocel Hencovce	**high**
3	Istrochem Bratislava	medium
4	Povazske Chemical Plants Zilina	medium
5	Slovhodvab Senica n. Myjavou	medium
6	Chemko Strazske	medium
7	ASSI DOMAN Sturovo	low
8	Tanning Factory Bosany	low
59	Biotika Slovenska Lupca	low
10	Bucina Zvolen	low

Following industrial point sources have transboundary impact to water quality: Istrochem Bratislava, ASSI DOMAN Sturovo, Bukocel Hencovce, Slovensky hodvab Senica, Chemko Strazske.

Order of pollution sources was prepared with regard to wastewater impact to transboundary waters, which are: Danube, Morava and Bodrog.

In case of common assessment of municipal and industrial point sources, order of pollution sources with regard to transboundary impact to water quality is following:

1. Istrochem Bratislava
2. ASSI DOMAN Sturovo
3. WWTP Kosice
4. Bukocel Hencovce
5. Slovensky hodvab Senica
6. Chemko Strazske

NOTE: Industrial hot spots appear to have a greater importance than municipal hot spots from viewpoint of transboundary effect.

For preparation of the order, combination of the two criteria we have assessed as most important: increasing of BOD-5 values in transboundary profile as a consequence of wastewater discharge and distance of pollution source of the border. These criteria have been used for all orders in this Chapter.

Summary of Information of the municipal hot spots - high priority

Name of the Hot Spots	**WWTP Košice**
Critical Emissions	Wastewater discharged into Hornad (r.km. 24,3). Analysis of wastewater in year 1996: Parameter — mg/l — t/y BOD-5 — 30 — 1 182,6 COD-Cr — 75 — 2 956,5 DS — 490 — 19 315,0 DAS — 360 — 14 191,0 NES — 1,5 — 59,1 N-NH4 — 6,2 — 245,7 total P — 0,9 — 36,2 Volume of discharged waters and discharge regime 1250l/s — 39 420 000 m^3/y — 24 h/ 365 days Data concerning total N and total P are not listed, because they are not required for State Water Management Balance. Those data (total N and total P) are calculated for municipal hot spots proposed to be solved in this programme (in detail in Part C - Water Environmental Engineering, where other data except SWMB are used as well).
Seasonal Variation	Hornad as recipient of wastewater has in check point upstream of WWTP Kosice following long-time hydrological characteristics : Sampling site - r. km 27,0: — Q355 — 4,383 m^3/s “Krasna nad Hornadom” — Q270 — 7,969 m^3/s Qa — 20,970 m^3/s For emission of year 1996 (above listed) average daily discharges were as follows: 8,888 m^3/s (March) — min. value 52, 668 m^3/s (July) — max. value 21, 243 m^3/s — average year value
Root Causes of Water Quality Problems	Mechanical WWTP Kosice has been started on year 1968. Here is treated municipal wastewater, phenol waters of VSZ Kosice and waters of local industry and services. Original WWTP was hydraulic and mass overloaded. For this reason construction of new mechanical part and decay tanks has been started. New mechanical WWTP part is in operation since 1988. The decay tanks are in operation as well. During years 1991-1992 started construction a new parallel biological WWTP, which is not yet finished. At the present it is necessary 3rd building part of biological level to finalize and technology fix up. Finalization exposes to danger because lack of money.
Immediate Causes of Emissions	At the present wastewater flowing into WWTP are distributed. About 1000 l/s of wastewater are treated at original MB WWTP, others, volume about 200-400 l/s are treated at new mechanical part of WWTP and after that are discharged into recipient (without additional treatment).
Receiving Waters	Check profiles (sampling sites) in which is possible to evaluate public sewerage-Kosice impact to recipient water quality are: Hornad “Krasna nad Hornadom” — r.km 27,0 Hornad “Zdana” — r.km 17,2 In year 1996 for which emission values of point source were listed, water quality in the check profiles was as follows : PARAMETER — (mg/l) — KRASNA N. HORNADOM — ZDANA Dissolved Oxygen — min — 7,8 — 6,2 max — 14,0 — 11,8 mean — 10,9 — 9,6 BOD-5 — min — 3,0 — 5,0 max — 10,0 — 1,0 mean — 6,1 — 6,8 COD Cr — min — 8,0 — 9,0 max — 18,0 — 26 mean — 13,0 — 17,4 N/NH4 — min — 0,039 — 0,210 max — 0,342 — 1,724 mean — 0,173 — 0,840 N-NO2 — min — 0,006 — 0,036 max — 0,042 — 0,107 mean — 0,018 — 0,070

<table>
<tr><th>Name of the Hot Spots</th><th colspan="4">WWTP Košice</th></tr>
<tr><td rowspan="9"></td><td>N-NO3</td><td>min</td><td>1,807</td><td>1,807</td></tr>
<tr><td></td><td>max</td><td>4,608</td><td>4,125</td></tr>
<tr><td></td><td>mean</td><td>2,829</td><td>2,850</td></tr>
<tr><td>total P</td><td>min</td><td>0,050</td><td>0,100</td></tr>
<tr><td></td><td>max</td><td>0,400</td><td>0,450</td></tr>
<tr><td></td><td>mean</td><td>0,126</td><td>0,260</td></tr>
<tr><td>Hg</td><td>min</td><td>0,05</td><td>0,05</td></tr>
<tr><td>microgram/l</td><td>max</td><td>1,9</td><td>0,55</td></tr>
<tr><td></td><td>mean</td><td>0,53</td><td>1,18</td></tr>
<tr><td>Nearby Downstream Uses</td><td colspan="4">Sewerage Kosice together with other pollution sources influence Hornad river quality such important, that water intakes are realized only in stretch upstream Spisska Nova Ves (r. km 129,9), upstream Krompachy (r. km 97,5) and upstream Kosice ahead of tributary Torysa (r. km 31,4). Water intakes are used by industry with lower demands for water quality.
Classification of the Hornad River in transboundary profile :
oxygen regime III class (polluted water)
nutrients(N-NH4, total P) IV class (heavily polluted water)
heavy metals, biological and microbiological parameters V class (strongly polluted water)</td></tr>
<tr><td>Transboundary Implications</td><td colspan="4">From point of view of transboundary impact is WWTP Kosice one of the biggest point sources of the Hornad river in border stretch with Hungary. For this reason is not possible to realize water intakes from water resources downstream.</td></tr>
<tr><td>Rank</td><td colspan="4">High Priority</td></tr>
</table>

Summary of municipal hot spots – high priority

Name of the Hot Spots	**WWTP N I T R A**
Critical Emissions	Wastewater discharged into the Nitra River (r. km 52,5). Analysis of wastewater in year 1996: Parameter — mg/l — t/y BOD-5 — 108,0 — 1 262 COD-Cr — 174,3 — 2 037 SS — 93,0 — 1 086 N-NH4 — 14,6 — 170,6 NES (UV) — 0,21 — 2,45 total P — 2,28 — 26,5 Volume of discharged waters and discharge regime 369 l/s — 1 168 794 m^3/y — 24 h. / 365 days
Seasonal Variation	Long-time hydrological characteristics at the check point profile Nitra-“Luzianky”, r. km 65.1 : Q355 — 3,5 m^3/s Q270 — 6,99 m^3/s Qa — 17,76 m^3/s Discharges in profile Nitra-“Luzianky” in year 1996: 5,86 m^3/s — min value 50,70 m^3/s — max value 10,45 m^3/s — average year value
Root Causes of Water Quality Problems	WWTP was built in year 1968 and is hydraulic and mass overloaded. Outmodel technology, construction of a new WWTP.
Immediate Causes of Emissions	Insufficient treated waters, part of them discharged into recipient after mechanical treatment
Receiving Waters	Check profiles (sampling sites) in which is possible to evaluate impact of WWTP Nitra : Nitra “Luzianky” — r.km 65,1 Nitra “Cechynce” — r.km 47,8 Surface water quality in those profiles in year 1996 : PARAMETER — (mg/l) — LUZIANKY — CECHYNCE Dissolved oxygen — min — 8,3 — 8,5 max — 13,2 — 13,5 mean — 10,7 — 10,2 BOD-5 — min — 3,0 — 4,0 max — 6,3 — 9,2 mean — 4,7 — 5,5 COD-Cr — min — 6,0 — 4,0 max — 38,0 — 43,0 mean — 21,5 — 21,8 N-NH4 — min — 0,45 — 0,47 max — 2,3 — 3,0 mean — 0,91 — 0,99 N-NO2 — min — 0,001 — 0,005 max — 0,142 — 0,138 mean — 0,058 — 0,065 N-NO3 — min — 2,60 — 2,23 max — 4,30 — 4,05 mean — 3,28 — 3,12 total P — min — 0,14 — 0,13 max — 0,71 — 0,56 mean — 0,29 — 0,31 total N — min — - — 5,6 max — - — 7,0 mean — - — 6,3

Name of the Hot Spots	**WWTP N I T R A**
	NES (UV) min 0,01 0,01 max 0,14 0,11 mean 0,06 0,06 Hg min 0,18 0,11 microgram/l max 1,04 0,53 mean 0,48 0,29 As min 3,4 5,2 microgram/l max 21,0 20,2 mean 11,89 12,84
Nearby Downstream Uses	Municipal and industrial waters of town Nitra together with other important pollution sources upstream of town Nitra are causes of the ground water deterioration in Nitra River alluvium. In this river stretch were not any more important water intakes realized during years 1996-1997
Transboundary Effect	Nitra River with regard to content of Hg and chlorine (chlorine hydrocarbons) and high salinity contributes to Danube river pollution.
Rank	High Priority

Summary of information of the industrial hot spots – high priority

<table>
<tr><th>Name of the Hot Spots</th><th>NOVÁCKE CHEMICKE ZAVODY
(CHEMICAL PLANTS) NOVAKY</th></tr>
<tr><td>Critical Emissions</td><td>
Wastewater is discharged into Nitra River by two outfalls.
I From sedimentation tanks
Wastewater containing CaCl2, Ca(OH)2, chlorinated hydrocarbons are pumped into sedimentation tanks. After continuous neutralization by HCl, they are discharged to Nitra in r. km 129,7
Wastewater quality and amount of pollution
<table>
<tr><th>Y Q355</th><th>BOD-5
(l/s)</th><th>COD-Cr
(mg/l)</th><th>DAS
(mg/l)</th><th>NES-UV
(mg/l)</th><th>
(mg/l)</th></tr>
<tr><td>1996</td><td>130,2</td><td>14,3</td><td>35,6</td><td>638</td><td>0,85</td></tr>
<tr><td>1995</td><td>186,3</td><td>75,2</td><td>240,6</td><td>3691</td><td>2,7</td></tr>
<tr><td>1994</td><td>179,7</td><td>95,5</td><td>350,3</td><td>3154</td><td>2,8</td></tr>
</table>
<table>
<tr><th>y</th><th>Q355
(m^3/y)</th><th>BOD-5
(t/y)</th><th>COD-Cr
(t/y)</th><th>DAS
(t/y)</th><th>NES-UV
(t/y)</th></tr>
<tr><td>1996</td><td>4 117 997</td><td>58,9</td><td>146,6</td><td>2 627</td><td>3,5</td></tr>
<tr><td>1995</td><td>5 875 649</td><td>441,8</td><td>1707,5</td><td>21 687</td><td>15,9</td></tr>
<tr><td>1994</td><td>5 666 258</td><td>541,1</td><td>1984,7</td><td>17 871</td><td>16,1</td></tr>
</table>
II. from sewerage X and mech.-biolog. WWTP to the Nitra River in r. km 130,6
- by sewerage x -untreated rain waters, sewage the old part of factory and cooling waters after oil traps
- from WWTP from new part of factory, sewage and municipal waste from Novaky and excrements from VVO Kos (pigs)
Waste water quality and discharged pollution
<table>
<tr><th>y</th><th>Q355
(l/s)</th><th>BOD-5
(mg/l)</th><th>COD-Cr
(mg/l)</th><th>DAS
(mg/l)</th><th>NES-UV
mg/l</th></tr>
<tr><td>1996</td><td>95,9</td><td>144,3</td><td>654,2</td><td>7 361</td><td>3,9</td></tr>
<tr><td>1995</td><td>25,5</td><td>149,1</td><td>808,1</td><td>10 526</td><td>3,1</td></tr>
<tr><td>1994</td><td>12,5</td><td>209,0</td><td>1 033,1</td><td>7 431</td><td>4,6</td></tr>
</table>
<table>
<tr><th>y</th><th>Q 355
(m^3/s)</th><th>BOD-5
(t/y)</th><th>COD-Cr
(t/y)</th><th>DAS
((t/y))</th><th>NES-UV
(mg/l)</th></tr>
<tr><td>1996</td><td>3 033 116</td><td>437,7</td><td>1 985,3</td><td>22 327</td><td>11,8</td></tr>
<tr><td>1995</td><td>802 796</td><td>119,7</td><td>648,7</td><td>8 450</td><td>2,5</td></tr>
<tr><td>1994</td><td>393 085</td><td>82,2</td><td>406,1</td><td>2 921</td><td>1,8</td></tr>
</table>
specif. Pollution:
<table>
<tr><th></th><th>sedim. tanks
mg/l</th><th>
t/y</th><th>MB WWTP
mg/l</th><th>
t/y</th></tr>
<tr><td>chlorinated hydrocarbons</td><td>5,14</td><td>19,4</td><td>140,7</td><td>449</td></tr>
<tr><td>detergents</td><td>0,59</td><td>2,25</td><td>2,66</td><td>8,5</td></tr>
<tr><td>active chlorine</td><td>0,94</td><td>3,56</td><td>0,29</td><td>0,94</td></tr>
<tr><td>Hg</td><td>0,002</td><td>0,00816</td><td>0,13</td><td>0,42</td></tr>
</table>
Regime of discharging 24 hours/ 365 days in year
</td></tr>
<tr><td>Seasonal Variation</td><td>
In profile Nitra-Opatovce, r. km 138,7 upstream of pollution source NCHZ (Chemical Plants) are long term discharged as follows:
Q355 0,55 m^3/s
Q270 1,11 m^3/s
Qa 2,90 m^3/s
Maximum discharges occur on March and April, min. on July and August
</td></tr>
<tr><td>Root Causes of Waste Quality Problems</td><td>
In 1992 the construction of new MB WWTP has started. It should consist of two parallel lines. In the frame of the sewage system reconstruction it should have been divided into organic and anorganic part with pre-treatment facilities such as facility for abstraction of mercury and two-step neutralization stations.
Due to the changes in production programme new plan of WWTP construction was design. Following this plan only one line of MB WWTP should be built with capacity 155 l/s (91 324 PE)
The term of its ending was planned on June 1996. This was not accomplished because of financial constrains.
</td></tr>
<tr><td>Immediate of Causes Emissions</td><td>Insufficient capacity and efficiency of treatment</td></tr>
<tr><td>Receiving Water</td><td>
Sampling Sites for comparison of influence are:
<table>
<tr><td>Nitra-Opatovce</td><td>r.km</td><td>138,7</td><td>QA</td><td>2,96 m^3/s</td></tr>
<tr><td>Nitra-Chalmova</td><td>r.km</td><td>123,8</td><td>Qa</td><td>6,3 m^3/s</td></tr>
</table>
Impact of wastewater has caused significant increase of chloride and mercury concentration in the Nitra river.
</td></tr>
</table>

<table>
<tr><th>Name of the Hot Spots</th><th>NOVÁCKE CHEMICKE ZAVODY
(CHEMICAL PLANTS) NOVAKY</th></tr>
<tr><td></td><td>The mean concentration of chlorides increased from 9,84 mg/l in Nitra-Opatovce up to 128,8 mg/l in Nitra Chalmova. Mercury contents from background concentration 0,03 microgram/l up to 3,63 microgram/l. As the wastewaters contain chlorinated hydrocarbons, in sampling site Nitra-Chalmova wide range of chlorinated hydrocarbons is regularly analyzed;
<table>
<tr><td>1,1-dichlorethane</td><td>0,0005 – 0,003</td><td>microgram/l</td></tr>
<tr><td>chloroform</td><td>2 -10</td><td>microgram/l</td></tr>
<tr><td>1,2-dichlorethane</td><td>10 - 500</td><td>microgram/l</td></tr>
<tr><td>1,1,2-trichlorethane</td><td>6,6 - 190</td><td>microgram/l</td></tr>
<tr><td>1,1,2,2, tetrachlorethene</td><td>8 - 73</td><td>microgram/l</td></tr>
</table>
Water quality related to relevant emissions from point sources in check points:
<table>
<tr><th>Parameter (mg/l)</th><th></th><th>Nitra-Opatovce</th><th>Nitra-Chalmova</th></tr>
<tr><td>BOD-5</td><td>1996</td><td>3,4</td><td>6,7</td></tr>
<tr><td></td><td>1995</td><td>2,6</td><td>4,6</td></tr>
<tr><td></td><td>1994</td><td>3,3</td><td>5,3</td></tr>
<tr><td>COD-Cr</td><td>1996</td><td>21,2</td><td>35,1</td></tr>
<tr><td></td><td>1995</td><td>12,6</td><td>24,5</td></tr>
<tr><td></td><td>1994</td><td>-</td><td>20,9</td></tr>
<tr><td>N-NH4</td><td>1996</td><td>0,30</td><td>1,5</td></tr>
<tr><td></td><td>1995</td><td>0,38</td><td>1,2</td></tr>
<tr><td></td><td>1994</td><td>0,18</td><td>1,0</td></tr>
<tr><td>N-NO2</td><td>1996</td><td>0,034</td><td>0,047</td></tr>
<tr><td></td><td>1995</td><td>0,027</td><td>0,068</td></tr>
<tr><td></td><td>1994</td><td>0,035</td><td>0,085</td></tr>
<tr><td>N-NO3</td><td>1996</td><td>2,08</td><td>2,21</td></tr>
<tr><td></td><td>1995</td><td>1,92</td><td>2,00</td></tr>
<tr><td></td><td>1994</td><td>2,26</td><td>1,86</td></tr>
<tr><td>Tot P</td><td>1996</td><td>0,13</td><td>0,34</td></tr>
<tr><td></td><td>1995</td><td>0,13</td><td>0,26</td></tr>
<tr><td></td><td>1994</td><td>0,12</td><td>0,22</td></tr>
</table>
From the other point sources of pollution in this stretch of river Nitra-Opatovce and Nitra-Chalmova are electric power plant Novaky (Zemianske Kostolany) and tributary Handlova</td></tr>
<tr><td>Nearby Downstream Uses</td><td>Water of Nitra River downstream of NCHZ Novaky is not possible to use for any purpose.</td></tr>
<tr><td>transboundary Implications</td><td>Nitra river-sub catchment belongs to Vah River basin and does not influence Danube river direct, even if NCHZ Nitra is big polluter with strong negative impact on whole environment in Horna Nitra .</td></tr>
<tr><td>Rank</td><td>High priority</td></tr>
</table>

Summary of information of the industrial hot spots – high priority

<table>
<tr><th>Name of the Hot Spots</th><th>BUKOCEL a.s. HENCOVCE
(BUKOZA VRANOV NAD TOPLOU)</th></tr>
<tr><td>Critical Emissions</td><td>
Wastewater is discharged into Ondava River by three outfalls :

from MB WWTP, r. km 48,7
outfall „Railway bridge“, r. km
outfall „under pumping station“, r. km 50,1

Waste water quality and amount of pollution :
<table>
<tr><th></th><th>1.</th><th></th><th>2.</th><th></th><th>3.</th><th></th></tr>
<tr><td>Parameter</td><td>mg/l</td><td>t/y</td><td>mg/l</td><td>t/y</td><td>mg/l</td><td>t/y</td></tr>
<tr><td>BOD-5</td><td>28</td><td>295,7</td><td>8,0</td><td>4,1</td><td>30,0</td><td>41,7</td></tr>
<tr><td>COD-Cr</td><td>240,0</td><td>2534,8</td><td>55,6</td><td>28,1</td><td>133,0</td><td>185,1</td></tr>
<tr><td>NES-UV</td><td>1,58</td><td>16,69</td><td>0,12</td><td>0,06</td><td>0,70</td><td>0,97</td></tr>
<tr><td>Cl</td><td>300,6</td><td>3174,9</td><td>25,2</td><td>12,7</td><td>12,2</td><td>16,9</td></tr>
<tr><td>DAS</td><td>969</td><td>10213,3</td><td>278,0</td><td>140,7</td><td>265,0</td><td>368,7</td></tr>
<tr><td>Discharge</td><td>l/s</td><td>m^3/y</td><td>l/s</td><td>m3/y</td><td>l/s</td><td>m3/y</td></tr>
<tr><td></td><td>334</td><td>10 561 882</td><td>16,0</td><td>505 958</td><td>44,0</td><td>139 1386</td></tr>
</table>
Regime of: the same for all - 24 hours, 365 days / year
Discharge
</td></tr>
<tr><td>Seasonal Variation</td><td>
In upstream sampling side „ Ondava-Kucin“, r. km 53.9 long-range discharges :
<table>
<tr><td>Q355</td><td>1,0 m^3/s</td></tr>
<tr><td>Q270</td><td>2,3 m^3/s</td></tr>
<tr><td>Qa</td><td>9,97 m^3/s</td></tr>
</table>
Max. values in 1996 were in January to April and min. values in September and October
</td></tr>
<tr><td>Root Causes of Water Quality

Problems</td><td>
MB WWTP is hydraulic and mass overloaded and is in bad technical state. It has been started construction of a new system of suspended solids fasten, so-called white water. Primary sludge would be after sedimentation and thickening pressed and burned in existing facilities for wood waste incinerator.
It is necessary the reconstruction and the extension of WWTP and after that would be possible to treat wastewater from outfalls 2 and 3, which are discharged without treatment into Ondava River at present (rain waters and septic waters in territory of factory).
The second till now not solved problem - potential danger - is dump (fly ash, dross from past, now wood waste sludge from cellulose production). Top of the dump is 8 m above field and its periphery is bank of Ondava River. High discharge could be reason for dam damage and following to the accident pollution of water. Rain water from dump flows into Ondava River.
</td></tr>
<tr><td>Immediate Causes of Emissions</td><td>
The reconstruction and extension of WWTP started in years 1992-1993, but later on was stopped because lack of money.
Consequence: not sufficient treated wastewater and part of untreated waters discharged into Ondava River.
</td></tr>
<tr><td>Receiving Waters</td><td>
Water quality check points upstream and downstream of source of pollution are :
<table>
<tr><td>Ondava – Kucin</td><td>r.km 53,9</td></tr>
<tr><td>Ondava – Posa</td><td>r.km 45,7</td></tr>
</table>
Water quality in those profiles:
<table>
<tr><th>Parameter (mg/l)</th><th>Ondava-Kucin</th><th>Ondava-Posa</th></tr>
<tr><td>Q mean (m^3/s)</td><td>7,14</td><td>7,20</td></tr>
<tr><td>BOD-5</td><td>5,5</td><td>6,6</td></tr>
<tr><td>COD-Cr</td><td>16,6</td><td>28,9</td></tr>
<tr><td>N-NH4</td><td>0,20</td><td>0,44</td></tr>
<tr><td>N-NO2</td><td>0,013</td><td>0,023</td></tr>
<tr><td>N-NO3</td><td>1,17</td><td>1,29</td></tr>
<tr><td>total P</td><td>0,06</td><td>0,14</td></tr>
<tr><td>formaldehyde free</td><td>0,034</td><td>0,63</td></tr>
<tr><td>formaldehyde tot,</td><td>0,061</td><td>1,00</td></tr>
<tr><td>phenols vol,</td><td>0,024</td><td>0,026</td></tr>
</table>
</td></tr>
<tr><td>Nearby Downstream Uses</td><td>
Upstream uses of water : by Chemko Strazske and Bukocek Hencovce
Downstream uses of water : there is not possible to use water, for industry with low demand for water quality as well
</td></tr>
<tr><td>Transboundary Implications</td><td>
Ondava River with main tributaries is the second branch of Bodrog River, our transboundary river with Hungary.
Sampling site Ondava-Posa is one of the most polluted river stretch, together with profile Ondava-Nizny Hrusov
</td></tr>
<tr><td>Rank</td><td>High priority</td></tr>
</table>

NOTE: Data of years 1994 - 1997, which include the flow conditions associated with the concentrations of substances in the receiving water are on extra disk and will be used for water quality modeling. Names of files related to hot spots are as follow:

WWTP Kosice: Horkras.txt, Horzdana.txt

WWTP Nitra: Nitluzi.txt, Nitcechy.txt

Novaky Chemical Plants: Nitop.txt, Nitchal.txt

Bukocel a.s.Hencovce: Onkuc.txt, Onposa.txt

File “Code of parameters” gives information, which parameter is under code /e.g. code A02 belongs to BOD5.

3. Identification of Diffuse Sources of Agricultural Pollution

3.1. Land Under Cultivation

Pollution from diffuse sources can be related to weathering of minerals, erosion of lands and forest including residues of natural vegetation, or artificial or semiartificial sources. The last one can be related to human activities such as fertilizer application or use of agricultural chemicals controlling weeds or insects, erosion of soil materials from agricultural farming areas and animal feedlots, construction sites, transportation cumulating of dust and litter on urban surfaces, strip mining, and others.

One of most important diffuse pollution sources with strong negative impact to water quality is agriculture. Greatness of pollution depends of the extent and utilization of soil. The structure of the land in relation to river basins is marked out in following table.

Table 3.1. Main rivers in the SR, their basins and length of bordering watercourses and structure of land

River basin	Length of Stream (km)	Length of border Stretch (km)	River basin area (km^2)	Total Agricul. Land (ha)	Arable Agricul. Land (ha)	Forest Area (ha)	Water Area (ha)
Morava	107,2	107,2	2 282	119 642	95 876	79 332	3 897
Danube	172,0	149,9	1 138	195 264	169 881	40 544	13 004
Vah	367,2	-	14 268	581 843	332 166	492 758	22 491
Nitra	168,4	-	4 501	314 449	258 169	144 068	10 868
Hron	278,3	-	5 465	265 342	120 866	259 041	5 616
Ipel	197,9	108,7	3 649	157 349	91 700	132 132	3 879
Slana	92,5	-	3 217	150 542	70 597	171 708	2 956
Hornad	178,5	10,4	4 414	174 032	96 851	175 581	4 414
Bodrog Tisa	153,8 5,2	5,2	7 265 7	381 550	217 648	271 288	19 827
Bodva	48,8	-	858	40 306	30 336	n,a,	1 244

NOTE: Data concerning Morava, Danube, Bodrog and Tisa Rivers are related only to Slovak territory
n.a „not available”

REFERENCES TO TABLE: Length of the streams, river basin areas and length of bordering water courses - *Statistical Office of the SR, 1997.*Structure of Land -*Office of Geodesy, Cartography and Land Register of the SR, 1997*

Due to the decline of agriculture production and decrease of industrial nutrient application on agricultural soils, nitrogen and phosphorus concentrations in surface waters have been decreased. The application of pure nutrients (N, P and K) was 251,6 kg/ha in years 1986/87, but in years 1991/92 63,9 kg/ha only (that means farming lands). Next table shows evolution of fertilizer consumption in the Slovak Republic within period 1990-1996 (kg per ha of agricultural soil)

Table 3.2. Fertilizer consumption

Year	Sum of N, P, K	N	P	K
1986 – 1987	251,6			
1990 – 1991	123,1	62,8	30,7	29,6
1991 – 1992	63,9	39,5	12,6	11,8
1992 – 1993	41,6	28,4	7,2	6,0
1993 – 1994	43,5	30,1	7,3	6,1
1994 – 1995	45,0	30,6	7,8	6,6
1995 – 1996	48,9	32,8	8,8	7,3

Reason of decrease of applied fertilizers and pesticides are changes in national economy and higher prices and it became evident on surface water quality (nutrients), but is not significant on ground water quality. To assess this fact with regard to ground water is more complicated.

Part of nutrients from agriculture applied to land penetrates into surface water by erosion, mainly water erosion. Research Institute of Soil Fertility has prepared a map “Water Erosion Risk on Slovakia Agricultural Soils” where are figured data from next table.

Table 3.3. Water erosion risk on Slovakia agricultural soils

Intensity of soil loss (t / ha . year)	Area Ha	Farming land (%)
0 - 4	1 065 420	45,0
4 - 10	473 520	20
10 - 30	426 170	18
more than 30	402 490	17

Calculation of nutrients flowing into surface water flow from above mentioned data is difficult from next viewpoints: under term “farming land“ are included arable soils and pasture as well. But between them there is different approach concerning fertilizer application and thus nutrient carried away from arable land is much higher. Other source of difficulties for calculation of nutrients flowing into water stream is that eroded soil is not removed only into surface water.

Another kind of erosion (e.g. wind erosion etc.) is much lower in our country and for this reason is not monitored.

Danubian Lowland (765.000 ha of agricultural soil and 678.000 ha of arable land) may be considered as relatively most intensive part of Danube Catchment Area.

Agricultural production in the Slovak Republic (of which Danube River basin covers 96 %) is listed in table as follows:

Table 3.4. Average yield of selected crops within period 1990 to 1996 (tons/ha)

Year	Winter wheat	Barley	Grain maize	Potatoes	Sugar beet	Legumes	Oil crops
1989-90	5,00	4,82	3,56	14,12	30,82	2,16	1,90
1990-91	5,22	4,59	5,40	12,26	31,07	2,26	2,22
1991-92	4,80	4,13	4,50	12,86	29,35	2,42	1,90
1992-93	3,85	3,33	4,62	18,15	34,26	1,88	1,70
1993-94	4,85	3,67	4,14	9,67	34,53	2,91	1,78
1994-95	4,44	3,40	4,90	10,07	34,26	2,17	1,90
1995-96	4,13	3,18	5,75	21,54	39,54	2,09	1,89

Research Institute of Soil Fertility deals with co-operation with agriculture sector in the area of fertilizer, waste and pesticide rations and their application conditions, but does not provide inspection activities.

There are not available present data concerning nutrient escape into waters from whole territory of Slovakia.

Ministry of Soil Management of the Slovak Republic has approved solution of research works concerning important water management areas: river basin of the water supply reservoir Klenovec and Nitra River basin. Reason for it was to ensure ecological and economical optimum management with water and water sources. Work was realized in co-operation of the Water Research Institute and the Research Institute of Soil Fertility. On the basis of research the methodology of work processes was elaborated, in which are included proposals for lowering of agricultural diffuse pollution of water.

Report of Water Engineer contents list of Regulations and Methodologies and research reports focused to sustainable agriculture and forest management and pollution reduction from this sector.

After year 1989 live stock has significantly decreased and those farms are not more important point sources of pollution, but could be diffuse pollution sources with regard to used practice (e.g. percolation from septic tanks represents about 40 % of the collected wastewater). At present Regulation concerning handling of manure etc. exists, but in reality does not exist inspection for it. In event of water quality threat or deterioration, Slovak Water Inspectorate starts activity. Weakness of this policy is that handling with fertilizers, manure etc. depends on human behavior, which is in relationship to his awareness. This problem would be solved in agricultural sector.

3.2. Grazing Area

Since 1993 pastureland is statistically assessed together with permanent grass-field. The area of permanent grassland in 1996 was 840.000 ha and pasture represents approximately one third of this area.

Due to low status of the animals pastureland is often extensively and sporadic. Typical pastureland dominates in hill area of the Slovak Republic.

In period 1995 on 1 ha of agricultural soil was in average 0,55 of cattle number.

Requested data to this Chapter, which were not available at present, we complete from the Final Report „Nutrient Balances for Danube Countries“ (Project EU/AR/ 102 A/91) prepared under the Danube Environmental Programme - Applied Research Programme. In Report are published latest data of year 1992.

There is stated:

- in whole Danube River basin main pollution source of nitrogen is agriculture (51 %), of which great part represents erosion/runoff 17 %
- in whole Danube River basin main pollution source of phosphorus is agriculture as well (57 %), of which erosion/runoff represents 28 %.

Table 3.5. Nutrient emission into surface water from Slovak Danube River basin

Emission		Nitrogen	Phosphorus
diffuse sources	kt	39	2
% of the total load		66	37
point sources	kt	20	3
% of the total load		34	63
total	kt	59	5
area specific emission	kg/ha.y	12	1,2
head specific emission	kg/cap.y	11,8	1,0

- erosion, including fertilizer washout: 1t/ha.y and N, P content therein.
- fertilizer washout: 20 % of the rest of applied N on agricultural soil (2,5-10 kg N/ha y) and 2-3 % of the rest of P is washed out
- percolation (agriculture): 10-20 kg N/ha. y and 0,5-1,0 kg P/ha .y
- percolation (septic tanks): 40 % of the collected wastewater percolates

4. Updating and Validation of Water Quality Data

4.1. Index of Water Quality Monitoring Records

From territory of the Slovak Republic (49.035 km^2) belong to Danube River basin 47 064 km^2. Length of flows in the Danube River basin represents 4017 km, of which 18 % are important from viewpoint of water management.

In the framework of environmental monitoring in whole Slovakia is the Slovak Hydrometeorological Institute the responsible body for partial monitoring system “Water”. There are monitored:

- surface water quality and quantity
- ground water level, quantity of water of wells and bores
- ground water quality

30-35 years old data are available for chosen profiles concerning characteristic discharges and basic water quality determinants.

Periodical measurement and assessment of discharges has been started in Bratislava (Danube River) in year 1901.

The list of available data for 20 monitoring stations on the flows, which characterize volumes and water quality flowing from Slovak territory into Danube River, is published in Annex 4.1.

In year 1996 430 gauging stations were upon the flows, which belong to the Danube River basin, of which:

Morava River basin	25
Danube River basin	41
Vah River basin	106
Nitra River basin	36
Hron River basin	68
Ipel River basin	30
Slana River basin	31
Hornad River basin	37
Bodva River basin	10
Bodrog River basin	46

The list of Gauging Stations or Quantity Profiles Corresponding with Water Quality Check Points is in Annex 4.2.

The Slovak Hydrometeorological Institute regularly publishes “Hydrological annual report” where it is possible to obtain data concerning hydrological evaluation of each relevant year. That means data of the gauging stations where discharges were measured whole year, e.g. average month value discharge and extreme hydrological characteristics as well.

Detailed hydrological evaluation on the basis of average daily discharges is worked out for 30 gauging stations. Those stations are part of the monitoring network, purpose of which is to monitor hydrological regime changes, and belong to the frame of the National Climatic Programme of the Slovak Republic.

Annual water temperature assessment is worked out for chosen 9 gauging stations and annual sediment discharges assessment in 9 stations as well.

For the purpose to calculate sediment discharges balance in the Danube River basin, the following 9 profiles are suitable:

- Morava River, profile Zahorska Ves, r. km 32,52
- Danube River, profile Bratislava, r km 1868,75
- Hron River, Brehy, r. km 93,9
- Ipel River, profile Slovenske Darmoty, r. km 89,5
- Slana River, profile Lenartovce, r.km 3,6
- Hornad River, profile Zdana, r.km 17,2

Relevant data of those stations of years 1996 are in Table 4.1.

4.2. Data Quality Control and Quality Assurance

4.3. Data Consistency, Compatibility and Transparency

Slovak Hydrometeorological Institute (SHMI) is responsible for the surface water quality monitoring in the Slovak Republic. Sampling and analytical measurements are realized on the basis of contract between SHMI and Slovak Water Management Authority, actually by its four river basin authorities: Danube River Basin Authority, Vah River Basin Authority, Hron River Basin Authority and Bodrog and Hornad River Basin Authority.

Surface water quality in Slovakia was monitored during year 1997 in 243 profiles belonging to the Danube River basin. The list of basic profiles is in Annex 4.2. There is information about discharge as well: average daily discharge and immediate discharge that belongs to sampling of water. Annex contents the list of surface water sampling stations and gauging stations, or quantity profiles. Sampling stations in year 1997 are in enclosed map.

Surface water quality is assessed by the norm STN 75 7221 “Classification of Surface Water Quality” (Annex 4.3).

The standards describe criteria for sampling and calculations of water quality statements in relation to a complex set of limiting values consisting of different parameters. These parameters are grouped into the following designated groups:

A. Oxygen regime
B. Basic chemical and physical parameters
C. Supplementary chemical parameters
D. Biological and microbiological parameters
E. Radioactivity

The water quality class being applied to a certain point of the river can thus be determined of values obtained in one or several of the groups of water quality parameters.

The Slovak Hydrometeorological Institute defines to the laboratories requirements on the detection limit values for water quality determinants (which should correspond to 10% of limit value set up for I class of water quality in accordance with Slovak classification system) and requirements on using of the standardized methods. The laboratories have also an obligation to provide information about quality system established in laboratory.

The laboratories send data to SHMI in defined structure and units (codes of river basins, rivers, sampling sites, determinants and analytical methods are unified). Apart of data control by laboratories, control is also performed by SHMI. Data needed to be checked (outliners, data that don’t conform to general pattern of a data set) are consulted with representatives of the laboratories. After checking the data are recorded into database system MAGIC and are archived. Also secondary data concerns sampling location, time and date of sampling, analysis methods, etc. are stored. Statistical analyze of data is performed by computerized processing. Limit of detection value is used for statistical treatment in cases when value below detection limit was measured.

The laboratories of River Basin Authorities have developed their internal QA/QC system. Despite of the Hron River Basin Authority, the laboratories are under the accreditation process, realized by Slovak National Accreditation System. The Hron River Basin Authority is planning to start with this process during a year 1998. In the Danube River Basin Authority and the Vah River Basin Authority persons responsible for quality management are already set up. Quality manuals are under preparation process in the Danube River Basin Authority, the Vah River Basin Authority and the Bodrog and Hornád River Basin Authority.

Standardized methods are used exclusively to analytical measurements of surface water samples in each laboratory. The results are well documented and archived. Documentation on maintenance of equipment and calibration is registered in logbooks. Principles of storage and maintenance of used chemicals are set up by each laboratory. Control and documentation in regard with the chemicals are performed by responsible persons.

Surface water sampling, transport conditions, sample conservation and storage before analytical measurements are in accordance with Slovak Technical Standard STN 83 0530, which is in Annex 4.4. Standardized sampling protocols are filled in during the sampling process.

The type of sampling bottle and cleaning procedure are set up for different types of analyses.

Internal quality control is ensured using control charts and analysis of control samples (blanks, spiked samples, replicates) in participating laboratories.

External quality control is realized by participating of laboratories in between-laboratory performance testing, which is organized mainly by National Reference Laboratory for Water in the Slovak Republic. The National Reference Laboratory for Water is also the methodological center for quality assurance of water and water related media analyses and is a part of Water Research Institute in Bratislava. Between-laboratory performance testing is organized in accordance with standards valid in European Union.

NOTE: Slovak Republic is regular member of ISO and affiliated member of the European Commission for Standardization (CEN). In spite of this there is a tendency to take over the European Standards (ES) and incorporate them into Slovak Technical Standards (STN) in field of water and wastewater management.

Great importance is given to continuous increasing of staff qualification in laboratories. The information on completed training courses or studies creates a part of personal documentation of the laboratory staff.

In the frame of the Danube Environmental Programme one of the existing activities is establishing of the Trans National Monitoring Network (TNMN). There are collected water quality data from Danubian countries in selected structure and upon chosen sampling sites. First report, prepared by “Monitoring” working group should be finalized by end of year 1998.

Analytical data produced for TNMN are measured in laboratories using standard QA/QC measures. The analytical methods applied for the analyses are mostly based on valid Slovak standards (former Czechoslovak standards), analytical procedures for organic micropollutants employ chromatographic techniques. Below is listed set of STNs including basic principles of used methods. Regarding the particular problem of phosphorus analysis it has to be stated that phosphorus is analyzed in non-filtered water and is determined as phosphates and total phosphorus.

The data produced by laboratories do not include flood discharges. However, this can be easily done by comparison of chemical and hydrological data.

Slovak Technical Norms applied for surface water analyses:

STN 75 7360	**Water Quality. Determination of Absorbency** *(UV spectrometry at 254 nm)*
STN 75 7530	**Water Quality. Determination of Extractable Organic Halogens.** *(LLE, Na dechlorination in isopropanol, photometric determination with mercury thiocyanate and FeIII in aqueous phase)*
STN 75 7550	**Water Quality. Determination of Chloroform.** *(GC)*
STN 75 7554	**Water Quality. Determination of Fluoranthene.** *(#1 GC; #2 HPLC)*
STN 75 7600	**Water Quality. Determination of Radionuclides. General Regulations.**
STN 75 7611	**Water Quality. Determination of Radionuclides. Gross Activity α.** *(Evaporation, proportional counter)*
STN 75 7612	**Water Quality. Determination of Radionuclides. Gross Activity ß.** *(Evaporation, proportional counter)*
STN 75 7614	**Water Quality. Determination of Radionuclides. Uranium.** *(Adsorption on Silica-gel, complexation with Arsenaso III, photometric detection)*
STN 75 7622	**Water Quality. Determination of Radionuclides. Radium 226.** *(Coprecipitation with barium (II) sulphate, scintillation counter)*
STN 75 7711	**Water Quality. Biological Analysis. Determination of Microscopic View.** *(Determination of groups and species and their number by fluorescent microscopy)*
STN 75 7712	**Water Quality. Biological Analysis. Determination of Abioseston.** *(Microscopic distinguishing of detrite, inorganic particles, etc.)*
STN 83 0530	**Physical and Chemical Analysis of Surface Water.**
	Part 1. General Regulations.
	Part 2. Sampling.
	Part 3. Determination of Temperature.
	Part 4. Determination of pH.
	Part 5. Determination of Odour.
	Part 6. Determination of Colour.
	Part 7. Determination of Turbidity. (Comparation with formazine suspension)
	Part 8. Determination of Transparency. *(Height of the water column, readability of 3.5 cm letters)*
	Part 9. Determination of Dissolved and Non-dissolved substances. (Filtration, evaporation, drying at 105oC)
	Part 10. Determination of Electrolytic Conductivity.
	Part 11. Determination of Dissolved Oxygen. *(#1 Winkler method with Alsterberg azide modification, reaction with Mn (OH) 2, reduction with iodide, titration with thiosulfate with starch as indicator; #2 sensor methods)*
	Part 12. Determination of Alkalinity. *(Titration with strong acid to pH 8.3 [apparent alkalinity] and to pH 4.5 [total alkalinity])*
	Part 13. Determination of Acidity. *(Titration with strong basis to pH 4.5 [apparent acidity] and to pH 8.3 [total acidity])*
	Part 14. Determination of Carbon Dioxide (its forms). *(#1 free carbon dioxide calculated from total acidity [see Part 8.]; #2 carbonates and hydrogencarbonates calculated from total and apparent alkalinity [see Part 7]; #3 total carbon dioxide calculated from concentrations of particular forms; #4 aggressive carbon dioxide calculated from total alkalinity and acidity according to Lehmann and Reuss; #5 determination of aggressive carbon dioxide by marble Heyer test)*
	Part 15. Determination of Hardness. *(EDTA titration with Eriochrome black T)*
	Part 16. Determination of Calcium. *(#1 EDTA titration with murexid; #2 flame AAS)*

Part 17. Determination of Magnesium.
(#1 calculation: hardness-calcium; #2 flame AAS)

Part 18. Determination of Sodium.
(Emission flame photometry)

Part 19. Determination of Potassium.
(Emission flame photometry)

Part 20. Determination of Chlorides.
(#1 argentometric titration; #2 merkurimetric titration with Hg(II) nitrate and diphenylcarbazone)

Part 21. Determination of Sulfates.
(#1 Titration with Lead (II) nitrate and dithizone; #2 Titration with barium (II) perchlorate and thorine)

Part 22. Determination of Phosphates.
(Reaction with ammonium molybdate (VI), reduction with ascorbic acid, photometry at 690 nm)

Part 23. Determination of Silicates.
(#1 Orthosilicates - reaction with ammonium molybdate, photometry at 43o nm; #2 Total silicates - alkali hydrolysis to orthosilicates, then see #1)

Part 24. Determination of Nitrites.
(Diazotation of sulphanilic acid and reaction with N-(1-naphthyl)-ethyldiaminohydrochloride, photometry at 550 nm)

Part 25. Determination of Nitrates.
(Reaction with sodium salicylate, photometry at 410 nm)

Part 26. Determination of Ammonium.
(#1 Reaction with hypochlorite and phenol, photometry at 630 nm; #2 Reaction with Nessler agent , photometry at 425 nm)

Part 27. Determination of Iron.
(#1 Reaction with bipyridile, photometry at 520 nm; #2 flame AAS; #3 Reaction with thiocyanate, photometry at 500 nm)

Part 28. Determination of Manganese.
(#1 Oxidation with peroxosulphate, photometry at 525 nm; #2 flame AAS)

Part 29. Determination of Chemical Oxygen Demand.
(#1 Oxidation with potassium (I) permanganate; #2 Oxidation with potassium dichromate, titration of excessive dichromate with Fe(NH4)2(SO4)2 and ferrosin)/non filtrared water sample/

Part 30. Determination of Fluorides.
(#1 Reaction with Zr(IV), photometric indication with alizarine at 520 - 550 nm; #2 Ionoselective electrodes; #3 Reaction with Zr(IV), photometric indication with Xylenol orange at 540 nm)

Part 31. Determination of Sulphides.
(Reaction with N,N-dimethyl-p-phenylenediamine, photometry at 660 nm; #2 Iodometric titration)

Part 32. Determination of Total Cyanides.
(Reaction with Chloramine T providing chlorocyane that reacts with barbituric acid and pyridine, photometric detection at 580 nm)

Part 33. Determination of Phenols (I)
(#1 Distillation/steam distillation, reaction with 4-aminoantipyrine and ferricyanide, chloroform extraction, photometric detection at 540 nm; #2 Reaction with diazoted p-nitroaniline, photometric detection at 530 nm)

Part 34. Determination of Detergents.
(#1 Anionactive - complexation with methylene blue, chloroform extraction, photometry at 650 nm; #2 Non-ionic - complexation with calcium and tungstatephosphoric acid, reaction with hydrochrome, photometry at 500 nm)

Part 35. Determination of Humic Substances.
(Extraction with amylalcohol, reextraction with sodium hydroxide, photometry at 420 nm)

Part 36. Determination of Oil and Oil Substances.
(#1 acidification, , extraction with carbon tetrachloride or trifluorotrichloroethane, clean-up on silicagel, photometry at 270 nm; #2 acidification, extraction with carbon tetrachloride or trifluorotrichloroethane, clean-up on silicagel, IR spectrophotometry at 3150 - 2750 cm-1)

Part 37. Determination of Biochemical Oxygen Demand.
*(#1 5 x 24 hrs, 20oC, no oxygen and light, aerobic conditions; #2 as previous, with suppression of nitrification)/water sample could be filtareted: 2.5-3.5 micrometer filter, or non-filtrated, Or analyzed after sedimentation. Used method depends on purpose of the analyze/*Part 38. Determination of Aluminium *(#1 Complexation with Eriochromcyanine R, photometry at 535 nm; #2 Reaction with Aluminon, photometry at 525 nm)*

Part 39. Determination of Copper.
(#1 Reaction with dikupral, photometry at 435 nm; #2 MIBK extract, flame AAS)

Part 40. Determination of Silver.

(#1 Reaction with p-dimethylaminobenzilidenrhodanide, photometry at 530 nm; #2 flame AAS)

Part 41. Determination of Zinc.

(#1 Ion exchange isolation, elution by sodium ions, reaction with zinkone, photometry at 625 nm; #2 flame AAS)

Part 42. Determination of Cadmium.

(#1 Reaction with dithizone in carbon tetrachloride, photometry at 515 nm; #2 methylisobutylketone extraction, flame AAS)

Part 43. Determination of Mercury.

(Mineralization, cold vapor flame AAS)

Part 44. Determination of Lead.

(#1 Reaction with diethyldithiocarbamate, carbon tetrachloride extraction, photometry at 435 nm; #2 flame AAS)

Part 45. Determination of Chromium.

(#1 Cr (VI) - reaction with diphenylcarbazide, photometry at 540 nm; Cr total - as previous after peroxosulphate oxidation; #2 Cr (III) - by calculation)

Part 46. Determination of Nickel.

(#1 Reaction with dimethylglyoxime, photometry at 540 nm; #2 flame AAS)

Part 47. Determination of Vanadium.

(Reaction with 8-hydroxychinoline, chloroform extraction, photometric detection at 550 nm)

Part 48. Determination of Arsenic.

(Reduction with hydrogen, reaction with silver diethyldithiocarbamate, photometry at 560 nm)

Part 49. Determination of Selenium.

(Reaction with 3,3'-diaminobenzidine, toluene extraction, photometry at 420 nm)

Part 50. Determination of Barium.

(Flame emission spectrometry)

STN 83 0531 Microbiological Analysis of Surface Water.

Part 1. General Regulations.

Part 2. Sampling and Sample Preparation.

Part 3. Determination of Coliform Bacteria.

(Membrane filtration, cultivation, cytochromeoxidase test)

Part 4. Determination of Mesophilic Microbes - Total Plate Count at 37oC

(Cultivation at 37oC, counting)

Part 5. Determination of Psychrophyllic Microbes - Totl Plate Count at 20oC

(Cultivation at 20oC, counting)

Part 6. Determination of Faecal Coliform Bacteria.

(Direct setting, cultivation at 43oC, cytochromeoxidase test)

Part 7. Determination of Enterococci.

(Direct setting with sodium azide, cultivation at 37oC)

STN 83 0532 Biological Analysis of Surface Water.

Part 1. General Data.

Part 2. Determination of Bioseston.

(#1 Small bioseston; #2 Larger bioseston; #3 Reoseston; #4 Flowing bacteria & fungi)

Part 3. Determination of Abioseston.

(Microscopic distinguishing of detrite, inorganic particles, etc.)

Part 4. Determination of Bentos.

(#1 Macrofauna of slowly flowing waters; #2 Macrofauna of fast flowing waters; #3 Macroflora; #4 Small bioseston of the contact zone)

Part 5. Determination of Periphyton.

(#1 On natural background; #2 On artificial background)

Part 6. Determination of Saprobic Index.

(Calculation according to Pantle and Buck)

Part 7. Prognosis of the Phytoplankton Development.

(Growth of the water flower)

Part 8. Determination of Biogenic Oxygen Production.

(Difference between concentrations of dissolved oxygen after some time with and without contact with light)

REMARK: At present, photometric standardized methods for determination of heavy metals are not widely used in practice. There is increased use of instrumental techniques based on AAS ot ICP.

Additional to above mentioned monitoring activities there exists monitoring of surface water quality with all neighboring countries, which was set up on the basis of co-operation on transboundary rivers. This monitoring is performed by Water Research Institute and some relevant river basin authorities.

This co-operation is treated by bilateral agreement on transboundary waters. The Slovak Republic has signed treaties with all neighboring countries (except the Czech Republic, but treaty is under preparation).

Data from bilateral monitoring in the Danube River basin are available as well, but it is presupposed agreement of both parties. Used analytical methods are agreed by both parties and in some cases are different as in the national monitoring network.

4.4. River Channel Characteristics

4.4.1. Network

Danube River basin covers 96 % territory of the Slovak Republic. Only Poprad and Dunajec River basins belong to other catchment area. The part of Slovak rivers are the direct tributaries of the Danube River at the territory of Slovakia (Morava, Vah, Hron, Ipel, Slana Rivers) and the remaining part of major Slovak rivers (Slana, Bodva, Hornad, Bodrog Rivers) are drained by the Tisa River, which is the tributary of the Danube River at the territory of Hungary.

River	Danube	Morava	Vah	Hron	Ipel	Slana	Bodva	Hornad	Bodrog
Catchment area (km^2)	1 138	2 282	18 769	5 465	3 649	3 217	858	4 414	7 272

The length of the common Slovak-Austrian reach of the Danube is 7,5 km, the length of the Slovak reach is 23,7 km and the length of the common Slovak-Hungarian reach is 140,8 km. The total length of the Danube River from the confluence with the Morava River to the confluence with Ipel River is 172 km (river km 1880,2 – 1708,2). The whole reach is navigable. The scheme of the river network in Slovakia is given on map „Surface Water Resources“

4.4.2. Channel Cross Sections[1]

The administration of major recipients and their tributaries is in the competence of four river basin authorities in Slovakia:

- The Danube River Basin Authority (including sub-basins of the Morava River and the Small Danube, which is the side river branch of the Danube)
- The Vah River Basin Authority (including sub-basins of the Nitra and Zitava Rivers)
- The Hron River Basin Authority(including sub-basins of the Ipel and Slana)
- The Bodrog and Hornad River Basin Authority (including sub-basins of the Bodva and Hornad Rivers)

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[1] **NOTE to the availability of cross sections:**
Channel cross section documentation belongs to individual river basin authorities and its state is very different. Some data are old and they are included in so called “passportization “ form. Requested information concerning cross section must be pick up from this papers by qualified specialist in this field. New documentation could be in digitized form, e.g. such exists for Danube and Morava Rivers.
To obtain requested data, it is necessary to specify channel cross sections and address Slovak Water Management Enterprise, which administers river basin authorities, with request.

In the frame of field investigations, the above mentioned authorities prepared geodetic documents of the rivers in their administration, which contain the following items:

- the cross-sections of both river channels and floodplains
- detailed longitudinal sections of rivers (including tributaries, hydraulic structures, bridges, levees, the sites of water withdrawal, water conduits etc.)
- photogrammetry images, cartographic layouts
- geodetic data of polygons, situated along the rivers, as well as of survey points, situated at the banks of reservoirs.

These documents have been renewed, based at the engineering activities. The Water Research Institute (in co-operation with other institutes, involved in geodesy, geophysics, geology, hydrogeology, petrography, hydrometeorology, radiology, etc.) established publishing of the edition “Hydro-morphological Atlas of Slovak Rivers”. Till now, two atlases have been issued in this edition - the Hron and Nitra Rivers (both from the whole river, from spring to mouth). These atlases contain detailed data of river photogrammetry, cartography, geodesy, hydrology, hydraulics, morphology (including characteristic of river bed material - petrography and mineralogy), analysis of both plain and vertical development (aggravation and degradation) of river bed. The travel time of water in the rivers has been determined for the emergency cases, by means of hydrological, hydraulic and radionuclide methods. The edition of next issues has been stopped because of lack of finances.

The Danube, Morava and Vah Rivers have been investigated mainly from point of view of navigation. The development of the Danube River bed is annually (in the sites of fords more frequently, according to needs) monitored in the whole, 172 km long river reach (in co-operation with Austrian and Hungarian sides), therefore, the cross-sections (in the distance approx. each 50 m) and echosounder contour images(ATLAS SUSY 30) of river bed are available. The deformations of riverbed, caused by the dredging are also monitored in detail. Similar investigations, focused at the possibilities of navigation, have been carried out at the Morava and Vah River (density of cross-sections 50-100m). The research works of both biotic and abiotic processes in the Morava River channel and floodplains, focused at the river training and river restoration, have been carried out in the frame of the project “Introductory solution of the Morava River restoration” (year 1997).

Special documents, dealing with the actual and perspective intentions in the field of water management, so called Water Management Master Plans, which also contain databases, required by the GEF Project, have been prepared.

Hydrological service of the Slovak Hydrometeorological Institute has characteristics of the cross-sections of the gauging stations. With regard to chosen hot spots there are following stations:

Table 4.2. List of gauging stations

Profile	Flow	r. km	Catchment area (km^2)
Senica	Teplica	1,00	152,01
Bratislava	Danube	1868,70	131 331,10
Sturovo	Danube	1718,60	172 438,00
Liptovsky Mikulas	Vah	346,60	1 106,64
Hlohovec	Vah	99,6	10 356,90
Nove Zamky	Nitra	12,30	4 063,66
Banska Bystrica	Hron	175,20	1 766,48
Harmanec	Bystrica	9,00	59,60
Zvolen	Slatina	1,89	790,16
Zvolen	Zolna	0,50	200,74
Lucenec	Krivansky potok	5,40	204,67
Roznava	Slana	51,90	301,53
Spis. Nova Ves	Hornad	132,00	336,53
Humenne	Laborec	73,50	1 266,60
Michalovce-Stranany	Laborec	39,20	1 450,07
Michalovce-Medov	Laborec	105,27	1 629,36
Svidnik	Ondava	113,90	167,50

4.4.3. Gradients

Geological conditions and processes influenced the development of two river systems of the Danube River at the territory of Slovakia:

- Western - Slovakian
- Eastern - Slovakian

The gradients of Slovak rivers, given below, reflect this division.

Danube River:

The average gradient of riverbed in the 400 km long river reach between Passau (Germany) and Sap (former Palkovicovo in Slovakia) is 0,4 per mile. The short transient reach with the gradient of 0,18-0,08 per mile follows then to Komarno. The average gradient drops to 0,06 per mile in the reach 430 km long (to Vukovar in Yugoslavia). At the common Slovak-Hungarian river reach between the river km 1810 and 1820, the river bed gradient suddenly decreases from 0,4 per mile to one third of this value and then to one sixth. The altitude of the Danube riverbed is 157,20 m a.s.l. when entering the territory of Slovakia and 101,43 m a.s.l. when leaving it.

Table 4.3. Morava River

r. km	River bed gradient (per mile)
67 – 45	0,20
45 – 25	0,170 - 0,178
25 – 0	0,23 - 0

Table 4.4. Vah River

r. km	River bed gradient (per mile)
352 – 320	5,42 - 3,12
320 – 265	3,54 -2,5
265 – 240	2,02 -1,43
240 – 110	1,51 - 1,12
110 – 42	0,81 - 0,61
42 – 0	0,16 - 0,06

Table 4.5. Hron River

r. km	River bed gradient (per mile)
292 –266	18,75 - 8,98
266 – 245	4,58
245 – 215	3,95 - 3,18
215 – 177	2,99 - 2,71
177 – 80	1,95 - 1,32
80 – 0	1,11 - 0,62

Table 4.6. Ipel River

r. km	River bed gradient (per mile)
233 - 177,2	13,28
177,2 - 67,2	0,44
67,2 - 0	0,26

Table 4.7. Slana River

r. km	River bed gradient (per mile)
102 – 95	28,3 - 19,12
95 – 86	10,6 - 8,06
87 – 67	5,69 - 4,82
67 – 62	3,49
62 – 58	6,66
58 – 50	3,53
50 – 0	2,92 - 0,46

Table 4.8. Hornad River

r. km	River bed gradient (per mile)
173,3 - 170	42,03
170 - 163	13,84
163 - 158	6,5
158 - 155	13,80
155 - 133	4,54 - 4,45
133 - 127	11,31
127 - 102	3,13 - 2,35
102 - 89	1,70 - 1,45
89 - 86	3,80
86 - 50	4,22 - 2,16
50 - 10	1,86 - 1,11
10 - 0	0,58

Bodrog River:

The Bodrog River basin is the most complicated Slovak basin from the hydrological viewpoint. It is a fan shaped basin, the axis of which is represented by the Ondava River. The Bodrog River is created by confluence of Ondava and Latorica Rivers. The total length of the Bodrog River is 65 km, 16 km of which is at the territory of Slovakia.

The Latorica River is the longest (188 km) river in the Bodrog River basin. Its gradient is 0,05 per mille. The Latorica River joins with the right-sided tributary Laborec River, 15 km upstream the mouth. Gradient of Laborec River in the upper part is 7 - 9 per mille and 0,7 per mille in the lowland part.

4.4.4. Flood Plains

Upon the rivers with big reservoirs (e.g. Liptovská Mara, Zemplínska Šírava etc.) usually there are not flood problems.

Flood occurrence is recorded :

- on the rivers and flows stretches, which are not canalized, usually on smaller flows (e. g. Kysuca, Rajčianka, Torysa).
- on the rivers and flows, which enter to our territory (Morava River) and there are not any reserve space or reservoirs (Latorica and Uh Rivers)

In water management sector there exist 2.780 km of dykes with purpose of flood protection. Following table shows surface of territory, which is endangered by floods and territory protected from floods:

Table 4.9. Surface of territory endangered and protected by flood

Surface of (km^2)					Volume of reservoirs (thousand m^3)	
River basin	**Territory endangered**		**protected territory**	**reservoirs**	**manipulated**	**Retentive**
	By flood		**from foods**			
	Q_{10}	Q_{100}				
D	230,5	273,3	2 632	1,1	3 735	210
V	554	1 306,6	1 090	91,6	912 296	79 099
H	287,8	306,2	220,8	8,4	70 889	3 604
BaH	397	1 087	950	73,3	574 389	107 666
total	1 469,3	2 973,1	4 892,8	174,4	1 561 309	190 579

Note: D – Danube V – Váh H – Hron BaH - Bodrog and Hornád
O_{10} ,Q_{100} - discharge which occur one time per 10, 100 years

Hydrological conditions and characteristics of Danube tributaries are described in detail in report *National Review - Slovakia.*

There is not at disposal more information and map, which are requested for this part of report. Only map from Master Plans is available - „Surface Water Resources“- on which inundation areas are marked. These information in detail contents set of 134 maps /whole SR/ water management maps, 1: 50 000. These maps sells Water Research Institute.

Flood plains areas are marked in “passports”, which are in ownership of individual river basin authorities.

4.4.5. Wetlands

Ramsar Localities in Slovakia

The following wetlands are in Slovakia that are considered internationally unique wetlands, wetlands important for biodiversity, containing ecological or hydrological functions.

Šúr (Nature reserve) - forest and meadow wetlands. Located between the Danube Lowland and Small Carpathian Mountains. Total are is 83.139 ha.

Paris swamps (Nature reserve) - extensive wetland system with reeds and sedges. The Paris steam is located in the southeast part of the Danube Lowlands. This area is an important habitat for nesting and migrating birds and others animals. Total area is 14.059 ha.

Čičov oxbow lake (nature reserve) - Danube oxbow lake, which was cut from the main stream by the creation of a dike. This area is a meadow and bush community. The area is dominated by reeds, cat-tales, sedges and water plants. Important habitat for rare plants and animals. Total area is 7.987 ha.

Senné ponds (Nature reserve) - A series of ponds built in a previously flooded area of the Okna River in the Eastern Slovakian Lowland. This is one of the most significant areas for nesting and migrating birds in Slovakia. This area consists of wet meadows and pastures around ponds with rare vegetation and animal species. Total area is 21.331 ha.

Morava River floodplain area (Protected landscape area of Záhorie) - situated along the Slovak part of the Morava River between the village Brodské and the confluence of the Morava and Danube Rivers. This area preserves a unique system of oxbow lakes, wet meadows and floodplain forests, which maintain a species-rich community of plants and animals. Total area is 4.971 ha.

Danube River floodplain area - area of wetland, forests, oxbow lakes and wet meadows. Within this total area of 14.335 ha are 19 small protected areas.

Latorica - 22 km stretch along the Latorica River in the Protected Landscape Area Latorica. This area is located in the southern part of the Eastern Slovakian Lowland and is composed of wetland forest, oxbow lakes and wet meadows. The total area is 4.358 ha.

SR has sent a request to put new 5 localities into Ramsar register (letter of February 11, 1998). Proposed localities are as follow: Orava River and its tributaries, Poiplie (area along Ipeľ River), Rudava River Aluvium, Wetlands in Turiec area and Wetlands in Orava River basin.

Map of the wetlands in the Slovak Republic is under preparation.

References: Wetlands for Life, publication of DAPHNE Foundation, Bratislava,1996, Ministry of Environment of the Slovak Republic, nature and Landscape Protection Department

Programme “Mapping of Wetlands” is running in Slovakia, responsible is Slovak Environmental Agency. Map is not yet finished, because financial problems. In the SR do not exist data about hydraulic loading of wetlands.

4.4.6. Erosion and Degradation

Modification of Slovak water streams was solved predominantly from point of view of local interests and flood protection. This approach led to “channelization” of water streams, which are not morphological stable. For this reason in many streams water community was significantly changed and selfpurification process of water went down.

Today the intensity of erosion upon more water streams is critical. Deepen stream bottom is in some cases higher than 1 meter. Deep stream erosion has negative influence upon riverbank stability.

Other negative consequence of channel erosion is change in ground water level.

Erosion processes are elaborated (both from the viewpoint of quality and quantity) in the separate documents - Atlases of erosion - sedimentation process, according to their character (sheet erosion, rill erosion, river erosion etc.) and location (Slovak river basins and their main recipients).

4.5. Dams and Reservoirs

4.6. Other Major Structures and Encroachments

The locations of dams and reservoirs including information concerning reservoir purpose, type of dam, its height and length, spillway, gate volume etc. are published in book *Slovak Dams and Reservoir*. Overview about reservoirs with total volume over 1 mill. m^3 is in Table 4.10. and the enclosed map „Surface Water Resources“

Table 4.10. Water reservoirs in Slovakia with total volume over 1 mill. m^3

No.	Basin	Stream	Reservoir	Total volume / mill. M^3/	Max. flooded area / km^2	Decisive purposes
1.	Morava	Teplica	Kunov	2,5	0,63	P, O, R
2.		Hrudky	Buková	1,2	0,36	Z, R, O
3.	Danube	Danube	Gabčíkovo	195,5		E, Pl, R
4.	Váh	Váh	Liptovská Mara	345,5	21,6	O, E, P, Z, R
5.		Váh	Bešeňová	7,4	1,93	E, O
6.		Orava	Orava	345,9	35,06	E, O, P, Z, R
7.		Orava	Tvrdošín	4,4	0,92	E, O
8.		Váh	Krpeľany	8,3	1,26	E
9.		Bystrica	Nová Bystrica	36,9	1,91	V, O
10.		Váh	Hričov	8,5	2,53	E
11.		Váh	Nosice	36,0	5,7	E, R
12.		Váh	Dolné Kočkovce	2,1	0,5	E
13.		Váh	Trenčianske Biskupice	3,3	0,9	E
14.		Váh	Sĺňava	12,3	4,3	E, P, Z, R
15.		Váh	Kráľová	51,8	11,7	Z, E, R, P, O
16.		Kostolník	Dubník	1,1	0,22	O, R, Z
17.		Holeška	Čerenec	1,4	0,46	O, P, Z, R
18.		Trnávka	Boleráz	2,5	0,78	O, P, Z, R
19.	Nitra	Nitrica	Nitrianske Rudno	3,7	0,72	P, R, O
20.	Hron	Slatina	Hriňová	8,2	0,51	V
21.		Slatina	Môťová	2,8	0,59	P, R, O
22.		Hron	Veľké Kozmálovce	4,7	1,48	P, Z, R
23.		Jabloňovka	Bátovce	1,0	0,26	Z, R
24.	Ipeľ	Ipeľ	Málinec	24,9	1,38	V, O
25.		Budínsky potok	Ružiná	13,7	1,7	P, Z, R, O
26.	Slaná	Klenovecká Rimava	Klenovec	8,9	0,68	V, O
27		Blh	Teplý Vrch	5,2	1,2	Z, R, O
28.	Bodva	Ida	Bukovec	23,4	1,05	V, O
29.		Ida	Pod Bukovcom	2,2	0,32	R, P
30.		Turňa	Hrhov	3,8	2,49	R
31.	Hornád	Hnilec	Palcmanská Maša	11,1	0,86	E, R
32.		Hornád	Ružín	59,0	3,9	E, P, R, O
33.		Hornád	Malá Lodina	3,7	0,65	E, O
34.	Bodrog	Cirocha	Starina	48,7	2,76	V, O
35.		Laborec	Zemplínska Šírava	304,0	32,1	P, Z, R, O
36.		Okna	Senné	1,3	1,0	R
37.		Laborec	Beša	53,0	29,03	O - dry polder
38.		Ondava	Veľká Domaša	187,5	14,9	P, Z, R, E, O
39.		Ondava	Malá Domaša	1,0	0,54	E
40.		Chlmec	Veľké Ozorovce	1,2	0,38	R

* *O - flood protection Pl - navigation P - industry*
Z - irrigation E - hydropower V - public drinking water supply R - recreation

For drinking water supply are used reservoirs: Bukovec, Hriňová, Klenovec, Málinec, Nová Bystrica, Rozgrund and Stariná. Area of these reservoirs has a special regime with the aim to protect hygienic quality of water.

Detail information about reservoirs in each river basin and sub-basin and about utilization of hydro-energy is published in report *National Review-Slovakia.*

During more than 30 years of the operation almost 12,7 million m^3 of reservoir volume have been lost due to sedimentation. This amount represents 35 % of the original reservoir volume.

The most significant volume of the sand and gravel bed material was dredged on the river Danube in order to protect the riverbed from sedimentation (the river reaches with sediment aggravation), for navigation purposes and also for commercial purposes /Annex 4.4./. The volumes of dredged and gravel mining occurred on the Danube River over the period of 60th and 70th. Since 80th the annual amounts of dredged material continually has decreased.

The volumes of a dredged material on the further Slovak rivers were substantially smaller and these amounts do not effected the morphological development of the river channel significantly.

4.7. Major Water Transfers

Water transfers, like water reservoirs facilitate regulation of outlet upon the flows and this way better utilization of water sources. Water management contribution of water transfers is possible to heighten substantially in connection with reservoirs. Purposes of water transfer are as follows: drinking water supply, irrigation, hydropower using, improvement of water quality in other catchment, supply small reservoirs and ponds etc.

Water transfers in year 1996 including information concerning relevant river basins shows Table 4.4.

Table 4.11. Water transfer in year 1996

No.	From flow	River basin	Into flow	River basin	Volume (thousand m^3)	Discharge (m^3/s)
1	Danube	Danube	Small Danube	Small Danube	697 980,7	22,072
2	Turiec	Vah	Hron	Hron	13 367,117	0,423
3	Nitra	Vah	Mala Nitra	Vah	22 101,119	0,699
4	Zitava	Vah	Stara Zitava	Vah	5 918,227	0,187
5	Hron	Hron	Perec	Hron	68 468,547	2,165
6	Krivansky creek	Ipel	Budinsky creek	Ipel	3 883,42	0,123
7	Hnilec	Hornad	Slana	Hron	42 422,486	1,342
8	Topla	Bodrog	Manov channel	Bodrog	18 094,579	0,572

4.8. Preferred Sampling Stations and Data Sets

For top ten municipal and industrial hot spots average values of chosen water quality parameters in upstream and downstream checking profiles are listed in Tables 2.8. and 2.13. Data were taken over from annual report “Surface Water Quality in Slovakia” from years 1995-1996, published by SHMI.

List of upstream and downstream municipal pollution source profiles is in Table 2.9. and in Table 2.14. for industrial pollution sources. Profiles relevant to hot spots are marked in the map „Significant Pollution Sources and main Profiles of the State Water Management Balance“.

It is necessary to take in consideration the fact, that qualitative downstream check profiles include not only pollution source impact, but they could include other factors as well (e.g. tributary etc.)

Data sets for years 1994 - 1997 for discharges related to Danube water quality in profiles of entering and leaving our territory are published in Tables 4.12. and 4.13.

Water quality of the Danube tributaries short of Danube confluence (Morava, Váh and Hron Rivers) and in profiles short of Slovak border leaving (Ipeľ, Slaná, Bodva, Hornád, Bodrog) is in Table s 4.14. and 4.20.

Trans National Monitoring Network (TNMN) includes on our territory following profiles on Danube and Vah Rivers:

- Danube Bratislava, r. km 1869
- Danube Medveďov/Medve, r. km 1806
- Danube Komárno/Komarom, r.km 1768
- Váh Komárno, r. km 1,0

TNMN was set up in the framework of the Danube Environmental Programme and Sub-Group for Monitoring, Laboratory and Information Management is responsible for the preparation /namely working group Monitoring/. The Final Yearbook 1996 should be at disposal about by end of 1998. For this reason it is not necessary to collect more information in this report.

The Slovak Hydrometeorological Institute in Bratislava, belonging to guidance of the Ministry of Environment of the Slovak Republic, is responsible for water quantity and quality monitoring and collects data from responsible institutions /river basin authorities, regional hydrometeorological institutions/ from whole SR. Also it publishes annual and other relevant reports.

Address: Slovak Hydrometeorological Institute, Jeseniova 17, Bratislava

NOTE: For purpose of GEF project solution /e.g. request for some additional data etc./ it is necessary to contact responsible persons in the Water Protection Department of the Ministry of Environment

4.9. Water Discharges

List of gauging stations in the Danube River basin on Slovak territory is in Annex 4.5.

Hydrographs:

In Annex 4.6. are published hydrological data for years 1994 - 1996 /data of year 1997 will be available later this year/ related to water quality monitoring stations - Danube and its tributaries.

Discharge measurement exists for following of water quality monitoring stations:

Danube – Bratislava	/r.km 1879,78/
Slaná – Lenártovce	/r.km 3,6/
Hornad – Ždana	/r.km 17,2/
Bodrog - Streda nad Bodrogom	/r.km 5,2/

NOTE: small differences exist in **r.km** in some of above listed profiles

Tables in Annex include:

Daily discharge
average month discharge
year maximum discharge
year minimum discharge
year average discharge
average daily discharge curve /except Danube-Bratislava,1996/

To other water quality monitored localities do not exist discharge measuring. There is more or less far discharge measuring or measuring of “water stage” /H/, or do not exist in form as above /e.g. Hron/

Morava
Devínska Nova Ves H /r.km 8,28/ *discharge is measured in r. km 9,6 -Borinka*

Váh
Komárno H /r.km 0,05/ *discharge is measured in r.km 58,5 -Sala*

Hron
Kamenín *4discharge measured in r. km 10,9*

Ipeľ
Vyškovce nad Iplom *discharge measured in r. km 46*

Bodva
Hosťovce *discharge measured in r. km 0,20*

Dunaj
Šturovo H /in r. km 1718,6/ *discharge measured in r. km 1763,96 -Iza*

To those 5 stations with measuring of discharge /does not exist for Morava-Devinska Nova Ves/ are tables “Average Month and Extreme Discharges” published in the report “Hydrological Annual Report - Surface Waters, 1996“ /issued by the Slovak Hydrometeorological Institute, Bratislava,1997/.

For solution of some other requests is necessary to consult with relevant department of this institute, if it is possible to handle existing data with aim to fulfill requests.

For some profiles there exist following tables:

„Maximal mean daily discharges in month” /years 1994-1996/ - Annex 4.7.

“Minimal mean daily discharges in month” /years 1994-1996/ - Annex 4.8.

Basic available data for flow duration curves /curves are not prepared/ of the Danube and its tributaries from years 1994 - 1996 are published in Annex 4.9.

Data of year 1997 are not yet handled.

4.10. Sediment Discharges

4.11. Suspended Sediment Concentration

Sediment discharge balance for last available year 1996 is in Table 4.1. Daily measuring of sediment discharged is performed only in few stations:

Danube - Bratislava
Morava - Záhorská Ves
Hron - Brehy
Ipeľ - Slovenské Ďarmoty
Slaná - lenartovce
Hornád - Ždaňa

Data of years 1994 - 1996 are in Annex 4 - 10. Each table contains:

daily concentration of sediment discharge /mg/l/
sum for month and year
average, maximum and minimum values for individual month and for year
mean sediment discharge /kg/s/, in tables as **MSD**
year runoff of sediment discharge /t/, in tables as **YRSD**
specific year runoff of sediment discharge /t/km^2/, in tables as **SYRSD**
curve for year

NOTE: from viewpoint of this report the data from the following stations important:

Danube-Bratislava, Hron-Brehy, Ipel-Slovenske Darmoty, Slana-Lenartovce, Hornad-Zdana.

Others, which are not listed in the annex, are: Poprad-Chmelnica, Nitra-Nitrianska Streda, Kysuca-Kysucke Nove Mesto, Topla-Hanusovce. On disk exists whole information.

4.12. Water Quality Data

Water quality data related to chosen 10 municipal and 10 industrial hot spots are published in this report as well as data of main Danube tributaries and key profiles of the Danube that means inflow and outflow from country. Those data give picture about water quality.

Beside of mentioned Final Report on Nutrient Balances for Danube Countries”, following reports should be mentioned:

- Study on Removal of Phosphate from Detergents in Countries in the Danube Basin
- Quality of Sediments and Biomonitoring
- Danube Regional Pesticide Study

In the frame of national research was prepared report „Solution of Agricultural Non Point Sources Reduction with regard to Surface and Ground Water. Report was prepared by Mr. M. Lichvár and issued by Water Research Bratislava, 1995.

Research in this report was realized on small river basin with aim to prepare proposals for good agricultural practice.

5. Legal and Institutional Framework for Water Quality Control

Relevant umbrella legislation, enabling legislation and regulations

Environmental protection in Slovakia (until December 31, 1992 Czechoslovakia) has been started mainly after year 1990.

The main document of the Slovak Republic - Constitution - defines the main principle in article 45 that every citizen has a right to a favorable environmental has a duty to protect this environment.

Complete list of laws and regulations concerning environment protection is at disposal at the Ministry of Environment of the Slovak Republic. This part of the report is focused to water protection legislation and related laws.

Relevant umbrella legislation:

17/1992 Coll., Act on Environment (Amendment: 127/1994 Coll. and 287/1994 Coll.) stipulates the basic concepts and determines the basic principles of environment protection and improvement of environment conditions and for the utilization of natural resources as well as it follows from the principles of permanently sustainable development.

595/1990 Coll., Act. on State Administration for Environment (Amendment: 494/1991 Coll., 134/1992 Coll., 87/1994 Coll., 222/1996 Coll.)

The State Administration in the matters of creation and conservation of environment is executed by

- the Ministry of Environment as central body of state environmental administration and
- District Offices
- Regional Offices
- Slovak Inspectorate for Environment
- municipalities (in case of commission by law)

The care for environment according to the Act should be comprehended as: nature protection, protection of the quality and quantity of waters and their rational utilization, air protection, spatial planning and Building Order, waste management.

Ministry of Environment secures a unified information system on environment including spatial monitoring in the territory of Slovak Republic.

138/1973 Coll., Act on the Water (Water Act) is basic law in water protection branch, which sets up basic duties in water management. The aim of this Act is to widely preserve water for its notability to be replaced and whole society meaning, to plan its usage and other handling with it, so that the balance between usage of water and the capacity of water resources is achieved, to take care of its purity and the most effective usage, to arrange protection against flooding and at the same time to preserve the nature, recreation, shipping and other important interests of society.

The distribution of key mandates through the government hierarchy

Water resource management and exploitation in the Slovak Republic is divided between three section ministries: the Ministry of Environment, the Ministry of Soil Management and the Ministry of the Interior.

The Ministry of Environment controls decision process in the area of state administration (legislation, law enforcement), inspection, and the preparation of technical documentation for state administration.

The Ministry of Soil Management is more body of economic management in the area of watercourse management, maintenance and development, public water supply, village and city sewerage.

In the sector of the Ministry of the Interior are established Regional and District Offices, part of which are Environment Departments (air, water and nature protection, waste management). Methodological guidance of these departments is administered by the Ministry of Environment.

From point of view of the water branch the Ministry of Environment governs Environment Department in the District and Regional Offices (in case of commission by law - on municipal level as well), the Slovak Environmental Inspection and the Slovak Hydrometeorological Institute. The sector of the Ministry of Soil Management includes Slovak Water Management Enterprise, state river basin enterprises, Water Research Institute, Hydroconsult and Water Management Construction.

Ministry of Environment:

The current water management legislation constitutes water management authorities, which perform the state administration of water. District and regional environmental authorities perform state administration on the regional level. The Ministry of Environment of the Slovak Republic is the supreme body of the state administration of water and is the highest appeal body as well.

Water management authorities decide about the withdrawal of surface and ground water, as well as about wastewater discharge into surface and ground water. They are special construction authorities, which authorize the construction of water management facilities, and issue certificates. They are in charge of issuing planning permissions and permissions for activities that may influence the water situation. This concerns especially objects built on waterways, long distance pipelines, storage places for substances dangerous to water quality, and the construction of communications. Bodies issuing such planning permissions are bound by an approval from the corresponding water management authority.

An important responsibility of water management authorities, required by the Water Law, is water management inspection. Within the framework of this inspection activity, water management authorities verify whether duties imposed by the Water Act or by water management authorities are performed. The Ministry of Environment of the Slovak Republic is in charge of the main water management inspection. In the order to carry out this responsibility, the Ministry runs the Slovak Environmental Inspection, which verifies whether requirements specified in permissions are fulfilled, especially in the area of water protection and management. Water management authorities are authorized to impose measures in order to correct discovered shortcomings. They are obliged to sanction those who do not perform their duties. Fines are imposed according to the actual illegal activity specified in the Water Act.

Under auspices of the Ministry of Environment are regularly prepared “Drainage Areas Hydroecologic Plans” and “State Water Management Balance”.

Slovak Hydrometeorological Institute is sectoral institute, which deals with problems of the area: meteorology, climatology and hydrology and nature environment protection. From point of view of water, there are solved water quality and water quantity aspects, water balance, international information exchange concerning water in accordance with the agreement, e.g. performs monitoring, prepares and publishes annual reports „Water Quality in Slovak Rivers“ and „Ground Water Quality in Slovakia“ and other documents and reports for section of the Ministry of Environment.

Ministry of Soil Management:

The length of the Slovak river network is about 44.000 km. The Slovak Water Management Enterprise governs 4 state river basin enterprises. Besides them watercourse management is performed also by state forest organizations, and army forest organizations.

At present the river basin enterprises manage more than 24,000 km of rivers, out of which about 29 % is regulated. The enterprises manage 260 water reservoirs, which include 42 big water reservoirs. The reservoir volume under control represents about 1.803 mil. m^3. Besides this they manage 562 pump stations, 11 locks etc.

Basic duties of the river basin enterprises (and also other administrators) in watercourse management are specified by the Water Act and relevant regulations. River basin enterprises are responsible for:

- the management, operation and maintenance of watercourses, dams, and water management facilities built on them
- conditions for surface water supply to all sectors of the national economy, including the construction of new water supply systems
- performance of surface water quality monitoring on the basis of agreement with Slovak Hydrometeorological Institute
- preventive work in the vicinity of waterways and water dams in order to provide protection against unfavorable influence of water
- performing tasks required by flood plans and decision taken by flood committees during flood activity
- performing construction and erection works, and extraction of riverbed material
- activities connected to the managed border rivers, and activities, that are required by special agreements about border waters
- water carriage, creating conditions for the exploitation of the hydroenergetic potential of rivers
- the management, operation, maintenance, repairs, reconstruction, and modernization of irrigation and drainage systems

Water works is the complex of the objects and facilities for mass supplying of citizens with water, and for covering the need for water for national economy and villages, towns and cities sewerage. At current starts process of change of the ownership from the state to the municipalities.

Water Research Institute is sectoral institute that deals with many aspects of water quality and quantity, including preparation regular reports for ministries, scientific research, monitoring of transboundary rivers etc.

The National Reference Laboratory for water analyses was established in the Water Research Institute in co-operation of the Ministry of Environment, the Ministry of Soil Management and the Ministry of Health.

Hydroconsult is project organization for the water management sector and the Water Management Construction realizes structures in the same sector.

In the scope of the Ministry of Soil Management are regularly prepared “Water Management Plans”.

Under auspices of both Ministries was prepared a „General Plan for the Protection and Effective Utilization of Water“. It is unifying document with a national wide scope and is approved by the Slovak Government.

Applicable standards

Most important Laws and Regulations from water management sector and related to this sector are as follows:

General Environment:

127/1994 Coll., Act on Environmental Impact Assessment regulates the procedure for the overall expert and public assessment of constructions and facilities under construction and other activities specified under this Act.

128/1991 Coll., Act on the State Fund of the Environment of the Slovak Republic (Amendment: 311/1992 Coll. and 58/1995 Coll.). The State Fund of the Environment of the Slovak Republic has been established with the purpose to gather financial resources and use them for the support of the environment.

The Fund sources in the protection of water quality and quantity and their rational using are especially:

- charges for wastewater discharges to surface waters
- penalties imposed by the state administration authorities in the water management
- contribution from the state budget SR

176/1992 Coll., Regulation of the Slovak Commission for the Environment on Condition for the Provision and Use of Finances of the State Fund of the Environment of the Slovak Republic adjusts conditions for the provision of finances of the State Fund of the Environment of the Slovak Republic. The Fund is internally structured as follows:

- a section for the protection of the quality and quantity of water and water rational use
- a section for air protection
- a section for nature protection
- a section for waste management
- a general section

Water Protection Legislation:

318/1991 Coll., Act on State Water Management Fund of the Slovak Republic (Amendment: 58/1995 Coll. and 304/1995 Coll.). The Fund is used to cover concrete developmental water management constructions, hydro-geological research, removal of accidents in water structures, development of sciences and technologies.

Sources of this Fund are as follows:

- charges for the ground water consumption
- subsidies from the state budget SR for development
- loans from financial institutions
- interests from the Fund sources
- gifts and contributions by legal and physical entities

23/1977 Coll., Regulation of the Ministry of Forest and Water Management of the Slovak Socialist Republic on Protection of the Quality of Surface and Ground Water deals with the manipulation of the materials, endangering the quality or health harmless quality of water. This Regulation sets up detail conditions for water protection and list of harmful substances.

242/1993 Coll., Governmental Order of the Slovak Republic, which provides the indicators of the permissible degree of contamination of waters. In permitting of discharging of waste and special waters into surface waters the water management authority proceeds according to indicators of the admissible degree of contamination of waters which have been specified in annexes No. 1 to 3 of this decree.

135/1974 Coll., Act on State Administration in Water Management in paragraph 16 sets up function of the factory and business water managers. The organizations, which withdraw, or otherwise use the water or drain waste, respectively extraordinary water, in the quantity and the quality, over the level determined by the Ministry, after the agreement with relevant central bodies, are obliged to take actions, in order to arrange qualified workers (factory and business water manager) for professional managing with water and cleaning waste water.

31/1975 Coll., Governmental Order on Penalties for infringing of obligations provided in the sector of water management defines cases in which water management authorities impose penalties. It especially concerns:

- water withdrawal without permit issued by the water management authority
- discharge of waters without permit issued by the water management authority or contrary to it
- pollution of surface or ground waters or endangering their quality or health unexceptionable through manipulation with the substances harmful to water
- damage of the public water supply or public sewage
- breaching of other duties determined by the above acts or duties imposed by them

35/1979 Coll. Governmental Order on the Charges in the water management (Amendment: 91/1988 Coll. and 235/1996 Coll.) sets up system of charges, valid equally for the whole territory SR:

- the charges for the water consumption from water streams
- the charges for the ground water consumption
- the charges for discharging of wastewater to surface water

154/1978 Coll., Regulation of the Ministry of Forest and Water Management of the Slovak socialist Republic on Public water supply and public sewerage (Amendment: 15/1989 Coll.) sets up management and operation of the public water supply and public sewerage and general conditions for this operation as well. There is established the obligation of the payment for drinking water supply from public water supply and for waste or rain water draining.

NOTE: All above mentioned Acts, Regulations and Governmental Orders are at disposal in special report "*Legal Framework for Water Quality*", which is annex of main documents prepared in the frame of the GEF Project "Pollution Reduction in the Danube River Basin".

Other Regulations from water management area:

- ***117/1976 Coll. Regulation of the Ministry of Forest and Water Management of the Slovak socialist Republic on Slovak Water Management Inspection***
- ***66/1976 Coll. Regulation of the Ministry of Forest and Water Management of the Slovak Republic on Water Managers***
- ***32/1975 Coll. Governmental Regulation on the Protection against flooding***
- ***46/1978 Coll., Act on Protected Region of Natural Accumulation of Water in the Žitný Ostrov as amended by the Act 52/1981***
- ***13/1987 Coll., Act on some Protected Regions of Natural Water Accumulation***

- ***169/1975 Coll., Regulation of the Ministry of Forestry and Water Management on professional technical and safety supervision at some water management works and on technical and safety supervision of national committees***
- ***170/1975 Coll., Regulation of the Ministry of Forestry and Water Management on obligations of organizations to deliver reports on findings of underground waters and to report information about supplying the same***
- ***158/1976 Coll., Regulation of the Ministry of Forestry and Water Management on water guards as amended by Regulation 112/1978***
- ***24/1977 Coll., Regulation of the Ministry of Forestry and Water Management on water management records***
- ***34/1977 Coll., Regulation of the Ministry of Forestry and Water Management on use of surface water for the sail of motor boats***
- ***6/1978 Coll., Regulation of the Ministry of Forestry and Water Management stipulating obligations of water flow managers and some issues related to water flows***

At present time a new Water Act and related Regulations and Governmental Orders are being prepared.

Relevant International Agreement

The Slovak Republic has signed bilateral agreement with all neighboring countries except the Czech Republic. This agreement is under preparation and will be signed soon.

For each bilateral co-operation was established the Committee for Transboundary Waters, which deals with all aspects of water quality and quantity.

From point of view of water resources protection and their sustainable use are most important:

- ***Convention on the Protection and Use of Transboundary Watercourses and International Lakes***
- ***Convention on Cooperation for the Protection and Sustainable Use of the Danube River***

Convention on the Protection and Use of Transboundary Watercourses and International Lakes:

The Slovak Republic is in the process of accession to this Convention now. Under auspices of the UN/ECE was set up Task Force for Monitoring and Assessment of Transboundary Waters, which governs activities concerning monitoring and assessment of surface and ground transboundary water. In the practice has been started co-operation on pilot projects with three neighboring countries:

Ipeľ River (Hungary)
Morava River (Czech Republic)
Latorica and Uh (Ukraine)

Objective of the pilot projects is verification of the “Guidelines for Monitoring and Assessment of Transboundary Rivers” that was prepared by the Task Force.

Convention on Cooperation for the Protection and Sustainable Use of the Danube River (Danube Convention) :

The Slovak Republic ratified this Convention in year 1997. Under auspices of the Heads of Delegations of the Danubian countries was in the frame of this Convention set up Expert Group „Emission“

Since year 1992 is working the Danube Environmental Programme, which is very extensive and well known in the Danube region. Activities of this Programme will take over Danube Convention.

The representatives of the Slovak Republic are members of all relevant expert and working groups.

Other relevant agreement:

The Slovak Republic has acceded to the following international Conventions (Protocol to the Conventions):

- ***Convention on Wetlands of International Importance Especially as waterfowl Habitat*** (Ramsar Convention)
- ***Convention on the Protection of the World Culture and Natural Heritage***
- ***Convention on International Trade in Endangered Species of Wild fauna and Flora***
- ***Convention on Long-Rang Transboundary Air Pollution*** (and other air protection relevant conventions and protocols)
- ***Convention on Biological Diversity***
- ***Convention on the Conservation of Migratory Species of Wild Animals*** (Bonn Convention)
- ***Convention on the Conservation of European Wildlife and Natural Habitats*** (Bern Convention)

Tables

to the Chapter 2
“Updating of Hot Spots”

to the Chapter 3
“Identification of Diffuse Source of Agricultural Pollution”

to the Chapter 4
“Updating and Validation of Water Quality Data”

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Table 2.7. Municipal hot spots (year: 1996) Emission into the Danube River basin

No	Name of Hot-Spot Locality	Receiving Water		Number of Inhabitants	Share of Industrial Waste Water
		Name r.km	Q_{355} m^3/s	connected to WWTP (PE)	%
1	VK Kosice	Hornad 24.3	6,28	219.864	23
2	VK Nitra	Nitra 52.5	3,50	88.206	43,6
3	VK Malacky	Malina branch 1.6	0,380	11.326	26,6
4	VK Banska Bystrica	Hron 168.4-181-172.1 Selcian.creek 2.3-2.2-2.1-2.0-1.8 Bystrica 3.2-2.6-1.8-1.5-0.8 Malach. creek 2.0-1.6	8,1	81.572	60,6
5	VK Michalovce	Laborec 34.2	1,474	41.297	
6	VK Svidnik	Ondava 117.2 115.3	0,216		
7	VK Trencin, Right bank	Zlatov. creek 2.8	33,270		
8	VK Humenne	Laborec 63.4	1,247	36.102	
9	VK Ruzomberok	Vah 314.8	Qg: 10	122.774	
10	VK Topolcany	Nitra 93.4	2,943	29.560	63

Table 2.7. continued

No	Name of Hot-Spot Locality	Wastewater	Discharged Pollution t/y						
		Volume T. m^3/y	BOD (5 d)	COD (Cr)	susp. solids	NEL	N-NH4	Total N	Total P
1	VK Kosice	39420,000	1182,6	2956,9	2759,4	59,13	245,67		36,24
2	VK Nitra	11687,940	1262,3	2037,2	1085,8	2,45	170,64		26,65
3	VK Malacky	2 333,24	151,7	315	170,3	2,4	27,07		
4	VK Ban.Bystrica Hron Selciansky creek Bystrica Malachovsky cr.	17975,520 283,836 331,128	1092,9 13,7 10,5	2876,1 39,1 33,1	1006,6 16,8 14,1	30,02 0,25 0,15	76,22 1,71 1,71	194,1 3,4 2,9	19,59 0,2 0,34
5	VK Michalovce	7096,600	425,7	922,4	319,3	17,74	83,83		15,43
6	VK Svidnik	630,720 378,432	69,4 45,4	176,6 98,4	61,3 37,8		0,95		
7	VK Trencin, r. b.	1856,241	455,9	942,8	146,6	1,37	15,96		1,47
8	VK Humenne	9618,480	500,2	865,7	432,8	14,43	97,93		18,32
9	VK Ruzomberok	25 349,9	529,8	4471,7	1622,4	10,55	55,77		10,7
10	VK Topolcany	3326,220	194,5	326,3	171,3	0,40	74,17		8,55

NOTE: *EL:* *non-polar extractable substances*
S: *suspended solods*
g: *guarantee discharge*

Table 2.8. Municipal hot spots (year 1996)
Water quality deterioration

No.	Name of Hot Spot	Dillution factor (l/s)			Lenght of Receiving Water Influenced by
	Locality	Q_{355}	up down	Q_{mean}	Hot Spotd
1	VK Kosice	4383	6280	1250	more than 20 km
2	VK Nitra	3420	3500	371	more than 15 km
3	VK Malacky	203	380	74	more than 20 km
4	VK Banska Bystrica	6155	8100	570	more than 15 km
5	VK Michalovce	1300	1474	225	more than 15 km
6	VK Svidnik	78	216	32	more than 20 km
7	VK Trencin, right bank	33120	33370	59	more than 20 km
8	VK Humenne	613	1247	305	more than 20 km
9	VK Ruzomberok	8050	10000	803	more than 20 km
10	VK Topolcany	2735	2943	105	more than 15 km

Qmean: mean discharge of waste water

Table 2.8. continued

No	Name of Hot Spot Locality	Ambient Water Quality (1995 - 1996) mg/l											
		BOD 5		BOD Cr		NEL		$N\text{-}NH_4$		$N\text{-}NO_3$		Total P	
		Up down	Class	up down	Class	up down	Class	up down	Class	up down	Class	up down	Class
1	VK Kosice	5,4	III	12,7	II	-	-	0,143	I	2,756	III	0,1171	III
		6,3	III	17,0	III	0,033	III	0,724	IV	2,946	III	0,2420	IV
2	VK Nitra	4,7	III	19,4	III	0,057	IV	0,788	IV	3,054	III	0,2546	III
		5,7	III	21,1	III	0,988	IV	1,000	IV	2,916	III	0,3008	IV
3	VK Malacky	-	-	-	-	-	-	-	-	-	-	-	-
		4,9	III	22,3	III	0,053	IV	0,691	IV	4,045	IV	0,3063	IV
4	VK Banska Bystrica	5,4	III	22,2	III	0,148	IV	0,544	III	1,257	II	0,1217	III
		5,9	III	22,0	III	0,282	V	0,521	III	1,300	II	0,1458	III
5	VK Michalovce	3,4	II	13,5	II	0,055	III	0,681	III	1,888	II	0,0285	II
		3,5	II	14,6	II	0,124	IV	0,843	III	1,579	II	0,0314	II
6	VK Svidnik	3,7	III	10,9	II	0,039	III	0,137	I	1,092	II	0,0455	II
		4,7	III	11,7	II	0,040	III	0,335	III	1,465	II	0,1161	III
7	VK Trencin,r.b	3,3	II	12,9	II	0,040	IV	0,253	II	1,943	II	0,0858	II
		10,7	IV	31,6	IV	0,150	V	0,759	III	1,923	II	0,1979	IV
8	VK Humenne	3,1	II	12,3	II	-	-	0,283	III	1,336	II	0,0256	II
		3,5	II	13,8	II			0,604	III	1,591	II	0,0294	II
9	VK Ruzomberok	3,4	II	11,5	II	0,010	-	0,161	II			0,0442	II
		2,9	II	17,1	II	0,0153	III	0,285	II			0,0826	II
10	VK Topolcany	4,4	III	28,7	IV	0,125	V	1,031	IV	-	-	0,2746	IV
		4,5	III	22,8	IV	0,121	V	0,826	IV			0,2414	III

NOTE up: upstream
down: downstram
Cl: class

Table 2.9. Municipal hot spots check river points of receiving water

N o	Hot Spots Lokality [Name of Catchment]	Receiving water	Check River Point		
		Name r.km	Upstream	Downstream	Remark
			r.km		
1	**VK Košice** [Hornad]	***Hornád*** 24,3	***Hornád*** Krásná n.Hor. 27,0	***Hornád*** Ždaňa 17,2	*r.km 22,1 tributary Torysa - Q_{355} 1,235 m^3/s* *r.km 18,2 tributary Olšava - Q_{355} 0,088 m^3/s*
2	**VK Nitra** [V8h]	***Nitra*** 52,5	***Nitra*** Lužianky 65,1	***Nitra*** Čechynce 47,8	
3	**VK Malacky** [Morava]	***Rameno Maliny*** 1,6 (Malina - 23,6)	-	***Malina*** Zohor 4.2	
4	**VK Banská Bystrica** [Hron]	***Hron*** 168,4 - odtok z ČOV; 181,0; 172,1 ***Selčiansky p.*** 2,3; 2,2; 2,1; 2,0;1,8 ***Bystrica*** 3,2; 2,6; 1,8; 1,5; 0,8 ***Malachovský p.*** *2,0; 1,6*	***Hron*** Banská Bystrica 175.8	***Hron*** Sliač 161.1	
5	**VK Michalovce** [Bodrog]	***Laborec*** 34,2	***Laborec*** Petrovce 45,1	***Laborec*** Lastomír 31,0	*r.km 37,2 tributary Zálužický kanál* *(outlet from Zemplínska Šírava reservoir)*
6	**VK Svidník** [Bodrog]	***Ondava*** 115,3	***Ondava*** nad Svidníkom 125,1	***Ondava*** pod Svidníkom 113,9	
7	**VK Trenčín** prav8 strana [V8h]	***Zlatovský p.*** 2,8 (Váh - 159,6)	***Váh*** Trenčín 165,1	***Váh*** Opatovce 157,2	*r.km 162,5 WWTP Trenčín-ľavá str.*
8	**VK Humenné** [Bodrog]	***Laborec*** 63,4	***Laborec*** nad Cirochou 69,9	***Laborec*** Beckov 59,9	*r.km 68,5 tributary Cirocha - Q_{355} 0,504 m^3/s*
9	**VK Ružomberok** [Váh]	***Váh*** 314,8	***Váh*** Lisková 324,9	***Váh*** Hubová 308,8	*r.km 322,4 CELPAP* *r.km 321,5 SUPRA* *r.km 320,95 tributary Revúca - Q_{355} 1,280 m^3/s*
10	**VK Topoľčany** [V8h]	***Nitra*** 93.4	***Nitra*** Práznovce 98,0	***Nitra*** Nitr. Streda 91,1	*r.km 94,0 tributary Chotina - Q_{355} 0,116 m^3/s*

Table 2.10. Municipal hot spots (year 1996), State of treatment

	Locality Hot Spots	Current Treatment					State of Treatment Facilities	Problems and Measures
		NT	M	MB	CH	O		
1	VK Kosice	-	x	x	-	-	Municipal wastewater is transported into Central WWTP in Koksov-Baksa. It consists of MB level. In 1998 new mechanical part was put into operation. Transported waste waters are divided before treating-about 1000 m^3/s water flow through MB WWTP and the rest 200-400 l/s flows through the new mechanical part and without biolog. treatment is discharged into the receiving water body	➢ III structure part of biological treatment to finish ➢ technology and its fixing up ➢ lack of money
2	VK Nitra	-	x	x	-	-	➢ WWTP built in 1968 has insufficient capacity and out-moded technology ➢ new WWTP is under construction	➢ WWTP under construction ➢ reconstruction of the other properties ➢ revaluation of biological part necessary ➢ lack of money
3	VK Malacky	-	-	x	-	-	➢ out-moded MB WWTP ➢ under reconstruction now, 1st stage should be finished in 1998	➢ present problems : wastewater is discharged into Malina branch with Q355=0,001m^3/s
4	VK Banska Bystrica	-	-	x	-	-	➢ 15 outlets together ➢ insufficient capacity ➢ part of wastewater is discharged into recipient without treatment	it is needed : ➢ to build sewerage collector ➢ to reconstruct and extend WWTP (some properties of the 2nd reconstruction were put to test operation)
5	VK Michalovce	-	-	x	-	-	➢ WWTP has insufficient capacity and low effect	➢ improvement of treatment process has been started in 1993, but is not finished because lack of money
6	VK Svidnik	x	-	-	-	-	➢ wastewater discharged directly into recipient Ondava	➢ 4 outlets together ➢ finalization of sewerage is necessary ➢ WWTP is under construction ➢ financial budget is not provided
7	VK Trencin, r.b.	x	-	-	-	-	➢ wastewater without treatment is discharged directly into Zlatovsky creek (Q355=0,03m^3/s)	➢ WWTP project was elaborated in year 1997
8	VK Humenne	-	-	x	-	-	➢ MB treatment effect is insufficient ➢ enlargement of WWTP has been started, but lack of money was reason for stoppage of work	➢ lack of money
9	VK Ruzomberok	-	-	x	-	-	➢ insufficient treatment process of COD	➢ ownership is not clear at present
10	VK Topolcany	-	-	x	-	-	➢ WWTP is hydraulic and material overloaded ➢ foaming in biological treatment ➢ sludge disposal is not function	➢ project work is finalized ➢ WWTP reconstruction and upgrading started ➢ in 1996

NOTE: *NT =* *no treatment*
M = *mechanical*
MB = *mech.-biological*
CH = *chemical*
O = *others*

Table 2.11. Municipal hot spots (Year 1996), Downstream uses of water

No	Name Locality	Downstream Use of Water		Season Variat.	Canalis. of River	Selfpurification of Stream	Trans-boundary Effect Distance to the border (km)	Diffuse Pollution Effect
		water withdrawals	other activities					
1	VK Kosice	for industry which has not high demand on quality	➢ fishing - ➢ zone of. Hygienic Protection of Water Resources	no	min. trained stream channel	stream gradient higher than 3 per milles meandering tributaries	14,3	middle intensive agricultural activities protection of water resources up to Miskolc
2	VK Nitra	irrigation	➢ fishing ➢ contaminated water resources (ground water)	from food industry (cannery)	partly trained stream channel	-gradient 0,4 per milles -small tributaries	82	intensive agricultural activities
3	VK Malacky	irrigation	Protected Landscape Area "Zahorie"	low discharge	mostly artificial bottom and bank	uniform small gradient 0,4 per milles	27	➢ middle agricultural activities ➢ forests
4	VK Banska Bystrica	➢ irrigation ➢ for industry with lower demands on quality	➢ Zone of Protection ➢ of Mineral Springs (Spa)	no	min. artificial bottom	gradient per mille meandering tributaries		➢ low intensive agricultural activities ➢ forests
5	VK Michalov.	Irrigation	➢ fishing ➢ Zone of Hygienic Protection of Water Resources.	no	mostly artificial banks and bottom	gradient lower than 0,4 per milles direct stream without tributaries	65	minimum agricultural activities
6	VK Svidnik	-	➢ bathing ➢ recreation ➢ fishing	no	➢ min. trained stream channel ➢ water reservoir "Domasa"	gradient 2,2 per milles tributaries meandering	132	minimum agricultural activities
7	VK Trencin, right bank	-	➢ fishing ➢ Zone of Hygienic Protection of Water Resources	no	min. trained stream channel	➢ gradient lower than ➢ 3 per milles ➢ tributaries meandering	160	low intensity of agricultural activities
8	VK Humenne	➢ industry with lower demand on water quality ➢ irrigation	➢ recreation ➢ fishing	no	➢ water reservoir "Zemplinska Sirava" ➢ minimum artificial bottom	➢ gradient 1,5 per milles ➢ tributaries meandering	88	low intensity of agricultural activities
9	VK Ruzomberok	-	➢ Protected Area of Nature Water Accumulation ➢ fishing	no	➢ water reservoir "Krpelany" ➢ min. artificial bottom	➢ gradient lower than 3 per milles ➢ tributaries meandering	315	nearly natural vegetation cover
10	VK Topolcany	Irrigation	fishing	no	min. trained stream channel	➢ gradient lower than 1 per mille ➢ tributaries meandering	123	high intensity of agricultural activities

NOTE: Season Variat. = Seasonal Variation Canalis. of River = Canalisation of River Selfpurif.of Stream = Selfpurification of Stream

Table 2.12. Industrial hot spots (year 1996), Emission into the Danube River basin

No.	Name of Hot Spot Locality	Receiving Water		Discharged Specific Pollution
		Name r.km	Q_{355} $m^3.s^{-1}$	t/y
1	Novaky Chemical Plants-Novaky	Nitra 130,0-129,7	1,179	Alkalinity: 2kmol Cl: 14874 CV: 468 active C: 4.5 Hg: 0,4362 detergents: 10,75
2	Bukocel Vranov nad Toplou (Hencovce)	Ondava 50,1-48,7-48,65	Qg: 1,034	SO4: 1604,4 Cl: 2455,3 39,2 15,2 101,8 19,1
3	Povaz. Chemical Plants-Zilina	Vah 255,0	Qg : 8,443	N-NH4: 168,3
4	Istrochem Bratislava	Danube 1863,6	Qg.: 838	N-NH4: 37,44 SO4: 6610,4 Zn: 12,5 Cl: 5316,5
5	Slovensky hodvab Senica nad Myjavou	Teplica 1,8	O,043	N-NH4: 2,14 SO4: 3400 Cl: 350 Zn : 2,2
6	Chemko Strazske	Ondava 43,2	1,037	NO3: 66,7 NO2: 6,6 Tot.Fe: 133,4 phenols volat: 0,77 NH3: 27,8 cyclohexane : lower than 0,19 cyclohexanol :lower than 0,19 benzene: 0,04 methanol: 3,9 acetaldehyde: lower than 0,39 phenols: lower than 0,04 Cl: 555,4 SO4: 917,9 PO4: 7,3
7	ASSI DOMAN Sturovo	Danube: 1722,0 Obidsky chan.	917,0	
8	Bucina -Zvolen	Hron: 153,8 Slatina Zolna	8,235 0,34 0,291	Tot. phenols: 3,13 (Hron: 0,99, Slatina: 2,8, Zolna: 0) formaldehyde resins
9	Biotika Slovenska Lupca	Hron	5,993	Cl: 377, N-NH4: 151 DAS RL
10	Tanning Factory Bosany	Nitra	2,735	N-NH4: 29,78 Tot. Cr: 1,05 SO4: 420 S2: 3,7 Cl: 755

Table 2.12. continued

No.	Name of Hot Spot Locality	Wastewater Volume	Discharged Pollution t/y				
		T. m^3/y	BOD5	CODCr	SS	NES	DIS
1	Novaky Chemical Plants-Novaky	4 117,9 3 033,1	58,9 437,7	146,6 1984,3	82,4 210,6	3,5 11,8	1 458 21 844
2	Bukocel Vranov nad Toplou	505,958 10 561,8 1 391,3	4,1 295,7 41,7	28,1 2534,9 185,1	28,3 549,2 87,7	0,06 16,69 0,97	
3	Povaz. Chemical Plants-Zilina	1 556,7	104,0	400,2	82,5	2,12	656,9
4	Istrochem Bratislava	4 018,5	638,9	1904,8	172,8	2,451	
5	Slovensky hodvab Senica nad Myjavou	2 209,3	132,6	351,3	95,0	1,17	
6	Chemko Strazske	3 956,3	138,5	735,9	360, 0	1,78	
7	ASSI DOMAN Sturovo	13 997,7	2292,4	6 771	1733, 2	33,50	
8	Bucina Zvolen	Hron: 54,000 1 324,5 Slat: 240,580 Zolna: 74,650	16,2 34,4 8,2 1,5	45,0 107,3 15,6 5,2	2,5 54,3 9,6 1,8	0,49 1,86 0,43 0,28	
9	Biotika Slovenska Lupca	1 198,3	185,8	587,2	76,7	1,95	1 038
10	Tanning Factory Bosany	1 504,0	48,1	312,8	57,2	0,26	

NOTE:	*Qg:*	*guarantee discharge*	*NES:*	*non-polar extractable substances*
	DIS:	*dissolved inorganic salts*	*SS:*	*suspended solids*

Table 2.13. Industrial hot spots (year 1996), Water quality deterioration

No.	Name of Hot Spot Locality	Dillution factor (l/s)			Influenced Lenght (km)
		Q_{355}	up down	Q_{mean}	
1	Novaky Chemical Plants-Novaky	550	1179	226	more than 20
2	Bukocel-Vranov nad Toplou (Hencovce)	1000	1034	395	more than 20
3	Povaz. Chemical Plants-Zilina	24500	-	49	more than 20
4	Istrochem-Bratislava	83000	838000	127	less than 5
5	Slovensky hodvab Senica nad Myjavou	41	43	70	more than 20
6	Chemko-Strazske	1034	1037	125	more than 5
7	ASSI DOMAN-Sturovo	916000	917000	444	less than 5
8	Bucina-Zvolen	8100	8235	54	more than 5
9	Biotika-Slovenska Lupca	4684	5993	38	more than 5
10	Tanning Factory-Bosany	1179	2735	48	more than 5

No	Name of Hot Spot Locality	Ambient Water Quality (1995-1996)** mg/l							
		BOD 5	Class	COD-Cr	Class	NEL	Class	Cl	Class
		up down		up down		up down		up down	
1	Novaky Chem. Plants-Novaky	3,0	III	17,0	III			11,6	I
		5,5		29,9	IV	0,218	V	132,9	III
2	Bukocel-Vranov nad Toplou	4,8	III	15,4	II	-	-	15,4	I
		6,5		29,4	IV	-	-	30,7	I
3	Povaz. Chem. Plants-Zilina	3,6	III	14,4	II	0,023	III	12,6	I
		3,2	III	17,7	III	0,012	II	9,5	I
4	Istrochem Bratislava	2,1	II	11,7	II	0,021	II	18,6	I
		1,9	II	10,0	I	0,015	II	18,2	I
5	Slovhodvab-Senica n. Myjavou	2,1	II	9,6	V	0,025	II	25,4	I
		14,2	V	35,1		0,119	IV	54,2	II
6	Chemko-Strazske	6,5	III	29,4	IV	-	-	30,7	I
		6,6	III	30,9	IV	0,083	IV	31,1	I
7	ASSI DOMAN-Sturovo	2,3	II	10,2	I	0,025	II	21,9	I
		2,4	II	10,4	I	0,053	IV	19,9	I
8	Bucina Zvolen	5,9	III	22,0	III	0,282	V	12,8	I
		4,7	III	18,6	III	0,180	V	12,7	I
9	Biotika-Slovenska Lupca	3,0	II	13,5	II	0,333	V	8,9	I
		5,1	III	22,3	III	-	-	9,7	I
10	Tanning Factory-Bosany	5,5	III	29,9	IV	0,218	V	132,9	III
		4,4	III	28,7	IV	0,125	V	86,9	II

No.	Name of Hot Spot Locality	Ambient Water Quality (1995-1996)** mg/l							
		SO4	Class	Hg*	Class	Zn*	Class	N-NH4	Class
		up down		up down		up down		up down	
1	Novaky Chemical Plants-Novaky	48,4	I	-	-	-	-	0,328	III
		98,4	III	3,187	-		-	1,328	IV
2	Bukocel-Vranov nad Toplou	54,8	I	-	-	-	-	0,155	II
		69,0	II	-	-	-	-	0,394	III
3	Povaz. Chemical Plants-Zilina	29,7	I	0,16	II	20,6	-	0,43	III
		24,9	I	0,13	II	18,2	II	0,54	III
4	Istrochem-Bratislava	32,5	II	0,133	II		II	0,258	II
		30,0	I	0,117	II		II	0,211	II
5	Slovhodvab-Senica n. Myjavou	81,3	II	0,411	-		-	0,295	III
		363,5	V	1,780	V		V	1,260	IV
6	Chemko-Strazske	69,0	II	-	-	-	-	0,394	III
		69,8	II	0,165	III		-	0,360	III
7	ASSI DOMAN-Sturovo	44,4	I	0,173	-		-	0,344	III
		38,4	I	0,225	-		-	0,320	III
8	Bucina-Zvolen	32,8	I	0,075	I		II	0,521	III
		33,8	I	-	-		-	0,440	III
9	Biotika-Slovenska Lupca	24,7	I	-	-		II	0,168	II
		27,7	I	-	-		-	0,556	III
10	Tanning Factory-Bosany	98,4	III	3,187	-		-	1,308	IV
		85,0	II	-	-		-	1,030	IV

NOTE: *Q mean:* *average of waste water discharge* * *that means concentration microgram/l*
** *than means average concentration* *up:* *upstream*
down: *downstream* *NES:* *non-polar exctractable substances*
\- that means no data in 1995-1996

Table 2.14. Industrial hot spots check river points of receiving water

N o	Hot Spots Lokality [Name of Catchment]	Receiving water	Check River Point		Remark
		Name r.km	Upstream	Downstream	
			r.km		
1	**NCHZ Nováky** [Váh]	***Nitra*** *131,0; 129,7*	***Nitra*** Opatovce n.Nitr. 138,7	***Nitra*** Chalmová 123,8	*r.km 135,7 tributary Handlovka - Q_{355} 0,366 m^3/s (WWTP Prievidza)*
2	**Bukóza Vranov** [Bodrog]	***Ondava*** 50,1	***Ondava*** Kučín 53,9	***Ondava*** Poša 45,4	
3	**PCHZ Žilina** [Váh]	***Váh*** 255,0	***Váh*** nad Žilinou 260,7	**Váh** Budatín 252,7	
4	**Istrochem Bratislava** [Dunaj]	***Dunaj*** 1863,6	***Dunaj*** Bratislava-stred 1869,0	***Dunaj*** Rajka 1848,0	*r.km 1863,7 Slovnaft Bratislava- MCHB* *r.km 1862,2 WWTP Bratislava - Petržalka*
5	**SH Senica** [Morava]	***Teplica*** 1,8	***Teplica*** nad Senicou 7,5	***Teplica*** pod Senicou 0,8	*r.km 1,6 WWTP Senica*
6	**Chemko Strážske** [Bodrog]	***Ondava*** 43,2 (Kyjovský p.)	***Ondava*** Poša 45,4	***Ondava*** Hrušov 42,0	
7	**JCP Štúrovo** [Dunaj]	***Dunaj*** 1722,0	***Dunaj*** Radvaň 1748,0	***Dunaj*** Štúrovo 1718,8	
8	**Biotika Slov. Ľupča** [Hron]	***Hron*** 183,8	***Hron*** Nemecká 200,8	***Hron*** Šálková 181,4	
9	**Bučina Zvolen** [Hron]	***Hron*** 153,8	***Hron*** Sliač 161,1	***Hron*** Zvolen MB ČOV 153,6	
		Slatina 3,7	-	***Slatina*** - ústie	*r.km 3,5 tributary Zolná - Q_{355} 0,291 m^3/s*
		Zolná 1,5; 1,5; 1,2;	-	-	
10	**Koželužne Bošany** [V8h]	***Nitra*** 100,9	***Nitra*** Chalmová 123,8	***Nitra*** Práznovce 98,0	*r.km 111,9 tributary Nitrica - Q_{355} 0,408 m^3/s* *r.km 111,1 WWTP Partizánske* *r.km 98,5 tributary Bebrava - Q_{355} 0,812 m^3/s*

Table 2.15. Industrial hot spots (year 1998), State of treatment

No.	Name	Current Treatment					State of Treatment Facilities	Problems and Measures
	Locality	NT	M	M B	CH	O		
1	Novaky Chem. Plants-Novaky	-		x	-	sediment. Ponds	➢ insufficient MB WWTP effect ➢ WWTP extention (treatment of all technologywater)	➢ to build technolog. water pipes and pumping station for sewage water from administrative buildings ➢ changes in technological process
2	Bukocel Vranov n. Toplou	-	-	x	-		➢ insufficient WWTP effect (susp. solids and ➢ COD-Cr)	➢ reconstruction of mechan. part of WWTP ➢ measures in production technology
3	Povaz.Chem. Plant-Zilina	-	-	x	x	dump of contaminated waste	➢ insufficient efficiency	➢ measures in production technology ➢ upgrading of WWTP
4	Istrochem Bratislava	-	x	-	x		➢ BOD and COD limit values are exceeded ➢ biolog. treatment is missing	➢ to complete biol. part of WWTP (project prepared)
5	Slovhodvab Senica n Myjavou	-	-	x	x	lagoons for chemical and biological sludge	➢ WWTR is out of date from point of view of ➢ technology and under dimension ➢ problems with chem. and biolog. sludge	➢ 20 years old sewage is considerably corroded ➢ to improve effect of biolog. Treatment
6	Chemko Strazske	-		x		sludge storing lagoon "Posa"	➢ general reconstruction of activation ➢ part of facilities is under reconstruction	➢ measures in production process ➢ technology of alkalinity water neutralization
7	ASSI DOMAN Sturovo	-	-	x	-	oil removal	➢ COD and susp. Solids limit values are exceeded	➢ reconstruction and bring up to date of production ➢ to complete WWTP
8	Bucina Zvolen	-	-	-	-	electro flotatation	➢ other water to connect to electroflotation	➢ to complete biolog. Treatment ➢ protection measures for territoty "white impregnation"
9	Biotika Slov. Lupca	-	-	x	-		➢ WWTP is overloaded and treats part of municipal ➢ wastewater as well ➢ insufficient treatment ➢ effect	➢ WWTP extension (activation) ➢ to build anaerobic part of WWTP
10	Tanning Factory Bosany	-	-	x	-		➢ contaminated sludge with Cr	➢ Cr removal from partial wastewater ➢ reconstruction of biolog.part of WWTP

NOTE: *NT =* *no treatment*
M = *mechanical*
MB = *mech.-biological*
CH - *chemical*
O = *other*

Table 2.16. Industrial hot spots (1998), Downstream uses of water

No	Name	Downstream Use of Water		Eutrop.	Canalis. of River	Selfpurification of Stream	Transboundary Effect	Diffuse Pollution Effect
	Locality	water withdrawals	other activities				Distance to the border (km)	
1	Novaky Chemical Plants Novaky	➢ for industry with lower demand on quality ➢ irrigation	➢ fishing	no	channel is partly regulated	➢ stream gradient higher than 3 per milles ➢ tributaries	160	middle intensive agricultural activities
2	Bukocel Vranov-Hencovce	no	➢ fishing ➢ Hygienic Protection of water sources	no	partly regulated channel	➢ gradient 0,7 per milles ➢ tributaries ➢ direct flow dominant	65	middle agricultural activities
3	Istrochem Bratislava	no	➢ recreation (reservoir Gabcikovo), fishing ➢ Protected Water Management Area	yes	swell out	➢ gradient lower than 0,2 per milles	transboundary river	no (minimal river basin)
4	SH Senica nad Myjavou	➢ for industry with lower demands on quality		no	partly regulated channel (bank fortification)	➢ gradient lower than per mille ➢ tributaries	29,7	-middle intensive agricultural activities
5	Chemko Strazske	no	➢ fishing ➢ Zone of Hygienic Protection of Water Resources.	no	partly regulated channel	➢ gradient 0,5 per milles ➢ direct stream ➢ tributaries	58	middle agricultural activities
6	ASSI DOMAN Sturrovo	➢ for industry with lower demand	➢ fishing	yes	min. trained stream channel	➢ gradient 0,2 per milles ➢ tributaries	transboundary river	middle agricultural activities
7	Bucina Zvolen	➢ -for industry with lower demand	➢ fishing ➢ Zone of Hygienic Protection of Health Water Resources	no	Hron : nature flow Slatina : regulated flow	➢ -gradient lower than ➢ 3 per milles ➢ -tributaries	153,8	low intensity of agricultural activities
8	Biotika Slovenska Lupca	➢ industry with lower demand on water quality	➢ fishing	no	partly regulated stream	➢ gradient lower than 3,0 per milles ➢ tributaries	183,6	low intensity of agricultural activities
9	Tannery Bosany	no	➢ fishing	no	partly regulated flow	➢ gradient lower than 3 per milles ➢ tributaries ➢ meandering	131	middle intensity of agricultural activities

Table 4.1. Sediment discharges of chosen profiles (year 1996)

River Station	r. km	Mean Sediment Discharge (kg/s)	Runoff of Sediment Discharge (t/y)	Specific Runoff of Sediment Discharge (t/km^2)
Morava - Zahorska Ves	32,52	9,849	311 435,0	12,2
Danube - Bratislava	1868,65	114,0687	36 07125,0	27,5
Hron - Brehy	89,5	1,277	40 377,9	14,6
Ipel - Slovenske Darmoty	93,9	4,919	155 560,0	40,7
Slana - Lenartovce	3,6	1,365	43169,0	23,6
Hornad - Zdana	17,2	5,330	168 455,0	39,8

Table 4.12. Water quality in the main check point “DANUBE-NAD BRATISLAVOU”, r.km 1877,30

year	Q (m^3/s)			BOD-5 (mg/l)			COD-5 (mg/l)			NES (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997												
1996	859,3	5595,0	2157,4	1,0	6,5	2,7	3,0	30,8	12,7	0,05	0,13	0,06
1995	1237,2	3649,9	2237,5	0,5	2,7	1,6	5,8	20,4	10,2	0,06	0,08	0,03
1994	951,7	4495,3	2017,9	1,0	3,8	2,2	COD Mn 2,8	COD Mn 7,7	COD Mn 4,3	0,03	0,03	0,03

year	N-NH4 (mg/l)			N-NO2 (mg/l)			N-NO3 (mg/l)			Norg. (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997												
1996	0,16	0,66	0,38	0,015	0,050	0,034	1,72	5,96	2,96	0,56	2,90	1,32
1995	0,10	0,81	0,29	0,008	0,090	0,034	1,70	4,00	2,92	0,07	1,40	0,99
1994	0,10	0,35	0,24	0,008	0,054	0,027	1,40	4,10	2,46			

year	Total P (mg/l)			Chlorophyl (microgram/l)			Hg (microgram/l)			Cd (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997												
1996	0,08	0,38	0,17	7,95	59,670	31,976	0,10	0,55	0,27	0,01	0,12	0,07
1995	0,09	0,27	0,16	8,75	29,920	18,176	0,05	2,57	0,83	0,01	0,13	0,04
1994							0,05	0,05	0,05	0,02	0,03	0,03

year	Pb (microgram/l)			As (microgram/l)			Cu (microgram/l)			Cr (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997												
1996	0,53	2,06	1,34	1,00	1,75	1,19	1,83	8,93	4,06	0,10	1,49	0,68
1995	0,70	3,80	1,55	0,50	2,07	1,04	2,07	4,65	3,16	0,37	2,14	1,24
1994	1,15	1,88	1,52				3,03	5,01	4,02	1,04	1,10	1,10

year	Ni (microgram/l)			Zn (microgram/l)		
	min.	max.	mean	min.	max.	mean
1997						
1996	1,13	3,84	2,26	10,0	43,0	20,5
1995	0,05	3,46	1,79			
1994	2,05	2,44	2,25	36,0	37,0	36,5

Table 4.13. Water quality in the main check point “DANUBE-STUROVO”, r.km 1718,80

year	Q (m^3/s)			BOD-5 (mg/l)			COD-Cr (mg/l			NES (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	1158,0	7054,9	2396,5	2,3	5,0	3,15	6,4	12,7	9,9	0,03	0,07	0,05
1996	1150,4	4489,0	2244,6	1,0	3,5	2,3	5,4	16,8	11,1	0,05	0,11	0,06
1995	1355,1	4283,9	2516,6	0,5	4,4	2,5	6,2	12,9	9,6	0,03	0,30	0,05
1994	1028,9	5573,7	2273,3	0,5	5,2	2,3	COD Mn 2,9	COD Mn 9,4	COD Mn 5,5	0,03	0,10	0,03

year	N-NH4 (mg/l)			N-NO2 (mg/l)			N-NO3 (mg/l)			Total P (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	man
1997	0,11	0,85	0,28	0,015	0,063	0,034	0,79	3,32	2,00	0,05	0,19	0,12
1996	0,20	0,62	0,33	0,030	0,054	0,042	1,51	3,68	2,44	0,07	0,16	0,11
1995	0,11	0,67	0,31	0,008	0,070	0,039	1,30	3,60	2,42	0,12	0,20	0,16
1994	0,12	0,37	0,25	0,008	0,060	0,040	1,00	3,50	2,18			

year	Hg (microgram/l)			Cr (microgram/l)			Ni (microgram/l)			Zn (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,17	0,32	0,23	0,14	0,19	0,17	0,93	3,74	1,92	10,0	18,0	13,8
1996	0,10	0,50	0,23	0,10	1,11	0,54	0,71	2,39	1,32	10,0	31,0	17,8
1995				0,44	1,61	0,96	0,14	1,96	1,07	13,0	36,0	21,7
1994	0,05	0,05	0,05	0,49	1,03	0,76	1,91	3,30	2,11	19,0	23,0	21,0

year	Cd (microgram/l)			Pb (microgram/l)			Cu (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997									
1996	0,01	0,02	0,01	0,61	1,22	0,92	2,12	2,81	2,47
1995	0,03	0,05	0,04	1,14	1,48	1,31	2,39	2,97	2,68
1994									

Table 4.14. Water quality in the main check point “MORAVA-DEVINSKA NOVA VES”, r.km 1,5

year	Q (m^3/s)			BOD-5 (mg/l)			COD -Cr (mg/l)			NES (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997				2,5	6,7	4,4	12,3	18,9	14,9	0,05	0,11	0,07
1996	46,09	376,74	143,28	2,1	5,3	3,5	10,0	28,0	16,8	0,05	0,15	0,07
1995	42,,65	199,88	109,74	2,7	6,6	4,3	9,4	28,0	17,8	0,03	0,19	0,04
1994	19,13	157,37	80,66	2,6	8,8	5,3	COD Mn 6,1	COD Mn 24	COD Mn 10,5	0,03	0,18	0,05

year	N-NH4 (mg/l)			N-NO2 (mg/l)			N-NO3 (mg/l)			N-organ. (mg/lm)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,19	2,39	0,81	0,024	0,063	0,039	2,24	5,67	3,58	0,50	2,80	1,97
1996	0,18	1,66	0,58	0,015	0,096	0,059	2,24	5,69	4,07			
1995	0,17	1,42	0,44	0,008	0,140	0,054	2,80	5,40	4,10			
1994	0,06	1,98	0,48	0,008	0,160	0,064	0,45	6,20	4,17			

year	Hg (microgram/l)			Cd (microgram/l)			Pb (microgram/l)			As (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,23	0,44	0,32									
1996	0,10	0,85	0,30									
1995	0,05	2,75	0,95	0,005	0,05	0,026	0,023	3,62	1,27	1,22	2,84	2,0
1994	0,05	0,05	9,05	0,09	0,09	0,09	0,91	1,21	1,06			

year	Cu (microgram/l)			Cr (microgram/l)			Ni (microgram/l)			Zn (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997				0,10	0,35	0,18	2,63	5,29	3,46	10,00	20,00	23,80
1996										10,00	28,00	18,17
1995	2,46	6,23	3,84	0,52	1,89	1,27	2,23	4,75	3,05	17,00	119,00	40,17
1994	2,15	4,14	3,15	1,14	1,95	1,55	3,95	4,57	4,26	35,00	37,00	35,99

year	total P (mg/l)			chlorophyl (microgram/l)			HCB (microgram/l)			gama HCH (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,17	0,54	0,30	8,44	48,31	33,05	0,001	0,001	0,001	0,002	0,002	0,002
1996	0,14	0,62	0,42									
1995	0,17	0,54	0,35									
1994	0,16	0,61	0,39									

year	heptachlor (microgram/l)			p-p DDT (microgram/l)			PCB (microgram/l)			TOC (microgram/ l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,01	0,01	0,01	0,01	0,01	0,01						
1996												
1995										4,0	6,9	,5,8
1994							0,010	0,010				

Table 4.15. Water quality in the main check point “VAH-KOMARNO”, r.km 2,5

year	Q (m^3/s)			BOD-5 (mg/l)			COD-Cr (mg/l)			NES (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997				1,9	6,5	3,9	8,9	19,5	15,0	0,02	0,12	0,05
1996				0,9	13,0	4,5	9,0	54,5	17,6	0,01	0,08	0,02
1995				0,7	6,6	2,9	12,3	29,6	15,3	0,01	0,04	0,03
1994				1,4	4,7	3,0	COD Mn 3,4	COD Mn 6,9	COD Mn 4,8	0,03	0,03	0,03

year	N-NH4 (mg/l)			N-NO2 (mg/l)			N-NO3 (mg/l)			N-organ. (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,04	1,24	0,54	0,009	0,074	0,044	1,27	3,28	2,12	0,01	2,66	0,78
1996	0,29	1,18	0,63	0,022	0,103	0,046	1,54	3,43	2,41	0,01	1,23	0,27
1995	0,06	1,14	0,57	0,020	0,240	0,046	0,61	3,61	2,28	0,01	1,66	0,60
1994	0,17	0,63	0,32	0,020	0,090	0,049	1,00	2,70	2,00			

year	total N (mg/l)			total P (mg/l)			Hg (microgram/l)			Cd (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	2,04	6,48	3,31	0,02	0,29	0,15	0,20	1,00	0,87	0,02	0,22	0,09
1996	2,05	4,85	3,36	0,07	0,67	0,24	0,10	0,10	0,10	0,01	0,17	0,06
1995	2,30	5,22	3,53	0,10	0,32	0,21	0,10	0,40	0,16	0,02	0,15	0,08
1994							0,05	0,05	0,05	0,01	0,04	0,03

year	Pb (microgram/l)			As (microgram/l)			Cu (microgram/l)			Cr (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,10	5,4	1,15	0,01	4,9	2,59	1,00	2,70	1,73	0,60	2,00	1,02
1996	0,10	1,4	0,58	1,00	1,7	1,22	1,60	2,50	2,02	0,20	1,00	0,65
1995	0,20	2,4	0,82	2,1	4,8	3,58	1,20	6,00	2,56	0,10	1,60	0,52
1994	0,91	0,94	0,93				2,17	3,81	3,00	0,84	1,00	0,92

year	Ni (microgram/l)			Zn (microgram/l)			HCB (microgram/l)			Heptachlor (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	2,30	8,70	3,87	20,0	68,0	28,0	0,005	0,005	0,005	0,005	0,005	0,005
1996	1,40	7,80	3,53	20,0	30,0	22,7	0,005	0,005	0,005	0,005	0,005	0,005
1995	0,80	3,80	2,20	20,0	20,0	20,0	0,005	0,005	0,005	0,005	0,005	0,005
1994	2,44	2,82	2,63	21,0	30,0	25,5						

year	p-p DDT (microgram/l)			Chlorbenzene (microgram/l)			Chloroform (microgram/l)			PCB (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,01	0,01	0,01	1,00	1,00	1,00	0,001	0,113	0,031	0,01	0,01	0,01
1996	0,01	0,01	0,01	1,00	2,50	1,38	0,001	0,011	0,005			
1995	0,01	0,01	0,01	1,00	1,00	1,00	0,001	0,002	0,002			
1994												0,01

Table 4.16. Water quality in the main check point “HRON-KAMENIN”, r.km 10,9

year	Q (m^3/s)			BOD-5 (mg/l)			COD-5 (mg/l)			TOC (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997				2,9	4,3	3,3	13,0	21,0	16,3			
1996	15,97	159,86	57,21	2,7	7,2	3,9	12,0	44,0	20,8			
1995	19,05	151,67	60,20	2,0	4,9	2,9	9,0	17,0	12,8			
1994	13,68	105,80	49,88	2,0	3,9	2,8	COD Mn 4,3	COD Mn 8,0	COD Mn 5,8	5,6	14,9	8,8

year	N-NH4 (mg/l)			N-NO2 (mg/l)			N-NO3 (mg/l)			N-organ. (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,11	0,98	0,30	0,007	0,085	0,030	0,99	2,54	1,96	2,10	3,50	2,74
1996	0,12	1,10	0,46	0,004	0,052	0,032	1,30	2,82	1,86	1,70	2,20	1,90
1995	0,06	0,35	0,19	0,003	0,044	0,023	1,10	2,20	1,69	0,88	1,40	1,15
1994	0,02	0,97	0,18				1,30	2,30	1,83			

year	total P (mg/l)			Chlorophyl (microgram/l)		
	min.	max.	mean	min.	max.	mean
1997	0,12	0,28	0,21	0,100	5,920	3,803
1996	0,13	0,30	0,26	0,100	4,440	1,470
1995	0,09	0,24	0,15	0,370	14,060	3,38
1994	0,07	0,22	0,16			

Table 4.17. Water quality in the main check point “IPEL-IPELSKY SOKOLEC”, r.km 35,20 in year 1997 “IPEL-KUBANOVO, r.km 38,3

year	Q (m^3/s)			BOD-5 (mg/l)			COD-Cr (mg/l)			N-NH4 (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997				3,1	4,0	3,6	88,5	104,8	95,8	0,15	1,41	0,59
1996	2,42	22,95	9,26	2,3	4,6	3,7	10,0	27,0	17,3	0,08	1,32	0,48
1995	2,55	48,42	16,24	3,0	4,7	3,5	12,0	44,0	23,3	0,16	1,29	0,67
1994	1,41	29,66	11,06	2,5	4,5	3,3	CODMn 5,7	COD Mn 9,0	COD Mn 7,1	0,02	1,51	0,26

year	N-NO2 (mg/l)			N-NO3 (mg/l)			N-org. (mg /l)			Total P (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,019	0,059	0,035	2,04	4,14	2,67	2,80	10,80	5,34	0,14	0,67	0,38
1996	0,015	0,049	0,032	1,90	5,20	2,91	1,50	3,50	2,20	0,16	0,36	0,25
1995	0,018	0,073	0,035	1,40	3,20	2,43	1,20	3,00	2,09	0,10	0,35	0,23
1994	TOT, N 5,6	TOT, N 7,0	TOT,N 6,1	0,28	3,20	2,07				0,12	0,51	0,27

year	Chlorophyl (microgram/l)			HCB (microgram/l)			gama-HCH (microgram/l)			Heptachlor (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,100	14,800	4,771	0,010	0,410	0,010	0,30	0,30	0,30	0,01	0,01	0,01
1996	0,100	45,880	11,287	0,010	0,010	0,010	0,30	0,30	0,30	0,01	0,01	0,01
1995	1,480	27,750	7,717	0,010	0,010	0,010	0,03	0,03	0,03	0,01	0,01	0,01
1994							0,03	0,03	0,03	0,01	0,01	0,01

year	p-p DDT (microgram/l)			Metoxychlor (microgram/l)			TOC (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,10	0,10	0,10	3,00	3,00	3,00			
1996	0,10	0,10	0,10	3,00	3,00	3,00			
1995	0,03	0,03	0,03	0,05	0,05	0,05			
1994	0,03	0,03	0,03	0,05	0,05	0,05	5,9	15,9	10,1

Table 4.18. Water quality in the main check point “SLANA-LENARTOVCE”, r.km 3,6

year	Q (m^3/s)			BOD-5 (mg/l)			COD-5 (mg/l)			TOC (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997				2,2	4,4	3,1	9,0	57,0	18,3			
1996	3,75	26,02	11,48	2,4	16,3	4,0	10,0	54,0	19,2			
1995	3,72	21,65	9,98	2,1	3,9	2,8	8,0	19,0	13,8			
1994	2,39	23,58	10,66	1,8	3,0	2,3	COD Mn 4,0	COD Mn 5,6	COD Mn 4,8	4,4	16,7	9,7

year	NES (mg/l)			N-NH4 (mg/l)			N-NO2 (mg/l)			N-NO3 (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max	mean
1997	0,01	0,57	0,14	0,05	0,40	0,16	0,012	0,042	0,020	1,35	2,53	1,93
1996	0,01	0,26	0,12	0,04	1,37	0,22	0,012	0,046	0,023	0,80	2,71	1,79
1995	0,06	0,19	0,10	0,05	1,35	0,28	0,020	0,059	0,021	1,50	3,00	2,02
1994	0,05	0,32	0,12	0,02	0,19	0,06				1,50	3,10	2,13

year	N-org. (mg/l)			Total P (mg/l)			Chlorophyl (microgram/l)			Cd (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,70	4,20	3,20	0,08	0,82	0,18	0,100	5,920	1,643	0,20	0,20	0,20
1996	0,70	2,45	1,85	0,07	0,26	0,13	0,100	2,960	1,100	0,20	0,20	0,20
1995	1,00	2,10	1,37	0,07	0,41	0,14	0,370	0,740	0,529	0,10	0,10	0,10
1994				0,07	0,27	0,12				0,05	0,16	0,09

year	Pb (microgram/l)			Cu (microgram/l)			Zn (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	1,00	1,40	1,08	1,90	7,30	4,02	5,00	8,00	5,80
1996	1,00	1,00	3,00	3,00	12,00	6,17	1,00	33,00	8,67
1995	0,50	1,00	2,00	2,00	11,00	5,00	7,00	24,00	12,17
1994	0,50	2,00	1,00	1,00	5,00	2,33	10,00	27,00	17,50

Table 4.19. Water quality in the main check point “BODVA - HOSTOVCE”, r.km 0,00

year	Q (m^3/s)			BOD-5 (mg/l)			COD-5 (mg/l)			NES (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	1,32	4,73	2,5	2,7	9,6	5,3	8,0	87,0	23,8	0,007	0,065	0,029
1996	0,80	12,08	3,35	2,4	8,6	4,9	8,0	38,0	17,2	0,001	0,076	0,029
1995	0,53	19,66	4,44	2,6	9,0	5,8	7,0	89,0	25,1	0,01	0,08	0,030
1994	0,22	6,64	1,86	2,0	9,6	4,2	9,3	54,0	24,8	0,01	0,15	0,030

year	N-NH4 (mg/l)			N-NO2 (mg/l)			N-NO3 (mg/l)			N-org. (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,030	0,46	0,16	0,018	0,117	0,046	2,76	5,78	3,79	0,15	1,64	0,64
1996	0,020	1,25	0,27	0,022	0,074	0,041	1,81	7,17	4,19	0,40	2,04	0,72
1995	0,060	0,46	0,20	0,014	0,135	0,040	2,80	5,60	4,00	0,05	1,34	0,65
1994	0,090	0,41	0,20	0,026	0,064	0,040	2,30	4,90	3,38	0,22	2,35	1,12

year	Total N (mg/l)			Total P (mg/l)			Chlorophyl (microgram/l)			Hg (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	3,27	5,45	4,48	0,05	0,17	0,11	2,400	27,3000	12,568	0,05	0,55	0,20
1996	4,01	7,80	5,83	0,06	0,22	0,14	2,000	26,2000	9,743	0,05	0,40	0,12
1995	2,93	5,14	4,54	0,08	0,26	0,15	3,000	67,5000	19,333	0,05	0,40	0,11
1994	3,03	6,00	4,23	0,12	0,39	0,18	3,200	81,4000	17,700	0,05	0,05	0,05

year	Cd (microgram/l)			Pb (microgram/l)			Cu (microgram/l)			Cr (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,05	0,70	0,46	1,10	11,30	6,90	2,00	24,40	9,93	0,10	2,80	1,42
1996	0,05	1,00	0,37	2,90	13,40	6,95	3,10	55,30	21,27	0,05	2,90	1,51
1995	0,05	5,60	1,18	0,60	10,00	3,12	0,20	15,00	7,08	0,10	7,80	3,12
1994	0,05	0,80	0,28	0,90	19,00	6,18	0,05	32,00	10,34	0,60	21,70	6,82

Year	Zn (microgram/l)			Atrazin (microgram/l)			Prometrin (microgram/l)			Ametryn (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	119,10	326,40	193,18	0,01	5,40	2,23	1,47	2,03	1,77	2,50	4,90	3,77
1996	111,00	278,10	169,95	0,67	6,24	2,96	0,09	6,30	2,53	0,56	4,91	3,41
1995	14,60	173,20	72,90									
1994	75,40	138,60	97,28									

Year	Prometon (microgram/l)			Simazin (mg/l)			Cerbatrin (microgram/l)			PCB (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	2,60	2,70	2,68	0,30	2,90	1,90	0,01	4,08	2,73	0,005	0,008	0,006
1996	0,00	2,60	0,98	0,08	3,77	1,85	0,83	4,19	2,13	0,002	0,054	0,020
1995												
1994										0,010	0,010	0,010

Table 4.20. Water quality in the main check point “BODROG -STREDA N.BODROGOM”, r.km 6,00

year	Q (m^3/s)			BOD-5 (mg/l)			COD-Cr (mg/l)			NES (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	41,1	183,0	85,1	2,2	6,1	3,8	9,0	22,0	13,8	0,01	0,07	0,03
1996	41,0	150,3	73,5	1,8	7,9	4,0	9,0	17,0	13,1	0,01	0,06	0,03
1995	39,0	310,5	100,4	2,1	5,8	3,7	9,0	29,0	15,1	0,00	0,07	0,02
1994	31,6	338,8	112,0	1,7	5,8	4,2	8,0	41,0	19,2	0,01	0,50	0,07

year	N-NH4 (mg/l)			N-NO2 (mg/l)			N-NO3 (mg/l)			N-org. (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,04	0,40	0,13	0,009	0,072	0,029	0,51	1,84	1,11	0,16	0,37	0,26
1996	0,09	0,47	0,25	0,017	0,055	0,034	0,99	2,71	1,58	0,10	0,72	0,42
1995	0,12	0,45	0,25	0,020	0,090	0,041	0,83	2,80	1,74	0,05	0,10	0,06
1994	0,11	0,42	0,25	0,030	0,090	0,045	0,87	3,30	1,72	0,78	1,52	1,00

year	Total N (mg/l)			Total P (mg/l)			Chlorophyl (microgram/l)			Hg (mg/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	1,09	1,94	1,43	0,05	0,14	0,08	2,400	15,100	5,490	0,05	0,20	0,08
1996	1,18	2,90	2,12	0,06	0,22	0,12	2,100	17,000	6,369	0,05	0,50	0,17
1995	1,89	3,04	2,27	0,07	0,21	0,13	1,000	23,100	5,967	0,05	0,60	0,12
1994	2,42	4,34	3,16	0,06	0,34	0,13	1,800	9,500	5,790	0,05	0,05	0,05

year	Cd (microgram/l)			Pb (microgram/l)			Cu (microgram/l)			Cr (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	0,05	1,15	0,35	0,60	33,20	8,65	0,90	5,50	3,27	0,05	6,50	1,71
1996	0,00	0,50	0,24	2,60	10,50	5,05	1,00	19,0	8,55	0,05	1,90	1,03
1995	0,05	4,00	0,65	0,10	19,20	5,37	0,10	20,2	8,23	0,05	3,70	1,32
1994	0,05	4,50	0,98	0,05	57,00	7,90	1,30	35,50	19,97	1,20	11,00	4,48

year	Zn (microgram/l)			Atrazin (microgram/l)			Prometrin (microgram/l)			Ametryn (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	89,6	313,3	195,3	1,40	8,70	3,44	1,35	2,04	1,81	1,03	4,90	3,31
1996	107,7	270,9	156,8	0,81	1,91	1,36	1,69	3,46	2,25	0,07	8,05	3,90
1995	23,3	210,5	92,3									
1994	39,9	249,6	126,7									

year	Prometon (microgram/l)			Simazin (microgram/l)			Terbutrin (microgram/l)			PCB (microgram/l)		
	min.	max.	mean	min.	max.	mean	min.	max.	mean	min.	max.	mean
1997	1,50	2,70	2,15	2,70	3,01	2,83	1,10	4,20	3,30	0,006	0,130	0,043
1996	0,52	2,79	1,98	0,90	9,71	3,82	0,20	7,12	2,96	0,003	0,023	0,012
1995												
1994												

Annexes

2-1 Criteria for Order of Urgency of WWTP Construction

4-1 Index of water Quality Discharge and Records

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4-4 Total Volumes of Dredged Material from Danube River in the Period 1962-94

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4-7 Maximal Mean Daily Discharges in Month

4-8 Minimal Mean Daily Discharges in Month

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Annex 2-1

Criteria for Order of Urgency of WWTP Construction

Annex 2.1. Criteria for Order of Urgency of WWTP Construction

Order of criteria	Characteristics of criteria	Basis Documents	Point Evaluation					Weight of criteria
			5	4	3	2	1	
1	Water quality deterioration downstream of pollution source (BOD 5)	Surface water quality monitoring in Slovak rivers SWMB-data about produced and discharged pollution	<5 - >15 mg/l BOD-5	<5 - >10 <10 - >15	<10 - <15 >15 - >50	<5 - <10	<15 - >15 <5 - 5 <10 - 10 15 - >15	11
2	Water intakes for drinking water supply (volume and distance of pollution source)	SWMB SR (State Water Management Balance) Quantitative water management balance	intake > 1 mil.m3/y			others intakes		10
			< 20 km	< 50 km	< 100 km	< 20 km	< 50 km	
3	State of sewerage and treatment of pollution source	Water management permit for waste water discharge Consultation with River Basin Authority	crash state of WWTP	construction or reconstruction of WWTP	without WWTP	insufficient WWTP capacity, deficiency in operation and technology construction of removal of N andP	proper WWTP with insufficient sewerage system	9
4	Importance of recipient	Data of Slovak Hydromet. Institute	Q355 > 5 m3/s	> 3	> 1	> 0,2	< 0,2	8
5	Length of recipient influenced by pollution source	Studies about water quaity Hydroecological Plans Annual reports (water quality) Expert´s estimation	> 20 km	> 15	> 10	> 5	< 5	7
6	Other water uses in stretch of recipent influenced by pollution source	Quantitative Water Management Balance Water management maps of ČSFR 1:50 000	a /water intakes - present situation					6
			for industry with higher demands for water quality	for ponds systems	for irrigation	for industry with lower demand for water quality	other intakes (no for drinking water supply)	
			b/ others activities - present situation					
			bathing area of hygien.protection of water sources, protected areas, protected areas of health water endangering of water source	trout ground influence of reservoirs	rowing transboundary river	flow through spa resp. recreation area	flow through urban area non trout ground	
			c/ future water uses					

Order of criteria	Characteristics of criteria	Basis Documents	Point Evaluation					Weight of criteria
			5	**4**	3	2	1	
			extraction for drinking water supply	intakes for industry with higher demands	recreation area	intakes for irrigation, pond systems	intakes for industry with lower demands	
7	Amount of discharged pollution in tons of BOD-5/y	SWMB - list of produced and discharged pollution	> 1000	> 500	> 200	> 100	< 100	5
7	Specific pollution in waste water	Others			yes			5
8	Stability of biocenose	Water management maps of ČSFR 1:50 000 Recognization of locality	covered flow	bottom and banks fortification	partial river channel modification	minimal river channel modification	condition similar to natural state	4
9	Selfpurification of recipient	Water management maps of ČSFR 1:50 000	average slope < 1 ‰ equable declivity, direct flow, without tributaries	< 1 ‰ non equable declivity, meanders, tributaries	< 3 ‰ equable declivity, direct flow, without tributaries	< 3 ‰ non equable declivity, meanders, tributaries	> 3 ‰	3
10	Influence of areal pollution NOTE : HRP - Gross plant production	Atlas of SSR	mainly industrial landscape	high intensive agricultural use of landscape (HRP > 6000 Kčs/ha/y)	mid intensive agricultural use of landscape (HRP > 3000 Kčs/ha/y)	low intensive agricultural use of landscape (HRP < 3000 Kčs/ha/y)	landscape nearly to natural vegetation	2
11	Term (year) for harmonization of discharged waste water with law in compliance with water management permit (VH)	Water management permit	1998	1999	2000	2001	2002	1

Annex 4-1

Index of Water Quality Discharge and Records

Annex 4.1. Index of Water Quality and Discharge Records

	Sampling Station Name	River Name	River Mile	Water Discharg	N	P	BOD	Heavy Metals	Phenols	ENP	CN	Pesticides	PCB	Other Toxics
1	Dunaj - nad Bratislavou	Dunaj	1877,3	32/96		2/96	32/96	5/96	3/96	10/96	2/96		4/92	
2	Dunaj - Karlova Ves	Dunaj	1873,0	2/98		2/98	2/98	2/98		2/98		2/98		2/98
3	Dunaj - Bratislava	Dunaj	1869,0	29/96		1/95	29/95	4/95	2/95	22/95	1/95		4/92	
4	Dunaj - Bratislava	Dunaj	1869,0	4/98	4/98	4/98	4/98	4/98	4/98	4/98		4/98		4/98
4	Dunaj - Rajka	Dunaj	1848,0		4/98	4/98	4/98	4/98	4/98	4/98		4/98		4/98
5	Dunaj - Hrušov	Dunaj	1842,0		4/98	4/98	4/98	4/98	4/98	4/98		4/98		4/98
6	Dunaj - Gabčíkovo	Dunaj	1819,6	1/91		4/98	10/98	8/98	10/98	10/95	1/95		4/92	
7	Dunaj - Medveďov	Dunaj	1806,0	2/98		4/98	4/98	4/98	4/98	4/98		4/98		4/98
8	Dunaj - Komárno	Dunaj	1768,0	2/98		4/98	4/98	4/98	4/98	4/98		4/98		4/98
9	Dunaj Radvaň	Dunaj	1748,0	12/96		2/96	12/96	4/95	1/95	12/95		1/89	4/92	
10	Dunaj - Štúrovo	Dunaj	1718,8	32/98		4/98	32/98	8/98	6/95	29/98			4/92	
11	Morava - Dev.Nová Ves	Morava	1,5	32/98		4/98	32/98	8/98	28/98	22/98	1/95	2/98		
12	Váh - Komárno	Váh	3,0			1/95	28/95	4/95	6/95	26/95	1/95		6/94	
13	Váh - Komárno	Váh	2,5			4/98	4/98	4/98	4/98	4/98				
14	Hron - Kamenín	Hron	10,9	35/98	13/98	11/98	35/98							
15	Ipeľ - Ipeľský Sokolec	Ipeľ	35,2	32/96	7/94	10/96	32/96					5/96		
16	Ipeľ - Kubáňovo	Ipeľ	38,3	2/98		2/98	2/98					2/98		
17	Slaná - Lenártovce	Slaná	3,6	35/98	4/94	8/98	35/98	8/98		8/98				
18	Bodva - Hosťovce	Bodva	0,0	32/98	8/98	8/98	32/98	7/98	22/98	12/98		3/98	8/98	
19	Hornád - Ždaňa	Hornád	17,2	32/98		4/98	32/98	4/98	30/98	23/98	4/98	3/98	10/98	
20	Bodrog- Streda n.Bodr.	Bodrog	6,0	33/98	8/98	8/98	35/98	7/98	22/98	21/98		3/98	15/98	

Note: ENP - extractable non-polar substances

Annex 4-2

List of the Sampling Sites of Surface Water Quality Monitoring Programme in the Slovak Republic, year 1997

Annex 4-2

LIST OF THE SAMPLING SITES OF SURFACE WATER QUALITY MONITORING PROGRAMME IN SLOVAK REPUBLIC - year 1997

Map's number	NEC	River - Sampling site	River's km	Discharge
	DUNAJ RIVER BASIN			
	DUNAJ			
D60	D002011R	DUNAJ - WOLFSTHAL	1873,50	
D61	D002012R	DUNAJ - KARLOVA VES	1873,00	Qprden, Qok
D16	D002010D	DUNAJ - NAD BRATISLAVOU	1877,30	Qprden, Qok
D63	D002051D	DUNAJ - BRATISLAVA	1869,00 VS	Qprden, Qok
D65	D011000D	DUNAJ - RAJKA	1848,00	
D66	D007010D	DUNAJ - HRUŠOV	1842,00	
D21	D013000D	DUNAJ - GABČÍKOVO	1819,60	
D67	D017000D	DUNAJ - MEDVEĎOV	1806,00	Qprden, Qok
D23	D022210D	K. VEĽKÝ MEDER-HOLIARE - POD V.MEDEROM	2,00	
D69	D034051D	DUNAJ - KOMÁRNO (stred)	1768,00 VS	Qprden, Qok
D27	D059000D	DUNAJ - RADVAŇ	1748,00 VS	
D28	D084000D	DUNAJ - ŠTÚROVO	1718,80 VS	
	MORAVA			
D1	M083000D	MORAVA - BRODSKÉ	79,00	Qprden, Qok
D2	M032020D	MYJAVA - NAD MYJAVOU	67,80	Qprden, Qok
D3	M032010D	MYJAVA - POD MYJAVOU	60,40	Qprden
D4	M046020D	BREZOVSKÝ POTOK - OSUSKÉ	1,70	
D5	M046010D	MYJAVA - JABLONICA	38,50 VS	Qprden, Qok
D6	M065000D	TEPLICA - NAD SENICOU	7,50	
D7	M065010D	TEPLICA - POD SENICOU	0,80	Qprden, Qok
D8	M072010D	MYJAVA - DOJČ	23,90	Qprden
D9	M082000D	MYJAVA - KÚTY	3,00	Qprden
D10	M103000D	MORAVA - MORAVSKÝ JÁN	67,10	Qprden, Qok
D11	M095000D	RUDAVA - MALÉ LEVÁRE	4,10	Qprden
D12	M118020D	MORAVA - GAJARY	44,50	Qprden
D44	M111000D	MALINA - JAKUBOV	19,60	Qprden
D13	M117010D	MALINA - ZOHOR	4,20	Qprden
D45	M118030D	ZOHORSKÝ KANÁL - GAJARY	23,90	
D14	M128040D	MLÁKA - POD DEVÍNSKOU NOVOU VSOU	0,50	
D15	M128020D	MORAVA - DEVÍNSKA NOVÁ VES	1,50	Qprden
	MALÝ DUNAJ			
D29	W604010D	MALÝ DUNAJ - BRATISLAVA	126,00	Qprden, Qok
D30	W604000D	MALÝ DUNAJ - PODUNAJSKÉ BISKUPICE	123,40	Qprden
D31	W610500D	MALÝ DUNAJ - MALINOVO	114,70 VS	
D32	W625500D	MALÝ DUNAJ - NOVÁ DEDINKA	107,60 VS	Qprden, Qok
D33	W613500D	MALÝ DUNAJ - JELKA	81,50 VS	
D34	W627510D	ČIERNA VODA - SENEC	31,90	Qprden
D50	W671500D	STOLIČNÝ POTOK - SLÁDKOVIČOVO	2,20	

Map's number	NEC	River - Sampling site	River's km	Discharge
D36	W673000D	ČIERNA VODA - ČIERNA VODA	4,80	
D37	W679500D	MALÝ DUNAJ - TRSTICE	22,80	Qprden, Qok
D38	W680500D	STARÝ KLATOVSKÝ KANÁL - HORNÁ POTÔŇ	15,50	Qprden
D39	W719020D	KLÁTOVSKÉ RAMENO - TRHOVÁ HRADSKÁ	6,50	VS Qprden, Qok
D46	W713000D	K.GABČÍKOVO-TOPOĽNÍKY - KÚTNIKY	10,40	
D47	W723000D	CHOTÁRNY KANÁL - JÁNOŠÍKOVO NA OSTROVE	11,00	Qprden
D42	W744510D	MALÝ DUNAJ - KOLÁROVO	2,50	Qprden
	VÁH RIVER BASIN			
	VÁH			
V2	V002510D	ČIERNY VÁH - NAD VN ČIERNY VÁH	11,40	Qprden, Qok
V4	V001510D	BIELY VÁH - VAŽEC	15,00	
V5	V002540D	VÁH - NAD LIPTOVSKÝM HRÁDKOM	364,60	Qprden, Qok
V6	V007020D	BELÁ - LIPTOVSKÝ HRÁDOK	0,40	Qprden, Qok
V8	V045000D	VÁH - LISKOVÁ	324,90	Qprden, Qok BP
V10	V052530D	REVÚCA - RUŽOMBEROK	0,00	Qprden, Qok BP
V11	V055010D	VÁH - HUBOVÁ	308,80	Qprden, Qok BP
V16	V071510D	ORAVA - POD VN TVRDOŠÍN	57,50	Qprden, Qok BP
V18	V071520D	ORAVICA - ÚSTIE (TVRDOŠÍN)	0,30	Qprden, Qok
V21	V095510D	ORAVA - KRAĽOVANY	0,30	Qprden, Qok
V22	V097000D	VÁH - POD KRPEĽANMI	294,20	Qprden, Qok BP
V130	V101500D	TURIEC - DOLNÝ TURČEK	67,40	
V26	V140520D	TURIEC - VRÚTKY	3,50	Qprden, Qok
V27	V146500D	VÁH - DUBNÁ SKALA	270,30	Qprden, Qok
V28	V146520D	VARÍNKA - VARÍN	0,50	Qprden, Qok
V29	V150000D	VÁH - NAD ŽILINOU	260,70	Qprden, Qok
V134	V179510D	VÁH - BUDATÍN	252,70	
V30	V153010D	KYSUCA - MAKOV	58,50	Qprden, Qok
V32	V165530D	BYSTRICA - POD VN NOVÁ BYSTRICA	19,70	
V34	V180010D	KYSUCA - POVAŽSKÝ CHLMEC	0,60	Qprden, Qok
V35	V183010D	RAJČANKA - NAD RAJCOM	25,00	VS Qprden, Qok
V37	V196000D	RAJČANKA - ŽILINA	1,50	VS Qprden, Qok
V135	V202011D	VÁH - VN HORNÝ HRIČOV -stred VN	248,50	
V38	V201010D	VÁH - POD VN HRIČOV	246,00	Qprden, Qok
V39	V208000D	VÁH - BYTČA	236,70	
V111	V208010D	HRIČOVSKÝ KANÁL - BYTČA	17,40	
V42	V238010D	VÁH - PÚCHOV	204,30	Qprden, Qok BP
V43	V267010D	VÁH - POD DUBNICOU	177,80	
V45	V277000D	NOSICKÝ KANÁL - POD DUBNICOU	10,90	
V46	V290500D	VÁH - TRENČÍN	165,10	
V47	V275000D	VÁH - OPATOVCE	157,20	
V52	V321000D	VÁH - NOVÉ MESTO NAD VÁHOM	142,50	
V115	V339010D	VÁH - HLOHOVEC	100,70	Qprden, Qok
V62	V355000Z	HORNÝ DUDVÁH - VEĽKÉ KOSTOĽANY	18,80	
V66	V356500Z	HORNÝ DUDVÁH - ŽLKOVCE	13,00	

Map's number	NEC	River - Sampling site	River's km	Discharge
V68	V356510Z	MANIVIER - ŽLKOVCE (EBO)	0,50	
V69	V357000Z	HORNÝ DUDVÁH - TRAKOVICE	11,00	
V71	V364000D	HORNÝ DUDVÁH - SILADICE	1,70	
V57	V367000D	VÁH - NAD SEREĎOU	81,00	Qprden, Qok
V60	V380000D	VÁH - SELICE	47,70	Qprden, Qok
V79	V656000D	TRNÁVKA - MODRANKA	8,10	
V80	V671510D	DOLNÝ DUDVÁH - SLÁDKOVIČOVO	11,30	
V61	V744500Z	VÁH - KOLÁROVO	24,40 VS	
V136	V787501D	VÁH - KOMÁRNO	2,50	
NITRA				
V82	N388000D	NITRA - NAD KĽAČNOM	165,00	Qprden, Qok
V133	N399500D	NITRA - OPATOVCE NAD NITROU	138,70	Qprden
V85	N400510D	HANDLOVKA - POD HANDLOVOU	23,00	Qprden
V86	N410510D	HANDLOVKA - KOŠ	1,20	Qprden
V88	N416000D	NITRA - CHALMOVÁ	123,80	Qprden, Qok BP
V90	N439010D	NITRICA - PARTIZÁNSKE	0,20	Qprden
V94	N487500D	BEBRAVA - KRUŠOVCE	3,40	Qprden
V95	N495020D	NITRA - PRÁZNOVCE	98,00	Qprden
V96	N497000D	NITRA - NITRIANSKA STREDA	91,10 VS	Qprden, Qok
V97	N538000D	NITRA - LUŽIANKY	65,10	Qprden
V98	N544500D	NITRA - ČECHYNCE	47,80	
V100	N559000D	ŽITAVA - TESÁRSKE MLYŇANY	39,30	Qprden
V102	N580000D	ŽITAVA - LÚČNICA	18,40	Qprden
V103	N590000D	ŽITAVA - DOLNÝ OHÁJ	2,10	Qprden
V104	N598520D	MALÁ NITRA - POD ŠURANMI	0,80	
V106	N599500D	NITRA - NOVÉ ZÁMKY	14,50	Qprden
V107	N775500D	NITRA - KOMOČA	6,50	
HRON RIVER BASIN				
HRON				
H1	R008000D	HRON - VALKOVŇA	261,30	Qprden
H2	R014000D	HRON - POLOMKA	243,40 VS	Qprden, Qok
H3	R025010D	HRON - NAD BREZNOM	224,80	Qprden
H4	R028000D	HRON - VALASKÁ	217,00	Qprden
H5	R036500D	ČIERNY HRON - ÚSTIE	0,05	Qprden
H6	R048000D	HRON - NEMECKÁ	200,80	Qprden
H7	R064000D	HRON - ŠALKOVÁ	181,40	Qprden
H8	R095010D	HRON - BANSKÁ BYSTRICA	175,80 VS	Qprden
H9	R095020D	BYSTRICA - BANSKÁ BYSTRICA	2,10	Qprden, Qok
H11	R112000D	HRON - SLIAČ	161,10	Qprden
H12	R113000D	HRON - ZVOLEN MB ČOV	153,60	Qprden
H15	R143000D	HUČAVA - HROCHOŤ	13,80 VS	Qprden, Qok
H16	R146010D	ZOLNÁ - ÚSTIE	0,50 VS	Qprden, Qok
H60	R113010D	NERESNICA - ÚSTIE	0,05	Qprden, Qok
H17	R153500D	SLATINA - ÚSTIE	0,30	Qprden

cont. Annex 4-2

Map's number	NEC	River - Sampling site	River's km	Discharge
H18	R156000D	HRON - BUDČA	148,20	Qprden BP
H21	R185000D	HRON - ŽIAR NAD HRONOM	131,50 VS	Qprden, Qok
H22	R223010D	HRON - ŽARNOVICA	112,00	Qprden
H23	R234000D	HRON - TEKOVSKÁ BREZNICA	88,90	Qprden BP
H25	R247000D	HRON - KALNÁ NAD HRONOM	63,70	Qprden
H26	R296510D	SIKENICA - ÚSTIE	2,70	
H27	R340000D	HRON - KAMENÍN	10,90 VS	Qprden, Qok
	IPEL			
H69	I004020D	IPEĽ - POD VN MÁLINEC	179,50 VS	Qprden, Qok
H29	I021020D	IPEĽ - BREZNIČKA	163,00 VS	Qprden
H30	I043000D	SUCHÁ - PRŠA	3,10 VS	Qprden, Qok
H31	I028000D	IPEĽ - HOLIŠA	143,20	Qprden, QokBP
H32	I066010D	KRIVÁNSKY POTOK - NAD LUČENCOM	5,40 VS	Qprden, Qok
H33	I066020D	KRIVÁNSKY POTOK - POD LUČENCOM	4,20	Qprden
H34	I087000D	IPEĽ - RAPOVCE	137,90	Qprden BP
H35	I126000D	IPEĽ - MUĽA	120,70	Qprden BP
H36	I150000D	KRTÍŠ - NOVÁ VES	11,60	
H37	I161010D	IPEĽ - SLOVENSKÉ ĎARMOTY	89,50 VS	Qprden, Qok
H39	I228510D	KRUPINICA - NAD ŠAHAMI	1,10	Qprden
H67	I268000D	ŠTIAVNICA - ÚSTIE	1,10 VS	Qprden
H74	I279001D	IPEĽ - KUBÁŇOVO	38,3	Qprden
	SLANÁ			
H42	S003000D	DOBŠINSKÝ POTOK - PRÍTOK DO VN DOBŠINÁ	2,00	
H43	S011000D	SLANÁ - NAD ROŽŇAVOU	55,30	Qprden
H44	S017010D	SLANÁ - POD ROŽŇAVOU	49,20	Qprden
H45	S048020D	ŠTÍTNIK - ÚSTIE	1,30 VS	Qprden, Qok
H46	S053000D	SLANÁ - ČOLTOVO	28,30	Qprden
H47	S070010D	MURÁŇ - POD JELŠAVOU	21,30	Qprden
H48	S055000D	MURÁŇ - BRETKA	0,60 VS	Qprden, Qok
H49	S131000D	SLANÁ - LENÁRTOVCE	3,60 VS	Qprden, Qok
H50	S145000D	RIMAVA - POD HAČAVOU	63,20	Qprden
H51	S145010D	RIMAVA - HNÚŠŤA	58,00 VS	Qprden, Qok
H52	S168010D	RIMAVA - ČERENČANY	37,20	Qprden
H53	S187000D	RIMAVA - RIMAVSKÉ JANOVCE	26,50	Qprden
H55	S273000D	RIMAVA - VLKYŇA	1,60 VS	Qprden, Qok

Map's number	NEC	River - Sampling site	River's km	Discharge
	BODROGU AND HORNÁD RIVER BASIN			
	BODROG			
B10	B607000D	LATORICA - LELES	21,30 VS	Qprden, Qok
B11	B027000D	LABOREC - KRÁSNY BROD	108,30	Qprden, Qok
B12	B068000D	LABOREC - NAD CIROCHOU	69,90	Qprden, Qok
B13	B074000D	CIROCHA - PRÍTOK DO VN STARINA	43,80	Qprden, Qok
B14	B074010D	STRUŽNICA - PRÍTOK DO VN STARINA	0,50	Qprden, Qok
B15	B074020D	VN STARINA - PRIEHRADNÝ MÚR	37,40	
B16	B074030D	VN STARINA - ODTOK Z NÁDRŽE	37,00	Qprden, Qok
B17	B086000D	CIROCHA - POD SNINOU	19,60	Qprden, Qok
B18	B067000D	CIROCHA - ÚSTIE	2,10	Qprden, Qok
B19	B099000D	LABOREC - BREKOV	59,90	Qprden, Qok
B20	B107000D	LABOREC - PETROVCE	45,10	Qprden, Qok
B26	B117000D	ŠÍRAVSKÝ KANÁL - ÚSTIE	4,50	Qprden, Qok
B27	B117010D	ŠÍRAVA - MEDVEDIA HORA		
B28	B183000D	ŠÍRAVA - LÚČKY		
B21	B208000D	ZÁLUŽICKÝ KANÁL - POD ŠÍRAVOU	2,50	Qprden, Qok
B22	B127000D	LABOREC - LASTOMÍR	31,00	Qprden, Qok
B23	B215000D	LABOREC - STRETÁVKA	19,00	Qprden, Qok
B24	B154000D	UH - PINKOVCE	18,50	Qprden, Qok
B25	B203000D	K.REVIŠTIA- BEŽOVCE - KRISTY	11,20 VS	Qprden, Qok
B29	B213000D	ČIERNA VODA 4 - STRETAVA	5,30	
B30	B215020D	LABOREC - IŽKOVCE	10,30 VS	Qprden, Qok
B102	B257500D	ONDAVA - NAD SVIDNÍKOM	121,50	
B31	B287010D	LADOMÍRKA - NAD SVIDNÍKOM	2,20	Qprden, Qok
B32	B287030D	ONDAVA - POD SVIDNÍKOM	113,90	Qprden, Qok
B33	B330000D	ONDAVA - PRÍTOK DO VN DOMAŠA	91,40	Qprden, Qok
B34	B343000D	VN DOMAŠA - PRIEHRADNÝ MÚR	72,30	
B35	B344010D	ONDAVA - MALÁ DOMAŠA	67,30	
B36	B342000D	OĽKA - ÚSTIE	1,20	Qprden, Qok
B38	B394000D	ONDAVA - KUČÍN	53,90 VS	Qprden, Qok
B37	B397000D	ONDAVA - POŠA	45,40	Qprden, Qok
B39	B400010D	ONDAVA - NIŽNÝ HRUŠOV	42,00	Qprden, Qok
B40	B410000D	TOPĽA - GERLACHOV	118,60 VS	Qprden, Qok
B41	B443000D	TOPĽA - KOMÁROV	95,20	Qprden, Qok
B103	B467000D	TOPĽA - MARHAŇ	71,70	Qprden, Qok
B43	B502000D	TOPĽA - HANUŠOVCE	47,70	Qprden, Qok BP
B44	B534000D	TOPĽA - POD VRANOVOM	15,30	Qprden, Qok
B104	B544000D	TOPĽA - BOŽČICE	3,20	Qprden, Qok
B45	B549000D	ONDAVA - HOROVCE	29,10	Qprden, Qok BP
B98	B569000D	TRNÁVKA 1 - VOJČICE	18,00	
B47	B575000D	TRNÁVKA 1 - ZEMPLÍNSKE HRADIŠTE	7,50	Qprden, Qok
B48	B595000D	ONDAVA - BREHOV	4,20	Qprden, Qok
B49	B624000D	SOMOTORSKÝ KANÁL - MALÝ HOREŠ	14,00	

Map's number	NEC	River - Sampling site	River's km	Discharge
B50	B634000D	SOMOTORSKÝ KANÁL - SOMOTOR	3,60	
B51	B615000D	BODROG - STREDA NAD BODROGOM	6,00	Qprden, Qok
B52	B663000D	ROŇAVA - SLOVENSKÉ NOVÉ MESTO	2,20	
	BODVA			
B88	A001000D	BODVA - NAD ODBER. OBJEK. VVaK	41,80	Qprden, Qok
B89	A002000D	BODVA - NAD MEDZEVOM	36,40	Qprden, Qok
B90	A006000D	BODVA - NAD MOLDAVOU N/BODVOU	19,20	Qprden, Qok
B91	A011000D	IDA - PRÍTOK DO VN BUKOVEC	41,30	Qprden, Qok
B92	A012010D	VN BUKOVEC - PRIEHRADNÝ MÚR	37,90	
B93	A012000D	VN BUKOVEC - ODTOK Z NÁDRŽE	37,40	Qprden, Qok
B113	A022000D	IDA - BUZICA	8,00	Qprden, Qok
B95	A034000D	IDA - ÚSTIE	1,80 VS	Qprden, Qok
B96	A053000D	TURŇA - ÚSTIE	2,20	Qprden, Qok
B97	A053010D	BODVA - HOSŤOVCE	0,00	Qprden, Qok BP
	HORNÁD			
B105	H005000D	HORNÁD - HRANOVNICA	159,40 VS	
B54	H006000D	GÁNOVSKÝ POTOK - ÚSTIE	0,70 VS	Qprden, Qok
B56	H025000D	HORNÁD - SMIŽANY	136,40	Qprden, Qok
B59	H038000D	HORNÁD - POD SPIŠ. NOVOU VSOU	124,60	Qprden, Qok
B60	H038010D	LEVOČSKÝ POTOK - ÚSTIE	0,10 VS	
B61	H038030D	RUDNIANSKY POTOK 2 - ÚSTIE	0,40	
B62	H082000D	HORNÁD - KOLINOVCE	100,70	Qprden, Qok
B63	H085000D	SLOVINSKÝ POTOK - ÚSTIE	0,10	Qprden, Qok
B106	H091000D	HORNÁD - POD KLUKNAVOU	92,10	Qprden, Qok
B65	H094000D	HNILEC - PRÍTOK DO VN PALCM. MAŠA	75,40	Qprden, Qok
B66	H096000D	VN PALCMANSKÁ MAŠA - PRIEHRADNÝ MÚR	71,35	
B67	H096010Z	VN PALCMANSKÁ MAŠA - ODTOK Z NÁDRŽE	71,20	
B107	H102000D	HNILEC - POD NÁLEPKOVOM	42,50	Qprden, Qok
B68	H109000D	SMOLNÍK 1 - ÚSTIE	0,40	Qprden, Qok
B69	H110000D	HNILEC - POD MNÍŠKOM	22,20	Qprden, Qok
B70	H112010D	HNILEC - PRÍTOK DO VN RUŽÍN	4,10	Qprden, Qok
B71	H120000D	HORNÁD - MALÁ LODINA	64,80	Qprden, Qok
B108	H156000D	SVINKA - ROKYCANY	17,20	Qprden, Qok
B72	H163000D	SVINKA - OBIŠOVCE	2,00	Qprden, Qok
B73	H165000D	HORNÁD - TREBEJOV	48,20	Qprden, Qok
B74	H171000D	HORNÁD - ŤAHANOVCE	38,80	Qprden, Qok
B75	H178000D	MYSLAVSKÝ POTOK - VTOK DO ŠTÔLNE	15,60	
B76	H372000D	HORNÁD - KRÁSNA NAD HORNÁDOM	27,00	Qprden, Qok
B77	H188020D	TORYSA - POD NIŽNÝMI REPÁŠAMI	119,90	Qprden, Qok
B78	H188030D	OĽŠAVICA - ÚSTIE	0,02	Qprden, Qok
B79	H189500D	TORYSA - NAD ODBER. OBJEK. TICHÝ P.	113,70	Qprden, Qok
B109	H209000D	TORYSA - POD LIPANMI	89,80	Qprden, Qok
B81	H227000D	TORYSA - ŠARIŠSKÉ MICHAĽANY	73,30	Qprden, Qok
B82	H247000D	SEKČOV - POD RASLAVICAMI	29,50	Qprden, Qok

Map's number	NEC	River - Sampling site	River's km	Discharge
B83	H292010D	SEKČOV - ÚSTIE	0,20	Qprden, Qok
B114	H298010D	TORYSA - KENDICE	49,90	Qprden, Qok
B85	H328000D	TORYSA - KOŠICKÉ OLŠANY	13,00	Qprden, Qok BP
B110	H361000D	OLŠAVA 2 - OLŠOVANY	18,00	Qprden, Qok
B86	H370000D	OLŠAVA 2 - ÚSTIE	0,60	Qprden, Qok
B87	H371000D	HORNÁD - ŽDAŇA	17,20 VS	Qprden, Qok

NOTE

Q prden	mean daily discharge [m3.s-1]
Q ok	instantaneous discharge [$m^3.s^{-1}$]
MO	sampling site
VS	gauging station
BP	balance calculation point

Annex 4-3

Classification of Surface Water Quality, STN 75 7221

Water quality

CLASSIFICATION OF SURFACE WATER QUALITY

STN 75 7221

Effective since July 1, 1990

This standard is a replacement for ČSN 83 0602 of June 23, 1965

This standard is valid for determination of the category of surface water quality - for classification, which serves to comparison of its quality on different places and in different time.

This standard does not apply to assessment and classification of transboundary water quality.

For surface water quality control the STN 75 7220 standard is valid.

TERMINOLOGY

1. Terminology used in this standards corresponds to STN 73 6510 and STN 74 0170 standards, and for these purposes is supplemented as follows:
2. ***Water quality assessment*** - procedure at assessment of the results of water quality control transferring obtained data on water quality into certain numerical characteristic values and then these values into verbal expression of the state of water quality.
3. ***Water quality classification*** - arrangement of water according to their quality into categories using system of limit values of water quality categories. It is a basic method of water quality control results assessment. The classification results represent a part of water quality evaluation from the environmental standpoint, and they can serve to route-identification determination of possibilities of water uses for various purposes. For water quality assessment from the standpoint of the possibilities of water use for certain purposes corresponding regulations or recommendations are valid,
4. ***Characteristic value*** - the value of water quality indice, which characterizes and replaces at water quality assessment the whole set of measured values of water quality index.
5. ***Set of values*** - all values of water quality indice obtained by control.
6. ***Range of the set of value*** - number of elements (values of water quality index) in the set of the values.
7. ***Control frequency*** - number of findings carried out, e.g. number of water samples taken within a certain period, in a year, as a rule.
8. ***Representative set of values*** - set of values obtained by investigation (selective set), which describes best the basic set (set of all possible values in control profile). Basic set is infinitively large, and therefore it cannot be measured entirely.
9. ***Random selection of values*** - selection of „n“ elements from the basic set in the way, so that all possible combinations of „n“ elements have the same probability to be selected.
10. ***Limit values of water quality categories*** - the lowest and the highest value of water quality index in given category of water quality.
11. ***Group of water quality indices*** - water quality indices with a certain common property (e.g. radioactivity indices).

GENERAL

12. Classification of water quality proceeds from the assessment of selected water quality indices, which are divided into 6 groups for the purpose of this standard, according to Table 1.

Table 1

Group of indices	Group indication
oxygen regime	A
basic chemical and physical	B
complementary chemical	C
heavy metals	D
biological and and microbiological	E
radioactivity	F

13. Water quality is classified separately for each individual indice of corresponding group of indices. Inside of each group resulting category of water quality will be determined according to the most unfavorable water quality index in the group.
14. Total classification of water quality must be based at least upon the classification of values of water quality indices in individual groups in accordance with Table 2 and upon the classification in groups A, B, and E (please, see point 12).

Table 2

Group	Indices
A	dissolved oxygen, BOD_5, COD_{Mn} or COD_{Cr}
B	pH, water temperature, dissolved solids or conductivity, suspended solids, ammonium N, nitrate N, total P
C	calcium, magnesium, chlorides, sulphates, anion active detergents, non-polar extractable substances, organic bound Cl
D	mercury, cadmium, arsenic, lead
E	saprobic index, coliform bacteria or fecal coloform bacteria
F	total volume alpha activity, total volume beta activity

15. Water quality is classified on the basis of control results from a longer entire period. The shortest evaluated period is one year, the longest one is determined by changes in water management in the basin of check profile; as a rule a period not longer than 5 years is chosen.
16. Surface water is classified into 5 categories according to water quality :
    - I category - very clean water
    - II category - clean water
    - III category - polluted water
    - IV category - heavily polluted water
    - V category - very heavily polluted water
17. Assessment of water quality and classification of water quality must be based on the representative set of values of water quality indices. Representativeness of the sets of water quality indice values is to be ensured best by random sampling (randomly chosen day of the year and randomly chosen hour of the day). Owing to stochastic character of water quality in the flow, randomness of selection (and hence also its representativeness) from the viewpoint of the day in the year can be appropriately ensured also by control with relatively constant interval (e.g. by water sampling schedule prepared in advance). In near check profiles downstream of large pollution sources, however, it is impossible to ensure randomness (and hence also representativeness) of the sampling in relatively constant daily hour from the viewpoint of the hour in the course of the day.
18. Examples of utilization of water in individual categories are given in Annex 2.

CLASSIFICATION

19. Inclusion of water quality according to each individual indice into the category of water quality is performed by comparison of calculated characteristic value of this index with its corresponding set of limit values. Limit values of water quality indices for individual categories of water quality are given in Table 3.
20. Characteristic value of water quality index will be calculated from all obtained control results. Values of water quality index are not to be recalculated to any reference rate of flow.

    No value is excluded. As far as the value of water quality index was affected by an accident, and hence additional quality determination is to be performed out of the original control programme, the results of this additional determination are not included into the calculation of characteristic value od water quality index.
21. Characteristic value of water quality index is the value with probability of not exceeding 90 %. In case of dissolved oxygen it is value with probability exceeding 90 %.
22. Characteristic value is calculated from the set of at least 24 values.
23. If the usual check frequency is 12 samplings per year, for characteristic value calculation it is necessary to combine observations from 2 years together. Then the classification is related to this two-year period. At evaluation of water quality development either two-year periods or sliding two-year periods are then used; the way of calculation has always to be indicated.
24. Characteristic value with the probability of not exceeding (of exceeding) chosen in advance is calculated according to Annex 3.
25. If it is necessary to classify water quality for 1 year period at checking frequency of 12 samplings per year (exceptionally 11 samplings per year), characteristic value will be calculated as an average of 3 most unfavorable values od water quality index. The probability of non-exceeding of this value is usually between 85 % to 90 %, depending on the shape of values distribution.

EXPRESSION OF RESULTS

26. As a rule the results of classification are expressed in form of tables always containing (in addition to identification data, see point 27) :
    a. arithmetic mean of the rate of flow to the date of water sampling,
    b. for each water quality index
        - arithmetic mean of values
        - characteristic value
        - category of water quality
    c. resulting category for group of indices and the number of critical water quality index, which determines the resulting category of the group e.g. III, $B_{10.}$
27. The place of water quality determination must be defined exactly by its name, river km and hydrological order. At the same time it is recommended, in order to exclude mistakes at interpretation of the check results, to indicate also in the name of the check profile, if it is situated over or under the locality, by which it is named. At the same time the investigation point of water quality must be indicated, i.e. the exact place in the transverse profile (sampling from the left bank, right bank, from the middle of the flow etc.).
28. The results of the classification can be expressed also by the form of a map of water quality. At its construction, however, it is necessary to have more detailed information about the changes of values of water quality index in longitudinal direction (especially

on substances that are subjected to natural process in the flow) and about sudden changes of values of water quality index (places of waste water discharges, river tributaries etc.). As a rule the resulting classification in the group of oxygen regime indices is put on the maps. Usually following colors are chosen :

I category	light blue
II category	dark blue
III category	green
IV category	yellow
V category	red

Table 4 Water quality categories and their limit values

A. Oxygen regime indices

	Parameter	Symbol	Unit	Category				
				I	II	III	IV	V
1	Dissolved oxygen	O_2	mg/l	>7	>6	>5	>3	‹3
2	Biochem. oxygen demand	BOD_5	mg/l	‹2	‹5	‹10	‹15	>15
3	Chem. oxygen demand(Mn)	COD_{Mn}	mg/l	‹5	‹10	‹15	‹25	>25
4	Chem. oxygen demand (Cr)	COD_{Cr}	mg/l	‹15	‹25	‹35	‹55	>55
5	Organic carbon	TOC	mg/l	‹5	‹8	‹11	‹17	>17
6	Sulfate and sulfides	S^{2-}	mg/l	uld	uld	uld	‹0.02	>0.02

uld - under the limit of determination

B. Chemical parameters - basic

	Parameter	Symbol	Unit	Category				
				I	II	III	IV	V
1	Water reaction	pH		6-8,5	6-8,5	6-8,5	5,5-9	‹5,5-9
2	Water temperature	t	^0C	‹22	‹23	‹24	‹26	>26
3	Dissolved substances	DS	mg/l	‹300	‹500	‹800	‹1200	>1200
4	Conductivity	×	mS/m	‹40	‹70	‹110	‹160	>160
5	Suspended solids	SS	mg/l	‹20	‹40	‹60	‹100	>100
6	Total iron	Fe	mg/l	‹0,05	‹1,0	‹2,0	‹3,0	>3,0
7	Total manganese	Mn	mg/l	‹0,05	‹0,1	‹0,3	‹0,8	>0,8
8	Ammonium nitrogen	$N\text{-}NH_4^+$	mg/l	‹0,3	‹0,5	‹1,5	‹5,0	>5,0
9	Nitrite nitrogen	$N\text{-}NO_2^-$	mg/l	**‹0,002**	**‹0,005**	‹0,02	‹0,05	>0,05
10	Nitrate nitrogen	$N\text{-}NO_3^-$	mg/l	‹1,0	‹3,4	‹7,0	‹11,0	>11
11	Organic nitrogen	N-org.	Mg/l	‹0,5	‹1,0	‹2,5	‹3,5	>3,5
12	Total phosphorus	P	mg/l	;0,03	‹0,15	‹0,4	‹1,0	>1,0

C. Chemical parameters - supplementary

	Parameter	Symbol	Unit	Category				
				I	II	III	IV	V
1	Chlorides	Cl^-	mg/l	‹50	‹200	‹300	‹400	>400
2	Sulphates	SO_4^{2-}	mg/l	‹80	‹150	‹250	‹300	>300
3	Calcium	Ca	mg/l	‹75	‹150	‹200	‹300	>300
4	Magnesium	Mg	mg/l	‹25	‹50	‹100	‹200	>200
5	Absorbency (254 nm, 1cm)	a_1 cm^{254}		‹0,15	‹0,25	‹0,35	‹0,55	>0,55
6	Fluorides	F	mg/l	‹0,2	‹0,5	‹1,0	‹1,5	>1,5
7	Volatile phenols	Ph1	mg/l	**‹0,002**	‹0,01	‹0,02	‹0,5	>0,5
8	Anion active detergents	PAL-A	mg/l	uld	‹0,5	‹1,0	‹2,0	>2,0
9	Non-polar extractable subs	NES	mg/l	uld	‹0,05	‹0,1	‹0,3	>0,3
10	Total cyanides	CN^-	mg/l	uld	uld	‹0,2	‹0,5	>0,5
11	Active chlorine	Cl_2	mg/l	uld	uld	uld	‹0,05	>0,05
12	Extractable organic chlorine	EOCl	µg/l	‹5	‹10	‹20	‹30	>30

D. Heavy metals

	Parameter	Symbol	Unit	Category				
				I	II	III	IV	V
1	Mercury	Hg	µg/l	‹0,1	‹0,2	‹0,5	‹1,0	>1,0
2	Cadmium	Cd	µg/l	‹3	‹5	‹10	‹20	>20
3	Lead	Pb	µg/l	‹10	‹20	‹50	‹100	>100
4	Arsenic	As	µg/l	‹10	‹20	‹50	‹100	>100
5	Copper	Cu	µg/l	‹20	‹50	‹100	‹200	>200
6	Total chromium	Cr	µg/l	‹20	‹100	‹200	‹500	>500
7	Chromium (VI)	Cr^{VI}	µg/l	udl	‹10	‹20	‹50	>50
8	Cobalt	Co	µg/l	‹10	‹20	‹50	‹100	>100
9	Nickel	Ni	µg/l	‹20	‹50	‹100	‹200	>200
10	Zinc	Zn	µg/l	‹20	‹50	‹100	‹500	>500
11	Vanadium	V	µg/l	‹10	‹20	‹50	‹100	>100
12	Silver	Ag	µg/l	udl	10	20	50	50

E. Biological and microbiological parameters

	Parameter	Unit #	Category				
			I	II	III	IV	V
1	Saprobic index of bioseston (acc. to Pantle and Buck)		‹1,2	‹2,2	‹3,2	‹3,7	>3,7
2	Psychrofile bacteria	CFU/1ml	‹500	‹1000	‹5000	‹10000	>10000
3	Coliform bacteria	CFU/1ml	‹1	‹10	‹100	‹1000	>1000
4	Fecal coliform bacteria	CFU/1ml	‹0,2	‹2	‹20	‹200	>200
5	Enterococcuses	CFU/1ml	‹0,1	‹1	‹10	‹100	>100

 # Bacteria number determination is performed by cultivation on solid soils, the number of grown colonies is evaluated. Colony can arise from one independent cell of from clusters (microcolonies) and therefore results are given as the numbers of colony forming units (number of colonies) in 1 ml of sample. CFU is the colony-forming unit.

F. Radioactivity parameters

	Parameter	Symbol	Unit	Category				
				I	II	III	IV	V
1	Total volume activity alpha	$a_{v,c}$	mBq/l	‹50	‹100	‹500	‹2500	>2500
2	Total volume activity beta	$a_{v,c}$	mBq/l	‹200	‹500	‹1000	‹2500	>2500
3	Radium 226	Ra 226	mBq/l	‹20	‹50	‹120	‹500	>500
4	Uranium	U	µg/l	‹5	‹20	‹50	‹100	>100
5	Tritium	H3 (T)	Bq/l	‹10	‹100	‹1000	‹5000	>5000

APPENDIX 2

EXAMPLES OF UTILIZATION OF INDIVIDUAL WATER CATEGORIES

I category	water can be used for the all purposes, especially for drinking water supply, food industry, bathing, salmon fish farming water has a great landscape forming value
II category	water is usually suitable for most types of utilization, mainly for: drinking water supply, water sports, fisheries, industry water supply water has landscape forming value
III category	water is usually suitable only for industry, for drinking water supply only with the use of extensive treatment technologies (only in the case, that it is not available source of better quality) water has small landscape forming value
IV category	the usage of water is limits
V category	water is usually unsuitable for any

APPENDIX 3

CHARACTERISTIC VALUE CALCULATION

Characteristic value of selective set is the value of water quality index with pre-chosen probability of not-exceeding (probability of exceeding in case of dissolved oxygen) found from selective distribution line.

Principle of calculation

The value with pre-chosen probability of not-exceeding (probability of exceeding in case of dissolved oxygen) will be found from selective distribution line represented by broken line connecting empirical probabilities of individual values of selective set. The principle of such way of distribution line estimate is based on arrangement of measured values into ascending series (descending series in case of dissolved oxygen) and assesment of empirical probabilities of not-exceeding (probabilities of exceeding in case of dissolved oxygen) to individual values of series. Empirical probability of not-exceeding (probability of exceeding in case of dissolved oxygen) will be calculated from formula (1)

$$P_m = (m - 0,3)/(n + 0,4) \qquad (1)$$

where P_m is empirical probability of m value in series;
m is serial number in ascending series (descending series in case of dissolved oxygen)
n is number of elements in the series.

Pairs of values and of probabilities can be plotted into the distribution diagram and its individual points can be connected by nonlinear line.

In case of very extensive sets (several hundreds of values) an alternative procedure can be applied based on the calculation of cumulative relative frequency.

Calculation of value with pre-chosen probability

With respect to the frequency (n) and choise of characteristic probability the values with prechosen probability P % (cp) will be calculated by following simple procedure:

1) Value k will be calculated

$$k = \left\langle \frac{100 - P}{100} \cdot (n + 0,4) + 0,3 \right\rangle \qquad (2)$$

where ⟨ ⟩ means the value rounded-off to a higher integer.

Example: If P = 90% is chosen, then equation (2) will be transfered to equation (3)

$$k = (0,1 \ . \ n + 0,34) \qquad (3)$$

if $n = 24$, then k is calculated from the equation (3)

2) From the set the k highest values (k lowest values in case of dissolved oxygen) will be chosen and these k values will be arranged into descending series (ascending series in case of dissolved oxygen).

3) The value with prechosen probablity of non-exceeding (probability of exceeding in case of dissolved oxygen) P % (c_p) will be calculated from equations (4) and (5)

$$c_p = (d_p \ . \ c_{K-1}) + (1 - d_p) \ . \ c_K \qquad (4)$$

$$d_p = k - \frac{100 - P}{100} \ . \ (n + 0,4) + 0,3 \qquad (5)$$

where c_p is the value with pre-chosen probability;
c_K is the k value in ascending series of k values (descending series in case of dissolved oxygen)
c_{K-1} is the (k-1)-th value in ascending series of k values (descending series in case of dissolved oxygen)
d_p is auxilliary variable

Example: If P = 90% is chosen, then equation (5) will be transfered to equation

$$d_{90} = k - 0,1 \ . \ n - 0,34 \qquad (6)$$

if $n = 1$, then d_{90} will be calculated from equation (6)

$$d_{90} = 3 - 2,74 = 0,26$$

Examples:

1) From 24 values of BOD_5 the c_{90} value has to be calculated. First $k = 3$ is calculated, 3 highest values will be determined and arranged into descending series: $c_1 = 16$, $c_2 = 14$, $c_3 = 13$. By substitution into equations (4) and (6) resulting equation (7) for the c_{90} value calculation will be determined

$$c_{90} = (0,26 \ . \ c_2) + (0,74 \ . \ c_3) \qquad (7)$$

and after substitution

$$c_{90} = (0,26 \ . \ 14) + (0,74 \ . \ 13) = 3,64 + 9,62 = 13,26$$

2) From 24 values of dissolved oxygen the c_{90} value has to be calculated. First $k = 3$ is calculated, then 3 lowest values will be determined and arranged into ascending series: $c_1 = 2$, $c_2 = 4$, $c_3 = 5$. By substitution into equation (7) we obtain

$$c_{90} = (0,26 \ . \ 4) + (0,74 \ . \ 5) = 1,04 + 3,70 = 4,74$$

Annex 4-4

Total Volumes of Dredged Material from Danube River in the Period 1962-94

Annex 4-4 Total Volumes of Dredged Material from Danube River in the Period of 1962-1994 Industrial and Channel Ford Dredging

rkm	V [1000. m3]
1880	0
1879	0
1878	0
1877	76
1876	0
1875	0
1874	0
1873	0
1872	0
1871	264
1870	191
1869	251
1868	155
1867	831
1866	12
1865	73
1864	1010
1863	2251
1862	2540
1861	1004
1860	478
1859	501
1858	20
1857	0
1856	0
1855	0
1854	412
1853	203
1852	53
1851	109
1850	167
1849	90
1848	126
1847	0
1846	0
1845	12
1844	81
1843	70
1842	866
1841	0
1840	222
1839	75
1838	0
1837	265
1836	94
1835	7
1834	0
1833	0
1832	65
1831	0
1830	0
1829	419
1828	0
1827	311
1826	374
1825	56
1824	547
1823	507
1822	61
1821	566
1820	54
1819	0
1818	415
1817	0
1816	0
1815	140
1814	256
1813	167
1812	19
1811	85
1810	412
1809	1037
1808	154
1807	697
1806	517
1805	1214
1804	341
1803	935
1802	37
1801	479
1800	370
1799	376
1798	375
1797	1002
1796	776
1795	1144
1794	280
1793	317
1792	761
1791	686
1790	1359
1789	1019
1788	711
1787	488
1786	1630
1785	1866
1784	536
1783	1043
1782	998
1781	952
1780	888
1779	681
1778	1452
1777	1234
1776	1040
1775	772
1774	824
1773	549
1772	594
1771	790
1770	363
1769	255
1768	62
1767	251
1766	322
1765	471
1764	519
1763	312
1762	255
1761	772
1760	671
1759	129
1758	360
1757	1387
1756	1240
1755	104
1754	887
1753	518
1752	561
1751	677
1750	774
1749	902
1748	266
1747	80
1746	676
1745	931
1744	1406
1743	295
1742	435
1741	1085
1740	337
1739	252
1738	174
1737	260
1736	120
1735	0
1734	67
1733	387
1732	410
1731	206
1730	139
1729	0
1728	311
1727	451
1726	869
1725	790
1724	1492
1723	524
1722	612
1721	1115
1720	228
1719	386
1718	178
1717	734
1716	666
1715	378
1714	781
1713	1545
1712	1964
1711	2159
1710	275
1709	176
1708	1348

Annex 4-5

Gauging Stations in Danube River Basin

Annex 4-5 GAUGIN STATIONS - Danube River Basin
ZOZNAM VODOMERNÝCH STANÍC - POVODIE DUNAJA

POR. ČIS.	DB ČIS.	STANICA station	TOK river	HYDROLOGICKE ČISLO	RIECNY KM r. km	PLOCHA POVODIA [km2]	NADM.V. "0" VDČ [m n.m.]	OZOROVANIA OD ROKU			
								H wat.stage	Q disch	T wat.tem.	P sed.dis
1.	5127	BRATISLAVA, DEVÍN	DUNAJ	1-4-20-01-001-01	1879,78	131244,00	132,87	1926	1990	1993	
2.	5130	SPARISKÁ	VYDRICA	1-4-20-01-004-01	11,50	7,25	321,06	1926*	1931*		
3.	5135	ČERVENÝ MOST	VYDRICA	1-4-20-01-005-01	3,30	22,60	173,17	1928*	1965		
4.	5140	BRATISLAVA	DUNAJ	1-4-20-01-006-01	1868,75	131329,10	128,43	1876	1901	1925	1992
5.	5141	RUSOVCE	DUNAJ	1-4-20-01-008-01	1855,90	131354,75	123,90	1948*		1974*	
6.	5144	PALKOVIČOVO	DUNAJ	1-4-20-01-011-01	1810,00	132152,00	109,10	1882			
7.	5145	MEDVEĎOV, MOST	DUNAJ	1-4-20-01-011-01	1806,30	132168,00	108,42	1925*	1979	1971	1992
8.	5150	MALÉ PÁLENISKO	MALÝ DUNAJ	1-4-21-15-001-01	125,80	0,10	126,72	1965	1968		
9.	5155	VLČIE HRDLO	MALÝ DUNAJ	1-4-21-15-001-02	125,00	0,10	126,10	1974		1974	
10.	5160	PEZINOK	BLATINA	1-4-21-15-002-01	11,30	19,09	238,56	1954	1961		
11.	5170	SVÄTÝ JUR	ŠURSKÝ KANÁL	1-4-21-15-009-01	10,90	106,10	131,01	1947	1968	1971	
12.	5180	VAJNORY	RAČIANSKY P.	1-4-21-15-010-01	1,60	19,54	130,70	1960	1968		
13.	5190	NOVÁ DEDINKA	MALÝ DUNAJ	1-4-21-15-012-03	107,50	51,67	122,64	1974	1974	1974	
14.	5195	JAHODNÁ	MALÝ DUNAJ	1-4-21-17-001-02	42,30	0,10	110,92	1975			
15.	5200	BERNOLÁKOVO	ČIERNA VODA	1-4-21-15-013-01	43,30	72,18	125,27	1949	1961		
16.	5210	MODRA	STOLIČNÝ P.	1-4-21-15-016-01	34,90	9,88	0,00	1956	1963		
17.	5215	JELKA	MALÝ DUNAJ	1-4-21-15-012-01	81,40	251,82	117,71	1963			
18.	5220	BUKOVÁ	TRNÁVKA	1-4-21-16-013-01	34,20	21,88	-	1956	1969		
19.	5230	BOHDANOVCE n/TRNÁV.	TRNÁVKA	1-4-21-16-021-01	20,30	115,02	158,19	1949	1961		
20.	5250	HORNÉ OREŠANY	PARNÁ	1-4-21-16-026-01	26,80	37,86	234,72	1957	1961		
21.	5260	PÍLA	GIDRA	1-4-21-16-038-01	33,30	32,95	270,10	1956	1961	1971	
22.	5270	ČIERNY BROD	DUDVÁH	1-4-21-16-044-01	2,70	750,49	115,05	1950	1968		
23.	5280	TRSTICE	MALÝ DUNAJ	1-4-21-17-001-01	22,60	1596,81	107,88	1963	1970	1979	
24.	6810	KLIŽSKÁ NEMÁ	DUNAJ	1-4-20-01-014-01	1792,40	150260,00	104,65	1930			
25.	6849	KOMÁRNO - MOST	DUNAJ	1-4-20-01-016-03	1767,80	151961,60	103,40	1917	1931	1946	1992
26.	6860	IŽA	DUNAJ	1-4-20-02-001-01	1763,96	171624,60	103,58	1930	1985	1987	
27.	6870	RADVAŇ n/ DUNAJOM	DUNAJ	1-4-20-02-006-01	1748,25	172435,10	102,92	1948			
28.	6880	ŠTÚROVO	DUNAJ	1-4-20-02-016-01	1718,60	172435,10	100,96	1933		1974	
29.	9912	BAKA	KANÁL CVII	1-4-21-17-005-01	1,60	10,00	112,18	1975	1975	1975	
30.	9914	GABČÍKOVO	KANÁL SVII	1-4-21-17-005-02	25,70	15,00	111,98	1975	1975	1975	
31.	9916	JUROVÁ	KANÁL BVII	1-4-21-17-005-03	3,80	10,00	113,10	1975	1975	1975	
32.	9921	VRAKÚŇ	KANÁL AVII	1-4-21-17-005-07	1,35	10,00	111,64	1975	1975	1975	
33.	9924	TOPOĽNÍKY	KANÁL S VII	1-4-21-17-005-09	0,50	20,00	108,81	1975	1975	1975	
34.	9926	BLÁHOVÁ	SEV. ŠARRÉT	1-4-21-17-003-01	14,40	5,00	115,02	1975	1975	1975	
35.	9928	MALÉ DVORNÍKY	SEV. ŠARRÉT	1-4-21-17-003-02	3,20	5,00	110,83	1975	1975	1975	
36.	9930	BENKOVA POTOŇ	JUŽ. ŠARRÉT	1-4-21-17-003-03	15,60	5,00	115,12	1975	1975	1975	
37.	9932	MALÉ DVORNÍKY	JUŽ. ŠARRÉT	1-4-21-17-003-04	2,80	5,00	110,84	1975	1975	1975	
38.	9934	TRHOVÉ MÝTO	KLAT.RAM.M.DUN.	1-4-21-17-004-01	6,50	25,00	109,64	1976	1976	1976	
39.	9938	GABČÍKOVO	KANÁL L	1-4-21-12-085-02	8,00	10,00	111,13	1975	1975	1975	
40.	9944	JÁNOŠÍKOVO	KANÁL SVI	1-4-21-17-010-05	10,00	12,00	107,80	1975	1975	1975	
41.	9947	NOVÁ DEDINKA	SP.K.ČIERNA VODA	1-4-21-17-014-01	0,05	5,00	124,59	1975	1976	1976	

* - obdobie pozorovania prerušené - **observation interrupted**

NOTE:

H Water stage

Q Discharge

T Water Temperature

P Sediment Discharge

Annex 4-5 GAUGIN STATIONS - Morava River Basin
ZOZNAM VODOMERNÝCH STANÍC - POVODIE MORAVY

POR. ČIS.	DB ČIS.	STANICA station	TOK river	HYDROLOGICKE ČISLO	RIECNY KM r. km	PLOCHA POVODIA $[km^2]$	NADM.V. "0" VDČ [m n.m.]	H wat.stage	Q disch.	T wat.tem	P sed.dis
1.	5010	LOPAŠOV	CHVOJNICA	1-4-13-02-079-01	20,90	31,13	272,70	1969	1969		
2.	5011	MORAVA	KOPČANY	1-4-13-02-092-01	96,80	9629,32	-	1996	1996		
3.	5020	MYJAVA	MYJAVA	1-4-13-03-003-01	67,40	32,02	324,34	1973	1974		
4.	5021	BREZOVÁ p/BRADLOM	BREZOVSKÝ P.	1-4-13-03-018-01	11,50	35,86	259,37	1988	1988	1988	
5.	5022	JABLONICA	MYJAVA	1-4-13-03-025-01	38,40	238,45	203,57	1980	1980	1980	
6.	5025	SOBOTIŠTE	TEPLICA	1-4-13-03-039-01	12,00	85,58	236,29	1973	1974		
7.	5027	KUNOV	TEPLICA	1-4-13-03-040-01	8,50	94,53	215,37	1992	1992	1992	
8.	5028	SENICA	TEPLICA	1-4-13-03-046-01	1,00	152,01	188,50	1992	1992	1992	
9.	5030	ŠAŠTÍN - STRÁŽE	MYJAVA	1-4-13-03-073-01	15,18	644,89	164,25	1968	1969	1969	
10.	5040	MORAVSKÝ JÁN	MORAVA	1-4-17-02-001-01	67,15	24129,30	146,24	1889	1922	1962	
11.	5055	PLAVECKÉ PODHRADIE	KRÁĽOV P.	1-4-17-02-017-01	2,80	6,20	211,80	1971	1971		
12.	5060	SOLOŠNICA	SOLOŠNICKÝ P.	1-4-17-02-027-01	5,82	10,38	245,35	1971	1971	1990	
13.	5065	ROHOŽNÍK	RUDAVKA	1-4-17-02-022-01	6,80	27,36	192,53	1971	1971	1990	
14.	5070	STUDIENKA	RUDAVA	1-4-17-02-033-01	17,00	280,32	170,78	1971	1971	1990	
15.	5072	VEĽKÉ LEVÁRE	RUDAVA	1-4-17-02-033-02	7,20	300,30	152,36	1943	1962	1990	
16.	5074	VEĽKÉ LEVÁRE	RUDAVA, NÁHON	1-4-17-02-033-03	2,30	0,10	155,55	1943	1962		
17.	5085	ZÁHORSKÁ VES	MORAVA	1-4-17-02-044-01	32,52	25521,30	139,89	1889	1977	1948*	1992
18.	5087	VYSOKÁ PRI MORAVE	MORAVA	1-4-17-02-055-01	20,75	25569,10	138,71	1942			
19.	5090	KUCHYŇA	MALINA	1-4-17-02-070-01	42,05	7,94	288,74	1973	1974	1990	
20.	5095	JAKUBOV	MALINA	1-4-17-02-083-01	21,95	171,46	144,71	1942	1964	1990	
21.	5100	LÁB	MOČIARKA	1-4-17-02-086-01	1,35	47,10	144,33	1943	1961	1990	
22.	5105	LÁB	OLIVA	1-4-17-02-087-01	1,88	19,50	144,02	1943	1963	1990	
23.	5110	ZOHOR	ONDRIAŠOVSKÝ P.	1-4-17-02-090-01	0,80	40,16	145,03	1943	1964	1990	
24.	5120	BORINKA	STUPAVKA	1-4-17-02-097-01	9,70	35,50	216,71	1974	1974	1974	
25.	5125	DEVÍNSKA NOVÁ VES	MORAVA	1-4-17-02-101-01	8,28	26339,30	134,65	1895			

* - obdobie pozorovania prerušené - **observation interrupted**

NOTE: **H Water stage**
Q Discharge
T Water Temperature
P Sediment Discharge

Annex 4-5 GAUGIN STATIONS - Vah River Basin

ZOZNAM VODOMERNÝCH STANÍC - POVODIE VÁHU

POR. ČIS.	DB ČIS.	STANICA station	TOK river	HYDROLOGICKE ČISLO	RIECNY KM r. km	PLOCHA POVODIA [km^2]	NADM.V. "0" VDČ [m n.m.]	H wat.stage	Q disch.	T wat.tem	P sed.dis
1.	5300	LIPTOVSKÁ TEPLIČKA	ČIERNY VÁH	1-4-21-01-005-01	25,90	61,84	866,81	1967	1967	1967	
2.	5310	ČIERNY VÁH	IPOLTICA	1-4-21-01-019-01	0,28	87,06	737,65	1947	1961		
3.	5311	ČIERNY VÁH	ČIERNY VÁH	1-4-21-01-020-01	11,50	243,06	733,31	1917	1921	1984	
4.	5314	SVARÍN	SVARÍNKA	1-4-21-01-026-01	0,20	24,46	-	1979	1980*		
5.	5316	SVARÍN	ČIERNY VÁH	1-4-21-01-027-01	4,00	302,15	687,75	1982	1982		
6.	5330	VÝCHODNÁ	BIELY VÁH	1-4-21-01-034-01	10,10	105,64	731,64	1922	1923		
7.	5336	MALUŽINÁ	BOCA	1-4-21-01-049-01	7,10	82,75	732,15	1970	1970		
8.	5340	KRÁĽOVA LEHOTA	BOCA	1-4-21-01-053-01	0,20	116,60	655,08	1922	1931		
9.	5350	KRÁĽOVA LEHOTA	HYBICA	1-4-21-01-058-01	0,30	45,03	654,45	1964	1965	1965	
10.	5370	LIPTOVSKÝ HRÁDOK	VÁH	1-4-21-01-059-01	359,30	638,68	630,05	1951	1951	1962	
11.	5380	TICHÁ DOLINA	TICHÝ P.	1-4-21-01-067-01	23,70	57,45	978,82	1939	1973	1973	
12.	5390	KÔPROVÁ DOLINA	KÔPROVÝ P.	1-4-21-01-070-01	0,20	31,20	989,67	1939	1971	1971	
13.	5400	PODBANSKÉ	BELÁ	1-4-21-01-071-01	21,35	93,49	922,72	1924	1928	1955	
14.	5460	RAČKOVÁ DOLINA	RAČKOVÁ	1-4-21-01-080-01	4,10	35,51	894,41	1939*	1963	1973	
15.	5465	DOVALOVO	DOVALOVSKÝ P.	1-4-21-01-085-01	1,10	21,75	626,61	1979	1980		
16.	5480	LIPTOVSKÝ HRÁDOK	BELÁ	1-4-21-01-092-01	0,70	243,94	633,94	1950	1965	1961	
17.	5520	LIPTOVSKÝ JÁN	ŠTIAVNICA	1-4-21-02-009-01	2,00	61,79	633,51	1922*	1963*	1989	
18.	5530	ŽIARSKA DOLINA	SMREČIANKA	1-4-21-02-021-01	10,75	17,99	872,11	1938	1963		
19.	5540	IĽANOVO	IĽANOVIANKA	1-4-21-02-024-01	1,70	14,73	624,28	1969	1969		
20.	5550	LIPTOVSKÝ MIKULÁŠ	VÁH	1-4-21-02-027-01	346,60	1107,21	567,68	1921	1921	1958	
21.	5558	DEMÄNOVSKÁ DOLINA	RADOVÝ P.	1-4-21-02-029-01	0,10	1,28	-	1991	1991		
22.	5577	KOŽIARKA	ZADNÁ VODA	1-4-21-02-029-03	1,20	15,80	-	1971	1971*		
23.	5590	DEMÄNOVÁ	DEMÄNOVKA	1-4-21-02-030-03	7,10	47,38	692,54	1969	1969	1971	
24.	5600	LIPTOVSKÁ ONDRÁŠOVÁ	JALOVČIANKA	1-4-21-02-036-02	0,20	45,00	566,59	1972	1972	1972	
25.	5610	HUTY	KVAČIANKA	1-4-21-02-042-01	9,10	18,78	-	1970*	1970*		
26.	5632	KVAČANY	KVAČIANKA	1-4-21-02-044-01	5,75	32,21	645,92	1978	1979		
27.	5642	LIPTOVSKÉ MATIAŠOVCE	SUCHÝ P.	1-4-21-02-045-04	4,70	18,85	690,35	1979	1979		
28.	5644	LIPTOVSKÁ SIELNICA	KVAČIANKA	1-4-21-02-046-01	1,50	73,86	577,76	1977	1977		
29.	5650	PROSIEK	PROSIEČANKA	1-4-21-02-047-04	2,70	13,40	597,41	1969	1969	1969	
30.	5660	HORÁREŇ HLUCHÉ	KRIŽIANKA	1-4-21-02-050-01	10,20	20,98	825,86	1970	1970		
31.	5680	LIPTOVSKÝ SV. KRÍŽ	KRIŽIANKA	1-4-21-02-053-01	5,20	39,90	647,25	1969	1969		
32.	5714	DÚBRAVA	DÚBRAVKA	1-4-21-02-054-01	8,50	0,70	-	1985	1985		
33.	5720	LIPTOVSKÉ VLACHY	KĽAČIANKA	1-4-21-02-061-01	0,40	27,17	522,09	1923	1962		
34.	5730	PARTIZÁNSKA ĽUPČA	ĽUPČIANKA	1-4-21-02-069-02	5,50	70,43	585,68	1925	1961	1971	
35.	5734	BEŠEŇOVÁ	VÁH	1-4-21-02-071-01	332,90	1612,43	507,29	1978	1978		
36.	5740	PODSUCHÁ	REVÚCA	1-4-21-02-105-01	11,20	217,95	558,21	1927	1928	1985	
37.	5780	HUBOVÁ	VÁH	1-4-21-02-119-01	308,60	2133,20	444,70	1921	1921	1963	1992
38.	5790	ĽUBOCHŇA	ĽUBOCHNIANKA	1-4-21-02-131-01	0,15	118,48	442,00	1921	1931		
39.	5795	ZAKAMENNÉ	BIELA ORAVA	1-4-21-03-009-01	17,00	82,70	-	1943*	1979*		
40.	5799	LOKCA	HRUŠTÍNKA	1-4-21-03-040-01	0,30	76,44	627,89	1978	1979		
41.	5800	LOKCA	BIELA ORAVA	1-4-21-03-041-01	5,80	359,96	626,47	1943	1951	1962	
42.	5810	ORAVSKÁ JASENICA	VESELIANKA	1-4-21-03-051-02	1,00	90,10	618,09	1942	1951	1962	
43.	5816	ORAVSKÁ POLHORA	POLHORANKA	1-4-21-03-062-01	14,80	58,15	700,62	1986	1986		
44.	5820	ZUBROHLAVA	POLHORANKA	1-4-21-03-072-01	1,60	158,67	605,69	1943	1951	1962	
45.	5830	TVRDOŠÍN	ORAVA	1-4-21-04-002-01	57,70	1199,50	564,04	1911	1921	1962	
46.	5833	VITANOVÁ	ORAVICA	1-4-21-04-007-01	17,40	64,15	689,52	1944*	1979		
47.	5840	TRSTENÁ	ORAVICA	1-4-21-04-014-01	3,80	129,95	585,49	1924	1961		
48.	5842	BRESTOVÁ	STUDENÝ P.	1-4-21-04-024-01	16,30	36,60	-	1987	1987		
49.	5845	ORAVSKÝ BIELY POTOK	STUDENÝ P.	1-4-21-04-028-02	5,50	118,09	632,54	1920	1979*		
50.	5847	CHLEBNICE	CHLEBNICKÝ P.	1-4-21-04-039-01	3,20	25,50	-	1988	1988		
51.	5848	ORAVSKÝ PODZÁMOK	ORAVA	1-4-21-04-044-01	30,05	1662,44	-	1955*	1985*	1962*	
52.	5870	PÁRNICA	ZÁZRIVKA	1-4-21-04-077-01	0,50	96,36	-	1920	1963	1964	
53.	5880	DIEROVÁ	ORAVA	1-4-21-04-079-01	6,00	1966,75	439,05	1927	1931	1962	1992
54.	5890	TURANY	ČIERNIK	1-4-21-05-008-01	0,50	2,86	410,61	1969	1969		
55.	5930	TURČEK	TURIEC	1-4-21-05-024-01	68,80	44,70	687,80	1929	1967		
56.	5940	ČREMOŠNÉ	ŽARNOVICA	1-4-21-05-047-01	22,30	12,91	677,99	1969	1969		
57.	5970	TURČIANSKE TEPLICE	ŽARNOVICA	1-4-21-05-051-01	10,00	62,04	498,76	1922	1963		
58.	5980	HÁJ	SOMOLAN	1-4-21-05-060-02	2,00	8,54	500,90	1969	1969		
59.	5990	MOŠOVCE	ČIERNA VODA	1-4-21-05-062-02	3,85	12,66	464,10	1969	1969		
60.	5995	KLÁŠTOR p/ZNIEVOM	VRÍCA 1	1-4-21-05-069-01	8,40	44,95	510,30	1984	1984		
61.	6018	VALČA	VALČIANSKY P.	1-4-21-05-071-01	7,50	10,70	-	1968*	1969*		
62.	6020	VALČA	HNILICKÝ P.	1-4-21-05-071-02	0,10	3,63	534,33	1968	1968		
63.	6030	BRČNA	SLOVIANSKY P.	1-4-21-05-071-01	3,00	11,90	514,67	1969	1969		

POR. ČIS.	DB ČIS.	STANICA station	TOK river	HYDROLOGICKE ČISLO	RIECNY KM r. km	PLOCHA POVODIA [km^2]	NADM.V. "0" VDČ [m n.m.]				
								H wat.stage	Q disch.	T wat.tem	P sed.dis
64.	6040	BLATNICA I	BLATNICKÝ P.	1-4-21-05-075-01	10,00	15,68	503,14	1969	1969		
65.	6060	DEDOŠOVA DOLINA	GADERSKÝ P.	1-4-21-05-076-02	14,20	9,53	875,25	1970	1970		
66.	6070	BLATNICA	GADERSKÝ P.	1-4-21-05-078-01	0,80	55,00	501,79	1969	1969		
67.	6091	BLATNICA II	BLATNICKÝ P.	1-4-21-05-079-02	8,20	72,17	-	1988	1988		
68.	6110	NECPALY	NECPALSKY P.	1-4-21-05-092-01	5,90	29,57	523,24	1922	1963*	1971	
69.	6130	MARTIN	TURIEC	1-4-21-05-097-01	6,90	827,00	389,90	1931	1931	1961	
70.	6140	MARTIN	PIVOVARSKÝ P.	1-4-21-05-099-01	1,90	9,05	430,86	1969	1969		
71.	6150	STRÁŽA	VARÍNKA	1-4-21-05-124-01	5,10	139,70	398,76	1925	1941	1984	
72.	6169	KLOKOČOV	PREDMIERANKA	1-4-21-06-029-01	5,00	34,78	513,84	1986	1986	1986	
73.	6170	TURZOVKA	KYSUCA	1-4-21-06-034-01	43,90	194,40	463,59	1964	1965		
74.	6179	ČADCA	ČIERŇANKA	1-4-21-06-059-01	0,80	157,00	412,86	1978	1978		
75.	6180	ČADCA	KYSUCA	1-4-21-06-062-01	29,20	492,54	408,36	1897	1931	1961	
76.	6190	ZBOROV n/ BYSTRICOU	BYSTRICA	1-4-21-06-091-01	6,60	218,07	427,08	1932	1932	1969	
77.	6200	KYSUCKÉ NOVÉ MESTO	KYSUCA	1-4-21-06-105-01	8,00	955,09	346,09	1925	1931	1967	1992
78.	6230	RAJECKÁ LESNÁ	LESŇANKA	1-4-21-06-124-01	1,70	23,34	-	1968	1968	1969	
79.	6240	ŠUJA	RAJČIANKA	1-4-21-06-125-02	25,00	108,59	464,15	1968	1968	1968	
80.	6260	RAJEC	ČIERŇANKA	1-4-21-06-130-01	2,50	19,72	448,21	1968	1968	1968	
81.	6270	RAJECKÉ TEPLICE	PORUBSKÝ P.	1-4-21-06-136-01	0,30	31,25	413,76	1968	1968	1968	
82.	6280	KUNERÁD	KUNERÁDSKY P.	1-4-21-06-136-01	8,30	11,44	623,29	1968	1968	1968	
83.	6290	RAJECKÉ TEPLICE	KUNERÁDSKY P.	1-4-21-06-139-01	0,30	26,37	413,30	1969	1969	1970	
84.	6300	POLUVSIE	RAJČIANKA	1-4-21-06-142-01	13,30	243,60	393,06	1921	1931	1993	
85.	6310	POLUVSIE	MEDZIHOR. P.	1-4-21-06-142-03	0,03	9,04	391,10	1969	1969	1970	
86.	6330	LIETAVA, MAJER	LIETAVKA	1-4-21-06-147-02	2,90	13,56	397,35	1969	1969	1969	
87.	6338	BÁNOVÁ	BITAROVSKÝ P.	1-4-21-06-149-01	1,03	18,68	-	1991	1991		
88.	6340	ZÁVODIE	RAJČIANKA	1-4-21-06-150-01	1,55	355,20	328,33	1967	1967	1967	
89.	6350	HLBOKÉ n/VÁHOM	HLBOCKÝ P.	1-4-21-07-006-01	1,80	4,64	339,36	1969	1969	1970	
90.	6360	BYTČA	PETROVIČKA	1-4-21-07-011-01	2,70	65,10	314,20	1951	1961		
91.	6362	JASENICA	PAPRADNIANKA	1-4-21-07-062-01	2,40	76,75	308,89	1961	1980		
92.	6370	PREČÍN	DOMANIŽANKA	1-4-21-07-029-01	6,10	74,05	322,08	1969	1969	1969	
93.	6380	POVAŽSKÁ BYSTRICA	DOMANIŽANKA	1-4-21-07-031-01	0,90	100,66	291,66	1951	1961	1972	
94.	6382	POV.BYSTRICA, FAPŠOVÁ	MOŠTENÍK	1-4-21-07-033-01	1,30	17,20	-	1985	1985	1985	
95.	6390	VYDRNÁ	PETRINOVEC	1-4-21-07-087-01	2,20	8,40	380,83	1951	1961		
96.	6400	DOHŇANY	BIELA VODA	1-4-21-07-093-01	4,00	163,17	284,09	1938	1961		
97.	6410	TRSTIE	PRUŽINKA	1-4-21-08-010-01	11,50	70,25	322,79	1969	1969	1969	
98.	6420	VISOLAJE	PRUŽINKA	1-4-21-08-012-01	4,40	110,92	268,22	1951	1961	1971	
99.	6425	TUCHYŇA	TOVÁRSKY P.	1-4-21-08-026-01	2,50	48,64	261,52	1969	1969		
100.	6450	HORNÉ SŔNIE	VLÁRA	1-4-21-08-078-01	4,60	341,79	239,24	1921	1961	1971	
101.	6460	TRENČIANSKE TEPLICE	TEPLIČKA	1-4-21-08-114-01	11,50	48,83	263,48	1949	1962	1971	
102.	6470	ČACHTICE	JABLONKA	1-4-21-09-069-01	9,50	163,25	-	1942	1961	1971	
103.	6475	HLOHOVEC	VÁH	1-4-21-10-008-01	99,00	10441,34	-	1975	1976	1975	
104.	6480	ŠAĽA	VÁH	1-4-21-10-057-01	58,50	11217,61	109,23	1927	1963	1963	
105.	6775	KOLÁROVO	VÁH	1-4-21-18-001-01	24,50	18486,00	105,91	1901		1972	
106.	6845	KOMÁRNO	VÁH	1-4-21-18-020-02	0,05	19660,98	103,69	1929			

* - obdobie pozorovania prerušené - **observation interrupted**

NOTE:

H Water stage
Q Discharge
T Water Temperature
P Sediment Discharge

Annex 4-5 GAUGIN STATIONS - Hron River Basin
ZOZNAM VODOMERNÝCH STANÍC - POVODIE DUNAJA

POR. ČIS.	DB ČIS.	STANICA Station	TOK River	HYDROLOGICKE ČISLO	RIECNY KM r.km	PLOCHA POVODIA [km^2]	NADM.V. "0" VDČ [m n.m.]	H wat.stage	Q disch.	T wat.tem	P sed.dis
1.	6914	TELGÁRT	HRON	1-4-23-01-003-02	270,10	36,61	804,95	1971	1971		
2.	6950	ZLATNO	HRON	1-4-23-01-011-01	263,90	79,28	737,65	1925	1931		
3.	6960	ZLATNO	HAVRANÍK	1-4-23-01-014-01	0,10	16,72	732,65	1949	1967		
4.	6995	POLOMKA	HRON	1-4-23-01-043-01	243,40	329,54	581,33	1991	1991	1991	
5.	6999	BACÚCH p/ KYSLOU	BACÚŠSKY P.	1-4-23-01-046-02	2,70	23,74	629,23	1984	1984		
6.	7010	MICHALOVÁ	ROHOZNÁ	1-4-23-01-071-01	9,70	59,04	553,68	1974	1974		
7.	7015	BREZNO	HRON	1-4-23-01-076-01	223,30	582,08	491,30	1925	1931	1961	
8.	7029	ČIERNY BALOG	ŠALING	1-4-23-01-085-01	0,90	24,98	582,03	1987	1987		
9.	7030	ČIERNY BALOG	ČIERNY HRON	1-4-23-01-086-01	15,50	64,61	563,87	1969	1969		
10.	7033	ČIERNY BALOG	BRÔTOVO	1-4-23-01-087-01	3,30	9,28	625,89	1980	1980		
11.	7036	ČIERNY BALOG	VYDROVO	1-4-23-01-093-01	1,10	31,80	545,64	1981	1981		
12.	7040	HRONČEK	KAMENISTÝ P.	1-4-23-01-100-01	11,60	48,86	655,83	1928*	1970		
13.	7045	HRONEC	ČIERNY HRON	1-4-23-01-105-01	2,40	239,41	480,48	1925	1931	1976	
14.	7050	OSRBLIE	OSRBLIANKA	1-4-23-01-108-01	6,40	27,77	583,91	1925	1966		
15.	7058	BYSTRÁ, TÁLE	BYSTRIANKA	1-4-23-02-002-01	12,10	22,48	-	1985	1985		
16.	7060	BYSTRÁ	BYSTRIANKA	1-4-23-02-004-01	7,00	36,01	573,73	1924*	1931	1967	
17.	7065	MÝTO p/ĎUMBIEROM	ŠTIAVNIČKA	1-4-23-02-009-01	2,90	47,10	616,75	1922	1931		
18.	7070	DOLNÁ LEHOTA	VAJSKOVSKÝ P.	1-4-23-02-024-01	2,70	53,02	495,28	1924	1931		
19.	7079	JASENIE	JASENIANSKY P.	1-4-23-02-036-01	4,20	87,71	487,95	1988	1988		
20.	7081	DUBOVÁ	HRON	1-4-23-02-038-01	203,10	1244,12	420,64	1987	1987		
21.	7084	BRUSNO	SOPOTNICA	1-4-23-02-044-01	7,60	11,31	-	1984	1984		
22.	7090	ĽUBIETOVÁ	HUTNÁ	1-4-23-02-060-01	3,70	38,99	453,49	1976	1976		
23.	7100	SLOVENSKÁ ĽUPČA	ĽUPČICA	1-4-23-02-069-01	1,30	39,30	376,71	1954	1956		
24.	7120	DOLNÝ HARMANEC	HARMANEC	1-4-23-02-093-01	0,30	23,01	507,87	1970	1970		
25.	7125	HARMANEC, PAPIEREŇ	BYSTRICA	1-4-23-02-098-01	8,50	59,60	409,35	1954	1956		
26.	7140	STARÉ HORY	RAMŽINÁ	1-4-23-02-108-01	0,10	12,29	478,48	1925	1966		
27.	7145	STARÉ HORY	STAROHORSKÝ P.	1-4-23-02-109-01	6,10	62,61	465,95	1920	1931		
28.	7147	UĽANKA	STAROHORSKÝ P.	1-4-23-02-110-01	0,40	78,75	-	1990	1990		
29.	7155	BANSKÁ BYSTRICA	BYSTRICA	1-4-23-02-113-01	2,10	160,37	352,94	1979	1979	1979	
30.	7160	BANSKÁ BYSTRICA	HRON	1-4-23-02-117-01	175,20	1766,48	334,29	1917	1931	1925	1993
31.	7170	BANSKÁ BYSTRICA	TAJOVSKÝ P.	1-4-23-02-122-01	0,20	44,09	336,50	1965	1966		
32.	7173	BANSKÁ BYSTRICA	MALACHOVSKÝ P.	1-4-23-02-124-02	0,60	16,00	-	1990	1990		
33.	7180	HRIŇOVÁ, n/VN	SLATINA	1-4-23-03-007-01	50,80	51,99	572,65	1971	1971		
34.	7183	HRIŇOVÁ	HUKAVA	1-4-23-03-008-01	0,30	9,96	568,83	1973	1973		
35.	7185	HRIŇOVÁ, p/VN	SLATINA	1-4-23-03-009-01	48,00	70,82	520,67	1922	1931		
36.	7190	STOŽOK	SLATINA	1-4-23-03-026-01	25,30	219,90	355,19	1973	1974*		
37.	7191	PSTRUŠA	KOCANSKÝ P.	1-4-23-03-028-01	0,60	35,45	355,23	1987	1987		
38.	7193	VÍGĽAŠ	DÚBRAVSKÝ P.	1-4-23-03-036-01	1,10	69,23	-	1983	1983		
39.	7205	MÔŤOVÁ	SLATINA	1-4-23-03-046-01	8,10	411,02	303,12	1960	1961		
40.	7206	MÔŤOVÁ	SEKIERSKY P.	1-4-23-03-049-01	2,90	20,65	366,37	1986	1986		
41.	7210	ZOLNÁ	ZOLNÁ	1-4-23-03-067-02	7,90	97,76	325,72	1983	1983		
42.	7215	HROCHOŤ	HUČAVA	1-4-23-03-070-01	13,80	41,45	522,54	1974	1974		
43.	7220	ZVOLEN	ZOLNÁ	1-4-23-03-074-01	0,50	200,74	288,22	1967	1967		
44.	7228	ZVOLEN	NERESNICA	1-4-23-03-089-01	0,50	139,33	286,59	1950	1963		
45.	7230	ZVOLEN	SLATINA	1-4-23-03-091-01	2,10	790,16	280,78	1920	1967	1973	
46.	7240	HRONSKÁ BREZNICA	HRON	1-4-23-04-013-01	146,10	2865,56	265,15	1992	1992		
47.	7241	HRONSKÁ BREZNICA	JASENICA	1-4-23-04-024-01	0,10	82,97	267,34	1992	1992		
48.	7245	KREMNICKÉ BANE	PREVOD Z TURCA	1-4-23-04-037-01	0,00	0,10	-	1993	1993		
49.	7251	IHRÁČ, PÍLA	VÁPENNÝ P.	1-4-23-04-034-01	0,70	24,27	-	1987	1987		
50.	7252	TRNAVÁ HORA	IHRÁČSKY P.	1-4-23-04-035-01	0,20	60,64	261,29	1987	1987		
51.	7253	STARÁ KREMNIČKA	KREMNICKÝ P.	1-4-23-04-042-01	1,80	80,87	273,27	1987	1987		
52.	7254	ŽIAR n/HRONOM	KREM.DED. ŠT.	1-4-23-04-045-02	0,10	0,10	-	1987	1987		
53.	7256	JANOVA LEHOTA	LUTILSKÝ P.	1-4-23-04-051-01	12,40	39,51	391,05	1984	1984		
54.	7260	ŽIAR n/HRONOM	HRON	1-4-23-04-061-01	131,50	3310,62	242,62	1978	1978	1978	
55.	7270	HORNÁ ŽDAŇA	PROCHOTSKÝ P.	1-4-23-04-079-01	4,50	24,11	325,44	1984			
56.	7272	BANSKÁ ŠTIAVNICA	VYHNIANSKY P.	1-4-23-04-081-01	13,40	0,91	-	1994	1994		
57.	7278	HRABIČOV	KĽAK	1-4-23-04-089-01	11,30	46,12	378,83	1984	1984		
58.	7280	ŽARNOVICA	KĽAK	1-4-23-04-095-01	1,10	131,95	222,51	1921*	1962		
59.	7290	BREHY	HRON	1-4-23-04-110-01	93,90	3821,38	194,63	1924	1931	1961	1993
60.	7296	PSIARE	HRON	1-4-23-04-125-01	80,90	3965,56	-	1992	1992		
61.	7305	HRONSKÉ KĽAČANY	PODLUŽIANKA	1-4-23-05-011-01	9,60	91,09	-	1992	1992		
62.	7308	PEČENICE	JABLOŇOVKA	1-4-23-05-022-01	2,60	51,36	-	1986	1986		
63.	7316	TEKOVSKÉ LUŽANY	LUŽIANKA	1-4-23-05-038-01	19,00	25,03	-	1991	1991		

POR. ČIS.	**DB ČIS.**	**STANICA** Station	**TOK** River	**HYDROLOGICKE ČISLO**	**RIECNY KM** r.km	**PLOCHA POVODIA [km^2]**	**NADM.V. "0" VDČ [m n.m.]**	**H** wat.stage	**Q** disch.	**T** wat.tem	**P** **sed.dis**
64.	7318	HRONOVCE	LUŽIANKA	1-4-23-05-040-01	2,40	98,42	-	1982	1982		
65.	7327	STARÝ TEKOV	PEREC	1-4-23-05-051-01	50,20	0,10	-	1987	1987		
66.	7330	ZALABA	PEREC	1-4-23-05-057-01	10,80	72,65	-	1923	1969		
67.	7335	KAMENÍN	HRON	1-4-23-05-060-01	10,90	5149,80	108,30	1992	1992	1992	1993
68.	7345	RÚBAŇ	PARÍŽ	1-4-23-05-066-01	25,30	81,90	127,16	1967*	1968*		

* - obdobie pozorovania prerušené - **observation interrupted**

NOTE:
H Water stage
Q Discharge
T Water Temperature
P Sediment Discharge

Annex 4-5 GAUGIN STATIONS - Ipel River Basin

ZOZNAM VODOMERNÝCH STANÍC - POVODIE DUNAJA

POR. ČÍS.	DB ČÍS.	STANICA Station	TOK river	HYDROLOGICKE ČÍSLO	RIECNY KM r. km	PLOCHA POVODIA $[km^2]$	NADM.V. "0" VDČ [m n.m.]	H wat.stage	Q disch.	T wat.tem	P sed.dis
1.	7398	MÁLINEC, n/VN	IPEĽ	1-4-24-01-004-01	183,50	54,24	-	1995	1995		
2.	7399	MÁLINEC	SMOLNÁ II.	1-4-24-01-005-02	0,40	13,28	-	1995	1995		
3.	7400	MÁLINEC	SMOLNÁ I.	1-4-24-01-005-01	0,40	0,10	-	1995	1995		
4.	7402	MÁLINEC, p/VN	IPEĽ	1-4-24-01-007-02	179,50	85,21	-	1995	1995		
5.	7410	ZLATNO	POLOVNO	1-4-24-01-019-01	2,80	11,27	368,45	1957*	1967*		
6.	7420	KALINOVO	IPEĽ	1-4-24-01-026-02	157,60	287,60	200,28	1969	1971	1969	
7.	7435	FIĽAKOVO	BELINA	1-4-24-01-052-01	4,10	70,20	-	1989	1989		
8.	7438	FIĽAKOVO	ČAMOVSKÝ P.	1-4-24-01-055-01	2,00	40,88	-	1989	1989		
9.	7439	PRŠA	SUCHÁ	1-4-24-01-057-01	3,10	325,43	178,09	1987	1987		
10.	7440	HOLIŠA	IPEĽ	1-4-24-01-058-01	143,20	685,67	171,23	1928	1931	1963	
11.	7450	LUČENEC	TUHÁRSKY P.	1-4-24-01-082-01	1,60	59,00	181,12	1936*	1941*		
12.	7464	PÍLA	PIĽANSKÝ P.	1-4-24-01-065-03	0,40	4,30	298,51	1988	1988		
13.	7466	MÝTNA, n/VN	KRIVÁNSKY P.	1-4-24-01-065-04	27,70	53,68	-	1994	1994		
14.	7468	MÝTNA, p/VN	KRIVÁNSKY P.	1-4-24-01-065-05	27,00	57,27	-	1994	1994		
15.	7470	DIVÍN	BUDINSKÝ P.	1-4-24-01-071-03	4,00	19,04	-	1968	1969	1972	
16.	7471	DIVÍN	PREV.VN MÝTNA	1-4-24-01-071-04	0,00	0,10	-	1995	1995		
17.	7472	RUŽINÁ, p/VN	BUDINSKÝ P.	1-4-24-01-071-02	1,70	31,28	-	1988	1988		
18.	7480	LUČENEC	KRIVÁNSKY P.	1-4-24-01-078-01	5,40	204,20	177,50	1922	1931	1971	
19.	7490	HORNÝ TISOVNÍK	TISOVNÍK	1-4-24-02-027-01	33,30	34,64	408,54	1957	1967		
20.	7500	DOLNÁ STREHOVÁ	TISOVNÍK	1-4-24-02-045-01	4,50	275,59	166,72	1951	1962	1971	
21.	7520	DOLNÉ STRHÁRE	KOPROVNICA	1-4-24-02-052-01	0,10	43,66	231,59	1950	1970		
22.	7525	POTOR	STARÁ RIEKA	1-4-24-02-055-01	12,10	114,80	204,30	1978	1979		
23.	7539	ŽELOVCE	KRTÍŠ	1-4-24-02-091-01	6,70	205,17	147,74	1992	1992		
24.	7540	SLOVENSKÉ ĎARMOTY	IPEĽ	1-4-24-03-001-01	89,50	2768,00	136,11	1978	1978	1978	1993
25.	7570	KRUPINA	KRUPINICA	1-4-24-03-052-01	38,40	194,06	-	1993	1993		
26.	7580	PLÁŠŤOVCE	KRUPINICA	1-4-24-03-058-01	11,80	302,79	140,61	1928	1931		
27.	7600	PLÁŠŤOVCE	LITAVA	1-4-24-03-071-01	0,90	214,27	142,64	1928	1931		
28.	7612	DUDINCE	ŠTIAVNICA	1-4-24-03-096-01	9,90	291,53	129,15	1988	1988	1988	
29.	7620	VYŠKOVCE n/IPĽOM	IPEĽ	1-4-24-03-109-02	46,00	4687,24	117,72	1969*	1972*	1983	1993
30.	7630	SAZDICE	BÚR	1-4-24-03-117-01	3,80	88,30	120,90	1974	1978		

* - obdobie pozorovania prerušené - **observation interrupted**

NOTE:

H Water stage
Q Discharge
T Water Temperature
P Sediment Discharge

Annex 4-5 GAUGIN STATIONS - Slana River Basin

ZOZNAM VODOMERNÝCH STANÍC - POVODIE DUNAJA

POR. ČIS.	DB ČIS.	STANICA station	TOK river	HYDROLOGICKE ČISLO	RIECNY KM r. km	PLOCHA POVODIA [km^2]	NADM.V. "0" VDČ [m n.m.]	H wat.stage	Q disch.	T wat.tem	P sed.dis
1.	7658	VYŠNÁ SLANÁ	SLANÁ	1-4-31-01-007-01	77,70	60,28	440,94	1983	1983		
2.	7660	DOBŠINÁ	DOBŠINSKÝ P.	1-4-31-01-011-01	3,40	31,97	453,46	1923	1931		
3.	7662	DOBŠINÁ, HC	ODPADOVÝ KAN.	1-4-31-01-012-03	0,20	0,10	-	1969	1969		
4.	7670	VLACHOVO	SLANÁ	1-4-31-01-016-01	75,00	123,16	411,97	1921	1931		
5.	7679	GEMERSKÁ POLOMA	SLANÁ	1-4-31-01-022-01	60,70	201,60	-	1993	1993		
6.	7680	GEMERSKÁ POLOMA	SÚĽOVSKÝ P.	1-4-31-01-027-01	0,30	57,38	324,04	1923	1964		
7.	7690	ROŽŇAVA	SLANÁ	1-4-31-01-031-01	51,90	301,53	276,56	1921*	1968*	1974	
8.	7693	ROŽŇAVA	ROŽŇAVSKÝ P.	1-4-31-01-036-01	1,00	41,80	297,48	1968	1968		
9.	7705	DRNAVA	ČREMOŠNÁ	1-4-31-01-048-01	14,50	53,89	372,26	1968	1968		
10.	7730	ŠTÍTNIK	ŠTÍTNIK	1-4-31-01-071-01	13,80	129,63	284,95	1924	1931	1974	
11.	7740	PLEŠIVEC	ŠTÍTNIK	1-4-31-01-078-03	1,30	224,17	214,15	1968	1968		
12.	7752	BRETKA	SLANÁ	1-4-31-02-006-01	26,20	889,12	188,89	1977	1977	1977	1993
13.	7762	MURÁŇ	HRDZAVÝ P.	1-4-31-02-010-01	1,30	38,39	-	1970	1970	1970	
14.	7782	REVÚCA	ZDYCHAVA	1-4-31-02-021-01	0,60	58,95	314,00	1974	1974		
15.	7785	LUBENÍK	MURÁŇ	1-4-31-02-024-02	28,90	204,61	276,35	1975	1975		
16.	7800	BRETKA	MURÁŇ	1-4-31-02-043-01	0,60	386,01	189,00	1978	1978		
17.	7805	GEMERSKÁ VES	TURIEC	1-4-31-02-063-01	10,30	131,61	-	1993	1993		
18.	7810	BEHYNCE	TURIEC	1-4-31-02-082-01	2,40	304,66	173,19	1969	1970		
19.	7820	LENARTOVCE	SLANÁ	1-4-31-02-098-01	3,60	1829,65	150,41	1925	1931	1958	1993
20.	7830	TISOVEC	RIMAVA	1-4-31-03-007-01	73,40	73,92	413,11	1921	1964		
21.	7840	RÁZTOČNÉ	KLENOV. RIMAVA	1-4-31-03-024-01	11,60	67,36	392,97	1959	1962		
22.	7843	HNÚŠŤA	KLENOV. RIMAVA	1-4-31-03-027-01	0,60	115,10	291,73	1924*	1963		
23.	7845	HNÚŠŤA, LIKIER	RIMAVA	1-4-31-03-029-01	58,00	275,64	279,58	1942*	1963*	1975	
24.	7855	KOKAVA n/RIMAVICOU	RIMAVICA	1-4-31-03-042-01	11,70	101,44	317,43	1974	1974		
25.	7860	LEHOTA n/RIMAVICOU	RIMAVICA	1-4-31-03-046-01	2,90	148,95	263,65	1925	1931		
26.	7864	RIM. SOBOTA, SOBÔTKA	RIMAVA	1-4-31-03-062-01	35,20	562,03	207,50	1990	1991	1992	1993
27.	7870	JESENSKÉ	GORTVA	1-4-31-03-092-01	1,70	164,39	181,76	1957*	1970*		
28.	7878	DRIENČANY, n/VN	BLH	1-4-31-03-118-01	26,30	79,37	-	1986	1986		
29.	7879	TEPLÝ VRCH, p/VN	BLH	1-4-31-03-120-01	24,00	105,40	-	1986	1986		
30.	7885	RIMAVSKÁ SEČ	BLH	1-4-31-03-136-01	1,40	270,18	157,98	1925	1931		
31.	7900	VLKYŇA	RIMAVA	1-4-31-03-146-01	1,60	1377,41	150,63	1973	1973	1989	

* - obdobie pozorovania prerušené - **observation interrupted**

NOTE:
H Water stage
Q Discharge
T Water Temperature
P Sediment Discharge

Annex 4-5 GAUGIN STATIONS - Bodva River Basin
ZOZNAM VODOMERNÝCH STANÍC - POVODIE DUNAJA

POR. ČIS.	DB ČIS.	STANICA station	TOK river	HYDROLOGICKE ČISLO	RIECNY KM r. km	PLOCHA POVODIA [km^2]	NADM.V. "0" VDČ [m n.m.]	H wat.stage	Q disch.	T wat.tem	P sed.dis
1.	8970	MEDZEV, NIŽNÝ MEDZEV	BODVA	1-4-33-01-011-01	34,80	90,15	310,24	1940	1941		
2.	8980	MOLDAVA n/BODVOU	BODVA	1-4-33-01-025-01	18,00	193,60	203,54	1952*	1965	1990	
3.	9000	HÝĽOV	IDA	1-4-33-01-030-01	41,70	34,50	-	1968	1968	1969	
4.	9005	BUKOVEC	IDA	1-4-33-01-031-01	35,00	52,10	-	1990	1990		
5.	9010	KOŠICE, ŠACA	IDA	1-4-33-01-032-01	25,70	70,86	245,78	1952	1953		
6.	9013	JANÍK	IDA	1-4-33-01-064-01	1,70	378,40	-	1993	1994		
7.	9020	TURNIANSKE PODHRADIE	BODVA	1-4-33-01-071-01	4,70	683,37	171,39	1934*	1941*	1970	
8.	9050	TURN.PODHRADIE, HÁJ	BLATNÝ P.	1-4-33-01-080-01	4,20	18,22	273,31	1968*	1968*		
9.	9060	NOVÁ BODVA, HOSŤOVCE	TURŇA	1-4-33-01-081-01	1,70	153,78	175,60	1968	1968		
10.	9063	HOSŤOVCE	STARÁ BODVA	1-4-33-01-085-01	0,20	0,10	167,88	1988	1990		

* - obdobie pozorovania prerušené - **observation interrupted**

NOTE:
H Water stage
Q Discharge
T Water Temperature
P Sediment Discharge

Annex 4-5 GAUGIN STATIONS - Hornad River Basin

ZOZNAM VODOMERNÝCH STANÍC - POVODIE DUNAJA

POR. ČIS.	DB ČIS.	STANICA station	TOK river	HYDROLOGICKE ČISLO	RIECNY KM r. km	PLOCHA POVODIA [km²]	NADM.V. "0" VDČ [m n.m.]	H wat.stage	Q disch.	T wat.tem	P sed.dis
1.	8370	HRANOVNICA	HORNÁD	1-4-32-01-010-01	159,30	113,50	593,66	1951	1965		
2.	8371	HRANOVNICA	VERNÁRSKY P.	1-4-32-01-013-01	6,80	25,50	705,46	1984	1984		
3.	8380	SPISŠKÝ ŠTIAVNIK	GÁNOVSKY P.	1-4-32-01-017-01	0,80	31,60	552,53	1951	1968		
4.	8390	HRABUŠICE	HORNÁD	1-4-32-01-023-01	149,40	219,60	534,15	1951	1967		
5.	8400	HRABUŠICE, PODLESOK	V. BIELA VODA	1-4-32-01-027-01	2,10	40,17	547,66	1949*	1972	1968	
6.	8410	SPIŠSKÁ NOVÁ VES	HORNÁD	1-4-32-01-033-01	132,00	336,53	449,18	1931	1972	1976	
7.	8414	SPIŠSKÁ NOVÁ VES	HOLUBNICA	1-4-32-01-038-01	2,70	30,41	-	1992	1993		
8.	8415	SPIŠSKÁ NOVÁ VES	BRUSNÍK	1-4-32-01-042-01	0,90	57,30	-	1920	1990	1960	
9.	8417	TEPLIČKA	TEPL. BRUSNÍK	1-4-32-01-044-01	0,50	12,50	-	1994	1994		
10.	8424	MARKUŠOVCE	LEVOČSKÝ P.	1-4-32-01-058-01	0,20	153,20	-	1990	1990		
11.	8430	SPIŠSKÉ VLACHY	HORNÁD	1-4-32-01-077-01	107,20	775,02	375,01	1921	1931	1960	1992
12.	8460	SPIŠSKÉ VLACHY	BRANISKO	1-4-32-01-090-01	1,40	110,04	382,38	1975	1975		
13.	8500	KROMPACHY	SLOVINSKÝ P.	1-4-32-01-106-01	0,50	78,50	367,50	1990	1991		
14.	8510	MARGECANY	HORNÁD	1-4-32-01-117-01	88,30	1132,78	329,56	1971	1972		
15.	8530	STRATENÁ	HNILEC	1-4-32-02-008-01	75,50	68,23	789,24	1953	1954	1958	
16.	8540	ŠVEDLÁR, NA HRABLIACH	HNILEC	1-4-32-02-036-01	31,00	354,25	439,99	1931	1931	1982	
17.	8542	MNÍŠEK n/HNILCOM	SMOLNÍK	1-4-32-02-051-01	0,20	99,20	-	1992	1993		
18.	8560	JAKLOVCE	HNILEC	1-4-32-02-064-01	3,00	606,32	327,14	1920	1931	1960	
19.	8565	KOŠICKÁ BELÁ	BELÁ	1-4-32-03-005-01	5,50	23,10	359,09	1973	1974		
20.	8590	VEĽKÁ LODINA	SOPOTNICA	1-4-32-03-016-01	0,30	38,40	257,15	1978	1978		
21.	8670	BZENOV	SVINKA	1-4-32-03-052-01	16,00	293,50	293,81	1969	1969	1992	1992
22.	8675	LIČARTOVCE	SVINKA	1-4-32-03-056-02	6,60	336,30	246,23	1978	1978		
23.	8690	KYSAK	HORNÁD	1-4-32-03-058-01	53,00	2345,70	235,08	1927	1929	1947	
24.	8710	NIŽNÉ REPÁŠE	TORYSA	1-4-32-04-003-01	123,90	21,44	760,81	1975	1975		
25.	8740	BREZOVICA	SLAVKOVSKÝ P.	1-4-32-04-026-01	0,35	83,50	450,68	1943*	1973		
26.	8750	BREZOVICA	TORYSA	1-4-32-04-027-01	101,90	228,30	443,72	1943	1973		
27.	8768	ĽUTINA	ĽUTINKA	1-4-32-04-054-01	5,10	49,20	-	1991	1991		
28.	8770	SABINOV	TORYSA	1-4-32-04-061-01	79,60	495,73	312,96	1968	1973	1987	
29.	8780	PREŠOV	TORYSA	1-4-32-04-078-01	58,30	673,89	234,89	1969	1970	1987	
30.	8830	DEMJATA	SEKČOV	1-4-32-04-100-01	26,00	123,17	279,94	1972	1973		
31.	8840	PREŠOV	SEKČOV	1-4-32-04-123-01	0,80	352,80	232,52	1925*	1961		
32.	8860	KOKOŠOVCE	DELŇA	1-4-32-04-127-01	11,00	28,96	413,55	1976	1976		
33.	8870	KOŠICKÉ OLŠANY	TORYSA	1-4-32-04-151-01	13,00	1298,30	185,83	1920	1931	1961	
34.	8910	SVINICA	SVINICKÝ P.	1-4-32-05-027-01	4,25	59,81	244,27	1972	1973		
35.	8920	BOHDANOVCE	OLŠAVA	1-4-32-05-030-01	10,30	306,20	194,26	1950	1966		
36.	8930	ŽDAŇA	HORNÁD	1-4-32-05-033-01	17,20	4232,20	-	1956	1958	1966	1992
37.	8950	SEŇA	SOKOLIANSKY P.	1-4-32-05-049-01	4,05	35,63	175,25	1970	1971		

* - obdobie pozorovania prerušené - **observation interrupted**

NOTE:
H Water stage
Q Discharge
T Water Temperature
P Sediment Discharge

Annex 4-6

Discharges of the Danube and its Tributaries

Discharges **ROCNE SPRACOVANIE PRIETOKOV [M3/S] [m3.s-1]**

station Bratislava year **ROK : 1994**
river : Danube **PLOCHA POVODIA : 131329,1 km2**

month day	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	1861	2120	1462	2326	2710	2662	2063	1163	1368	1141	919,2	1332
2.	2339	2077	1539	2341	2765	2460	1974	1237	1386	1047	964,8	1209
3.	2324	2021	1879	2516	2863	2344	1893	1267	1482	976,6	962,4	1205
4.	2516	1978	1898	2324	2592	2382	1786	1294	1611	1091	928,4	1126
5.	2569	2013	2071	2191	2564	2758	1690	1264	1701	1217	976,2	1065
6.	2766	1969	1927	2146	3039	2910	1778	1164	1519	1267	893,6	1060
7.	2502	1794	1789	2114	2854	3017	1839	1183	1443	1171	807,4	1269
8.	2452	1755	1881	2029	2520	2864	2226	1112	1398	1216	808,5	1307
9.	2388	1731	2001	1890	2334	2705	2119	1154	1401	1111	831,9	1305
10.	2206	1743	2482	1850	2210	2784	1959	1243	1434	1071	899	1199
11.	2120	1741	2462	1752	2390	2961	1836	1220	1455	1091	828,7	1200
12.	2023	1709	2478	1905	2433	2747	1651	1248	1397	1058	1048	2007
13.	1944	1666	2360	2339	2209	2403	1631	1373	1300	1150	1300	2024
14.	1844	1527	2403	4392	2154	2304	1594	1303	1324	1026	1343	1761
15.	1922	1440	2451	5082	2170	2194	1567	1163	1362	1003	1290	1632
16.	1951	1410	2325	4775	2150	2079	1564	1155	1642	997,2	1316	1583
17.	1917	1406	2300	4782	2181	2040	1541	1150	1607	940,3	1499	1485
18.	1800	1364	2275	4854	2269	2284	1437	1122	1606	863,8	1460	1398
19.	1719	1331	2263	5780	2323	2141	1467	1167	1547	954,6	1531	1287
20.	1619	1301	2194	4595	3170	2042	1726	1335	1499	987	1916	1189
21.	1568	1196	2192	3883	3230	2413	1672	1593	1405	870,8	2648	1268
22.	1540	1198	2382	3615	2949	2634	1677	1413	1373	916,6	2395	1297
23.	1440	1251	2719	3468	2525	2382	1655	1270	1254	852,5	2018	1271
24.	1350	1293	2640	3284	2382	2197	1585	1357	1239	815,2	1794	1199
25.	1468	1308	2625	3083	2586	2096	1434	1371	1189	821,2	1611	1131
26.	2197	1439	3072	3017	3043	2055	1397	1842	1098	938,7	1479	1122
27.	2844	1478	3365	3235	3142	1974	1392	2059	1113	942,3	1426	1051
28.	2657	1441	2958	2957	3277	1952	1429	1895	1123	911	1418	1046
29.	2659		2721	2942	2999	1970	1440	1640	1264	1015	1452	2338
30.	2372		2527	2837	2928	1906	1369	1457	1210	1055	1336	2865
31.	2183		2381		2879		1322	1439		954,5		2547

SUC.	65060	44700	72022	94304	81840	71660	51713	41653	41750	31472	40100	44778
average	2099	1596	2323	3143	2640	2389	1668	1344	1392	1015	1337	1444
S.O.	15,98	12,16	17,69	23,94	20,10	18,19	12,70	10,23	10,60	7,73	10,18	11,00
ODT.	5621,2	3862,1	6222,7	8147,9	7071,0	6191,4	4468,0	3598,8	3607,2	2719,2	3464,6	3868,8

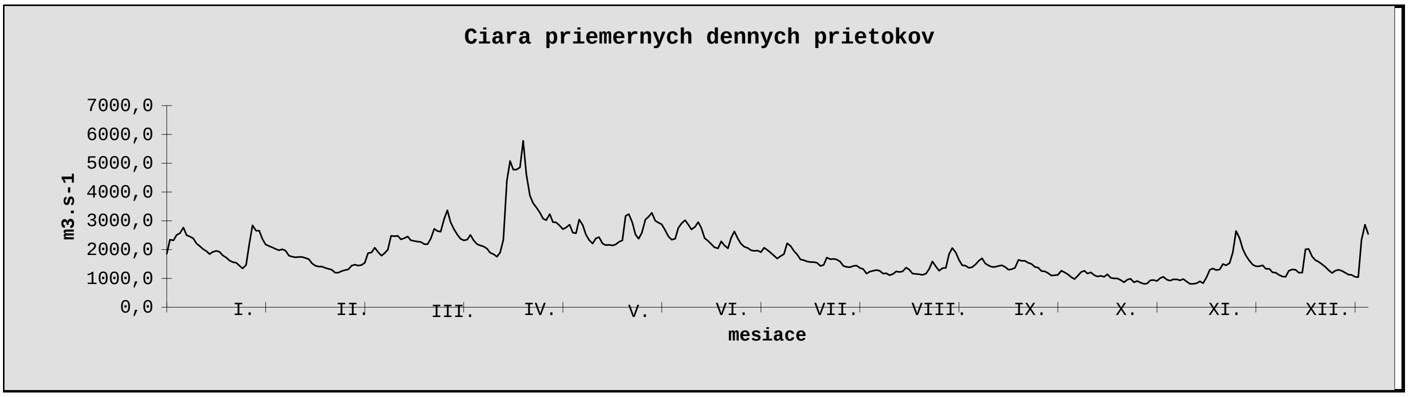
year sum 681052,4 year max. **5990,0** DEN/MES/HOD: 19/4/15 ROCNY SP. ODTOK: **14,210** l.s-1.km-2
year mean 1866 year min. **807,4** DEN/MESIAC : 7/11 ROCNY ODTOK : **58840** mil.m3

M - denne prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1994	2928	2338	1726	1303	1060	899,000	365
% Qmda	84,26	93,37	91,81	96,59	103,72	107,28	54,48

Mesacne prietoky

Qm	2099	1596	2323	3143	2640	2389	1668	1344	1392	1015	1337	1444
% Qma	143,85	93,03	112,40	129,04	99,47	82,62	60,68	58,93	79,75	67,23	88,76	96,30



discharge

ROČNÉ SPRACOVANIE PRIETOKOV [$m^3.s^{-1}$]

station : Bratislava **year** **ROK : 1995**
river : Danube **PLOCHA POVODIA : 131329,1 km^2**

month day	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1.	2446	3139	2211	2420	3035	3334	3525	1767	4123	1835	1220	1517
2.	2196	2914	2049	2821	2979	3570	3221	1793	4836	1775	1171	1541
3.	2010	2728	2105	4323	2982	4554	2979	1686	5700	2049	1420	1503
4.	1858	2472	2015	4043	2894	4384	3112	1654	4817	1929	1589	1354
5.	1665	2255	2049	3916	2785	4150	3443	1597	4100	1777	1695	1323
6.	1535	2127	1981	3767	2785	3769	3167	1507	3463	1718	1480	1374
7.	1450	2103	1985	3778	2786	4020	3048	1406	3043	1647	1404	1382
8.	1331	2196	1984	3622	2794	4968	2795	1383	2763	1570	1489	1384
9.	1237	2201	1882	3580	2919	4733	2584	1490	2678	1486	1391	1281
10.	1180	2331	1834	3016	3093	4379	2457	1638	2810	1454	1518	1217
11.	1352	2345	1725	2836	2942	3930	2435	1715	2545	1439	1522	1204
12.	1407	2212	1647	3159	2793	3558	2521	1582	2352	1454	1475	1152
13.	1386	2057	1591	3100	2712	3586	2502	1512	2222	1380	1468	1301
14.	1347	1969	1582	2918	3085	3787	2598	1362	2198	1403	1570	1274
15.	1284	2022	1578	2693	3501	3680	2658	1580	2375	1317	1598	1173
16.	1191	2036	1589	2573	3301	3590	2684	1944	3132	1270	1668	1221
17.	1121	2176	1590	2639	3078	3700	2604	2084	2610	1256	1797	1192
18.	1148	2291	1563	2623	2815	3612	2600	2196	2357	1283	2599	1072
19.	1185	2521	1751	2833	2710	3277	2404	1857	2151	1241	2802	1137
20.	1165	2381	2145	3012	2768	3073	2316	1688	2126	1200	2514	1341
21.	1141	2293	2725	2781	2669	3100	2203	1524	2051	1255	2219	1479
22.	1100	2331	2719	2864	2581	3214	2167	1524	2131	1177	1887	1966
23.	1080	2236	2533	3210	2408	4241	2085	1652	2269	1089	1817	2145
24.	1400	2122	2331	3363	2321	4147	2104	1588	2174	1107	1717	2261
25.	2387	2086	2247	3439	2339	3439	2020	1567	1905	1132	1679	2769
26.	2929	2107	2280	3316	2365	3486	2003	1615	1881	1116	1610	3189
27.	3798	2252	2636	3165	2504	5126	1910	1808	1828	1144	1531	3253
28.	3399	2274	2822	3188	2746	5392	1883	1824	1832	1127	1559	3054
29.	3420		2751	3055	2773	4236	2285	2306	1884	1108	1580	2751
30.	3255		2718	3025	2706	3770	2151	3566	1911	1066	1521	2344
31.	3249		2548		3148		1862	4495		1041		1992
SÚČ.	56652	64177	65166	95078	87317	117805	78326	56910	82267	42845	50510	53146
average	1827	2292	2102	3169	2817	3927	2527	1836	2742	1382	1684	1714
Š.O.	14	17	16	24	21	30	19	14	21	11	13	13
ODT.	4895	5545	5630	8215	7544	10178	6767	4917	7108	3702	4364	4592

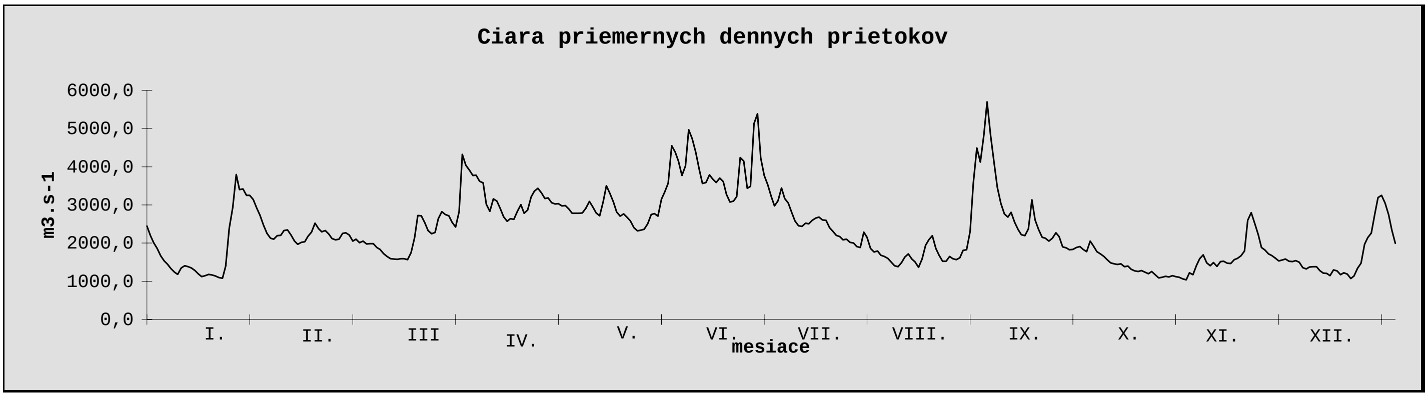
year sum	850199,0	year max.	**5832,0**	DEŇ/MES/HOD:	03/09/17	ROČNÝ ŠP. ODTOK:	**17,740**	$l.s^{-1}.km^{-2}$
year mean	2329	year min.	**1041,0**	DEŇ/MESIAC :	31/10	ROČNÝ ODTOK :	**73460**	$mil.m^3$

M - denné prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1995	3680	2894	2211	1589	1274	1127	1066
% Qmda	105,9	115,6	117,6	117,8	124,7	134,5	159,1

Mesačné prietoky

Qma	1459	1716	2067	2436	2654	2891	2749	2280	1745	1510	1506	1500
% Qma	125,3	133,6	101,7	130,1	106,1	135,8	91,9	80,5	157,1	91,5	111,8	114,3



discharge

ROČNÉ SPRACOVANIE PRIETOKOV [$m^3.s^{-1}$]

station : Bratislava **year** **ROK:** **1996**
river : Danube **PLOCHA POVODIA :** **131329,1 km^2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	1873	1098	1066	1914	2466	2874	2580	1740	1903	1996	2181	1800
2.	1763	1086	1011	1892	2554	2765	2276	1546	1795	1929	2357	1794
3.	1730	1014	1004	1857	2368	2741	2385	1564	2079	2156	2500	1908
4.	1660	1088	972	1922	2299	2597	2587	2191	2164	2388	2263	1948
5.	1603	948	880	1861	2095	2440	2237	2315	2019	2164	2114	1947
6.	1527	988	935	1935	2012	2286	2084	2014	2507	2199	2031	1813
7.	1452	994	914	2153	1958	2182	2015	1739	2760	2400	1905	1795
8.	1410	1005	934	2391	1979	2114	2087	1599	2921	2241	1926	1615
9.	1525	989	908	2574	2116	2107	2668	1668	2730	2190	2041	1536
10.	1650	985	996	2828	2601	1986	3766	1614	2371	2075	2023	1522
11.	1647	976	897	2876	2488	2045	3930	1457	2211	2002	1920	1549
12.	1594	940	822	2720	2222	2078	4261	1433	2068	1956	1831	1588
13.	1677	928	859	2765	2412	2067	4279	1576	1939	1798	1764	1513
14.	1622	982	911	2622	4238	2439	3634	2120	2105	1644	1743	1522
15.	1552	991	910	2492	5597	2120	3006	2190	3904	1565	2392	1419
16.	1493	1021	908	2384	4642	1955	2629	1954	3772	1604	2624	1400
17.	1436	1015	1062	2240	3760	1647	2467	1886	3345	1660	2731	1453
18.	1449	1103	1187	2148	3271	1615	2265	1949	2794	1763	2415	1497
19.	1340	1213	1182	2071	3077	1544	2061	1694	2507	1809	2281	1468
20.	1314	1429	1416	2113	2897	1511	1947	1522	2338	1846	2259	1654
21.	1227	1361	1478	2124	3027	1538	1784	1504	2177	2768	2137	1790
22.	1168	1307	1552	2231	3083	1608	1645	1429	2083	5367	2044	1853
23.	1104	1212	1800	2318	3179	2306	1537	1424	2077	6216	2021	1836
24.	1112	1100	2156	2455	2818	2903	1587	1549	2572	4905	1924	1768
25.	1159	1021	2490	2535	2518	2574	1667	1689	3484	3456	1798	1663
26.	1136	985	2741	2482	2598	2305	1711	2107	2830	2918	1705	1568
27.	1150	929	2648	2468	2987	2207	1739	1759	2508	2549	1764	1477
28.	1085	988	2760	2274	3758	2155	1522	1785	2363	2492	1863	1389
29.	1040	1026	2475	2213	4450	2084	1506	1964	2281	2421	1799	1309
30.	1000		2308	2357	3698	2109	1575	2368	2163	2304	1781	1146
31.	1060		2162		3242		1739	2194		2260		1148
SÚČ.	43558	30723	44342	69215	92410	64902	73176	55543	74770	77041	62137	49688
average	1405	1059	1430	2307	2981	2163	2361	1792	2492	2485	2071	1603
Š.O.	11	8	11	18	23	16	18	14	19	19	16	12
ODT.	3763	2654	3831	5980	7984	5608	6322	4799	6460	6656	5369	4293

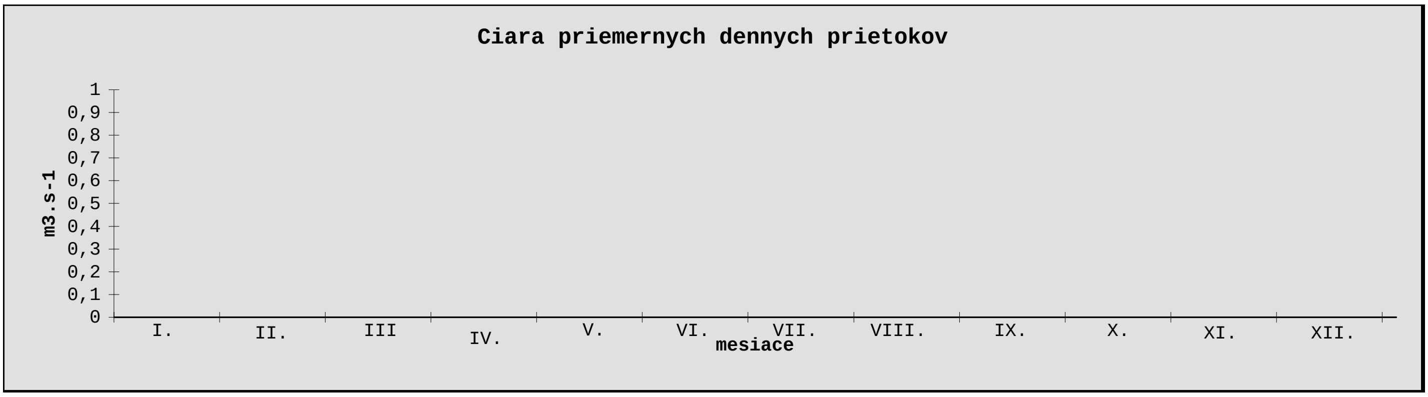
year sum	737504,6	year max.	**6393,0**	DEŇ/MES/HOD:	23/10/17	ROČNÝ ŠP. ODTOK:	**15,350**	$l.s^{-1}.km^{-2}$
year mean	2015	year min.	**822,3**	DEŇ/MESIAC :	12/03	ROČNÝ ODTOK :	**63720**	$mil.m^3$

M - denné prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1996	2918	2384	1956	1546	1060	933,8	880,4
% Qmda	84,0	95,2	104,0	114,6	103,7	111,4	131,4

Mesačné prietoky

Qma	1459	1716	2067	2436	2654	2891	2749	2280	1745	1510	1506	1500
% Qma	96,3	61,7	69,2	94,7	112,3	74,8	85,9	78,6	142,8	164,6	137,5	106,9



discharge **ROCNE SPRACOVANIE PRIETOKOV [m3.s-1]**

station : Lenartovce **year** **ROK : 1994**
river : Slana **PLOCHA POVODIA : 1829,65 km2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	16,59	10,41	10,14	10,65	20,19	20,93	7,968	2,390	7,551	5,643	16,68	6,193
2.	16,02	9,556	9,671	12,61	21,62	20,18	6,116	5,331	9,076	5,318	14,24	5,403
3.	16,18	10,08	10,08	29,03	24,71	18,77	5,424	4,323	4,634	5,612	13,61	5,122
4.	17,08	9,355	12,52	27,62	18,23	20,86	4,840	3,516	3,581	8,173	12,78	5,346
5.	19,80	9,639	11,25	23,92	16,66	22,03	4,600	2,939	3,748	7,090	11,75	6,783
6.	23,09	8,318	12,38	23,58	18,30	23,67	4,742	3,350	3,527	5,927	10,84	5,901
7.	20,55	8,114	10,75	25,59	15,70	24,08	4,552	3,620	3,133	6,133	9,738	5,625
8.	18,47	10,40	11,81	24,02	12,90	20,92	4,434	2,887	3,076	7,214	11,24	5,333
9.	19,65	8,859	12,60	22,37	12,95	18,70	4,262	2,728	2,935	7,336	11,48	5,372
10.	22,65	11,06	11,81	22,79	13,87	18,01	4,200	2,693	2,928	7,263	9,478	5,057
11.	35,26	12,39	12,88	31,16	17,58	18,81	4,200	2,255	2,604	8,643	12,98	4,884
12.	46,94	11,68	13,41	52,20	12,69	17,73	4,137	2,496	2,412	6,304	15,23	4,821
13.	47,71	10,31	14,28	113,80	11,21	19,32	4,015	3,175	2,406	6,724	13,79	4,887
14.	43,19	8,610	17,03	120,30	10,82	17,17	3,860	2,498	2,534	4,922	12,04	5,220
15.	39,69	9,525	18,46	101,90	10,76	12,99	3,767	2,262	2,432	4,421	11,75	6,807
16.	33,34	8,129	18,51	79,60	11,16	12,55	3,627	2,205	4,646	6,342	12,95	4,895
17.	31,50	9,936	19,97	65,15	11,41	12,51	3,472	3,047	4,502	5,180	10,67	4,479
18.	28,93	9,757	19,14	83,15	15,31	12,11	3,450	2,477	4,752	5,514	11,00	4,383
19.	23,50	9,294	17,08	111,70	16,28	10,59	5,813	2,478	6,972	4,174	10,01	4,283
20.	21,25	8,733	16,99	89,23	16,82	10,62	4,508	3,529	7,198	5,834	9,110	5,753
21.	20,64	8,209	16,66	72,57	17,48	9,707	3,719	2,418	6,957	6,025	10,41	4,508
22.	18,36	9,226	16,17	56,70	16,34	7,867	3,500	2,446	7,244	4,344	11,59	4,001
23.	17,79	7,897	13,63	51,48	14,64	7,267	3,356	2,438	5,922	4,893	10,30	3,950
24.	14,21	7,748	11,41	44,34	17,77	8,823	3,178	2,694	4,562	4,338	10,47	3,715
25.	13,62	9,652	12,42	35,53	21,91	7,895	3,104	2,905	4,458	6,072	10,08	3,640
26.	12,93	9,159	14,60	31,39	47,46	6,956	3,030	5,906	3,918	11,40	8,400	4,184
27.	12,66	8,138	15,38	29,80	32,47	6,582	3,169	8,601	3,869	12,53	6,996	5,023
28.	13,95	8,672	15,18	26,05	31,82	8,834	3,116	5,276	6,685	15,90	7,379	4,334
29.	13,21		12,77	24,67	33,31	7,888	2,842	3,650	5,701	24,14	8,080	5,252
30.	9,73		12,61	20,47	30,86	6,643	2,562	6,677	4,412	31,08	7,419	4,271
31.	9,85		12,36		28,52		2,433	6,166		23,47		5,111

SUC.	698,3	262,9	434,0	1463,4	601,8	431,0	126,0	109,4	138,4	268,0	332,5	154,5
average	22,53	9,388	14,00	48,78	19,411	14,37	4,064	3,528	4,613	8,644	11,08	4,985
S.O.	12,31	5,131	7,651	26,66	10,61	7,852	2,221	1,928	2,521	4,724	6,057	2,725
ODT.	60,34	22,71	37,49	126,4	51,99	37,24	10,89	9,45	11,96	23,15	28,73	13,35

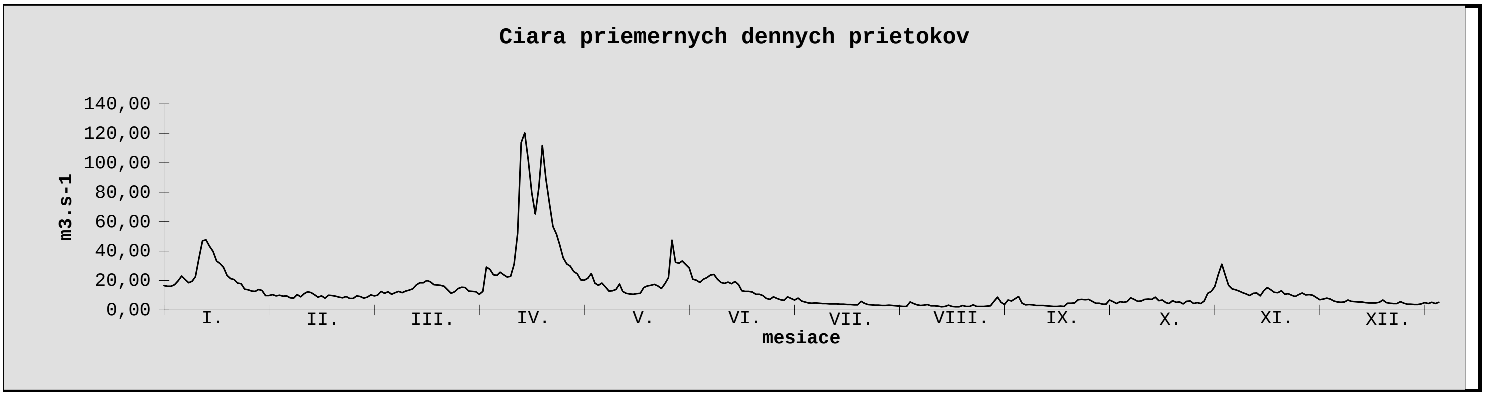
ROCNY SUCE year sum 5020 year. max. **123,7** DEN/MES/HOD: 14/4/6 ROCNY SP. ODTOK: **7,517** l.s-1.km-2
ROCNY PRIE year mean 13,75 year min. **2,205** DEN/MESIAC : 16/8 ROCNY ODTOK : **433,7** mil.m3

M - denne prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1994	29,80	16,66	9,733	5,057	3,178	2,446	2,255
% Qmda	96,38	102,65	105,56	92,69	85,73	89,66	114,29

Mesacne prietoky

Qm1994	22,53	9,388	14,00	48,78	19,41	14,37	4,064	3,528	4,613	8,644	11,08	4,985
% Qma	232,00	69,59	59,57	196,45	103,47	102,84	36,92	41,46	73,56	95,94	74,48	36,49



discharge

ROČNÉ SPRACOVANIE PRIETOKOV [$m^3.s^{-1}$]

station : Lenartovce year **ROK : 1995**
river : Slana **PLOCHA POVODIA : 1829,65 km^2**

month day	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1.	5,044	5,120	14,920	11,440	43,670	18,100	13,900	4,580	9,967	5,580	4,603	4,360
2.	4,614	4,774	14,280	10,520	37,530	29,190	14,420	5,627	9,138	5,473	4,245	3,965
3.	5,613	4,762	17,390	11,270	32,740	47,280	13,520	6,501	7,983	5,584	4,192	3,921
4.	4,318	5,969	34,060	11,080	27,890	62,480	27,630	6,757	9,797	5,105	4,327	4,020
5.	4,482	4,952	40,410	13,700	26,650	42,150	24,390	6,587	26,020	5,585	4,832	4,130
6.	4,361	3,838	43,160	13,780	25,640	35,950	22,360	6,598	16,130	5,228	5,727	6,642
7.	4,275	5,432	44,720	13,310	24,410	32,580	22,260	5,569	15,250	6,149	5,997	7,422
8.	4,496	5,370	39,730	11,420	19,630	32,510	17,440	7,090	12,490	7,669	4,874	6,000
9.	5,643	5,610	35,900	11,360	18,210	32,930	16,470	6,712	12,900	5,990	4,328	5,419
10.	4,658	5,604	31,440	13,180	18,160	39,050	14,590	4,666	11,340	5,521	3,899	7,042
11.	4,400	4,838	27,520	9,941	17,280	35,960	11,030	4,886	9,231	4,629	3,955	6,338
12.	4,809	4,802	23,820	9,018	16,630	114,300	9,796	4,250	8,183	4,673	3,813	4,235
13.	4,135	4,304	20,300	8,903	28,200	161,600	9,332	4,041	7,167	5,131	3,873	3,700
14.	4,000	4,593	20,090	8,826	37,550	141,200	11,010	3,725	8,208	5,167	3,750	3,700
15.	3,751	6,334	18,960	9,558	32,070	89,450	10,800	5,937	7,950	4,531	4,996	3,700
16.	3,560	7,371	18,090	8,392	28,920	62,630	9,979	5,464	5,723	4,125	4,824	3,700
17.	3,562	18,070	17,920	8,940	28,020	50,100	10,460	6,224	6,056	4,854	5,390	3,841
18.	3,957	15,690	15,070	8,062	27,650	41,930	13,830	6,311	7,494	4,166	5,032	3,789
19.	4,765	14,950	17,070	9,298	25,640	37,530	9,854	5,350	7,562	4,604	4,753	3,774
20.	4,255	12,710	15,760	8,608	38,490	31,750	9,178	4,056	5,928	4,953	4,458	5,683
21.	4,239	11,610	14,050	9,145	47,700	28,190	7,656	4,548	11,870	4,353	4,918	4,297
22.	4,203	10,980	13,040	8,993	41,980	26,330	7,302	5,595	13,110	3,824	3,933	3,140
23.	3,958	11,990	12,450	9,781	37,500	24,660	8,075	4,544	10,250	3,723	3,474	3,547
24.	3,896	13,300	12,670	10,180	34,740	21,190	6,484	4,652	9,081	3,873	3,518	4,299
25.	3,827	15,550	11,020	11,350	31,020	20,320	5,981	3,699	9,840	4,624	5,400	5,054
26.	3,959	14,580	11,800	19,990	28,570	21,610	6,298	3,875	8,264	5,248	4,273	5,578
27.	5,445	17,350	11,310	88,550	24,700	24,730	5,513	7,166	7,358	4,550	4,007	5,520
28.	7,060	17,440	12,420	100,000	22,560	20,420	5,315	5,432	8,609	3,925	4,170	4,422
29.	5,221		12,620	67,430	19,690	16,790	5,050	22,330	7,459	3,659	4,352	3,069
30.	4,886		14,450	50,570	19,930	16,200	4,868	14,880	5,637	3,457	4,205	2,850
31.	5,561		12,310		16,530		4,828	11,090		4,154		4,672
SÚČ.	140,953	257,893	648,750	586,595	879,900	1359,110	359,619	198,742	295,995	150,107	134,118	141,829
average	4,547	9,210	20,927	19,553	28,384	45,304	11,601	6,411	9,867	4,842	4,471	4,575
Š.O.	2,485	5,034	11,438	10,687	15,513	24,761	6,340	3,504	5,393	2,646	2,443	2,501
ODT.	12,178	22,282	56,052	50,682	76,023	117,427	31,071	17,171	25,574	12,969	11,588	12,254

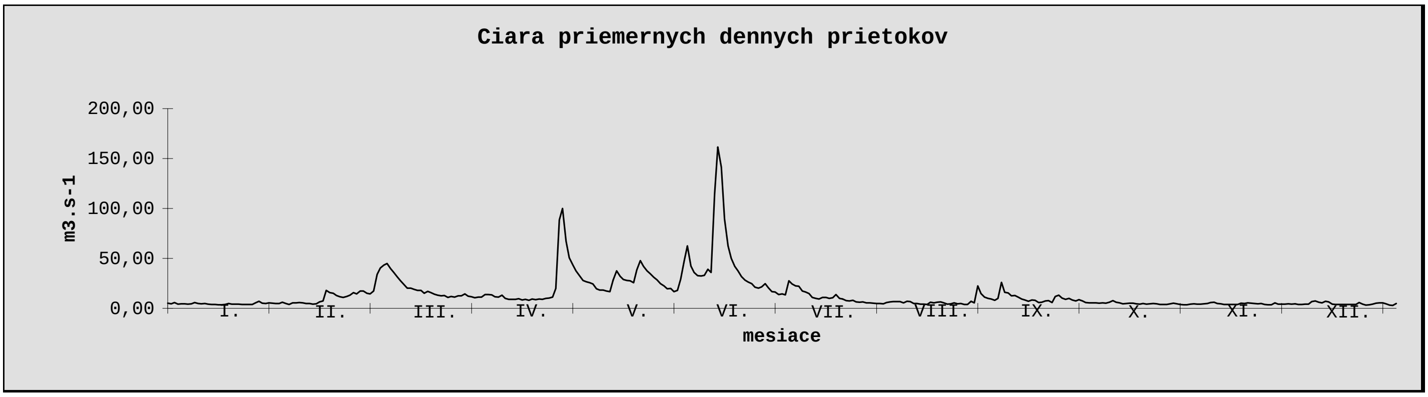
year sum	5153,611	year max.	**168,500**	DEŇ/MES/HOD:	13/06/12	ROČNÝ ŠP. ODTOK:	**7,717**	$l.s^{-1}.km^{-2}$
year mean	14,119	year min.	**2,850**	DEŇ/MESIAC :	30/12	ROČNÝ ODTOK :	**445,272**	$mil.m^3$

M - denné prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1995	35,900	16,630	7,669	4,802	3,957	3,699	3,069
% Qmda	116,1	102,5	83,2	88,0	106,7	135,6	155,5

Mesačné prietoky

Qma	9,710	13,490	23,500	24,830	18,760	13,970	11,010	8,510	6,270	9,010	14,880	13,660
% Qma	46,8	68,3	89,1	78,7	151,3	324,3	105,4	75,3	157,4	53,7	30,0	33,5



discharge

ROČNÉ SPRACOVANIE PRIETOKOV [m^3.s^{-1}]

station : Lenartovce **year** **ROK:** **1996**
river ; Slana **PLOCHA POVODIA :** **1829,7** **km2**

month day	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1.	5,552	3,004	6,222	17,320	38,930	21,530	8,893	5,144	33,030	14,080	5,572	14,730
2.	5,138	3,159	5,934	17,300	50,680	18,510	10,790	3,691	26,090	10,580	5,409	13,230
3.	5,119	3,579	4,794	65,980	54,030	15,830	11,760	3,509	20,070	11,190	6,617	13,390
4.	4,613	3,780	4,766	104,100	53,840	15,580	11,810	6,587	16,380	11,720	6,189	10,010
5.	4,034	3,696	4,330	85,810	48,740	17,020	10,880	9,659	14,590	10,930	5,670	10,920
6.	3,227	3,777	4,642	82,840	41,320	13,610	9,402	7,918	15,430	10,630	5,175	10,510
7.	2,996	3,765	4,068	70,680	36,620	11,820	11,820	5,340	14,270	8,664	5,680	10,100
8.	4,333	3,367	4,848	59,150	32,050	10,910	8,715	5,034	14,160	8,771	6,644	8,505
9.	3,766	3,631	4,668	53,490	34,740	9,559	9,273	4,309	12,120	10,070	5,889	7,819
10.	3,829	4,589	5,079	44,120	49,990	9,195	7,952	4,159	10,140	10,680	6,654	7,868
11.	3,708	4,503	5,382	38,940	57,980	10,490	7,179	4,872	10,040	11,260	5,699	7,200
12.	3,702	3,750	5,079	34,540	51,080	9,542	6,657	4,725	10,090	9,065	5,931	7,156
13.	3,790	3,963	4,827	32,340	50,140	12,700	6,446	5,080	12,670	7,088	5,633	7,121
14.	4,811	3,783	6,063	29,940	56,910	13,230	6,913	8,231	13,940	7,560	5,339	10,150
15.	4,691	3,726	6,042	25,550	50,130	8,614	5,954	6,714	12,670	6,616	4,836	11,190
16.	3,211	3,624	9,751	23,620	42,070	7,818	6,737	5,017	12,570	6,274	4,823	9,626
17.	3,311	3,469	17,570	21,240	37,520	8,783	5,909	4,717	11,600	6,251	6,797	8,904
18.	4,184	3,643	22,770	20,080	32,450	11,450	5,999	4,342	10,380	6,735	8,413	11,330
19.	2,889	4,105	24,580	19,040	28,480	11,610	8,082	4,201	9,383	8,797	8,391	8,392
20.	2,962	3,672	27,080	18,780	26,020	11,940	5,838	5,325	9,151	8,906	10,150	7,034
21.	3,221	3,581	22,590	19,660	38,900	11,330	5,514	5,921	8,293	8,041	35,950	7,201
22.	3,129	4,484	23,250	21,370	31,910	9,556	5,729	4,676	8,574	6,291	36,470	5,837
23.	3,453	5,379	20,960	24,000	32,340	10,250	7,498	6,736	11,560	5,928	25,510	4,529
24.	3,749	5,706	20,880	27,660	28,090	10,020	5,693	4,498	16,640	5,796	21,950	4,276
25.	3,333	5,286	20,110	29,250	26,110	9,706	5,424	4,621	17,930	7,106	18,170	6,184
26.	4,049	5,149	23,560	29,870	22,530	8,859	7,117	5,412	17,690	8,551	17,040	6,263
27.	3,621	5,531	27,750	29,600	21,530	10,010	5,269	5,318	16,770	7,931	13,720	7,608
28.	3,461	5,469	25,950	25,840	27,670	9,679	4,599	4,065	14,420	5,818	13,910	5,703
29.	3,305	5,309	22,340	26,010	32,360	8,876	4,201	9,965	14,190	7,601	13,820	4,863
30.	3,409		20,910	27,200	26,920	8,516	4,645	14,180	12,570	6,472	12,640	6,347
31.	3,132		19,230		22,700		10,160	15,930		5,967		6,321
SÚČ.	117,728	120,479	426,025	1125,320	1184,780	346,543	232,858	189,896	427,411	261,369	334,691	260,317
average	3,798	4,154	13,743	37,511	38,219	11,551	7,512	6,126	14,247	8,431	11,156	8,397
Š.O.	2,076	2,271	7,511	20,502	20,889	6,313	4,105	3,348	7,787	4,608	6,098	4,590
ODT.	10,172	10,409	36,809	97,228	102,365	29,941	20,119	16,407	36,928	22,582	28,917	22,491

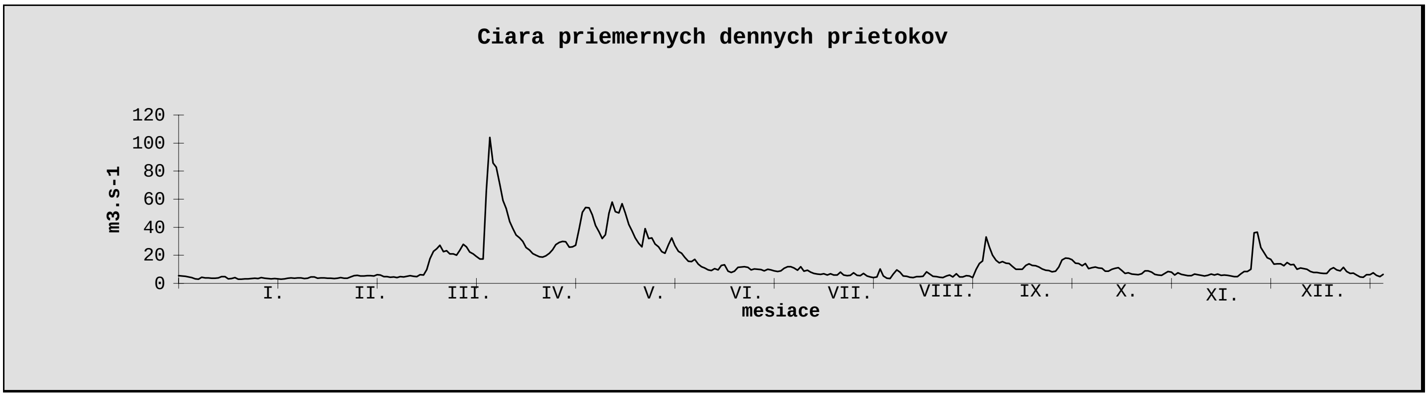
year sum	5027,417	year max.	**121,300**	DEŇ/MES/HOD:	04/04/2	ROČNÝ ŠP. ODTOK:	**7,508**	l.s^{-1}.km^{-2}
year mean	13,736	year min.	**2,889**	DEŇ/MESIAC :	19/01	ROČNÝ ODTOK :	**434,369**	mil.m^3

M - denné prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1996	33,030	17,020	8,783	5,379	3,780	3,311	2,996
% Qmda	106,8	104,9	95,3	98,6	102,0	121,4	151,8

Mesačné prietoky

Qma	9,710	13,490	23,500	24,830	18,760	13,970	11,010	8,510	6,270	9,010	14,880	13,660
% Qma	39,1	30,8	58,5	151,1	203,7	82,7	68,2	72,0	227,2	93,6	75,0	61,5



discharge

ROCNE SPRACOVANIE PRIETOKOV [m3.s-1]

station : Zdana **year** **ROK : 1994**
river : Hornad **PLOCHA POVODIA : 4232,2 km2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	11,62	12,33	16,11	14,58	32,22	42,81	21,02	12,99	10,32	9,467	25,10	14,39
2.	11,47	11,68	18,86	18,69	45,25	32,34	14,34	12,13	17,56	9,487	17,41	14,82
3.	11,70	11,57	22,97	43,22	40,12	29,92	17,25	13,76	14,39	12,33	13,22	11,19
4.	11,16	14,67	24,66	74,86	30,00	32,58	17,10	18,13	11,20	11,18	12,18	10,61
5.	13,95	14,89	20,09	57,01	26,40	38,55	19,07	18,12	9,47	8,693	11,11	12,81
6.	15,57	14,80	17,57	60,05	26,19	64,11	19,05	13,02	10,88	10,19	12,09	12,47
7.	14,15	14,55	15,47	103,6	25,72	85,74	18,24	11,16	12,42	13,32	10,69	10,35
8.	15,52	15,56	15,30	92,94	28,99	63,41	12,29	11,39	11,45	12,75	11,70	12,57
9.	16,75	15,50	15,04	77,81	31,73	52,56	14,65	13,83	8,893	9,458	10,82	11,52
10.	17,25	23,98	15,33	67,06	27,08	46,70	14,27	11,02	10,23	8,729	10,23	11,89
11.	18,05	29,42	19,96	81,32	25,19	37,43	13,39	12,20	10,50	9,483	9,86	11,51
12.	19,94	19,42	22,03	146,6	24,49	41,26	14,65	9,37	10,77	11,58	11,54	12,44
13.	37,77	15,76	23,24	219,7	24,34	33,67	11,86	10,61	10,74	9,906	10,31	12,45
14.	42,73	12,46	27,36	245,9	23,51	27,14	14,13	10,29	10,30	9,215	9,96	15,26
15.	26,48	15,86	26,59	179,8	23,00	26,14	13,46	10,10	11,01	8,865	11,75	17,98
16.	29,00	16,53	26,04	125,2	23,20	23,94	13,34	9,27	10,31	10,98	12,13	18,21
17.	28,24	17,58	24,55	117,2	20,40	22,61	12,90	9,76	10,71	9,745	10,81	16,63
18.	26,62	18,43	21,59	98,06	18,53	24,16	13,98	11,97	7,708	10,44	11,68	13,72
19.	26,00	17,27	25,98	131,3	17,21	26,39	14,02	12,05	8,122	13,54	12,07	12,56
20.	31,55	14,79	19,71	101,5	21,10	24,59	15,14	12,02	9,715	12,10	10,96	10,22
21.	23,01	13,36	17,59	92,73	22,68	23,52	12,08	11,69	11,58	9,583	10,88	9,23
22.	21,59	14,29	22,79	81,56	24,46	20,87	13,21	11,03	10,02	9,510	11,07	10,17
23.	20,19	13,01	21,44	63,64	24,29	19,12	14,47	11,24	8,260	9,437	10,43	10,10
24.	19,57	17,08	15,11	66,40	22,22	18,46	13,50	11,61	7,629	8,114	10,19	10,32
25.	20,42	11,96	18,89	55,73	22,81	17,52	13,11	9,20	7,321	7,860	11,13	9,56
26.	18,36	13,38	21,01	54,99	64,00	15,94	13,72	18,34	6,869	9,505	10,80	11,09
27.	18,87	14,46	20,43	48,29	56,26	19,30	13,13	17,74	8,745	10,74	10,98	12,00
28.	21,67	15,55	21,09	43,54	50,60	19,88	12,67	13,29	9,312	19,07	11,35	11,67
29.	20,57		21,86	41,63	43,51	16,96	12,68	10,62	8,474	24,99	11,33	11,65
30.	17,13		21,99	37,86	45,85	16,70	12,61	9,737	8,858	47,52	11,84	10,45
31.	13,32		19,51		45,26		12,74	10,16		37,82		11,91

SUC.	640,2	440,1	640,2	2642,8	956,6	964,3	448,1	377,8	303,8	405,6	355,6	381,7
average	20,65	15,72	20,65	88,09	30,86	32,14	14,45	12,19	10,13	13,08	11,85	12,31
S.O.	4,880	3,714	4,879	20,81	7,29	7,595	3,415	2,880	2,393	3,09	2,801	2,910
ODT.	55,32	38,03	55,31	228,34	82,65	83,32	38,71	32,65	26,25	35,04	30,73	32,98

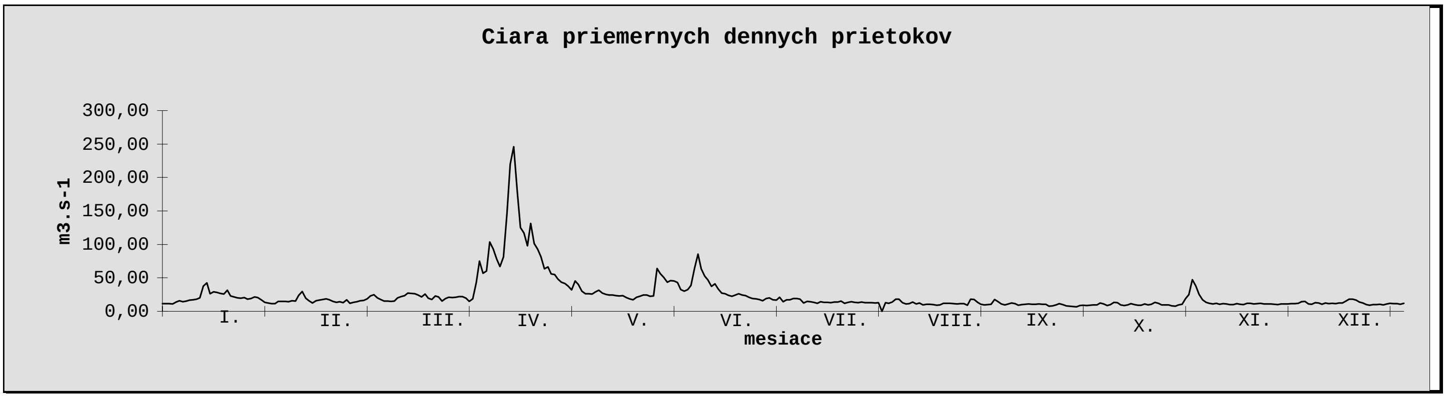
ROCNY SUCET : 8556,9 year. max. **261,3** DEN/MES/HOD: 14/4/4 ROCNY SP. ODTOK: **5,513** l.s-1.km-2
ROCNY PRIEMER: 23,444 year min. **6,869** DEN/MESIAC : 26/9 ROCNY ODTOK : **735,800** mil.m3

M - denne prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1994	50,60	23,51	14,89	11,47	9,857	8,729	7,321
% Qmda	67,11	66,68	78,24	98,03	120,80	139,00	155,44

Mesacne prietoky

Qm	20,65	15,72	20,65	88,09	30,86	32,14	14,45	12,19	10,13	13,08	11,85	12,31
% Qma	106,25	64,98	43,16	158,78	76,24	88,92	44,75	46,57	58,33	67,10	38,42	50,58


Ciara priemernych dennych prietokov

discharge

ROČNÉ SPRACOVANIE PRIETOKOV $[m^3.s^{-1}]$

station : Zdana **year** **ROK : 1995**
river : Hornad **PLOCHA POVODIA : 4232,2 km^2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	14,670	10,070	30,760	20,140	80,560	25,860	39,640	14,310	27,160	17,610	11,040	14,110
2.	12,450	12,450	26,260	19,690	76,980	23,090	36,960	13,190	21,170	14,190	10,830	13,020
3.	11,500	10,930	25,520	19,120	54,220	37,040	38,400	13,500	19,260	13,210	10,290	12,970
4.	10,620	10,360	50,750	18,940	46,800	54,560	44,540	12,630	23,710	12,020	12,020	13,130
5.	10,890	9,970	67,340	21,360	46,520	54,570	89,730	11,130	95,510	10,990	12,730	12,620
6.	12,560	9,878	71,560	24,540	45,610	38,510	65,310	10,600	105,500	10,450	12,110	12,340
7.	11,720	10,740	80,360	22,610	39,620	33,750	48,530	10,450	61,870	11,300	12,130	12,540
8.	11,580	11,300	80,790	25,170	36,670	34,830	42,310	13,000	48,200	11,580	12,970	12,100
9.	12,190	9,792	72,190	27,400	35,950	33,060	31,040	12,710	38,090	11,600	12,480	11,940
10.	11,260	9,808	56,790	26,500	30,240	24,780	28,810	12,240	45,480	13,640	11,070	12,250
11.	10,850	10,730	50,140	26,910	26,790	36,880	27,390	13,820	37,540	13,900	16,780	12,320
12.	10,340	10,330	43,710	22,520	27,100	63,660	26,380	11,880	29,020	15,090	12,360	12,080
13.	11,040	10,000	43,590	21,620	32,660	160,200	27,150	11,030	25,350	15,150	12,150	12,310
14.	11,710	10,280	42,730	24,440	48,100	131,800	25,800	11,060	20,960	16,750	9,850	12,240
5	10,790	9,547	38,190	22,790	47,720	107,500	27,510	10,920	18,970	14,080	11,480	11,600
16.	10,900	16,070	34,750	20,910	39,050	86,820	27,200	11,420	19,510	11,720	13,490	11,080
17.	12,250	45,430	31,840	32,580	32,940	71,930	37,580	12,480	25,620	11,160	18,410	11,090
18.	10,860	48,450	27,950	39,560	28,630	77,020	34,520	10,440	24,550	12,810	24,550	12,060
19.	7,870	39,220	21,700	37,370	28,350	55,270	25,170	10,210	20,370	12,530	20,490	12,360
20.	9,733	29,940	33,290	36,380	34,390	41,770	23,560	9,747	19,300	14,220	14,780	12,210
21.	11,380	25,290	35,820	36,250	44,160	40,290	18,920	9,984	16,180	13,750	12,060	12,080
22.	10,110	21,430	27,690	37,420	51,690	40,500	19,570	11,300	14,670	12,630	10,520	11,480
23.	10,280	19,700	23,710	35,770	41,820	40,740	15,060	11,740	15,730	12,580	12,920	10,870
24.	11,100	19,640	20,190	34,670	37,140	36,430	14,140	10,860	16,360	12,980	12,600	13,960
25.	10,710	23,120	20,460	32,390	36,660	30,640	14,140	9,820	16,220	13,140	13,420	14,710
26.	9,977	25,660	21,970	39,180	35,310	30,960	13,750	11,380	15,910	10,540	12,230	14,430
27.	11,080	31,090	26,250	79,350	32,320	61,580	12,740	13,690	15,390	13,860	12,460	13,350
28.	14,620	31,870	30,300	127,300	27,190	76,410	16,550	16,210	13,310	13,220	12,690	11,870
29.	11,140		26,480	106,900	29,330	72,310	14,760	48,220	14,510	13,230	13,080	10,840
30.	10,710		21,650	96,860	32,940	48,250	14,010	72,790	18,360	13,410	13,870	10,820
31.	10,630		21,230		29,460		14,210	35,450		11,210		12,940
SÚČ.	347,520	533,095	1205,960	1136,640	1236,920	1671,010	915,380	488,211	883,780	404,550	397,860	383,720
average	11,210	19,039	38,902	37,888	39,901	55,700	29,528	15,749	29,459	13,050	13,262	12,378
Š.O.	2,649	4,499	9,192	8,952	9,428	13,161	6,977	3,721	6,961	3,084	3,134	2,925
ODT.	30,026	46,059	104,195	98,206	106,870	144,375	79,089	42,181	76,359	34,953	34,375	33,153

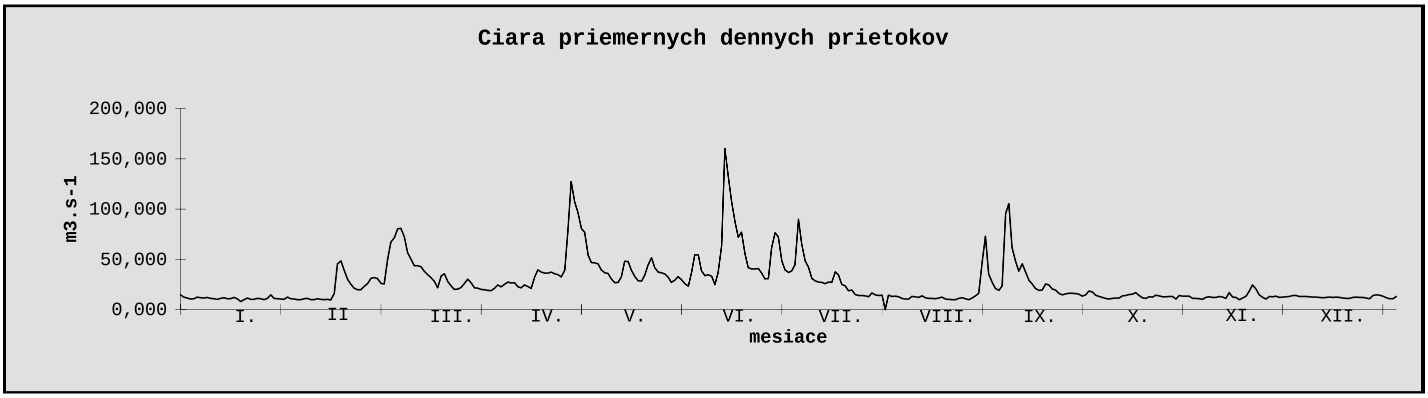
year sum	9604,646	year max.	**186,700**	DEŇ/MES/HOD:	13/06/12	ROČNÝ ŠP. ODTOK:	**6,218**	l.s^{-1}.km^{-2}
year mean	26,314	year min.	**7,870**	DEŇ/MESIAC :	19/01	ROČNÝ ODTOK :	**829,841**	mil.m^3

M - denné prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1995	54,570	34,520	18,940	12,240	10,820	9,977	9,547
% Qmda	72,4	97,9	99,5	104,6	132,6	158,9	202,7

Mesačné prietoky

Qm	11,210	19,039	38,902	37,888	39,901	55,700	29,528	15,749	29,459	13,050	13,262	12,378
% Qma	57,7	78,7	81,3	68,3	98,6	154,1	91,4	60,2	169,7	66,9	43,0	50,8



discharge

ROČNÉ SPRACOVANIE PRIETOKOV [$m^3.s^{-1}$]

station ; Zdana **year** **ROK :** **1996**
river : Hornad **PLOCHA POVODIA :** **4232,2** **km^2**

month day	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1.	15,080	11,520	10,670	24,750	72,810	33,840	36,580	19,820	105,200	56,840	20,070	22,570
2.	12,540	12,060	10,910	23,690	82,810	37,120	27,770	16,500	157,700	50,780	25,110	21,840
3.	12,060	15,580	10,830	40,940	110,900	28,220	22,760	10,730	82,870	43,800	25,480	24,360
4.	11,580	12,700	11,270	72,490	87,370	28,010	29,340	22,060	74,480	42,840	24,000	24,630
5.	10,770	12,080	11,690	78,910	75,310	28,720	25,330	45,000	55,040	45,370	23,060	18,640
6.	11,330	12,800	11,650	96,710	67,400	27,240	22,620	37,370	48,620	45,120	23,290	16,350
7.	11,550	12,100	11,040	94,200	63,590	23,170	22,480	23,090	69,080	32,930	22,510	16,030
8.	14,100	13,330	10,530	96,240	65,050	18,500	22,240	17,730	60,370	29,350	15,530	17,460
9.	12,660	13,780	11,240	79,870	68,260	15,640	20,860	14,750	52,040	28,300	15,200	21,470
10.	12,610	14,350	11,210	98,710	70,920	15,940	19,890	14,150	44,640	28,610	19,920	22,130
11.	13,490	14,640	8,649	61,550	70,130	17,580	18,950	12,300	42,710	29,380	20,990	17,260
12.	16,420	14,300	8,976	51,500	69,860	29,300	19,190	10,540	25,660	27,390	20,900	16,340
13.	20,260	12,610	8,777	48,980	63,170	41,380	18,110	9,791	54,080	28,420	19,820	16,280
14.	20,520	12,650	10,030	46,370	67,630	25,160	19,170	12,950	61,780	23,500	15,790	21,180
15.	16,930	11,630	11,770	42,720	70,880	24,700	16,400	16,410	61,030	20,210	17,810	33,620
16.	16,210	11,440	22,030	43,810	62,210	16,950	12,980	23,790	54,100	19,710	14,480	28,410
17.	13,740	12,790	32,020	40,970	54,650	16,080	10,960	49,600	49,030	20,780	21,350	26,250
18.	14,080	11,610	37,390	46,390	43,220	17,730	12,100	36,820	49,030	29,550	24,890	23,740
19.	14,300	10,150	35,150	58,970	47,860	18,740	15,970	26,310	49,350	56,720	24,540	23,180
20.	14,430	11,480	35,790	65,210	42,010	17,800	19,570	20,580	37,780	74,770	22,440	21,440
21.	13,380	11,480	34,650	67,360	54,890	21,710	17,030	15,880	34,510	52,040	27,820	20,350
22.	12,230	10,150	31,940	75,330	72,090	23,400	15,040	15,520	35,480	42,410	44,280	17,090
23.	12,150	9,515	31,740	82,390	73,060	22,320	11,600	14,280	42,350	35,750	38,880	15,430
24.	13,140	10,570	32,410	85,500	70,710	32,510	9,787	12,940	92,770	32,100	29,940	19,100
25.	11,150	11,270	43,260	81,770	58,840	38,910	10,750	13,030	108,000	28,200	28,690	16,730
26.	13,450	10,710	52,250	72,200	41,890	27,370	12,150	12,090	86,610	26,130	28,360	15,560
27.	16,240	11,770	46,370	71,250	24,890	17,600	20,690	16,010	78,000	24,670	27,360	17,590
28.	15,970	11,360	43,720	67,840	26,260	19,200	16,050	18,290	69,470	24,310	27,340	23,610
29.	13,190	11,230	33,240	57,100	42,790	17,020	10,090	18,510	64,430	30,190	27,000	23,960
30.	12,260		29,470	71,770	46,490	19,840	15,810	35,940	58,690	30,760	26,740	21,900
31.	11,490		27,650		44,050		22,630	34,870		25,060		16,470
SÚČ.	429,310	351,655	728,322	1945,490	1912,000	721,700	574,897	647,651	1904,900	1085,990	723,590	640,970
average	13,849	12,126	23,494	64,850	61,677	24,057	18,545	20,892	63,497	35,032	24,120	20,676
Š.O.	3,272	2,865	5,551	15,323	14,573	5,684	4,382	4,936	15,003	8,277	5,699	4,886
ODT.	37,092	30,383	62,927	168,090	165,197	62,355	49,671	55,957	164,583	93,830	62,518	55,380

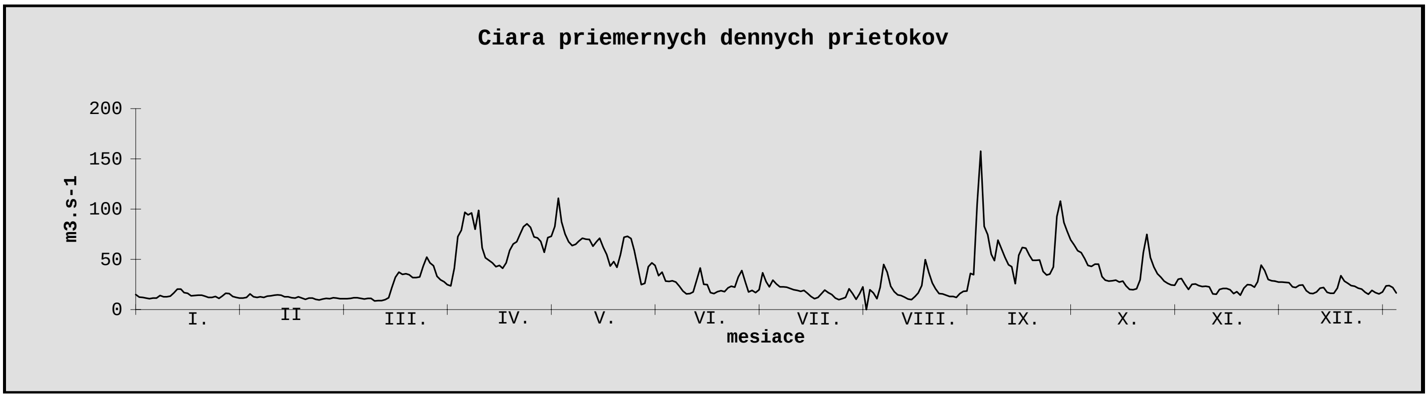
year sum	11666,475	year max	**184,600**	DEŇ/MES/HOD:	01/09/20	ROČNÝ ŠP. ODTOK:	**7,532**	$l.s^{-1}.km^{-2}$
year mean	31,876	year min	**8,649**	DEŇ/MESIAC :	11/03	ROČNÝ ODTOK :	**1007,983**	$mil.m^3$

M - denné prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1996	71,250	43,220	23,690	15,810	11,580	10,540	8,976
% Qmda	94,5	122,6	124,5	135,1	141,9	167,8	190,6

Mesačné prietoky

Qm	13,849	12,126	23,494	64,850	61,677	24,057	18,545	20,892	63,497	35,032	24,120	20,676
% Qma	71,2	50,1	49,1	116,9	152,4	66,5	57,4	79,8	365,7	179,7	78,2	84,9



Ciara priemernych dennych prietokov

discharge

ROCNE SPRACOVANIE PRIETOKOV [m3.s-1]

station : Streda nad Bodrogom year **ROK : 1994**
river : Bodrog **PLOCHA POVODIA : 11474,25** km2

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	156,4	70,69	123,6	141,4	103,9	178,6	51,75	34,96	40,20	39,56	160,9	46,96
2.	129,3	69,83	167,2	134,0	100,8	157,1	49,35	38,98	41,78	36,94	132,6	40,62
3.	116,2	69,43	197,7	140,4	103,3	135,0	46,95	41,47	49,63	37,73	104,2	35,57
4.	106,7	70,89	231,5	168,1	97,09	112,4	44,56	41,41	48,46	38,88	82,96	33,46
5.	113,2	81,79	261,6	194,4	89,34	95,25	43,60	39,46	41,57	54,59	71,32	34,47
6.	151,7	95,65	267,9	215,1	81,59	100,3	43,60	37,46	40,00	67,61	60,12	42,35
7.	167,6	108,0	267,7	250,7	74,48	161,6	43,35	36,84	40,73	60,22	53,70	49,71
8.	170,6	122,1	257,7	338,8	71,16	186,0	42,51	39,36	42,74	49,99	53,08	49,25
9.	174,9	136,3	242,8	376,9	71,30	165,8	41,65	41,46	40,00	43,24	53,70	43,50
10.	175,0	150,4	225,0	392,1	78,36	136,8	40,83	42,44	36,50	51,66	51,27	39,35
11.	175,0	158,9	196,5	394,0	78,39	109,0	42,15	40,65	33,01	69,85	47,25	39,66
12.	174,3	162,9	165,3	388,7	72,95	92,17	45,67	39,25	31,60	71,43	45,59	41,37
13.	169,8	163,0	140,9	354,2	67,51	81,73	43,33	39,50	31,64	59,88	44,64	66,16
14.	164,5	161,4	139,9	339,4	63,72	74,92	41,05	41,00	32,31	50,20	41,78	129,0
15.	158,0	154,3	155,4	347,8	62,81	70,97	42,25	42,51	32,40	45,59	40,01	170,1
16.	151,5	140,8	175,4	316,5	62,13	67,33	43,22	41,87	32,40	42,08	46,62	173,4
17.	145,0	126,4	194,8	267,7	61,77	63,86	42,99	40,84	32,56	40,19	63,64	159,7
18.	138,4	111,9	201,8	224,9	60,99	63,10	44,79	41,24	35,72	40,33	69,49	143,3
19.	130,1	94,99	193,9	233,6	56,48	65,09	47,36	42,43	39,86	41,44	82,56	126,9
20.	119,9	86,40	181,1	270,9	51,78	66,00	48,40	44,98	40,29	39,48	96,28	110,9
21.	109,6	81,67	168,4	253,1	54,54	66,00	46,26	47,19	46,14	39,40	92,48	95,78
22.	99,40	76,56	155,6	233,9	64,22	63,31	39,25	46,47	69,24	39,08	84,58	80,66
23.	89,17	73,19	142,8	215,3	75,05	58,13	32,05	43,96	69,46	38,02	75,18	69,99
24.	80,23	71,03	130,1	197,6	83,34	57,24	27,48	41,43	58,36	38,75	67,01	74,69
25.	76,56	70,25	125,0	180,0	92,44	56,41	27,48	40,02	46,15	38,90	58,45	70,35
26.	73,81	78,37	130,7	162,4	121,9	53,78	28,74	42,49	38,99	40,60	54,00	54,26
27.	75,28	93,75	146,3	144,7	173,6	52,90	28,09	47,22	38,00	45,32	54,22	52,00
28.	77,92	109,8	160,5	128,3	174,3	52,90	28,11	47,97	38,27	75,73	56,09	53,58
29.	77,43		160,9	121,0	180,5	52,90	28,47	46,21	43,56	86,31	53,77	53,05
30.	74,84		154,5	111,4	177,2	52,90	28,83	44,40	42,96	171,0	51,22	56,83
31.	72,24		148,1		182,6		31,08	43,05		203,0		89,27

SUC.	3894,6	2990,7	5610,6	7237,3	2889,5	2749,5	1235,2	1298,5	1254,5	1797,0	2048,7	2326,2
average	125,6	106,8	181,0	241,2	93,21	91,65	39,85	41,89	41,82	57,97	68,29	75,04
S.O.	10,95	9,309	15,773	21,02	8,12	7,987	3,473	3,651	3,644	5,05	5,952	6,540
ODT.	336,5	258,4	484,8	625,3	249,7	237,6	106,7	112,2	108,4	155,3	177,0	201,0

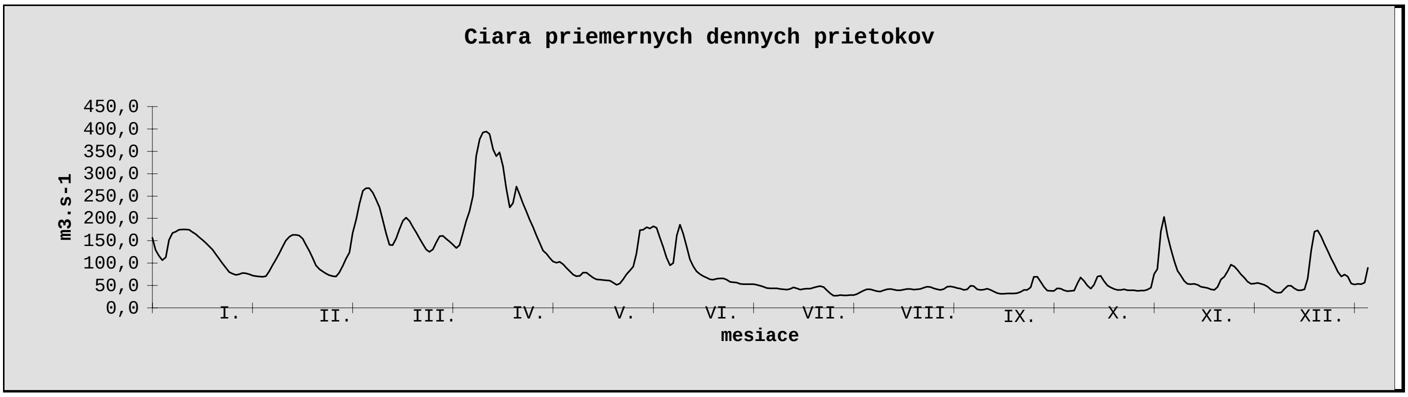
year sum 35332,4 year max. **394,0** DEN/MES/HOD: 10/ 4/12 ROCNY SP. ODTOK: **8,436** l.s-1.km-2
year mean 96,80 year min. **27,48** DEN/MESIAC : 24/ 2 viac krat ROCNY ODTOK : **3052,715** mil.m3

M - denne prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1994	196,5	139,9	70,35	43,96	39,25	32,05	27,48
% Qmda	66,69	106,42	114,95	138,54	203,73	235,66	295,71

Mesacne prietoky

Qm	125,6	106,8	181,0	241,2	93,21	91,65	39,85	41,89	41,82	57,97	68,29	75,04
% Qma	122,67	75,85	78,26	113,31	91,90	99,17	46,24	70,59	85,59	84,14	71,41	61,37



discharge

ROČNÉ SPRACOVANIE PRIETOKOV $[m^3.s^{-1}]$

station : Streda nad Bodrogom year **ROK : 1995**
river : Bodrog **PLOCHA POVODIA : 11474,25 km^2**

month day	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1.	149,500	276,400	432,700	189,400	378,800	72,090	112,100	41,430	47,100	63,650	38,830	66,980
2.	163,500	275,000	436,900	185,000	379,200	69,850	95,680	42,550	44,690	71,740	39,000	61,930
3.	164,000	266,000	404,200	180,600	322,300	67,070	79,250	41,340	43,870	75,860	39,000	56,890
4.	159,900	248,700	366,700	176,200	230,200	75,990	73,530	43,490	45,230	68,430	40,260	51,840
5.	147,800	221,800	333,800	172,000	188,900	90,110	107,800	44,480	81,050	59,190	45,320	48,910
6.	132,800	189,600	326,300	172,100	176,700	87,220	151,700	43,580	162,900	52,130	49,030	48,660
7.	117,800	160,200	322,700	163,700	165,100	81,030	135,700	44,850	133,500	48,500	48,010	48,430
8.	102,800	126,700	310,500	153,300	153,400	74,900	116,800	45,080	101,200	47,380	46,620	48,190
9.	87,820	113,900	279,100	143,400	151,200	69,220	97,940	43,970	75,490	47,000	46,290	47,570
10.	74,190	119,200	246,800	143,800	169,000	63,620	79,050	43,130	62,540	46,750	44,750	45,760
11.	65,880	125,000	214,600	143,800	158,900	62,970	67,580	43,190	58,580	46,160	43,060	44,210
12.	64,160	127,200	182,800	138,600	145,100	79,590	63,510	41,430	56,400	44,740	43,000	44,900
13.	65,350	127,400	160,400	133,200	131,500	99,050	61,690	41,100	52,940	42,910	44,930	45,800
14.	62,520	131,600	147,800	130,500	127,700	127,300	60,320	40,150	49,730	41,080	50,090	45,370
15.	55,910	135,100	136,500	133,800	133,900	115,700	58,090	39,490	48,780	39,250	53,380	44,280
16.	51,160	152,000	123,600	150,100	140,100	98,880	55,720	39,270	47,570	37,490	55,830	42,140
17.	51,000	199,000	110,800	172,300	139,300	85,600	59,920	41,170	45,960	37,000	91,370	38,530
18.	51,000	240,800	98,520	188,100	131,600	77,760	61,400	42,680	44,770	37,000	179,000	37,890
19.	56,640	265,500	94,290	194,200	123,700	69,940	59,960	41,760	46,400	36,860	203,000	40,830
20.	73,070	292,200	115,500	195,500	116,100	66,440	56,700	40,120	47,430	35,930	202,800	44,740
21.	79,840	301,700	144,700	195,700	108,600	63,870	53,430	38,470	46,920	34,760	199,600	46,980
22.	74,500	303,800	157,100	192,800	102,700	60,230	50,160	39,310	52,600	33,070	192,900	45,680
23.	66,500	299,500	160,900	190,000	98,720	62,860	46,890	40,820	59,000	31,790	173,800	43,460
24.	60,300	289,300	159,300	188,700	94,040	66,340	44,660	41,940	56,810	33,370	142,700	88,780
25.	64,230	294,600	156,800	186,500	89,660	61,140	46,040	40,220	49,630	39,170	106,300	171,400
26.	73,740	329,800	156,000	180,700	89,390	63,070	46,730	39,610	51,480	39,330	77,030	216,700
27.	104,800	368,100	159,200	196,200	92,900	85,380	45,750	42,800	49,600	38,800	64,230	237,500
28.	192,500	403,500	167,000	248,300	88,270	128,600	44,740	48,710	48,700	38,270	67,920	245,300
29.	234,100		174,900	319,000	79,270	151,400	42,560	44,970	61,520	38,000	68,800	252,800
30.	249,100		182,600	359,600	77,420	131,200	40,240	55,440	70,230	38,000	68,850	253,800
31.	264,500		189,600		74,850		40,050	53,710		38,000		258,300
SÚČ.	3360,910	6383,600	6652,610	5517,100	4658,520	2508,420	2155,690	1330,260	1842,620	1381,610	2565,700	2814,550
average	108,416	227,986	214,600	183,903	150,275	83,614	69,538	42,912	61,421	44,568	85,523	90,792
Š.O.	9,449	19,869	18,703	16,027	13,097	7,287	6,060	3,740	5,353	3,884	7,454	7,913
ODT.	290,383	551,543	574,786	476,677	402,496	216,727	186,252	114,934	159,202	119,371	221,676	243,177

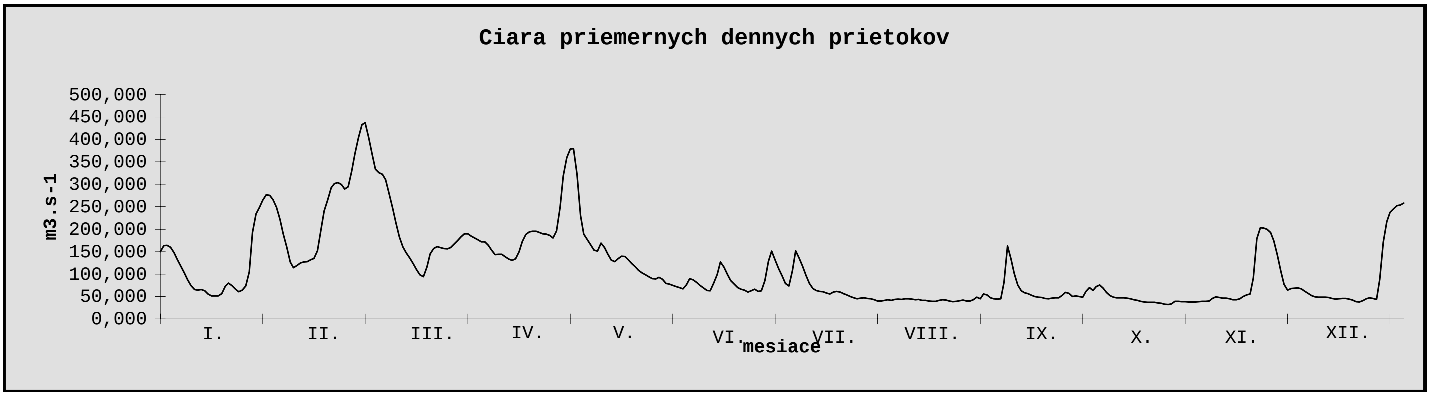
year sum 41171,590 year max/ **443,000** DEŇ/MES/HOD: 01/03/20 ROČNÝ ŠP. ODTOK: **9,831** l.s^{-1}.km^{-2}
year mean 112,799 year min. **31,790** DEŇ/MESIAC : 23/10 ROČNÝ ODTOK : **3557,225** mil.m^3

M - denné prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1995	253,800	158,900	75,990	47,570	41,080	38,000	33,070
% Qmda	86,1	120,9	124,2	149,9	213,2	279,4	355,9

Mesačné prietoky

Qm	108,416	227,986	214,600	183,903	150,275	83,614	69,538	42,912	61,421	44,568	85,523	90,792
% Qma	105,9	161,9	92,8	86,4	148,2	90,5	80,7	72,3	125,7	64,7	89,4	74,3



discharge

ROČNĖ SPRACOVANIE PRIETOKOV [$m^3.s^{-1}$]

station : Streda nad Bodrogom year **ROK : 1996**

river : Bodrog **PLOCHA POVODIA : 11474** km^2

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	239,400	55,680	34,010	95,230	125,900	101,100	50,850	73,120	36,500	116,700	141,200	82,000
2.	192,200	55,020	32,830	82,770	143,100	92,540	54,260	84,730	37,160	98,210	137,900	86,230
3.	151,900	54,360	32,640	91,620	139,300	83,270	55,090	73,640	39,150	86,940	126,400	99,360
4.	139,400	53,700	34,050	114,400	122,100	64,500	60,960	71,890	37,540	78,830	114,600	107,200
5.	122,000	53,070	36,850	145,700	104,400	53,140	61,400	104,500	34,890	71,070	104,200	110,700
6.	103,500	52,690	39,890	173,800	94,860	50,330	53,200	126,200	38,090	64,700	93,240	109,700
7.	94,490	52,350	42,930	184,700	91,710	49,010	48,000	112,300	63,190	59,070	85,320	104,500
8.	91,260	51,990	45,230	181,100	119,400	49,700	47,780	96,240	98,130	53,450	80,180	92,930
9.	90,860	51,360	44,920	174,600	142,600	48,270	51,580	81,080	94,460	47,840	75,040	80,250
10.	90,730	50,500	44,290	165,100	131,500	47,720	50,070	64,580	81,950	42,290	70,340	70,390
11.	90,600	49,600	43,690	150,300	120,400	49,510	48,180	49,260	70,550	44,690	68,080	67,830
12.	96,130	50,720	43,300	134,400	124,800	48,080	45,330	46,080	53,960	50,380	66,210	66,030
13.	114,600	50,830	43,030	119,300	122,600	46,040	41,420	55,360	56,510	49,760	64,330	64,220
14.	128,200	45,960	45,170	111,800	130,500	47,390	38,050	68,270	68,140	48,720	62,450	81,400
15.	117,300	41,060	52,630	105,500	158,900	49,510	37,600	62,330	83,940	47,670	60,580	138,500
16.	102,500	38,590	61,920	99,470	152,500	47,640	37,600	55,740	95,470	46,630	59,220	160,400
17.	87,720	37,400	77,250	104,800	142,300	46,430	39,420	59,850	110,100	45,590	58,420	154,900
18.	76,520	37,150	94,830	132,100	123,000	44,450	42,870	72,820	139,100	48,520	58,000	146,100
19.	69,810	38,170	110,800	136,700	103,600	43,840	41,890	64,490	134,600	73,420	58,810	135,400
20.	65,430	39,790	123,800	133,100	89,840	44,650	39,020	55,320	120,200	143,200	59,000	127,100
21.	61,290	42,810	121,800	126,900	82,400	47,790	40,230	49,210	100,000	172,300	64,010	125,300
22.	57,160	45,360	115,700	120,500	92,670	49,940	39,480	47,060	82,890	165,900	106,500	125,100
23.	57,060	41,720	109,600	114,200	108,200	47,970	41,510	45,650	75,290	155,600	141,500	124,300
24.	59,600	39,410	103,500	107,900	112,800	48,000	41,600	45,080	89,790	142,500	136,500	117,300
25.	58,130	36,830	104,700	101,500	105,400	45,010	41,600	44,600	135,700	122,900	129,000	107,100
26.	56,500	35,700	121,900	95,220	94,230	43,940	43,770	43,070	156,600	103,400	119,800	96,840
27.	54,870	35,390	124,400	88,900	83,110	42,150	50,750	41,000	163,000	90,370	110,100	86,610
28.	53,880	35,070	130,700	82,570	73,630	43,930	53,230	41,000	164,800	82,070	102,100	77,810
29.	60,120	34,750	133,500	76,310	85,790	43,620	51,260	41,000	153,800	79,250	93,480	72,300
30.	60,780		120,000	92,550	122,900	44,110	53,000	41,000	143,000	94,180	86,980	68,180
31.	57,550		106,800		112,800		56,360	39,420		132,000		64,680
SÚČ.	2901,490	1307,030	2376,660	3643,040	3557,240	1563,580	1457,360	1955,890	2758,500	2658,150	2733,490	3150,660
average	93,596	45,070	76,666	121,435	114,750	52,119	47,012	63,093	91,950	85,747	91,116	101,634
Š.O.	8,157	3,928	6,682	10,583	10,001	4,542	4,097	5,499	8,014	7,473	7,941	8,858
ODT.	250,689	112,927	205,343	314,759	307,346	135,093	125,916	168,989	238,334	229,664	236,174	272,217

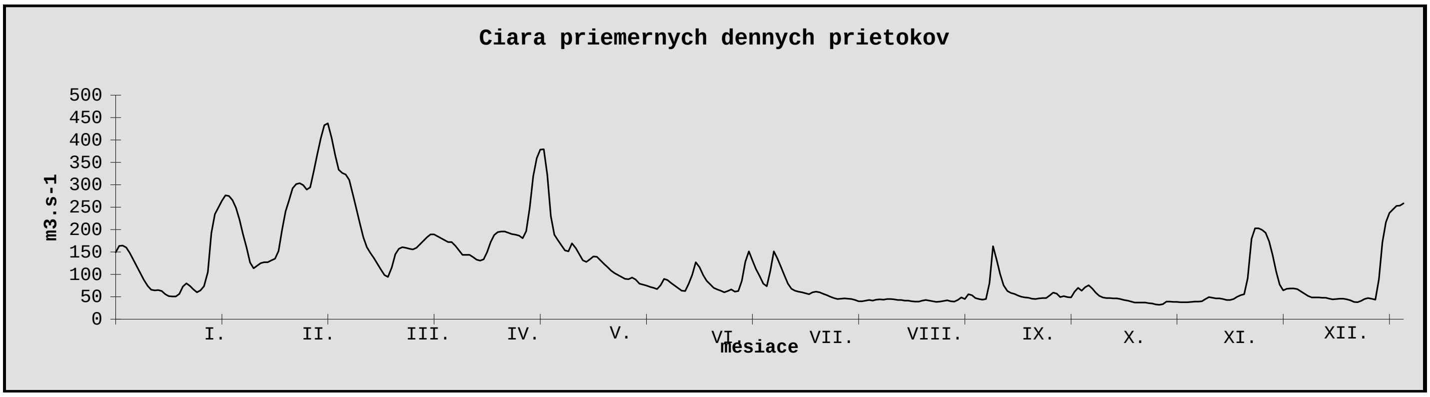
year sum	30063,090	year max.	**262,000**	DEŇ/MES/HOD:	01/01/ 1	ROČNÝ ŠP. ODTOK:	**7,159**	$l.s^{-1}.km^{-2}$
yar mean	82,140	year min.	**32,640**	DEŇ/MESIAC :	03/03	ROČNÝ ODTOK :	**2597,451**	$mil.m^3$

M - denné prietoky (Qmd)

DNI	**30**	**90**	**180**	**270**	**330**	**355**	**364**
Qmd 1996	141,200	110,700	73,640	49,510	41,420	36,850	34,010
% Qmda	47,9	84,2	120,3	156,0	215,0	271,0	366,0

Mesačné prietoky

Qm	93,596	45,070	76,666	121,435	114,750	52,119	47,012	63,093	91,950	85,747	91,116	101,634
% Qma	91,4	32,0	33,2	57,0	113,1	56,4	54,6	106,3	188,2	124,5	95,3	83,1



Annex 4-7

Maximal Mean Daily Discharges in Month

Maximal mean daily discharges in month in m^3.s^{-1}

Water gauginig station: 7620 Vyškovce nad Ipľom
River: : Ipeľ
Catchment area: 4687,2 km^2

Year	**Month**											
day	1	2	3	4	5	6	7	8	9	10	11	12
1994	76,8	13,57	10,48	100,7	30,37	15,53	2,373	8,524	12,54	43,41	37,64	7,921
	6	12	18	19	26	8	3	27	4	30	13	15
1995	28,96	36,44	53,23	94,41	67,37	129,2	14,24	7,105	11,32	5,272	5,31	12,71
	28	27	9	27	21	17	6	31	23	4	30	28
1996	32,02	5,877	74,38	202,1	67,71	18,39	7,498	13,15	15,11	9,287	27,31	13,66
	12	3	28	6	14	1	4	31	2	6	22	17

Water gauginig station: 7820 Lenartovce
River: Slaná
Catchment area: 1829,65 km^2

Year	**Month**											
day	1	2	3	4	5	6	7	8	9	10	11	12
1994	47,71	12,39	19,97	120,3	47,46	24,08	7,968	8,601	19,1976	31,08	16,68	6,807
	13	11	17	14	26	7	1	27	2	30	1	15
1995	17,196	18,07	44,72	100	47,7	161,6	27,63	22,33	26,02	7,669	5,997	7,422
	28	17	7	28	21	13	4	29	5	8	7	7
1996	5,552	5,706	27,75	104,1	57,98	21,53	11,82	15,93	33,03	14,08	36,47	14,73
	1	24	27	4	11	1	7	31	1	1	22	1

Water gauginig station: 9670 Streda mad Bodrogom
River: Bodrog
Catchment area: 11474,25 km^2

Year	**Month**											
day	1	2	3	4	5	6	7	8	9	10	11	12
1994	175	163	267,9	394	182,6	186	51,75	47,97	69,46	203	160,9	173,4
	10	13	6	11	31	8	1	28	23	31	1	16
1995	264,5	403,5	436,9	359,6	379,2	151,4	151,7	55,44	162,9	75,86	203	258,3
	31	28	2	30	2	29	6	30	6	3	19	31
1996	239,4	55,68	133,5	184,7	158,9	101,1	61,4	126,2	164,8	172,3	141,5	160,4
	1	1	29	7	15	1	5	6	28	21	23	16

Water gauginig station: 7335 Kamenín
River: Hron
Catchment area: 5149,8 km^2

Year	**Month**											
day	1	2	3	4	5	6	7	8	9	10	11	12
1994	181,7	59,41	105,3	449,2	205,1	81,7	26,66	111,9	102,8	202	107,3	62,42
	12	11	27	15	26	1	20	27	4	30	1	15
1995	110,9	180,3	211,6	306,5	267,3	251,4	59,26	57,16	55,63	27,86	29,23	59,52
	28	17	6	28	21	13	4	30	6	2	19	26
1996	55,9	19,97	119,5	459,1	228,1	82,42	70,24	76,9	108,4	41,61	206,7	48,74
	13	5	28	4	3	1	4	30	1	5	22	1

Water gauginig station: 8930 Ždaňa
River: Hornád
Catchment area: 4232,2 km^2

Year day	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
1994	42,73	29,42	27,36	245,9	64	85,74	19,11	18,34	17,56	47,52	25,1	18,21
	14	11	14	14	26	7	1	26	2	30	1	16
1995	14,67	48,45	80,79	127,3	80,56	160,2	89,73	72,79	105,5	17,61	24,55	14,71
	1	18	8	28	1	13	5	30	6	1	18	25
1996	20,52	15,58	52,25	98,71	110,9	41,38	36,58	49,6	157,7	74,77	44,28	33,62
	14	3	26	10	3	13	1	17	2	20	22	15

Water gauginig station: 5140 Bratislava
River: Dunaj
Catchment area: 131329,1 km^2

Year day	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
1994	2844	2120	3365	5780	3277	3017	2226	2059	1701	1267	2648	2865
	27	1	27	19	28	7	8	27	5	6	21	30
1995	3798	3139	2822	4323	3501	5392	3525	4495	5700	2049	2802	3253
	27	1	28	3	15	28	1	31	3	3	19	27
1996	1878	1410	2763	2884	5561	2920	4293	2369	3795	6212	2750	1949
	1	20	28	11	15	24	13	30	15	23	17	5

Water gauginig station: 9063 Hosťovce
River: Bodva
Catchment area: 0,1 km^2

Year day	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
1994	0,217	0,226	0,199	0,554	0,387	0,242	0,196	0,344	0,407	0,145	0,239	0,159
	6	14	1	14	26	6	20	27	22	29	13	5
1995	0,249	0,439	0,645	0,886	0,631	0,904	0,29	0,451	0,383	0,158	0,077	0,129
	31	28	4	28	1	13	5	29	5	10	2	26
1996	0,146	0,143	0,276	0,473	0,388	0,173	0,167	0,2	0,263	0,182	0,23	0,222
	13	22	17	6	14	24	4	5	24	31	21	16

Annex 4-8

Minimal Mean Daily Discharges in Month

Minimal mean daily discharges in month in m^3.s^{-1}

Water gauginig station: 7620 Vyškovce nad Ipľom
River: : Ipeľ
Catchment area: 4687,2 km^2

Year	***Month***											
day	1	2	3	4	5	6	7	8	9	10	11	12
1994	13,45	7,896	7,465	7,712	7,042	2,276	0,742	0,72	1,937	3,711	6,964	4,623
	31	16	31	1	19	30	31	1	13	3	30	3
1995	4,123	10,77	17,99	5,145	12,9	16,74	2,453	2,1	3,562	3,309	3,449	4,714
	21	7	27	25	12	30	30	20	15	24	23	18
1996	5,126	4,42	5,13	13,59	13,79	3,932	2,257	1,827	4,11	4,465	4,384	6,392
	26	25	6	30	27	19	31	28	12	17	18	28

Water gauginig station: 7820 Lenartovce
River: Slaná
Catchment area: 1829,65 km^2

Year	***Month***											
day	1	2	3	4	5	6	7	8	9	10	11	12
1994	9,733	7,748	9,671	10,65	10,76	6,582	2,433	2,205	2,406	4,174	6,996	3,64
	30	24	2	1	15	27	31	16	13	19	27	25
1995	3,56	3,838	11,02	8,062	16,53	16,2	4,828	3,699	5,637	3,457	3,474	2,85
	16	6	25	18	31	30	31	25	30	30	23	30
1996	2,889	3,004	4,068	17,3	21,53	7,818	4,201	3,509	8,293	5,796	4,823	4,276
	19	1	7	2	27	16	29	3	21	24	16	24

Water gauginig station: 9670 Streda mad Bodrogom
River: Bodrog
Catchment area: 11474,25 km^2

Year	***Month***											
day	1	2	3	4	5	6	7	8	9	10	11	12
1994	72,24	69,43	123,6	111,4	51,78	52,9	27,48	34,96	31,6	36,94	40,01	33,46
	31	3	1	30	20	27	24	1	12	2	15	4
1995	51	113,9	94,29	130,5	74,85	60,23	40,05	38,47	43,87	31,79	38,83	37,89
	17	9	19	14	31	22	31	21	3	23	1	18
1996	53,88	34,75	32,64	76,31	73,63	42,15	37,6	39,42	34,89	42,29	58	64,22
	28	29	3	29	28	27	15	31	5	10	18	13

Water gauginig station: 7335 Kamenín
River: Hron
Catchment area: 5149,8 km^2

Year	***Month***											
day	1	2	3	4	5	6	7	8	9	10	11	12
1994	45,68	30,73	35,7	74,74	52,35	20,26	12,13	11,26	15,93	21,87	40,2	28,95
	31	23	1	1	15	29	27	17	13	24	30	11
1995	19,34	39,23	56,23	48,71	59,02	41,5	21,92	16,26	23,59	18,33	13,35	18,89
	16	6	18	17	13	30	31	22	19	28	24	19
1996	12,07	14,18	15,89	58,93	55,38	29,51	23,03	18,11	36,34	27,36	24,31	14,01
	26	28	5	2	27	19	29	27	22	28	17	29

Water gauginig station: 8930 Ždaňa
River: Hornád
Catchment area: 4232,2 km^2

Year	**Month**											
day	1	2	3	4	5	6	7	8	9	10	11	12
day												
1994	11,16	11,57	15,04	14,58	17,21	15,94	10,78	9,2	6,869	7,86	9,857	9,229
	4	3	9	1	19	26	13	25	26	25	11	21
1995	7,87	9,547	20,19	18,94	26,79	23,09	12,74	9,747	13,31	10,45	9,85	10,82
	19	15	24	4	11	2	27	20	28	6	14	30
1996	10,77	9,515	8,649	23,69	24,89	15,64	9,787	9,791	25,66	19,71	14,48	15,43
	5	23	11	2	27	9	24	13	12	16	16	23

Water gauginig station: 5140 Bratislava
River: Dunaj
Catchment area: 131329,1 km^2

Year	**Month**											
day	1	2	3	4	5	6	7	8	9	10	11	12
1994	1350	1196	1462	1752	2150	1906	1322	1112	1098	815,2	807,4	1046
	24	21	1	11	16	30	31	8	26	24	7	28
1995	1080	1969	1563	2420	2321	3073	1862	1362	1828	1041	1171	1072
	23	14	18	1	24	20	31	14	27	31	2	18
1996	999,3	930,3	825,3	1853	1954	1505	1500	1423	1792	1555	1703	1127
	30	13	12	3	7	20	29	23	2	15	26	31

Water gauginig station: 9063 Hosťovce
River: Bodva
Catchment area: 0,1 km^2

Year	**Month**											
day	1	2	3	4	5	6	7	8	9	10	11	12
1994	0,113	0,121	0,145	0,179	0,226	0,125	0,06	0,024	0,038	0,001	0,064	0,11
	4	18	22	1	13	18	17	25	19	28	8	1
1995	0,1	0,101	0,231	0,148	0,157	0,137	0,05	0,000	0,11	0,07	0,03	0,066
	22	2	27	23	27	9	30	24	30	31	21	2
1996	0,071	0,086	0,077	0,076	0,011	0	0,079	0,066	0,101	0,054	0,116	0,122
	9	12	31	1	31	1	28	13	30	16	9	13

Annex 4-9

Data to Flow Duration Curves

Čiary prekročenia za jednotlivé roky v požadovaných vodomerných staniciach

Data to flow duration curves

Water gauginig station: 5140 Bratislava
River: Dunaj
Catchment area: 131329,1 km^2

Year	1	2	5	10	20	50	70	80	90	92	95	97	99
1994	4782	4392	3083	2844	2413	1701	1362	1237	1065	1046	955	911	829
1995	4968	4733	4100	3566	3073	2198	1668	1507	1283	1237	1171	1132	1089
1996	5059	4293	3537	2825	2482	1949	1603	1447	1049	1010	978	933	906

Water gauginig station: 7335 Kamenín
River: Hron
Catchment area: 5149,8 km^2

Year	1	2	5	10	20	50	70	80	90	92	95	97	99
1994	312,600	244,300	156,200	109,900	83,760	46,030	30,980	24,420	18,290	15,930	13,820	12,710	11,890
1995	235,500	228,100	170,000	112,900	83,620	37,540	24,100	20,950	19,050	18,780	18,330	17,340	16,780
1996	294,600	211,500	144,600	107,400	72,570	35,840	27,360	23,450	18,110	17,480	16,270	15,890	14,180

Water gauginig station: 7620 Vyškovce nad Ipľom
River: : Ipeľ
Catchment area: 4687,2 km^2

Year	1	2	5	10	20	50	70	80	90	92	95	97	99
1994	89,110	83,580	60,310	33,390	16,740	8,240	5,125	3,581	1,552	1,429	1,238	0,902	0,742
1995	110,100	93,020	53,230	38,500	27,020	6,126	4,537	3,937	3,534	3,313	2,612	2,453	2,188
1996	189,200	112,800	56,910	38,350	22,010	6,340	5,018	4,555	2,856	2,580	2,322	2,076	1,960

Water gauginig station: 7820 Lenartovce
River: Slaná
Catchment area: 1829,65 km^2

Year	1	2	5	10	20	50	70	80	90	92	95	97	99
1994	101,900	79,600	39,690	24,710	18,460	9,652	5,514	4,421	3,350	3,076	2,693	2,477	2,406
1995	100,000	67,430	41,980	32,070	19,930	7,494	4,996	4,482	3,958	3,896	3,751	3,700	3,474
1996	70,680	57,980	44,120	29,940	20,910	8,664	5,699	4,823	3,783	3,708	3,509	3,311	3,129

Water gauginig station: 9063 Hosťovce
River: Bodva
Catchment area: 0,1 km^2

Year	1	2	5	10	20	50	70	80	90	92	95	97	99
1994	0,510	0,448	0,388	0,303	0,226	0,152	0,127	0,107	0,053	0,042	0,032	0,027	0,012
1995	0,780	0,662	0,485	0,384	0,298	0,156	0,103	0,076	0,054	0,047	0,040	0,030	0,008
1996	0,440	0,385	0,316	0,261	0,182	0,130	0,099	0,087	0,077	0,074	0,069	0,057	0,032

Water gauginig station: 9670 Streda mad Bodrogom
River: Bodrog
Catchment area: 11474,25 km^2

Year	1	2	5	10	20	50	70	80	90	92	95	97	99
1994	376,900	339,400	242,800	180,500	155,600	69,850	46,470	41,870	39,250	38,750	34,960	32,310	28,470
1995	403,500	368,100	301,700	240,800	172,300	74,900	49,730	45,230	41,100	40,150	39,000	38,000	35,930
1996	181,100	172,300	152,500	136,500	120,000	73,120	51,360	46,080	41,510	39,890	38,050	36,850	34,750

Water gauginig station: 8930 Ždaňa
River: Hornád
Catchment area: 4232,2 km^2

Year	1	2	5	10	20	50	70	80	90	92	95	97	99
1994	146,600	117,200	67,060	43,540	26,000	14,790	11,670	10,960	9,906	9,556	9,270	8,745	7,860
1995	107,500	96,860	72,790	48,450	37,140	18,360	12,540	11,600	10,830	10,630	10,290	9,984	9,792
1996	105,200	96,240	78,910	69,080	48,980	23,400	16,400	13,740	11,600	11,360	10,830	10,540	9,787

Annex 4-10

Sediment Discharges

sediment discharge

ROČNÉ SPRACOVANIE MÚTNOSTI PLAVENÍN **[mg.l-1]**

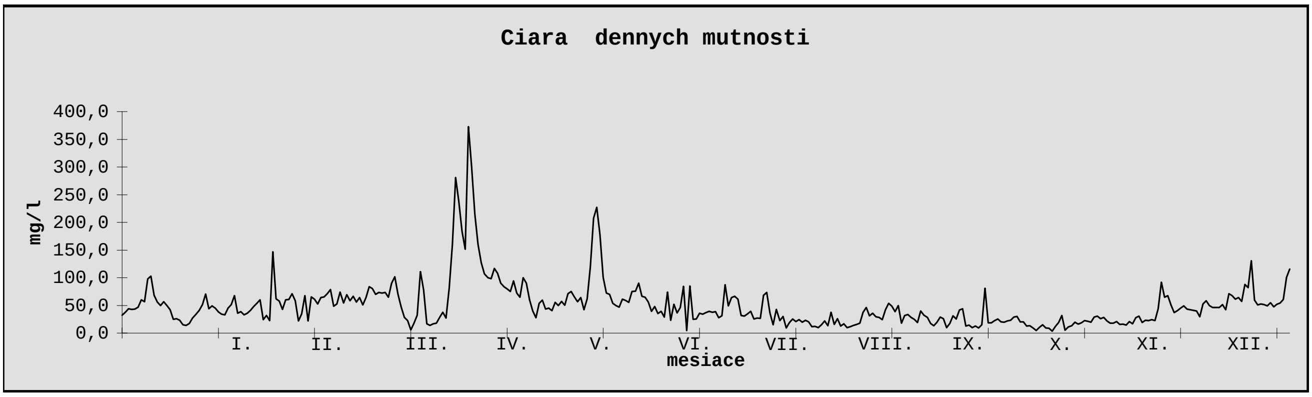
station : Bratislava **year** **ROK : 1994**
river : Danube **PLOCHA POVODIA : 131329,1 km2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	32,1	33,9	65,6	6,0	80,0	72,5	34,0	19,8	18,2	25,3	30,4	40,9
2.	37,8	33,0	61,3	17,8	75,0	69,9	37,1	23,0	31,8	20,1	26,0	40,0
3.	43,8	45,3	52,5	32,2	94,0	53,7	39,2	20,0	33,6	19,6	28,4	29,6
4.	42,8	51,2	64,3	111,1	72,0	50,0	37,4	11,8	28,2	21,7	22,1	52,4
5.	43,5	67,7	65,5	78,1	65,0	46,6	38,5	12,3	24,7	23,3	18,1	58,1
6.	46,6	35,9	71,1	16,6	100,0	61,6	27,8	10,0	19,2	28,9	17,9	49,6
7.	60,3	38,7	78,5	13,7	90,0	58,7	31,2	14,9	39,9	30,1	20,7	46,2
8.	56,7	32,7	48,8	16,9	60,0	55,3	87,1	21,7	32,3	20,3	15,4	46,0
9.	97,8	36,1	52,6	17,7	40,0	74,9	49,4	13,1	28,4	20,3	16,4	46,4
10.	102,9	41,0	73,8	28,1	27,6	75,9	64,1	37,7	17,6	12,6	14,7	51,6
11.	68,1	48,1	54,6	37,8	53,7	90,3	66,6	15,8	13,6	13,4	21,0	42,0
12.	56,1	53,5	69,5	27,2	59,3	66,5	61,2	26,2	19,7	9,3	16,8	71,1
13.	49,6	60,0	58,5	81,5	43,4	64,5	31,7	12,5	29,1	4,7	27,8	67,8
14.	56,5	24,5	66,8	160,6	45,4	56,0	30,7	16,7	26,0	10,4	30,6	61,1
15.	50,0	31,8	55,8	280,8	40,4	39,2	34,7	9,8	10,1	15,2	19,3	64,2
16.	41,9	22,4	64,1	237,8	55,7	47,8	39,3	11,6	17,5	9,3	23,1	57,1
17.	24,8	146,6	51,2	184,0	49,4	35,5	25,3	13,9	31,2	9,0	22,3	87,9
18.	26,1	61,7	64,4	151,6	57,3	39,5	27,1	15,4	25,4	3,7	24,3	82,0
19.	23,1	57,8	84,0	373,1	50,3	28,8	26,6	18,2	41,6	12,0	22,5	130,4
20.	15,2	42,7	80,6	300,0	71,1	74,1	68,4	37,3	44,0	19,1	44,1	59,6
21.	13,6	60,2	70,0	215,0	75,4	23,0	73,2	46,5	12,8	32,0	91,8	51,0
22.	17,2	60,6	73,3	160,0	65,2	52,1	36,3	31,4	14,6	5,1	64,5	52,4
23.	27,4	71,2	72,1	127,0	56,9	36,4	14,8	35,8	9,9	11,2	67,7	51,3
24.	34,3	58,5	73,1	107,0	64,4	46,1	42,7	29,5	12,6	13,2	50,8	49,1
25.	41,1	21,8	64,9	100,0	42,5	84,2	22,6	28,6	9,4	19,6	36,7	54,8
26.	51,2	34,8	90,1	98,0	62,0	4,8	29,9	24,2	15,3	16,3	40,7	47,2
27.	70,3	67,7	101,8	117,0	120,1	85,1	9,0	42,0	81,1	18,3	45,0	52,2
28.	43,9	22,0	70,0	108,0	207,4	25,0	18,8	53,5	18,4	22,7	49,0	54,3
29.	48,9		46,6	90,0	227,1	25,3	25,6	48,7	18,5	21,5	43,6	61,0
30.	45,0		28,5	84,0	177,4	36,0	21,0	38,5	22,6	19,5	42,4	100,3
31.	38,1		22,7		100,9		24,0	49,4		28,7		115,6

sum	1406,4	1361,2	1996,3	3378,6	2428,7	1579,2	1175,0	789,6	746,8	536,6	993,9	1873,1
mean	45,4	48,6	64,4	112,6	78,3	52,6	37,9	25,5	24,9	17,3	33,1	60,4
MIN.	13,6	21,8	22,7	6,0	27,6	4,8	9,0	9,8	9,4	3,7	14,7	29,6
MAX.	102,9	146,6	101,8	373,1	227,1	90,3	87,1	53,5	81,1	32,0	91,8	130,4

year sum 18265,3 year max. **373,1** DEŇ/MESIAC: 19/04
year mean 50,0 year min. **3,7** DEŇ/MESIAC : 18/10

MSD	kg/s	118,3
YRSD	t	3731729
SYRSD	t/km2	28,4



ROČNÉ SPRACOVANIE MÚTNOSTI PLAVENÍN [mg.l^{-1}]

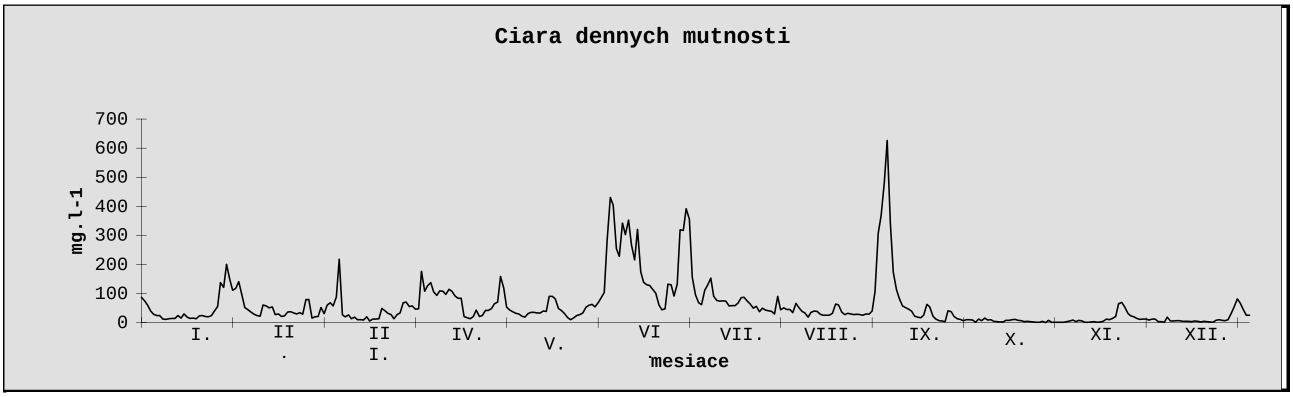
sediment discharge

station : 5140 BRATISLAVA **year** **ROK : 1995**
river : DUNAJ **PLOCHA POVODIA : 131329,1 km^2**

month day	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1.	86,7	117,5	51,3	46,0	53,3	85,0	156,7	45,1	367,8	9,0	3,2	3,5
2.	74,6	140,9	31,2	47,6	42,9	104,0	95,6	45,3	481,2	1,5	5,0	3,5
3.	60,2	95,0	59,7	176,4	37,1	283,4	68,0	34,2	625,9	12,3	8,8	1,6
4.	39,3	51,3	67,7	108,2	32,4	430,5	61,4	66,1	341,1	6,9	3,3	19,1
5.	28,1	44,4	57,2	126,1	29,2	404,0	110,8	51,9	173,8	15,5	8,1	5,0
6.	23,9	36,7	88,2	138,0	22,5	254,1	128,4	39,0	113,7	8,6	5,0	5,2
7.	24,3	29,1	217,9	105,5	18,8	228,3	153,5	32,6	82,0	10,3	0,8	6,1
8.	11,9	24,6	26,6	93,5	30,7	342,3	90,3	18,4	57,4	4,8	1,4	6,9
9.	10,6	22,6	19,7	109,2	34,9	302,3	75,5	35,3	51,6	3,7	2,0	4,8
10.	13,3	61,0	25,9	108,3	35,3	351,8	73,4	39,4	46,6	2,2	3,6	4,4
11.	14,4	57,2	12,8	96,6	33,0	267,1	74,4	38,1	39,5	2,4	1,6	4,2
12.	14,7	50,4	18,8	114,4	33,1	215,2	73,6	28,9	22,1	7,7	2,2	3,0
13.	24,2	54,5	9,6	107,6	39,5	320,3	57,1	25,4	18,8	7,6	4,1	5,1
14.	15,1	27,1	10,1	90,9	38,1	175,0	58,2	25,6	16,0	10,1	12,4	4,9
15.	30,2	29,3	9,2	84,0	90,2	138,4	58,1	24,9	25,2	11,1	10,0	2,6
16.	18,5	21,4	19,9	83,7	90,7	129,8	66,7	32,1	62,2	8,0	14,6	4,1
17.	14,4	22,7	5,6	20,4	81,7	127,9	85,8	63,8	53,8	6,3	20,6	3,6
18.	15,0	36,8	12,3	16,5	48,4	113,3	87,0	60,0	21,7	3,5	64,4	2,2
19.	13,2	37,2	12,5	13,0	41,2	101,1	73,7	36,7	12,5	4,0	69,3	1,0
20.	22,6	33,5	12,8	20,6	31,2	60,1	64,3	27,3	7,0	3,4	53,9	8,2
21.	24,0	30,0	48,1	42,7	16,1	44,2	49,0	31,7	5,5	2,5	31,5	10,0
22.	21,3	33,6	40,4	21,1	10,1	46,8	56,0	30,0	3,6	0,7	23,4	7,5
23.	19,8	28,6	31,9	24,0	16,3	132,4	37,9	27,0	40,7	0,7	19,3	6,5
24.	23,7	79,2	27,6	42,3	24,1	130,3	49,4	28,4	37,9	4,6	14,5	10,4
25.	39,6	79,2	13,3	42,2	27,5	91,6	42,5	28,0	20,4	0,4	11,5	31,5
26.	54,5	15,1	27,8	48,6	32,7	131,8	40,9	25,7	13,0	7,8	11,9	54,1
27.	137,3	20,1	33,4	65,4	53,3	318,9	38,6	29,7	10,5	1,0	12,3	81,9
28.	120,7	21,1	68,0	70,1	59,5	316,9	30,2	29,1	6,5	1,0	8,9	67,3
29.	200,7	39,8	70,4	158,7	62,3	391,5	90,7	40,0	10,0	1,0	12,3	44,5
30.	148,9		55,3	119,3	53,4	355,9	44,3	107,0	10,4	1,0	12,2	25,8
31.	111,0		56,9		68,6		50,7	306,6		1,0		25,0
sum	1456,7	1340,0	1242,1	2340,9	1288,1	6394,2	2242,7	1453,3	2778,4	160,6	452,1	463,5
mean	47,0	46,2	40,1	78,0	41,6	213,1	72,3	46,9	92,6	5,2	15,1	15,0
MAX.	200,7	140,9	217,9	176,4	90,7	430,5	153,5	306,6	625,9	15,5	69,3	81,9
MIN.	10,6	15,1	5,6	13,0	10,1	44,2	30,2	18,4	3,6	0,4	0,8	1,0

year sum	21612,6	year max	**625,9**	DEŇ/MESIAC	:	03 / IX.
year average	59,2	year min	**0,4**	DEŇ/MESIAC	:	25 / X.

MSD	kg/s	:	196,046
YRSD	**t**	:	6182496
SYRSD	t/km2	:	47,1



ROČNÉ SPRACOVANIE PLAVENÍN [mg. l $^{-1}$]

sediment **disch.**

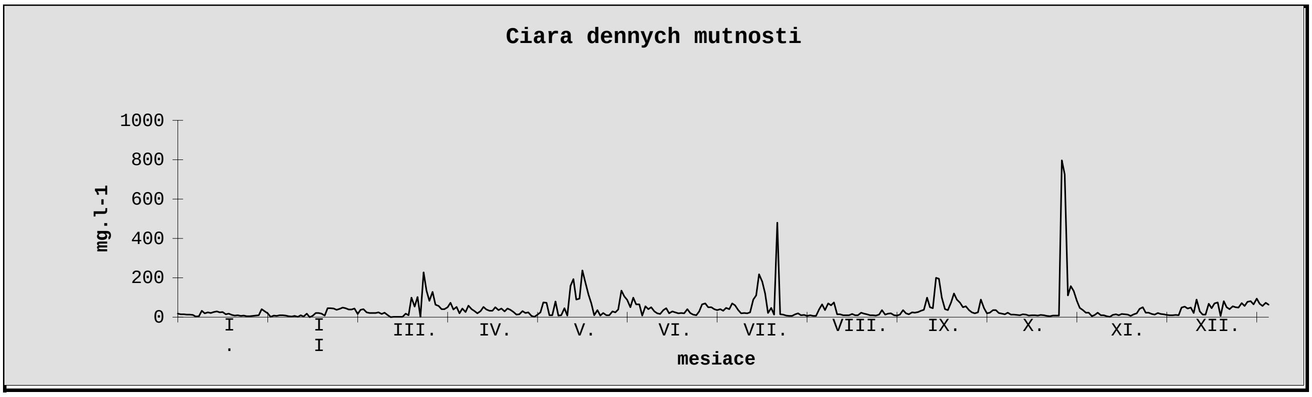
station **5140 BRATISLAVA** **year** **ROK :** **1996**

river **DUNAJ** **PLOCHA POVODIA :** **131329** **km^2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	17,9	1,4	16,6	73,4	25,0	100,0	32,5	6,0	15,0	20,5	5,0	48,0
2.	14,7	8,9	37,3	39,6	75,0	65,0	47,5	40,0	25,0	18,5	11,5	53,0
3.	15,2	7,3	40,0	51,9	73,0	65,5	40,0	65,0	22,5	14,0	22,0	44,5
4.	12,8	10,4	23,6	19,7	10,0	8,0	70,0	35,0	25,5	23,0	10,5	49,0
5.	13,5	10,5	21,0	43,5	10,5	55,0	60,5	70,0	33,0	12,5	9,5	20,5
6.	11,4	7,5	20,5	25,5	80,0	40,5	35,0	60,0	37,5	13,5	5,0	89,0
7.	3,7	4,7	20,6	59,3	8,0	50,0	20,0	75,5	100,0	11,0	1,9	30,0
8.	4,1	2,8	24,0	40,1	10,0	30,0	20,5	15,0	50,0	10,0	11,0	12,5
9.	32,9	6,1	16,1	30,9	45,0	20,0	19,0	15,0	45,0	15,0	15,0	12,5
10.	19,1	1,6	22,5	18,7	8,0	16,5	25,0	10,0	200,0	13,0	10,0	67,5
11.	23,6	9,1	11,6	30,9	160,0	35,5	90,0	10,5	195,0	7,5	16,5	46,0
12.	21,5	2,5	0,5	52,3	194,0	45,0	111,0	10,0	100,0	9,5	14,5	69,5
13.	26,0	17,4	1,0	38,5	90,0	20,0	217,5	16,0	40,0	10,0	12,5	74,0
14.	29,4	0,3	1,0	32,7	95,0	30,0	180,0	10,0	35,0	8,0	6,0	7,0
15.	25,0	5,8	1,1	32,9	237,5	25,0	120,5	10,0	75,0	11,0	14,0	81,5
16.	26,0	21,2	1,2	50,2	179,5	20,0	20,5	22,5	120,0	10,0	19,0	50,0
17.	15,1	20,4	17,2	35,3	115,0	20,5	46,5	18,0	90,0	6,0	41,5	40,0
18.	18,3	18,6	10,0	43,9	70,0	20,0	12,5	15,0	72,5	5,5	50,0	55,0
19.	11,3	8,6	99,3	28,8	10,5	40,0	480,1	10,0	50,5	7,5	22,5	50,0
20.	8,5	45,2	53,0	43,6	35,5	20,5	15,0	10,5	55,0	7,5	22,0	49,0
21.	9,5	45,5	101,8	37,2	8,0	12,5	13,0	8,0	35,0	8,0	16,5	71,5
22.	5,7	43,8	0,9	26,2	20,5	10,0	8,5	12,5	25,0	797,0	13,5	57,0
23.	7,9	37,3	228,4	13,4	10,0	30,0	6,5	35,0	20,0	725,0	21,0	78,0
24.	5,2	42,5	134,3	15,0	10,0	65,0	6,0	12,5	25,0	111,0	16,0	81,0
25.	5,2	48,2	83,5	30,7	30,0	70,0	15,0	17,5	90,0	158,5	14,5	65,0
26.	6,5	45,0	129,2	21,5	25,0	50,0	20,0	20,0	45,0	133,5	11,5	95,0
27.	7,4	39,2	63,7	23,9	38,5	50,0	10,5	10,5	20,0	82,5	9,5	68,0
28.	9,6	39,8	56,9	6,7	135,5	40,0	12,0	8,0	22,5	46,5	10,5	56,5
29.	41,4	43,7	40,5	1,3	105,0	35,0	6,0	12,5	35,0	36,5	11,5	72,5
30.	29,0	-	40,7	13,6	87,5	40,0	10,0	35,0	35,0	23,5	10,0	63,5
31.	19,3	-	50,2	-	50,0	-	6,0	20,0	-	23,5	-	64,0
sum	496,7	595,3	1368,2	981,2	2051,5	1129,5	1777,1	715,5	1739,0	2379,0	454,4	1720,5
mean	16,0	20,5	44,1	32,7	66,2	37,7	57,3	23,1	58,0	76,7	15,1	55,5
MIN.	3,7	0,3	0,5	1,3	8,0	8,0	6,0	6,0	15,0	5,5	1,9	7,0
MAX.	41,4	48,2	228,4	73,4	237,5	100,0	480,1	75,5	200,0	797,0	50,0	95,0

year sum	15407,9	year max.	**797,0**	DEŇ/MESIAC :	03 / IX.
year average	42,2	year min.	**0,3**	DEŇ/MESIAC :	25 / X.

MSD	kg/s	:	114,06867
YRSD	**t**	:	3607125,2
STRSD	t/km2	:	27,5



sediment discharges **ROČNÉ SPRACOVANIE MÚTNOSTI PLAVENÍN** **[mg.l-1]**

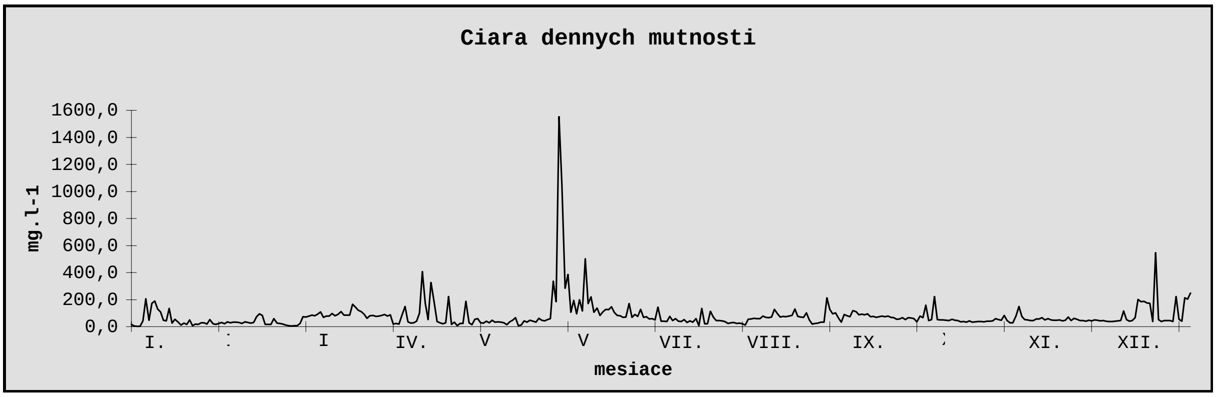
station : Z8h Zahorska Ves **year** **ROK : 1994**
river : Morava **PLOCHA POVODIA : 25521,3 km2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	16,1	29,8	74,0	18,0	29,0	107,5	143,9	53,4	65,0	158,1	80,0	46,2
2.	4,7	21,2	70,0	24,1	25,6	194,4	39,6	56,0	33,8	45,5	150,0	39,5
3.	1,6	35,3	79,0	20,1	40,0	94,7	40,7	60,6	90,1	51,2	75,0	36,7
4.	2,1	28,3	85,5	83,9	28,2	197,7	38,5	59,6	80,2	223,0	52,0	38,9
5.	42,2	32,8	80,5	149,4	47,2	114,9	75,6	58,0	74,0	53,2	50,0	41,2
6.	205,7	32,4	92,5	36,4	33,4	502,2	45,4	79,2	117,5	49,4	45,0	42,3
7.	46,9	31,1	109,1	24,9	34,4	169,9	58,1	68,6	111,8	49,8	44,3	45,0
8.	172,5	24,0	67,6	28,1	32,7	219,4	39,7	67,0	87,1	47,8	57,6	115,7
9.	190,0	34,5	78,0	39,5	27,9	105,3	37,0	70,2	91,4	44,8	56,8	52,9
10.	130,0	31,2	78,1	100,0	13,4	137,6	52,9	126,8	88,6	53,5	65,4	39,2
11.	110,0	26,5	98,2	406,9	36,3	83,6	31,6	96,3	94,1	46,2	50,3	43,8
12.	46,2	30,6	81,6	174,7	46,4	109,5	41,8	71,9	73,0	46,1	60,2	65,8
13.	43,7	72,6	89,3	51,1	66,9	127,8	34,3	75,7	74,7	36,7	50,2	201,7
14.	134,2	95,3	110,2	326,4	8,1	125,9	58,4	74,0	67,8	38,6	47,3	184,6
15.	25,6	82,5	84,9	194,2	10,8	147,4	6,3	79,2	74,2	33,2	47,1	186,9
16.	55,2	16,3	85,4	37,5	43,1	104,1	135,9	82,6	77,5	42,2	50,0	176,2
17.	36,6	17,0	85,5	28,2	32,3	83,1	21,5	130,5	72,3	33,7	42,7	172,0
18.	11,1	17,5	166,7	20,7	47,4	80,9	21,2	76,8	78,6	36,3	46,7	36,9
19.	25,1	58,3	145,1	29,5	40,9	69,6	114,3	70,6	67,5	36,9	70,8	547,9
20.	16,6	26,1	120,0	223,3	34,1	71,3	71,2	67,8	65,6	37,2	45,8	51,9
21.	48,7	24,6	111,2	17,7	62,1	169,8	45,7	100,9	54,1	34,6	60,5	37,6
22.	7,1	19,2	92,7	33,7	47,7	68,1	45,7	48,8	57,5	40,4	53,8	43,9
23.	19,1	12,3	62,3	8,1	41,8	88,8	41,6	19,9	66,2	39,1	45,9	45,2
24.	16,4	7,8	79,8	22,6	53,1	76,4	37,3	23,8	52,6	42,2	44,4	45,4
25.	29,0	5,1	83,0	24,4	58,6	127,2	23,8	27,2	66,9	60,2	41,0	36,9
26.	28,8	7,5	76,2	186,6	335,1	69,2	28,2	32,8	64,2	53,1	46,2	222,0
27.	19,1	8,1	77,1	29,0	185,4	73,8	31,2	34,2	58,9	46,4	43,6	55,5
28.	52,5	23,1	82,1	13,3	1552,9	55,7	24,9	212,9	35,9	84,0	49,3	41,3
29.	20,4		89,1	54,3	1051,9	59,2	26,8	127,9	79,1	45,3	47,9	213,4
30.	16,9		78,9	58,8	284,5	50,6	22,0	93,8	66,2	29,2	41,7	202,7
31.	22,7		87,0		386,0		11,6	101,3		29,0		248,7

sum	1596,8	850,8	2800,5	2465,3	4737,1	3685,6	1446,4	2348,4	2186,2	1666,8	1661,5	3357,9
mean	51,5	30,4	90,3	82,2	152,8	122,9	46,7	75,8	72,9	53,8	55,4	108,3
MIN.	1,6	5,1	62,3	8,1	8,1	50,6	6,3	19,9	33,8	29,0	41,0	36,7
MAX.	205,7	95,3	166,7	406,9	1552,9	502,2	135,9	212,9	117,5	223,0	150,0	547,9

year sum 28803,2 year max. **1552,9** DEŇ/MESIAC: 28/05
year mean 78,9 year min. **1,6** DEŇ/MESIAC : 03/01

MSD kg/s 8,2
YRSD t 258419,38
SYRSD t/km2 10,1



ROČNÉ SPRACOVANIE MÚTNOSTI PLAVENÍN [mg.l^{-1}]

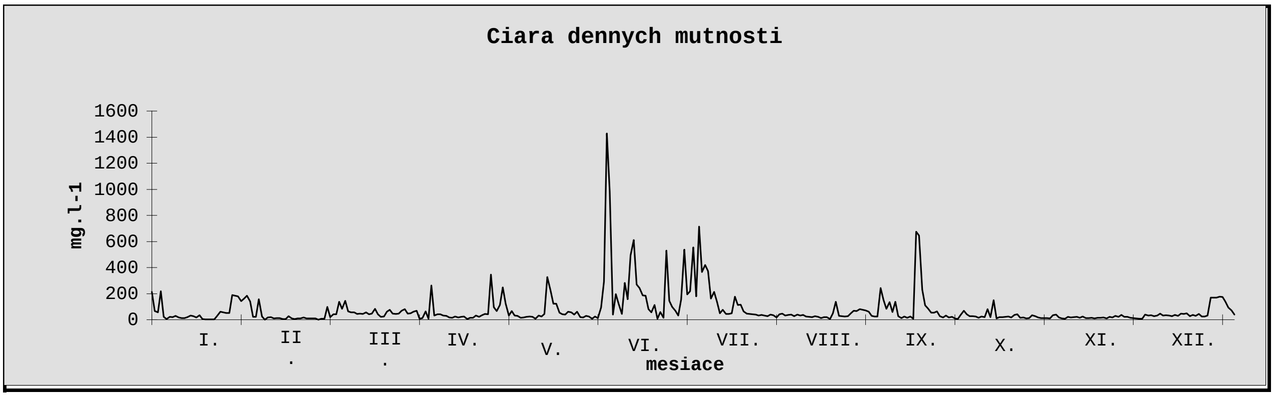
sediment discharge

station	**5085 ZÁHORSKÁ VES**	**year**	**ROK**	**:**	**1995**	
river	**MORAVA**		**PLOCHA POVODIA :**		**25521**	**km^2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	212,7	162,9	98,5	7,8	31,7	93,5	218,1	46,0	24,7	69,2	39,1	39,2
2.	67,3	185,1	18,6	11,2	65,3	292,0	555,6	31,0	25,6	41,1	16,0	31,5
3.	56,7	139,5	40,8	62,7	31,0	1429,1	179,7	36,7	243,8	27,9	9,1	33,9
4.	217,2	22,6	42,3	8,4	29,6	982,0	713,0	38,7	151,3	26,0	8,3	26,8
5.	22,5	21,8	138,6	261,9	13,7	39,8	364,8	27,6	83,9	23,6	21,3	31,0
6.	3,7	156,0	82,6	31,0	17,2	195,5	419,8	38,7	134,4	15,8	18,0	45,9
7.	23,0	24,2	145,0	41,1	22,5	120,3	373,8	31,0	59,6	24,1	20,4	31,1
8.	20,3	0,8	64,8	41,7	25,7	44,5	162,9	35,6	136,2	18,8	21,6	34,1
9.	28,6	18,3	56,3	30,9	20,9	281,3	212,5	25,1	27,2	80,4	15,2	32,7
10.	16,3	18,8	57,2	28,8	6,5	156,4	136,6	23,3	13,0	19,1	23,5	26,9
11.	11,8	10,9	44,6	18,4	31,0	494,2	48,6	19,2	24,2	148,6	12,4	36,3
12.	12,5	11,2	47,3	15,1	24,3	610,8	75,2	26,9	14,0	10,0	13,3	30,3
13.	20,5	13,3	45,1	24,8	43,1	270,5	44,4	21,7	24,3	19,4	13,6	47,4
14.	30,7	5,7	56,6	16,1	326,0	243,3	45,0	13,4	7,7	20,4	10,5	43,5
15.	26,4	4,0	41,4	21,3	225,4	186,5	50,3	20,3	674,6	21,7	15,3	48,6
16.	17,4	27,4	46,6	25,7	123,3	183,9	177,9	19,4	644,9	24,7	13,7	26,2
17.	34,3	9,6	82,8	4,6	121,9	82,2	111,9	5,7	230,0	16,0	16,3	37,7
18.	5,5	3,9	41,7	14,4	52,9	55,7	114,9	49,2	110,0	36,3	9,3	29,6
19.	2,2	10,9	22,9	15,3	41,2	113,8	64,5	138,1	86,1	42,1	22,2	43,7
20.	3,0	9,2	25,3	32,8	39,9	7,2	45,5	29,4	53,0	15,4	17,3	23,6
21.	1,9	16,4	60,5	21,0	60,2	59,2	44,7	27,7	53,4	16,7	29,4	25,0
22.	1,7	8,9	77,3	34,7	56,5	15,3	42,7	25,3	64,0	9,6	20,9	33,1
23.	28,9	11,0	46,6	43,3	39,1	531,1	39,7	26,4	27,2	11,4	37,7	169,9
24.	61,4	10,7	44,5	42,3	61,4	144,5	32,5	49,2	17,8	33,4	22,1	169,3
25.	56,2	10,7	46,2	345,4	20,0	99,0	37,0	68,1	32,2	28,2	21,4	170,2
26.	50,6	1,1	69,7	94,5	17,9	69,7	32,0	66,0	17,9	18,0	14,2	177,6
27.	52,6	6,4	81,2	65,6	30,6	31,4	27,3	81,3	21,3	12,0	12,8	175,0
28.	189,5	7,0	46,1	114,0	25,0	155,8	38,8	75,0	10,5	12,0	8,7	138,5
29.	183,4	16,0	49,8	247,5	8,4	538,0	34,8	70,5	4,1	12,0	8,0	93,8
30.	179,8		61,6	122,5	25,0	193,8	18,1	61,7	36,3	10,0	8,0	71,1
31.	141,8		69,8		13,0		42,5	30,6		35,0		39,2
sum	1780,5	944,3	1852,3	1844,8	1650,2	7720,3	4505,1	1258,8	3053,2	898,9	519,6	1962,7
mean	57,4	32,6	59,8	61,5	53,2	257,3	145,3	40,6	101,8	29,0	17,3	63,3
MAX.	217,2	185,1	145,0	345,4	326,0	1429,1	713,0	138,1	674,6	148,6	37,7	177,6
MIN.	1,7	0,8	18,6	4,6	6,5	7,2	18,1	5,7	4,1	9,6	8,0	23,6

year sum	27990,7	year max.	**1429,1**	DEŇ/MESIAC :	03 / IX.
year average	76,7	year min	**0,8**	DEŇ/MESIAC :	25 / X.

MSD	kg/s	:	10,535
YRSD	**t**	:	332219,7
SYRSD	t/km2	:	13,0



ROČNÉ SPRACOVANIE PLAVENÍN [mg. l $^{-1}$]

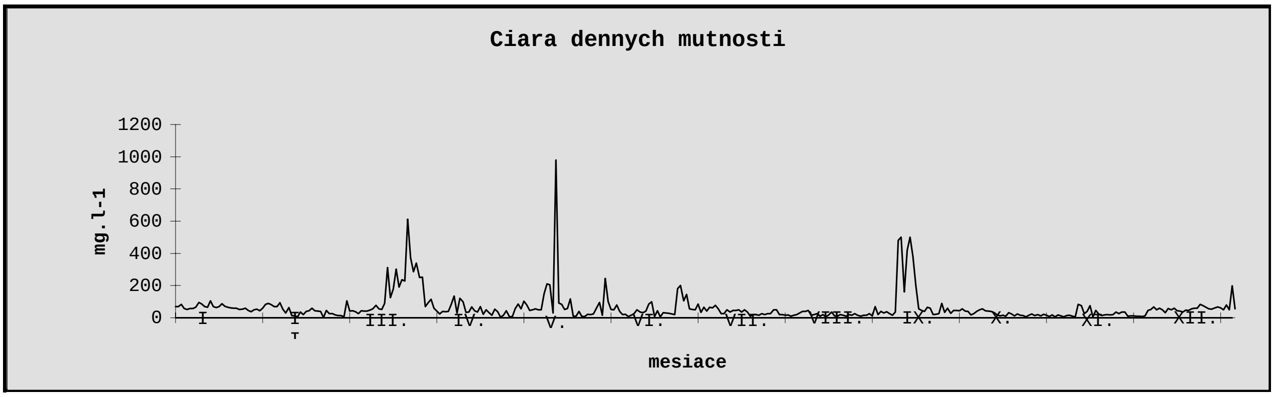
sediment **discharges**

station : **5085 ZÁHORSKÁ VES** year **ROK :** **1996**
river : **MORAVA** **PLOCHA POVODIA :** **25521** **km^2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	69,7	83,4	42,1	24,3	80,0	80,0	65,0	16,5	30,5	17,5	12,5	45,5
2.	69,8	88,6	44,5	39,2	45,0	40,0	42,7	20,0	37,5	25,0	6,0	52,5
3.	83,5	81,8	38,1	38,0	50,5	20,0	65,0	30,0	25,0	40,0	13,5	67,0
4.	57,9	69,5	25,9	38,9	55,0	21,5	62,0	40,0	15,5	50,0	15,0	49,5
5.	51,7	68,6	44,5	83,7	50,0	8,0	76,5	40,0	35,0	55,5	9,0	59,0
6.	58,2	92,8	40,8	134,8	50,5	16,0	55,0	45,0	480,0	43,5	6,5	49,5
7.	57,4	53,0	42,5	30,0	150,0	25,0	25,0	15,0	500,0	41,5	82,5	32,5
8.	65,7	29,4	47,9	121,3	210,0	50,0	25,0	20,0	160,5	40,0	75,0	58,0
9.	96,1	63,0	55,3	100,1	205,0	35,0	50,0	25,0	420,0	31,0	26,5	50,5
10.	86,0	13,2	77,1	33,5	30,0	32,5	35,0	10,0	500,0	17,0	40,0	59,0
11.	69,0	12,8	56,3	36,2	980,0	41,5	45,0	20,0	380,0	12,0	75,0	43,0
12.	64,9	6,4	52,3	67,8	90,5	85,0	45,5	6,0	200,0	15,5	6,5	42,5
13.	104,6	35,8	90,3	44,6	83,0	100,0	50,0	18,0	55,0	10,0	46,0	35,5
14.	70,3	20,8	312,6	36,6	52,5	8,0	35,5	35,0	45,0	32,5	23,5	48,0
15.	63,9	40,5	124,3	70,3	57,5	44,7	50,5	12,5	40,0	23,5	14,0	46,5
16.	69,5	44,1	179,7	21,0	118,0	6,0	35,0	10,0	65,0	11,5	17,0	56,5
17.	87,8	59,4	301,9	49,2	10,0	32,5	10,0	20,5	60,0	23,5	20,0	60,0
18.	71,5	44,1	190,2	31,7	10,0	30,0	20,0	15,0	20,5	16,0	17,5	60,0
19.	66,1	41,2	236,4	16,7	40,5	27,5	20,5	10,0	22,5	14,5	20,0	83,5
20.	60,9	39,5	229,2	54,1	8,0	24,0	16,0	20,4	25,0	5,0	35,0	75,5
21.	60,5	2,8	612,1	37,3	8,5	20,0	25,0	16,0	90,0	15,0	25,0	65,0
22.	60,5	46,4	373,9	4,6	22,5	181,5	20,0	25,0	34,5	23,5	35,0	55,5
23.	52,6	26,4	285,2	15,0	20,0	200,0	25,0	15,0	60,0	14,5	35,0	53,0
24.	53,4	25,9	339,6	43,6	24,0	105,0	25,5	10,5	27,0	19,0	10,0	61,5
25.	59,5	18,5	249,8	6,8	61,5	145,5	50,0	15,0	45,0	12,0	12,5	68,5
26.	45,0	13,8	252,4	8,3	95,0	55,3	50,0	15,0	45,0	22,5	11,0	62,5
27.	37,1	14,1	69,8	58,1	15,0	52,5	20,0	25,0	44,0	15,0	10,0	49,0
28.	49,9	6,3	93,5	85,5	244,0	50,5	20,0	12,5	55,0	8,5	10,0	79,0
29.	53,2	105,2	114,8	56,2	100,5	85,0	15,0	70,0	42,5	17,5	7,5	50,5
30.	43,4	-	58,9	103,6	52,0	34,5	17,5	20,0	40,0	6,5	12,5	199,5
31.	60,0	-	41,0	-	50,0	-	10,0	40,0	-	18,5	-	55,0
sum	1999,6	1247,3	4722,9	1491,0	3069,0	1657,0	1107,2	692,9	3600,0	697,5	729,5	1873,0
mean	64,5	43,0	152,4	49,7	99,0	55,2	35,7	22,4	120,0	22,5	24,3	60,4
MIN.	37,1	2,8	25,9	4,6	8,0	6,0	10,0	6,0	15,5	5,0	6,0	32,5
MAX.	104,6	105,2	612,1	134,8	980,0	200,0	76,5	70,0	500,0	55,5	82,5	199,5

year sum	22886,9	year max.	**980,0**	DEŇ/MESIAC	:	03 / IX.
year average	62,7	year min.	**2,8**	DEŇ/MESIAC	:	25 / X.

MSD	kg/s	:	9,849
YRSD	**t**	:	311435,0
SYRSD	t/km2	:	12,2



sediment discharge

ROČNÉ SPRACOVANIE PLAVENÍN [mg.l-1]

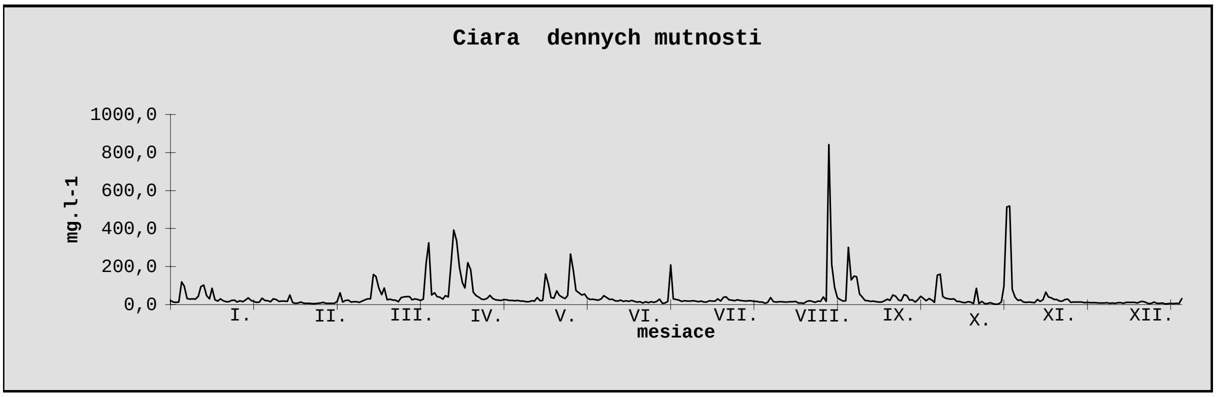
station : Brehy **year** **ROK : 1994**
river : Hron **PLOCHA POVODIA : 3821,38 km2**

month day	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1.	21,3	12,1	6,7	22,5	26,2	27,3	30,9	14,1	19,8	31,3	39,2	8,2
2.	13,1	12,7	16,0	29,4	26,0	28,3	27,3	14,1	301,5	23,5	22,5	7,9
3.	11,7	34,2	62,6	220,3	21,9	25,1	23,8	7,0	129,0	11,4	25,3	9,0
4.	13,9	22,7	14,1	325,0	22,4	24,2	16,1	12,5	150,6	155,0	13,7	10,5
5.	119,5	19,9	22,5	50,8	20,8	30,8	20,9	36,9	146,0	160,4	11,9	7,2
6.	97,9	15,6	22,8	63,1	21,8	47,6	17,9	15,1	56,0	42,3	13,8	7,9
7.	31,8	30,8	12,8	41,7	19,3	37,2	18,1	14,3	37,9	33,5	12,6	7,4
8.	28,4	27,3	15,2	38,5	17,8	27,4	20,6	15,3	22,5	30,6	10,2	10,0
9.	30,0	17,4	14,6	28,8	14,5	29,2	18,1	15,2	19,6	28,2	27,3	9,4
10.	29,4	19,3	11,3	47,4	14,9	20,2	15,6	13,1	17,6	30,0	16,8	7,1
11.	43,6	18,6	18,7	40,6	20,0	17,8	18,6	14,0	18,4	16,8	25,1	11,1
12.	94,0	16,5	25,8	222,6	18,6	23,3	14,0	14,5	14,4	17,3	66,2	12,2
13.	102,4	50,0	30,9	392,5	37,8	17,1	12,7	14,8	12,8	12,1	41,2	12,6
14.	47,0	9,3	31,0	335,9	19,6	20,7	20,4	16,3	13,3	10,1	35,0	11,0
15.	29,9	7,2	157,9	196,1	22,6	17,2	18,6	7,8	19,8	14,6	26,2	9,0
16.	86,4	9,2	148,9	115,4	162,0	21,3	18,2	8,6	28,3	13,2	26,5	15,6
17.	25,4	14,2	87,0	88,2	105,5	16,5	30,5	7,5	22,3	4,5	18,1	16,0
18.	18,2	6,6	53,0	220,1	37,0	13,0	18,8	16,6	49,9	86,2	18,2	11,0
19.	29,6	6,0	86,9	183,5	34,1	15,9	39,1	19,5	43,1	4,3	27,7	5,8
20.	20,3	6,4	25,6	65,8	73,2	8,5	41,1	16,1	24,1	17,5	29,0	6,1
21.	15,2	4,4	28,2	47,2	49,5	15,3	24,7	11,4	20,6	5,7	12,6	13,0
22.	14,8	4,8	23,7	38,2	39,2	9,8	24,3	19,0	51,5	4,4	13,3	6,6
23.	22,1	6,4	24,3	28,2	32,2	14,9	19,6	16,5	47,3	10,1	13,0	6,7
24.	24,4	7,8	15,6	26,6	47,2	11,6	25,1	40,8	23,8	5,8	14,2	9,0
25.	13,5	12,3	37,6	34,1	266,7	16,6	21,8	16,3	25,6	2,5	13,3	4,1
26.	19,5	7,4	40,8	48,5	176,7	28,8	19,7	842,4	13,2	3,4	10,8	5,1
27.	15,5	5,9	41,8	31,2	74,1	6,4	18,7	212,0	24,5	13,8	12,5	6,2
28.	24,4	5,9	42,1	25,0	62,5	7,6	19,6	91,5	44,5	95,8	10,8	4,5
29.	35,3		25,1	24,1	51,3	17,5	20,1	35,9	31,8	513,4	10,2	7,5
30.	22,4		30,9	22,1	55,6	209,1	17,3	26,5	20,7	518,0	10,9	5,5
31.	16,7		26,5		34,8		16,6	18,8		80,9		31,9

sum	1117,6	410,9	1200,9	3053,4	1625,8	806,2	668,8	1624,4	1450,4	1996,6	628,1	295,1
mean	36,1	14,7	38,7	101,8	52,4	26,9	21,6	52,4	48,3	64,4	20,9	9,5
MAX.	119,5	50,0	157,9	392,5	266,7	209,1	41,1	842,4	301,5	518,0	66,2	31,9
MIN.	11,7	4,4	6,7	22,1	14,5	6,4	12,7	7,0	12,8	2,5	10,2	4,1

year sum	14878,2	year max.	**1139,5**	DEŇ/MESIAC: 26/08
year mean	40,8	year min.	**2,5**	DEŇ/MESIAC: 25/10

MSD	kg/s	4,5
YRSD	**t**	143350,2
SYRSD	t/km2	37,5



ROČNÉ SPRACOVANIE MÚTNOSTI PLAVENÍN [mg.l^{-1}]

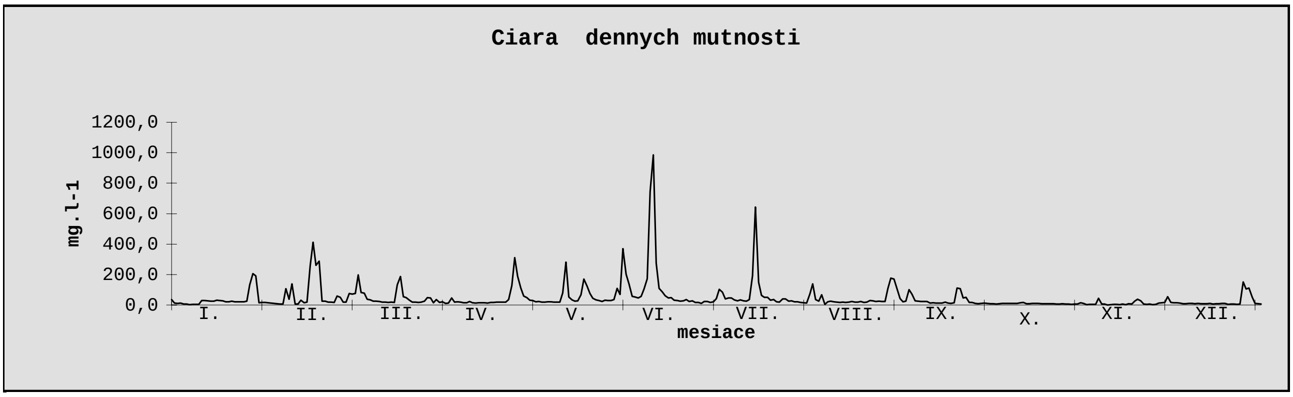
sediment discharge

station : 7290 BREHY year **ROK : 1995**
river : HRON **PLOCHA POVODIA : 3821,4 km^2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	35,9	17,7	18,1	36,4	48,4	70,4	17,5	15,3	108,3	10	14,6	17,3
2.	12,3	13,7	19,6	17,1	32,1	369,2	20,7	13,5	41,5	9,2	11,0	15,2
3.	11,2	11,6	76,1	20,0	30,2	201,5	41,3	72,3	20,8	7,5	2,8	14,8
4.	13,6	9,9	71,0	10,6	20,6	138,7	102,6	139,0	25,7	6,5	3,2	13,3
5.	5,7	8,1	75,6	12,8	22,8	56,9	84,2	35,5	100,9	7,6	4,4	9,0
6.	6,6	6,1	198,4	46,9	18,2	52,4	40,6	24,3	71,0	10,0	3,5	9,0
7.	2,9	6,4	81,9	18,6	18,0	46,3	46,9	66,2	26,6	9,5	43,7	9,9
8.	5,2	106,3	77,8	21,1	20,5	55,9	45,6	4,3	24,3	9,7	6,9	11,2
9.	3,7	38,0	36,8	19,8	20,6	104,8	32,8	20,0	22,5	10,4	7,1	8,8
10.	3,6	137,9	33,2	14,9	19,8	173,3	27,5	26,0	22,9	9,8	0,2	9,6
11.	29,6	6,8	24,9	14,9	18,6	743,9	34,0	20,3	23,6	9,6	2,5	8,1
12.	29,3	5,4	25,9	22,7	19,3	984,7	27,7	19,2	13,2	14,9	3,9	7,8
13.	27,1	30,9	22,7	15,2	80,2	275,2	24,2	17,5	15,4	15,9	3,9	8,3
14.	25,3	13,8	18,9	12,9	282,0	109,3	36,7	17,9	12,5	9,1	2,5	10,0
15.	24,8	18,6	19,5	14,9	51,7	85,2	194,3	17,7	12,8	9,1	6,0	7,3
16.	32,4	257,5	16,5	15,2	33,7	60,7	642,6	19,9	13,4	9,7	2,1	8,6
17.	28,8	412,6	18,9	15,0	25,7	46,7	148,5	23,7	19,2	10,7	7,4	8,8
18.	27,0	261,1	15,9	13,3	27,5	49,2	63,1	19,5	12,0	9,7	7,2	9,5
19.	20,0	287,8	133,2	15,9	68,1	32,4	50,8	18,6	10,5	8,3	25,1	10,9
20.	21,0	47,7	186,5	16,4	170,0	30,0	51,4	23,6	14,5	9,4	38,3	4,0
21.	25,0	48,6	55,0	19,4	124,5	26,1	32,1	17,7	112,3	8,5	27,1	5,9
22.	22,0	24,6	49,0	19,3	76,0	28,3	34,9	19,2	106,9	8,4	6,4	5,3
23.	20,0	25,6	32,3	18,8	43,3	34,7	20,8	29,8	47,1	8,3	3,3	3,7
24.	21,0	18,8	19,8	19,7	32,9	23,1	19,0	26,6	49,7	6,1	5,7	5,8
25.	20,0	18,3	19,9	35,4	29,9	28,3	40,9	23,9	17,4	6,2	2,4	151,7
26.	25,0	17,2	15,8	128,9	22,3	17,1	39,5	25,2	16,1	7,6	3,5	104,1
27.	132,3	58,2	19,7	310,1	32,0	16,4	25,8	24,1	10,7	7,2	13,3	110,9
28.	206,7	50,7	26,0	189,8	29,7	11,4	26,7	23,2	9,0	6,7	14,4	52,0
29.	191,5		47,4	110,8	29,3	22,6	20,4	109,2	10,4	5,0	15,8	9,8
30.	15,3		46,5	57,8	36,0	22,9	20,2	177,5	11,9	7,2	54,7	8,9
31.	17,4		15,5		109,0		16,7	170,5		7,2		5,5
sum	1062,2	1959,9	1518,3	1284,6	1592,9	3917,6	2030,0	1261,2	1003,1	275,0	342,9	665,0
mean	34,3	70,0	49,0	42,8	51,4	130,6	65,5	40,7	33,4	8,9	11,4	21,5
MAX.	206,7	412,6	198,4	310,1	282,0	984,7	642,6	177,5	112,3	15,9	54,7	151,7
MIN.	2,9	5,4	15,5	10,6	18,0	11,4	16,7	4,3	9,0	5,0	0,2	3,7

year sum 16912,7 year max. **1488,0** DEŇ/MESIAC: 12 / VI
year average 46,3 year min. **0,2** DEŇ/MESIAC: 10 / XI

MSD kg/s 4,546
YRSD **t** 142918,0
SYRSD t/km2 37,4



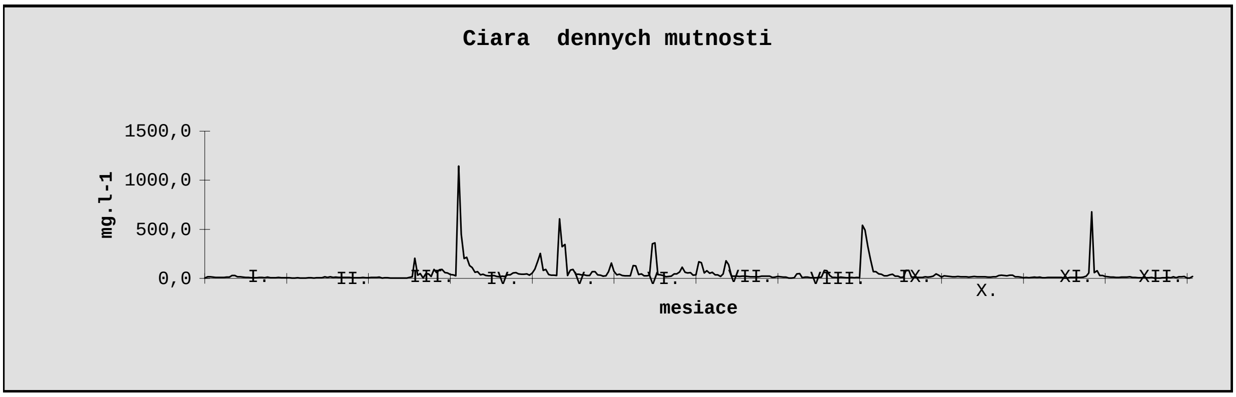
ROČNÉ SPRACOVANIE PLAVENÍN [mg.l^{-1}]
sediment discharge

station : **7290 BREHY** **year** **ROK:** **1996**
river : **HRON** **PLOCHA POVODIA :** **3821,38** **km^2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	3,0	5,1	7,9	36,1	95,1	41,9	160,8	12,7	195	17,8	10,8	10,1
2.	15,0	4,0	9,4	26,0	176,1	28,2	57,0	4,1	67,3	17,1	13,3	12,9
3.	16,0	4,3	11,0	1144,5	255,4	26,1	79,8	2,9	68,3	18,6	5,8	12,0
4.	12,0	6,0	10,5	450,7	82,9	25,1	52,4	7,7	44,1	16,0	7,0	11,5
5.	11,0	4,3	11,5	202,4	90,7	25,6	62,0	46,2	43,0	16,4	10,4	16,3
6.	10,5	4,3	2,0	216,7	37,6	130,2	35,9	49,7	24,8	15,3	9,6	10,8
7.	10,2	4,0	5,5	129,9	31,6	127,6	35,8	6,4	24,8	12,7	10,1	10,5
8.	10,0	6,8	5,0	109,7	33,8	40,4	19,7	13,8	35,5	16,2	9,7	6,3
9.	11,9	6,9	1,9	62,2	30,4	44,2	46,5	12,1	43,6	19,9	8,3	6,9
10.	13,0	4,1	3,0	67,7	606,2	26,6	180,6	6,7	22,6	17,3	8,3	7,6
11.	29,4	6,9	2,2	37,1	322,4	25,7	138,6	7,6	21,2	17,3	3,6	6,3
12.	28,6	7,8	3,5	41,1	344,9	33,0	22,1	5,3	11,4	15,5	4,2	6,2
13.	15,2	6,2	2,0	27,9	30,9	352,9	23,1	8,5	11,6	17,1	9,2	10,7
14.	16,1	16,2	4,7	27,5	86,1	360,9	23,0	14,4	82,9	14,5	11,2	4,0
15.	12,7	9,5	2,2	27,0	91,7	40,6	19,9	80,5	81,2	13,5	9,1	4,8
16.	8,6	16,5	10,0	27,9	42,4	37,2	22,1	79,4	11,5	15,6	8,3	4,3
17.	11,2	10,1	15,0	19,3	42,5	30,7	21,2	30,1	13,0	16,3	9,6	5,4
18.	7,4	12,4	207,0	17,6	35,2	17,7	19,9	10,2	10,5	30,1	12,1	5,5
19.	7,5	9,7	31,6	23,1	37,4	21,0	17,5	10,3	10,6	32,4	24,4	10,4
20.	5,3	9,4	47,4	19,5	27,8	24,0	14,9	6,2	10,5	28,9	56,2	8,0
21.	8,7	10,1	4,3	35,1	27,9	45,2	16,4	12,7	16,6	27,3	679,2	15,9
22.	8,6	10,6	46,4	35,0	69,8	47,1	17,6	8,4	12,7	32,8	59,9	6,2
23.	8,0	9,3	47,2	55,6	68,5	64,5	22,1	6,5	16,0	32,2	77,2	16,2
24.	14,4	6,7	19,3	58,4	34,3	114,9	22,0	7,0	24,2	16,0	29,0	15,9
25.	6,5	7,8	92,9	45,6	32,0	63,0	23,8	8,8	46,5	15,8	29,1	20,5
26.	7,0	6,6	60,2	42,6	21,8	54,3	22,6	7,0	34,0	12,6	18,2	4,4
27.	8,0	6,4	88,6	43,0	27,4	60,2	11,0	10,3	12,6	6,3	15,6	3,3
28.	8,4	8,7	91,2	47,1	70,0	33,8	13,2	6,1	25,0	8,4	14,2	19,1
29.	7,9	6,7	57,5	31,2	157,6	34,8	18,1	541,6	23,3	7,7	13,0	10,0
30.	7,7		54,0	55,2	71,6	169,3	17,1	491,1	19,4	10,9	11,2	15,0
31.	7,1		38,4		34,9		14,0	322,6		11,7		11,0
sum	346,9	227,4	993,3	3162,7	3116,9	2146,7	1250,7	1836,9	1063,7	550,2	1187,8	308,0
mean	11,2	7,8	32,0	105,4	100,5	71,6	40,3	59,3	35,5	17,7	39,6	9,9
MAX.	29,4	16,5	207,0	1144,5	606,2	360,9	180,6	541,6	195,0	32,8	679,2	20,5
MIN.	3,0	4,0	1,9	17,6	21,8	17,7	11,0	2,9	10,5	6,3	3,6	3,3

year sum	16191,2	year max.	**1329,0**	DEŇ/MESIAC: 03/04
year average	44,2	year min.	**1,9**	DEŇ/MESIAC: 09/03

MSD	kg/s	4,919
YRSD	**t**	155560,0
SYRSD	t/km2	40,7



sediment discharge

ROČNÉ SPRACOVANIE PLAVENÍN [mg.l-1]

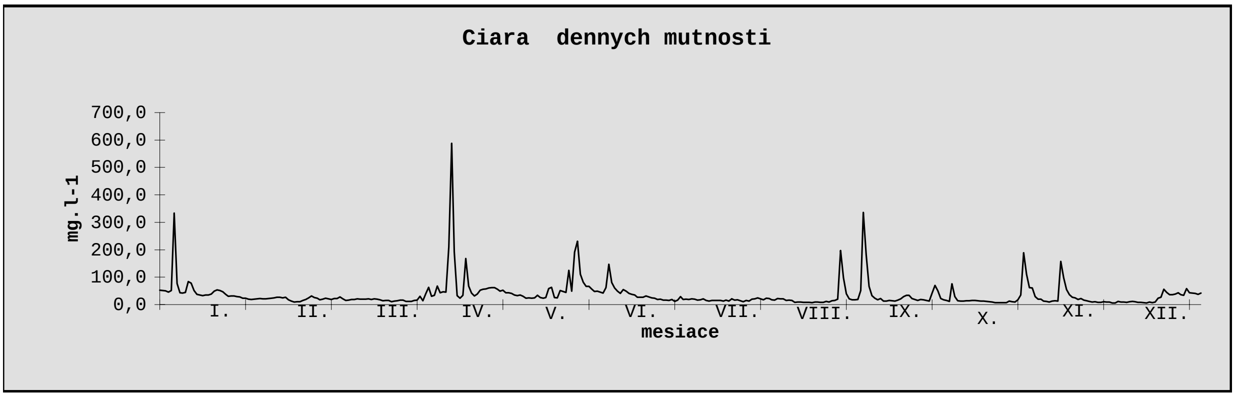
station ; Slovenske Darmoty **year** **ROK : 1994**
river : Ipel **PLOCHA POVODIA : 2768,00 km2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	52,2	20,1	21,1	16,3	52,2	57,5	15,8	23,0	17,5	22,0	61,7	6,3
2.	51,7	18,8	18,8	30,9	42,9	48,4	29,4	22,1	19,0	17,7	60,9	12,2
3.	50,6	19,5	22,5	14,4	43,4	49,0	18,4	18,0	50,8	14,6	29,2	8,8
4.	45,9	21,2	21,8	39,3	41,0	45,5	20,4	16,5	335,9	11,9	19,3	9,2
5.	51,6	22,2	27,5	63,0	35,2	41,9	18,4	22,1	181,9	75,5	19,9	7,9
6.	334,1	20,5	20,7	30,1	32,2	62,1	20,5	21,0	67,0	29,2	12,5	10,2
7.	76,6	20,7	15,3	34,3	35,1	147,3	19,6	20,6	32,4	13,5	11,9	11,8
8.	42,7	22,2	16,1	67,5	29,8	80,8	16,6	15,7	23,0	12,3	9,6	10,9
9.	41,9	23,8	18,4	43,7	23,8	60,9	17,3	16,6	18,0	13,3	12,9	8,3
10.	43,8	24,2	18,7	46,8	24,6	49,3	20,8	15,2	22,6	13,6	14,3	7,9
11.	84,0	27,1	21,1	45,4	23,4	40,7	15,3	7,8	12,9	14,4	12,4	7,2
12.	77,9	26,3	19,9	209,7	24,6	55,2	13,4	9,7	12,9	15,4	157,2	6,3
13.	50,8	25,0	19,3	588,3	34,1	49,5	15,4	9,6	14,6	14,6	97,9	9,7
14.	37,4	27,0	19,3	192,6	25,2	40,9	14,9	7,9	13,8	14,2	54,5	6,5
15.	34,5	17,5	20,5	32,4	23,8	37,2	15,3	7,9	12,6	12,7	36,2	9,1
16.	33,2	13,3	18,4	23,8	26,1	35,5	15,2	8,6	16,7	12,7	27,2	22,8
17.	34,5	9,1	21,5	33,3	57,8	26,9	12,5	6,9	21,1	11,8	25,0	27,2
18.	35,5	10,4	19,8	168,2	63,2	27,1	15,9	9,1	29,7	10,1	19,2	56,5
19.	38,4	10,8	17,0	67,4	25,7	27,1	13,1	9,9	34,3	8,9	22,4	43,9
20.	49,4	15,1	14,0	41,5	24,5	31,0	20,8	8,7	33,4	7,0	16,8	35,8
21.	54,1	18,1	15,5	31,7	51,7	28,1	16,5	7,7	22,6	7,0	14,1	36,4
22.	51,4	24,5	15,2	39,0	48,0	24,0	17,1	12,1	19,0	7,0	11,5	38,9
23.	47,2	31,9	10,1	52,5	44,6	23,9	13,6	9,7	14,7	7,0	9,6	43,0
24.	36,9	26,2	12,4	56,3	124,5	18,6	10,1	14,1	18,4	6,9	10,4	36,4
25.	29,9	23,1	13,6	57,4	48,9	19,3	15,6	14,9	17,5	13,2	7,8	33,3
26.	31,3	18,0	16,8	61,2	190,8	15,9	13,0	19,8	15,5	10,3	8,0	58,3
27.	31,3	19,7	16,6	62,1	231,2	15,8	19,5	196,7	12,7	9,9	10,2	43,3
28.	28,9	23,7	11,9	61,8	111,3	15,0	21,0	97,9	41,6	17,7	9,3	42,3
29.	28,2		11,8	56,0	82,0	19,2	24,0	39,8	69,8	34,5	9,9	40,8
30.	22,8		12,0	48,9	67,0	11,8	20,7	21,2	49,7	189,2	6,0	37,5
31.	22,8		15,6		66,6		17,8	17,9		111,2		41,7

sum	1651,5	580,0	543,2	2315,8	1755,2	1205,4	537,9	728,7	1251,6	759,3	817,8	770,4
mean	53,3	20,7	17,5	77,2	56,6	40,2	17,4	23,5	41,7	24,5	27,3	24,9
MAX.	334,1	31,9	27,5	588,3	231,2	147,3	29,4	196,7	335,9	189,2	157,2	58,3
MIN.	22,8	9,1	10,1	14,4	23,4	11,8	10,1	6,9	12,6	6,9	6,0	6,3

year sum	12916,8	year max.	**767,0**	DEŇ/MESIAC:13/04
year mean	35,4	year min.	**6,0**	DEŇ/MESIAC:30/11

MSD	kg/s	0,4
YRSD	**t**	13782,2
SYRSD	t/km2	5,0



ROČNÉ SPRACOVANIE MÚTNOSTI PLAVENÍN [mg.l^{-1}]

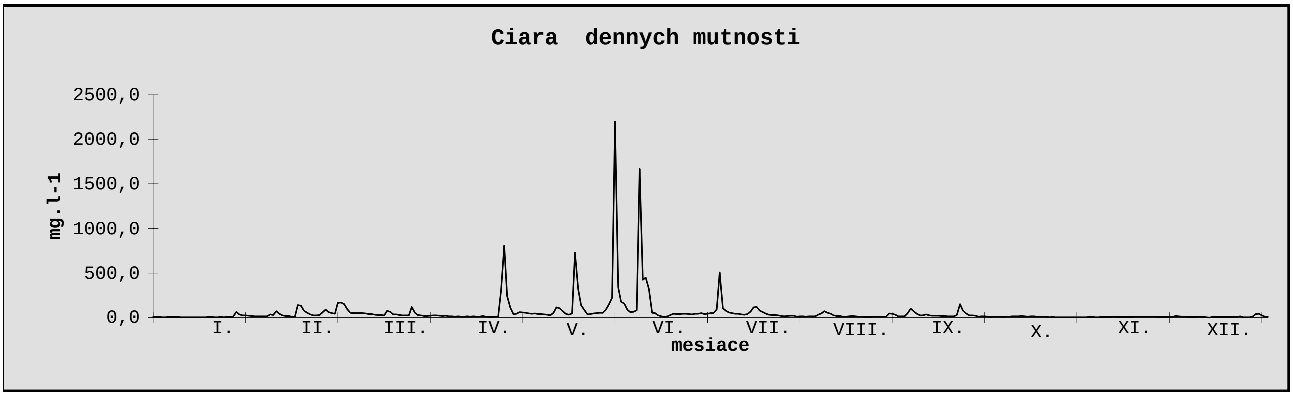
sediment dishage

station : Slovenske Darmoty **year** **ROK : 1995**
river : IPEĽ **PLOCHA POVODIA : 2768 km^2**

month day	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	7,0	20,8	61,9	19,1	41,5	224,3	39,8	12,6	30,6	10,2	4,4	18,1
2.	8,0	18,6	50,8	18,0	61,0	2201,7	41,8	15,0	16,0	8,5	4,4	14,8
3.	6,0	14,9	43,2	22,1	58,9	339,8	49,4	11,0	12,8	11,6	7,7	10,5
4.	3,0	15,8	164,0	24,5	52,5	175,6	51,6	13,7	16,1	10,5	7,8	9,6
5.	5,0	13,0	168,4	25,3	48,2	157,2	93,8	15,1	47,2	9,4	5,3	8,5
6.	6,0	13,9	150,2	21,9	44,7	86,2	508,2	13,3	101,1	7,9	5,3	7,5
7.	6,0	13,8	97,6	19,3	46,7	60,0	102,4	32,7	69,9	9,2	6,3	7,4
8.	7,0	35,1	54,1	19,9	41,1	66,1	75,0	45,4	43,0	9,9	6,5	7,6
9.	6,0	28,7	49,7	15,2	41,1	81,1	57,5	71,3	25,0	15,1	8,3	9,2
10.	5,0	72,3	49,6	13,8	35,7	1669,8	50,6	52,2	24,8	15,3	7,5	7,0
11.	4,0	43,6	48,7	11,8	31,5	423,8	42,3	44,2	35,6	14,8	9,3	2,8
12.	5,0	25,1	49,2	13,4	25,7	448,6	42,3	26,2	25,7	16,2	7,6	1,3
13.	4,0	17,7	45,0	9,0	55,2	319,1	35,5	17,9	23,0	12,6	7,5	7,5
14.	3,0	16,4	39,2	10,7	116,6	52,1	33,9	17,2	21,2	10,6	6,4	6,8
15.	2,0	11,9	39,8	12,6	104,3	50,2	39,6	12,5	20,9	12,6	8,2	7,3
16.	4,0	11,0	32,0	12,0	73,1	25,6	67,9	11,7	16,6	14,8	7,6	7,2
17.	4,0	140,0	28,1	13,2	42,9	12,9	116,0	13,7	18,7	10,0	7,6	7,0
18.	4,0	132,8	28,7	12,3	32,9	6,5	117,3	16,5	15,4	9,8	9,0	7,3
19.	6,0	77,9	26,2	11,7	45,0	13,7	80,4	12,6	13,6	11,3	11,0	7,9
20.	5,9	54,3	77,2	18,6	730,9	27,1	60,2	10,1	13,3	9,5	10,0	5,6
21.	4,0	35,4	65,7	9,1	319,9	43,1	43,0	12,0	27,7	3,0	9,5	5,5
22.	5,0	30,4	36,9	7,8	138,3	39,5	32,7	7,0	150,2	7,6	9,5	15,4
23.	6,4	26,7	36,3	8,0	88,0	40,3	27,0	8,9	80,6	5,0	9,3	4,1
24.	4,5	24,1	29,6	9,5	35,9	44,4	27,6	8,3	45,0	5,3	10,7	4,3
25.	6,2	25,5	24,5	10,7	38,5	42,7	24,5	10,6	26,4	3,3	7,0	1,9
26.	6,2	28,1	24,0	302,5	47,9	40,0	18,6	12,0	23,9	2,5	6,7	12,0
27.	9,6	57,4	26,6	807,2	49,1	37,1	15,8	9,3	22,6	2,8	6,4	39,5
28.	63,3	90,5	119,2	239,4	53,0	42,9	17,0	10,6	11,6	4,1	6,4	44,5
29.	36,9		55,4	113,1	53,6	43,7	20,5	11,1	15,6	4,8	5,4	26,4
30.	26,8		29,5	35,1	87,1	49,1	20,5	48,3	13,6	5,0	7,4	11,2
31.	26,8		23,6		147,5		10,0	42,0		4,5		7,6
sum	296,6	1095,7	1774,9	1866,8	2788,3	6864,2	1962,7	645,0	1007,7	277,7	226,0	333,3
mean	9,6	39,1	57,3	62,2	89,9	228,8	63,3	20,8	33,6	9,0	7,5	10,8
MAX.	63,3	140,0	168,4	807,2	730,9	2201,7	508,2	71,3	150,2	16,2	11,0	44,5
MIN.	2,0	11,0	23,6	7,8	25,7	6,5	10,0	7,0	11,6	2,5	4,4	1,3

year sum	19138,9	year max.	**3419,0**	DEŇ/MESIAC:	02 / VI
year average	52,4	year min.	**1,3**	DEŇ/MESIAC:	12 / XII

MSD	kg/s	:	1,100
YRSD	**t**	:	33197,2
SYRSD	t/km2	:	12,0



ROČNÉ SPRACOVANIE PLAVENÍN [mg.l^{-1}]

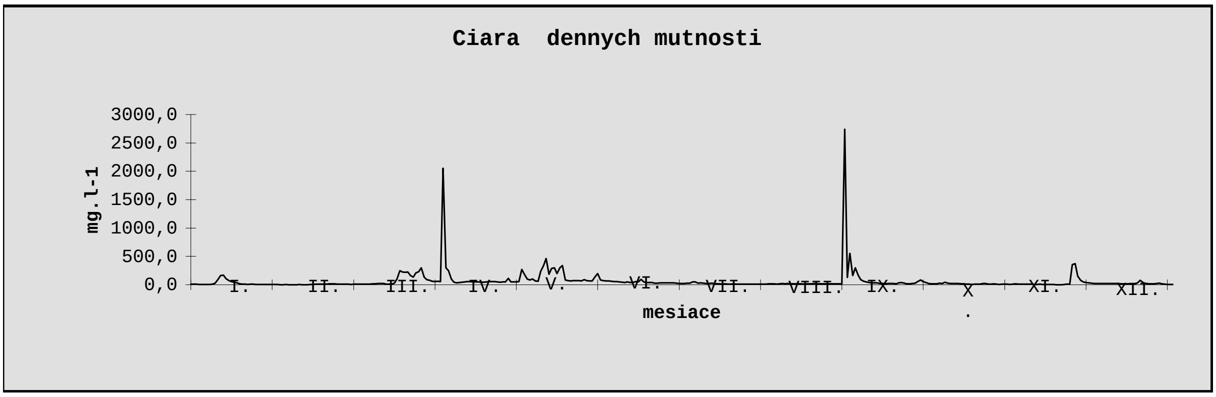
sediment discharge

station : **7540 SLOVENSKÉ ĎARMOTY** **year** **ROK:** **1996**
river : **IPEĽ** **PLOCHA POVODIA :** **2768,00** **km^2**

month day	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1.	8,5	3,7	11,5	61,4	55,9	72,6	23,9	18,2	161,5	15,4	12,1	22,8
2.	10,5	3,5	12,5	57,7	268,6	70,1	27,8	15,3	301,6	16,4	10,8	22,8
3.	10,1	2,7	11,5	2050,0	183,6	65,6	28,7	15,2	168,9	28,9	9,1	25,1
4.	6,2	2,8	11,4	296,6	103,9	63,8	51,8	13,7	91,7	24,1	10,4	22,1
5.	8,4	3,3	10,3	250,2	84,4	58,3	50,4	15,5	62,9	43,3	8,8	21,4
6.	6,8	1,9	11,1	101,9	100,9	55,2	29,7	21,1	48,2	29,0	8,7	25,3
7.	5,7	2,0	11,5	46,2	67,9	50,4	32,3	17,1	42,0	25,2	7,5	22,4
8.	7,1	1,2	15,9	36,2	62,4	46,4	29,5	21,6	33,2	22,0	6,2	21,1
9.	9,7	2,5	16,4	40,2	238,4	42,0	21,6	16,5	32,6	23,6	9,4	16,7
10.	30,0	3,6	21,0	43,9	340,0	52,2	25,0	18,1	32,8	20,9	5,1	14,5
11.	98,5	2,3	22,0	51,4	461,1	41,6	27,6	15,6	24,1	14,3	6,3	15,1
12.	161,3	2,1	22,0	55,7	185,2	39,2	21,0	15,6	23,9	14,2	5,0	18,0
13.	166,4	2,5	10,7	58,0	289,7	58,7	14,7	16,4	19,7	9,3	4,8	15,7
14.	109,1	3,6	11,0	50,5	296,4	48,0	18,7	12,1	21,2	10,5	5,8	16,6
15.	75,3	4,7	11,0	48,0	196,7	93,4	12,9	15,0	25,0	8,3	2,3	31,4
16.	56,3	9,0	30,0	50,7	296,6	50,0	14,6	19,2	20,8	9,1	2,6	80,8
17.	43,6	8,8	100,0	46,5	337,4	39,2	11,0	19,3	16,5	12,0	2,4	41,5
18.	33,0	9,1	250,0	47,2	83,3	40,3	12,3	19,8	34,2	12,7	7,9	25,1
19.	16,7	10,5	223,2	53,0	72,0	41,3	14,1	18,4	38,8	19,9	9,5	18,7
20.	13,9	12,4	222,2	54,0	67,6	28,4	10,5	19,0	31,0	20,4	12,9	17,4
21.	14,0	14,3	224,3	56,3	75,0	28,9	12,1	16,2	19,2	12,5	353,2	17,0
22.	7,7	14,8	161,8	54,8	71,3	33,5	12,2	18,7	17,9	10,5	371,4	25,3
23.	8,9	15,2	135,2	53,5	71,0	32,2	12,0	16,2	21,2	14,7	152,4	28,8
24.	8,7	11,8	206,5	45,2	66,8	32,2	12,6	15,7	30,9	11,6	81,3	16,5
25.	3,9	10,4	229,4	49,1	91,1	33,0	10,2	14,4	59,1	8,4	52,3	12,0
26.	2,9	9,1	298,9	48,0	75,3	32,6	10,2	14,5	83,2	11,4	41,3	7,0
27.	3,4	8,9	135,5	113,1	66,8	32,7	10,8	18,5	56,6	9,2	31,9	5,6
28.	4,7	8,8	87,9	50,1	65,1	26,0	12,5	17,1	38,0	8,8	26,3	8,4
29.	8,1	8,3	79,2	53,4	143,0	24,4	12,9	2741,3	20,5	8,3	25,1	9,5
30.	6,5		61,3	53,4	198,1	24,8	13,8	131,8	18,2	8,9	21,8	4,4
31.	4,9		57,0		86,7		13,9	555,3		15,1		8,4
sum	950,8	193,8	2712,2	4076,2	4802,2	1357,0	611,3	3902,4	1595,4	498,9	1304,6	637,4
mean	30,7	6,7	87,5	135,9	154,9	45,2	19,7	125,9	53,2	16,1	43,5	20,6
MAX.	166,4	15,2	298,9	2050,0	461,1	93,4	51,8	2741,3	301,6	43,3	371,4	80,8
MIN.	2,9	1,2	10,3	36,2	55,9	24,4	10,2	12,1	16,5	8,3	2,3	4,4

year sum	22642,2	year max.	**3271,0**	DEŇ/MESIAC: 03/04
year average	61,9	year min.	**1,2**	DEŇ/MESIAC: 08/02

MSD	kg/s	:	1,277
YRSD	**t**	:	40377,9
SYRSD	t/km2	:	14,6



sediment discharge

ROČNÉ SPRACOVANIE PLAVENÍN [mg.l-1]

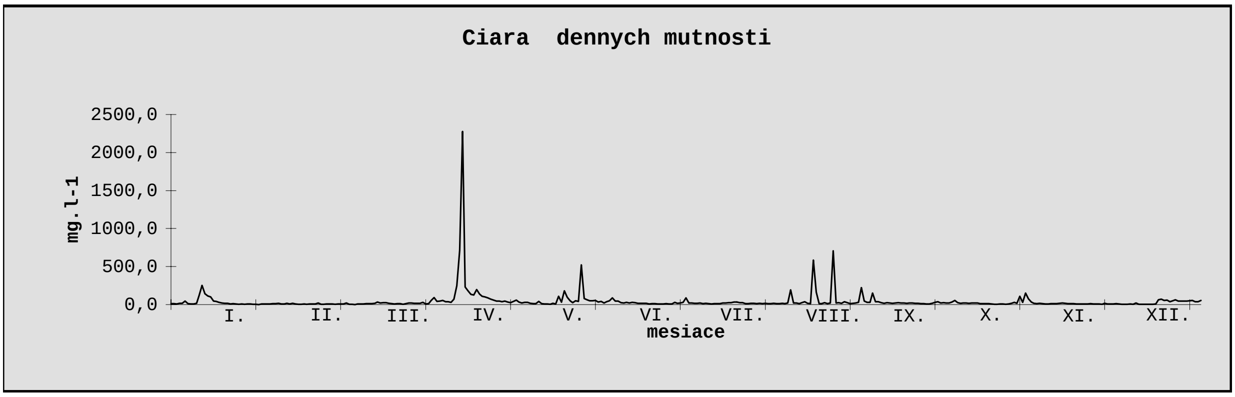
station : Lenartovce **year** **ROK : 1994**
river : Slana **PLOCHA POVODIA : 1829,65 km2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	14,5	0,9	8,6	8,7	26,6	31,6	28,2	10,9	30,5	26,3	33,2	14,2
2.	11,2	7,2	9,4	10,6	42,0	41,3	89,8	15,5	223,6	20,7	18,2	8,8
3.	8,7	7,5	10,2	55,5	59,9	22,5	20,6	13,2	47,4	22,7	13,2	4,1
4.	15,2	8,8	22,0	91,4	33,4	37,1	21,1	12,0	28,3	32,2	17	3,7
5.	18,4	7,3	4,5	40,9	19,8	49,3	17,9	15,1	28,0	56,6	11,8	3,4
6.	44,8	11,1	3,6	45,5	31,2	88,5	17,3	11,2	151,8	23,5	8,5	6,8
7.	12,9	10,9	2,0	54,1	28,8	46,4	21,2	22,9	38,5	17,5	9,5	4,2
8.	8,2	16,0	7,8	39,4	15,2	45,2	14,1	192,5	36,7	20,1	12,4	19,3
9.	9,5	6,9	9,5	38,8	13,2	27,0	15,7	22,5	24,0	19,7	14,7	4,8
10.	15,6	8,4	6,4	27,6	13,2	19,5	13,6	21,2	18,2	16,8	13,4	3,5
11.	121,6	16,3	14,2	71,3	42,5	28,5	10,3	10,7	23,3	19,4	16,8	4
12.	250,5	8,6	11,8	247,3	14,7	20,6	10,7	25,5	20,3	20,5	22,5	3,6
13.	144,3	14,8	13,5	713,6	7,6	29,6	12,3	35,8	18,1	22,0	18	2,2
14.	115,4	7,3	16,4	2277,1	9,1	24,6	12,7	16,5	22,6	11,3	12,2	6
15.	101,1	6,0	33,8	231,3	6,0	15,1	20,8	11,7	25,1	11,2	11	6,8
16.	47,3	5,0	19,2	179,1	17,1	16,5	21,5	586,2	21,1	14,3	12,2	61,6
17.	40,4	6,5	25,1	133,6	8,6	15,2	24,1	164,2	22,7	13,0	10	71,6
18.	29,8	6,0	24,0	126,3	110,0	15,1	24,4	14,2	14,9	7,2	8,4	53,2
19.	20,1	7,1	15,5	197,3	34,5	8,4	32,5	12,0	22,3	4,5	10	58,3
20.	17,8	6,8	14,2	137,4	182,2	13,0	33,1	23,6	21,5	3,5	8,1	38,9
21.	15,6	6,7	8,7	110,2	95,2	14,5	26,2	12,1	15,1	9,6	9,5	52,1
22.	8,1	19,4	10,7	99,6	49,5	9,3	23,8	19,6	15,8	7,6	10,8	62
23.	11,8	4,9	11,3	89,0	25,9	7,3	11,9	706,9	13,0	6,3	8,7	47,3
24.	6,8	6,1	4,9	73,0	49,4	10,4	10,7	20,1	11,0	8,7	8,9	46,7
25.	5,0	7,8	13,1	57,3	41,6	10,9	16,9	25,6	7,6	17,4	10	47,1
26.	6,8	7,7	21,0	48,3	520,5	7,6	18,4	18,9	9,3	28,6	5,8	47,9
27.	6,3	7,1	21,9	47,2	80,2	7,3	12,3	36,6	18,4	18,9	18	50,5
28.	10,2	5,8	18,6	38,1	65,1	28,1	15,9	26,4	27,6	111,0	8,6	52,8
29.	10,0		16,0	44,3	50,0	16,2	13,9	13,2	37,3	29,5	9,1	37,7
30.	2,8		16,5	31,6	49,6	21,0	15,5	18,8	21,6	150,9	6,8	35,8
31.	3,6		27,7		56,6		11,7	23,0		74,2		55,8

sum	1134,3	234,9	442,1	5365,4	1799,2	727,6	639,1	2158,6	1015,6	845,7	377,3	914,7
mean	36,6	8,4	14,3	178,8	58,0	24,3	20,6	69,6	33,9	27,3	12,6	29,5
MAX.	250,5	19,4	33,8	2277,1	520,5	88,5	89,8	706,9	223,6	150,9	33,2	71,6
MIN.	2,8	0,9	2,0	8,7	6,0	7,3	10,3	10,7	7,6	3,5	5,8	2,2

year sum 15654,5 year max. **5898,2** DEŇ/MESIAC: 14/04
year mean 42,9 year min. **0,9** DEŇ/MESIAC: 01/02

MSD	kg/s	1,8
YRDS	**t**	56121,9
SYRDS	t/km2	30,7


Ciara dennych mutnosti

ROČNÉ SPRACOVANIE MÚTNOSTI PLAVENÍN [mg.l^{-1}]

sediment discharge

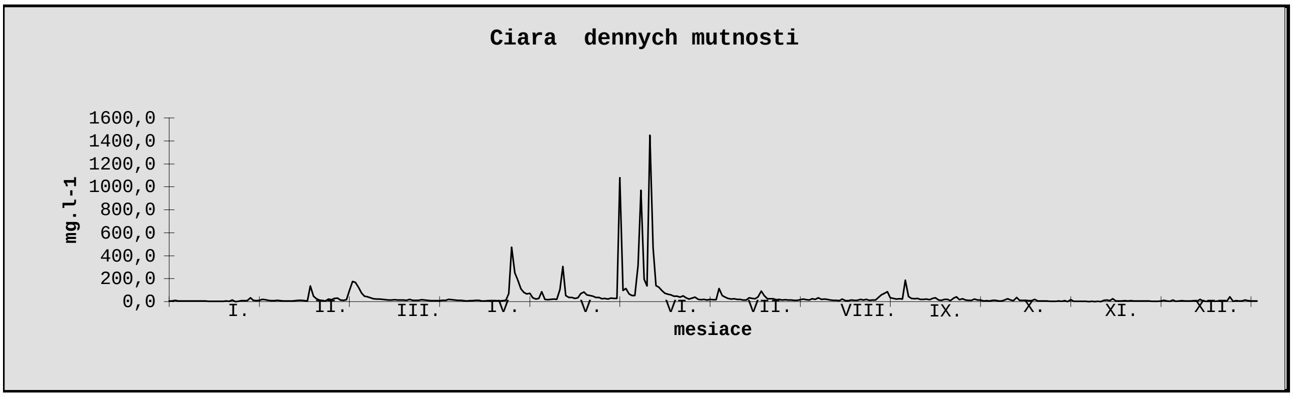
station : **7820 LENARTOVCE** **year** **ROK : 1,995**

river : **SLANÁ** **PLOCHA POVODIA : 1829,65 km^2**

month day	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
1.	6,0	20,3	13,0	9,3	81,2	28,2	15,2	17,2	27,3	6,0	2,6	6,2
2.	5,5	17,9	10,0	7,2	68,0	1077,9	20,0	23,0	21,4	7,2	2,3	3,3
3.	11,0	11,9	16,4	9,7	73,4	98,7	17,9	16,0	25,0	6,3	2,9	14,8
4.	5,0	7,0	94,8	10,5	33,5	115,1	16,8	15,2	21,6	11,8	2,9	4,0
5.	4,5	8,2	175,8	12,5	22,5	65,8	112,9	25,4	187,1	9,8	1,1	4,8
6.	6,0	11,2	166,6	20,4	28,5	52,7	52,4	20,5	45,6	5,8	2,6	8,3
7.	5,0	7,5	122,6	17,0	86,9	53,0	40,4	32,5	27,8	5,6	0,5	6,7
8.	5,5	6,1	73,9	13,0	20,6	313,6	27,1	18,2	23,9	14,5	2,6	6,4
9.	6,0	6,8	47,4	10,1	16,9	970,6	21,8	22,5	26,5	24,6	1,2	4,6
10.	6,0	6,1	43,0	10,7	20,5	195,7	24,4	20,4	18,7	14,0	11,9	7,3
11.	5,5	5,8	34,1	7,6	21,3	136,0	20,4	13,1	19,5	8,4	15,2	3,9
12.	5,0	7,9	25,7	6,5	19,1	1449,8	20,5	9,9	22,7	36,0	9,5	18,3
13.	5,5	10,6	22,7	7,1	105,2	466,9	14,9	11,2	17,1	10,6	25,3	4,4
14.	4,0	10,8	21,5	8,1	306,7	140,4	12,9	8,8	27,7	10,0	4,9	3,6
15.	4,0	8,9	19,7	12,5	52,5	126,1	32,7	22,3	32,7	12,1	5,7	3,5
16.	3,5	6,6	16,6	10,8	36,5	95,6	27,0	9,6	14,7	8,4	6,9	5,0
17.	3,5	136,0	13,7	5,0	36,4	73,5	25,2	8,9	11,4	8,7	8,6	3,5
18.	4,0	47,2	12,7	5,6	29,1	65,4	43,0	12,8	20,5	18,3	6,9	4,2
19.	3,5	25,9	16,0	7,2	32,3	59,6	91,0	12,0	19,1	6,3	8,8	3,8
20.	4,7	14,5	14,1	1,5	70,3	47,7	53,1	12,5	7,2	4,7	5,0	5,6
21.	3,3	8,3	12,7	5,2	84,3	47,2	26,4	19,9	31,6	5,1	5,2	6,2
22.	13,3	6,0	15,2	8,2	58,5	39,4	24,3	13,3	41,3	4,7	5,4	42,2
23.	0,8	9,7	12,0	6,4	53,3	51,5	25,6	19,2	17,3	3,0	5,8	3,6
24.	1,5	4,9	18,3	8,1	46,1	33,7	17,0	12,5	23,8	3,6	5,3	7,7
25.	7,3	21,7	10,0	11,6	35,7	22,9	18,5	12,7	15,0	3,4	4,3	4,4
26.	8,7	16,4	10,1	70,8	36,3	30,1	14,4	14,3	11,9	6,1	2,0	5,6
27.	8,5	27,2	10,1	473,8	26,2	40,3	17,8	35,3	12,5	1,5	1,9	12,9
28.	34,4	32,0	15,5	249,8	28,3	20,3	15,3	59,6	21,3	7,9	2,0	7,1
29.	10,9		15,3	188,2	23,6	15,5	14,1	71,3	13,5	0,5	6,7	5,4
30.	7,0		11,1	110,2	32,0	19,3	11,5	85,8	13,9	17,6	9,8	5,0
31.	10,2		9,0		26,8		12,5	34,7		2,9		5,2
sum	209,6	503,4	1099,6	1324,6	1612,5	5952,5	887,0	710,6	819,6	285,4	175,8	227,5
mean	6,8	18,0	35,5	44,2	52,0	198,4	28,6	22,9	27,3	9,2	5,9	7,3
MAX.	34,4	136,0	175,8	473,8	306,7	1449,8	112,9	85,8	187,1	36,0	25,3	42,2
MIN.	0,8	4,9	9,0	1,5	16,9	15,5	11,5	8,8	7,2	0,5	0,5	3,3

year sum	13808,1	year max	**2472,0**	DEŇ/MESIAC:	12 / VI
year average	37,8	year min.	**0,5**	DEŇ/MESIAC:	29 / X

MSD	kg/s	:	1,700
YRSD	**t**	:	53381,4
SYRSD	t/km2	:	29,2



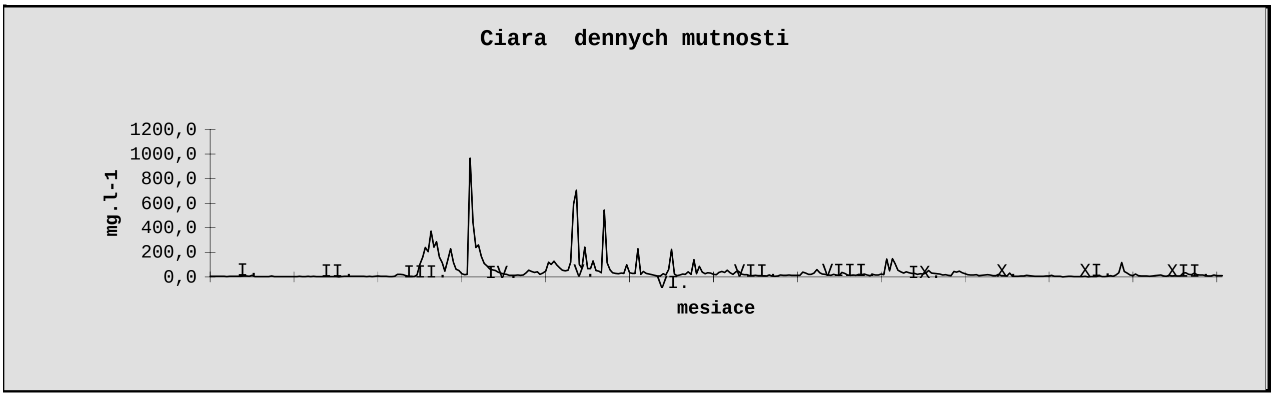
ROČNÉ SPRACOVANIE PLAVENÍN [mg.l^{-1}]
sediment discharge

station :	**7820 LENARTOVCE**	**year**	**ROK:**	**1996**	
river :	**SLANÁ**		**PLOCHA POVODIA :**	**1829,65**	**km^2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	5,5	2,7	7,1	19,5	120,8	27,6	35,2	31,2	149,4	17,6	0,5	8,2
2.	5,0	4,1	4,4	20,1	101,6	229,0	43,9	19,7	108,5	10,8	3,0	4,5
3.	5,2	2,9	4,9	965,9	126,6	22,1	37,4	19,8	54,7	13,0	4,1	8,1
4.	5,0	2,3	4,6	443,7	96,8	44,4	54,8	31,3	41,7	16,6	4,0	10,3
5.	4,9	6,3	3,1	238,3	72,4	27,6	33,6	60,4	31,6	19,1	1,6	14,1
6.	4,9	3,8	2,6	261,4	54,6	24,0	21,2	34,0	42,4	15,7	2,3	15,5
7.	2,0	4,3	5,1	165,4	48,3	18,1	41,8	24,5	33,4	9,8	2,2	8,2
8.	5,0	2,5	19,9	109,7	54,0	12,9	48,0	21,5	29,8	10,1	2,1	6,4
9.	5,1	1,8	21,3	90,4	120,8	9,0	24,3	15,7	28,1	19,6	5,8	12,8
10.	5,2	2,4	19,4	65,8	591,1	8,9	18,6	12,7	22,0	11,0	0,5	7,7
11.	5,3	2,2	9,7	56,8	706,6	25,5	17,6	21,6	25,5	11,1	3,0	10,8
12.	5,4	3,0	5,2	51,8	101,7	15,7	11,3	14,6	22,2	6,8	3,9	9,0
13.	6,9	3,5	5,0	39,3	70,9	58,8	9,9	14,3	32,2	31,8	3,3	9,0
14.	7,8	2,9	3,7	30,8	242,5	224,3	12,5	35,7	51,8	5,4	10,5	30,0
15.	5,5	3,0	15,0	23,7	67,3	23,3	10,3	27,4	32,0	4,8	3,6	35,0
16.	12,5	1,0	101,5	21,3	66,5	11,4	11,5	14,8	29,8	5,2	3,5	20,0
17.	2,4	3,7	160,8	13,8	129,3	16,6	9,1	12,9	25,4	7,1	4,6	19,0
18.	1,8	4,7	240,6	14,0	52,7	24,4	8,5	16,9	24,5	8,2	10,5	30,0
19.	1,6	5,4	206,2	13,4	47,4	20,6	16,0	12,1	16,4	13,9	5,6	18,0
20.	1,4	4,9	372,9	16,6	34,8	42,4	8,2	20,3	17,8	11,0	16,1	15,0
21.	3,0	4,8	241,7	13,0	545,2	20,5	5,8	18,5	12,1	7,6	32,7	16,0
22.	3,2	5,8	286,7	15,3	114,8	139,8	7,9	24,4	11,2	6,1	117,3	10,0
23.	8,7	6,1	161,4	34,9	58,1	26,8	15,5	16,0	45,3	5,3	43,8	9,0
24.	3,4	5,9	113,3	54,7	34,5	85,9	14,3	11,5	39,6	5,7	32,4	8,9
25.	3,8	6,2	47,3	43,8	28,6	39,8	13,3	20,8	48,0	6,1	16,6	15,0
26.	2,6	3,7	134,4	37,0	25,7	25,6	16,8	16,0	32,9	7,4	11,2	10,0
27.	3,1	5,0	229,9	42,4	30,3	33,4	13,5	16,9	25,4	8,0	23,7	10,5
28.	3,7	3,7	116,5	20,8	28,3	32,3	12,2	23,8	17,9	11,8	10,7	11,0
29.	3,5	5,8	61,2	30,5	99,6	22,0	12,8	18,0	15,8	5,0	7,2	10,0
30.	3,6		52,9	47,0	34,5	17,6	12,5	146,1	14,8	4,2	7,9	11,0
31.	3,0		25,2		27,5		38,6	49,4		4,4		11,0
sum	140,0	114,4	2683,5	3001,1	3933,8	1330,3	636,9	822,8	1082,2	320,2	394,2	414,0
mean	4,5	3,9	86,6	100,0	126,9	44,3	20,5	26,5	36,1	10,3	13,1	13,4
MAX.	12,5	6,3	372,9	965,9	706,6	229,0	54,8	146,1	149,4	31,8	117,3	35,0
MIN.	1,4	1,0	2,6	13,0	25,7	8,9	5,8	11,5	11,2	4,2	0,5	4,5

year sum	14873,4	year max.	**1283,0**	DEŇ/MESIAC: 03/04
year average	40,6	year min.	**0,5**	DEŇ/MESIAC: 01/11

MSD	kg/s	:	1,365
YRSD	**t**	:	43169,4
SYRSD	t/km2	:	23,6



sediment discharge

ROČNÉ SPRACOVANIE PLAVENÍN [mg.l-1]

station : Zdana **year** **ROK : 1994**
river : Hornad **PLOCHA POVODIA : 4232,2 km2**

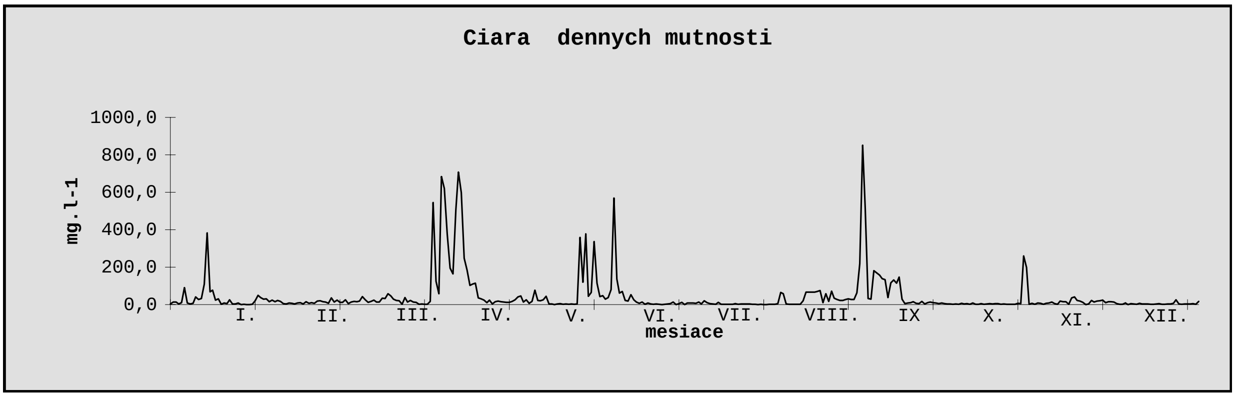
month day	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
7	3,6	49,0	24,1	1,6	12,3	114,9	11,3	1,6	63,2	7,8	2,0	14,1
2.	12,9	37,1	11,3	0,9	17,1	42,3	0,7	2,4	218,4	5,8	6,9	4,5
3.	13,2	28,2	12,7	16,3	25,2	48,0	8,2	2,2	850,9	3,9	1,9	2,4
4.	4,1	31,0	25,0	546,1	41,0	29,8	8,6	4,4	513,9	3,6	9,1	1,2
5.	10,5	14,7	4,7	125,0	45,4	37,1	8,6	65,6	32,4	1,5	6,0	7,7
6.	90,3	23,6	13,1	58,8	13,3	80,7	7,5	58,9	29,9	4,1	2,5	0,8
7.	9,2	16,1	17,9	683,4	26,0	569,3	14,2	3,8	180,8	2,2	7,0	5,7
8.	2,9	22,7	16,2	621,1	7,5	136,2	3,2	1,1	169,5	6,2	8,6	3,1
9.	7,4	17,7	18,8	377,6	16,3	61,7	21,1	1,1	157,1	2,7	13,8	2,4
10.	40,6	5,8	43,0	195,5	77,5	69,7	10,5	1,8	138,7	4,7	5,5	6,8
11.	27,0	3,6	25,9	164,7	23,0	21,8	5,0	2,4	132,5	1,7	1,1	3,7
12.	32,8	9,3	11,9	506,5	21,0	19,2	3,7	1,9	38,4	9,4	19,0	3,6
13.	109,4	6,2	16,7	707,7	25,7	53,6	1,7	20,3	116,7	1,4	15,2	3,7
14.	383,5	3,0	23,1	598,3	44,4	25,7	12,8	67,3	132,3	2,5	14,9	1,3
15.	69,0	7,8	14,0	247,6	4,3	13,9	1,2	65,9	115,1	4,9	2,0	1,3
16.	77,6	10,7	13,5	184,0	3,7	6,6	1,8	66,2	146,2	1,3	36,3	3,5
17.	23,2	3,0	33,4	103,2	0,6	13,8	1,4	66,6	29,2	3,7	41,6	5,3
18.	31,5	15,7	32,5	108,7	4,2	2,0	2,5	70,1	4,3	5,1	21,4	0,9
19.	2,3	7,1	58,1	114,4	4,4	9,0	1,8	75,7	8,7	4,2	18,0	1,5
20.	9,3	10,8	46,7	36,6	1,6	3,1	5,1	10,7	11,0	4,4	11,2	3,8
21.	4,6	7,0	29,2	31,3	3,8	1,0	2,3	58,3	15,5	5,1	0,8	2,7
22.	25,2	18,5	22,8	24,1	2,5	4,0	3,9	17,4	7,5	1,3	3,1	7,2
23.	3,2	20,8	20,7	10,4	3,9	1,5	3,3	71,0	4,6	2,7	22,6	26,3
24.	3,7	15,6	1,5	24,5	2,5	0,6	3,8	33,9	16,6	1,0	13,8	2,9
25.	8,6	13,5	38,3	2,9	4,2	1,2	2,7	27,9	3,0	2,0	18,5	2,5
26.	0,9	7,4	13,3	15,4	359,7	3,1	2,0	22,3	10,0	1,9	20,9	2,6
27.	2,5	35,1	22,3	18,2	120,5	4,7	2,1	23,1	13,4	1,9	24,0	2,6
28.	0,6	13,2	13,6	15,8	378,1	14,0	0,7	27,9	9,8	6,0	9,7	3,0
29.	0,7		11,7	13,7	44,6	0,2	1,5	30,5	7,9	4,8	15,4	4,4
30.	1,0		2,2	11,3	65,6	6,0	0,5	27,2	5,1	259,7	15,4	1,3
31.	19,9		3,5		337,1		0,4	27,7		198,5		17,7

sum	1030,9	454,3	641,7	5565,7	1736,9	1394,6	154,0	957,1	3182,5	565,9	388,1	150,5
mean	33,3	16,2	20,7	185,5	56,0	46,5	5,0	30,9	106,1	18,3	12,9	4,9
MAX.	383,5	49,0	58,1	707,7	378,1	569,3	21,1	75,7	850,9	259,7	41,6	26,3
MIN.	0,6	3,0	1,5	0,9	0,6	0,2	0,4	1,1	3,0	1,0	0,8	0,8

5

year sum	16222,3	year max.	**851,0**	DEŇ/MESIAC: 3/9
year mean	44,4	year min.	**0,2**	DEŇ/MESIAC: 29/6

MSD	kg/s	1,04
YRSD	**t**	32671,0
SYRSD	t/km2	7,72


Ciara dennych mutnosti

ROČNÉ SPRACOVANIE MÚTNOSTI PLAVENÍN [mg. l $^{-1}$]

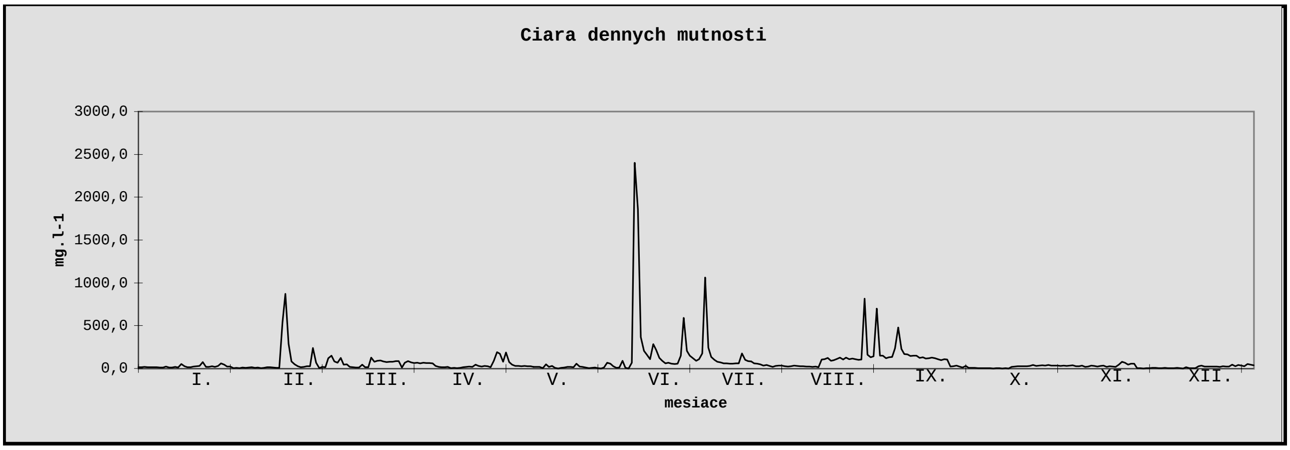
sediment discharge

station :	**8930 ŽDAŇA**	**year**	**ROK**	**:**	**1995**
river :	**HORNÁD**		**PLOCHA POVODIA :**		**4232,20 km^2**

month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	16,0	3,6	3,5	63,9	186,4	1,6	120,0	22,8	147,8	5,9	35,3	4,4
2.	15,7	7,3	16,9	66,3	75,1	9,5	89,1	27,9	119,2	4,5	35,6	5,7
3.	17,8	4,5	16,0	60,7	44,0	67,1	107,4	33,2	131,4	2,7	26,8	4,4
4.	16,1	12,9	118,5	66,8	30,6	55,0	174,2	29,1	133,0	5,3	24,7	4,7
5.	15,5	6,9	150,1	62,0	28,3	25,8	1063,9	24,5	235,7	3,6	33,8	2,9
6.	16,2	9,8	83,9	65,2	27,8	6,8	241,7	25,3	480,0	2,0	20,3	6,2
7.	14,5	16,1	69,1	58,2	28,3	10,2	136,4	22,2	226,7	1,4	20,7	3,0
8.	12,7	6,4	122,2	31,6	24,4	89,9	100,2	21,9	169,3	4,4	34,8	0,8
9.	12,8	10,7	43,9	18,5	27,8	9,3	80,3	17,3	163,4	5,5	31,7	13,6
10.	20,6	3,9	49,3	15,4	19,9	1,8	70,2	20,9	147,2	0,9	21,3	4,6
11.	12,3	6,2	19,0	16,5	18,1	68,7	59,3	15,9	148,3	3,2	29,2	3,1
12.	10,1	15,1	15,2	18,7	18,3	2402,2	59,5	106,3	150,0	0,4	32,0	2,6
13.	20,0	14,1	12,9	4,7	4,4	1861,0	55,3	107,4	124,4	17,1	18,0	26,3
14.	11,8	10,7	11,7	7,6	47,0	365,3	55,7	121,6	129,4	21,7	26,4	33,5
15.	50,6	7,9	43,7	2,4	18,2	204,7	60,0	88,9	117,3	26,3	21,8	23,8
16.	25,6	8,6	13,9	8,3	29,2	160,1	60,3	98,3	121,3	26,1	20,0	22,3
17.	13,5	538,3	14,1	13,5	7,1	108,1	176,5	110,8	126,4	26,0	46,0	20,8
18.	15,0	873,1	128,6	18,4	1,6	283,7	101,5	127,1	120,7	26,2	77,4	22,5
19.	21,6	289,8	77,7	22,1	7,5	218,1	86,9	106,2	109,6	30,7	68,9	21,7
20.	27,6	84,1	90,4	19,2	9,6	124,7	81,3	126,2	98,4	42,0	44,7	20,4
21.	29,5	47,4	95,0	45,1	17,9	90,3	61,2	109,1	106,7	30,7	55,6	27,1
22.	73,4	24,6	82,3	30,9	18,5	60,7	56,7	114,9	106,5	32,3	55,2	23,7
23.	20,2	16,3	76,1	21,6	14,4	67,6	50,3	108,9	21,5	35,6	4,3	23,7
24.	19,5	19,0	77,6	28,8	55,4	57,4	32,1	100,3	24,5	34,3	2,5	44,3
25.	24,6	25,4	78,0	25,9	20,7	51,5	41,5	105,1	32,8	40,0	1,7	26,7
26.	17,6	24,9	86,2	15,2	19,6	54,5	30,4	814,8	23,6	33,0	2,5	39,6
27.	28,9	241,1	86,1	90,1	10,7	149,2	20,0	159,9	13,0	32,6	3,1	31,9
28.	61,4	68,4	11,9	190,5	2,0	590,6	29,9	130,9	29,4	33,3	5,8	27,0
29.	44,0		68,5	172,9	5,8	204,9	32,2	143,0	7,6	31,7	6,2	51,7
30.	22,9		87,6	79,5	9,7	148,9	34,7	698,0	7,4	32,3	3,7	45,1
31.	20,7		70,5		4,5		25,5	149,3		29,4		37,0
sum	728,4	2397,1	1920,5	1340,6	832,6	7549,0	3394,2	3887,9	3572,3	621,1	809,4	625,1
mean	23,5	85,6	62,0	44,7	26,9	251,6	109,5	125,4	119,1	20,0	27,0	20,2
MAX.	73,4	873,1	150,1	190,5	186,4	2402,2	1063,9	814,8	480,0	42,0	77,4	51,7
MIN.	10,1	3,6	3,5	2,4	1,6	1,6	20,0	15,9	7,4	0,4	1,7	0,8

year sum	27678	year max	2402,17	DEŇ/MES./HOD.:	12 / VI
year average	75,8	year min.	0,44	DEŇ/MESIAC:	12 / X

MSD	kg/s	:	1,990
YRSD	t	:	62756,6
SYRSD	t/km2	:	14,8



ROČNÉ SPRACOVANIE PLAVENÍN [mg. l^{-1}]

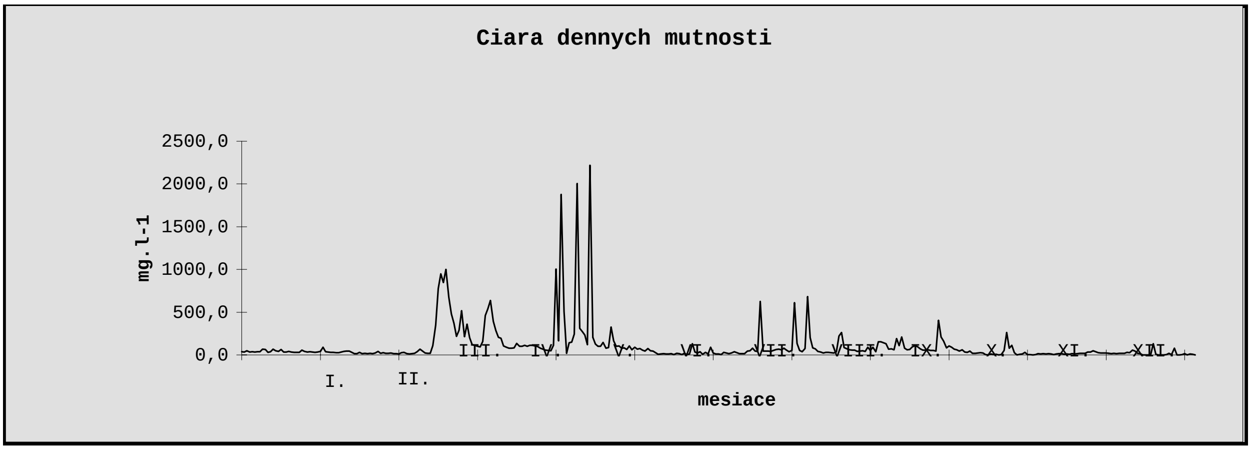
sediment discharge

station :	**8930 ŽDAŇA**	**year**	**ROK:**	**1996**	
river :	**HORNÁD**		**PLOCHA POVODIA :**	**4232,2**	**# km^2**

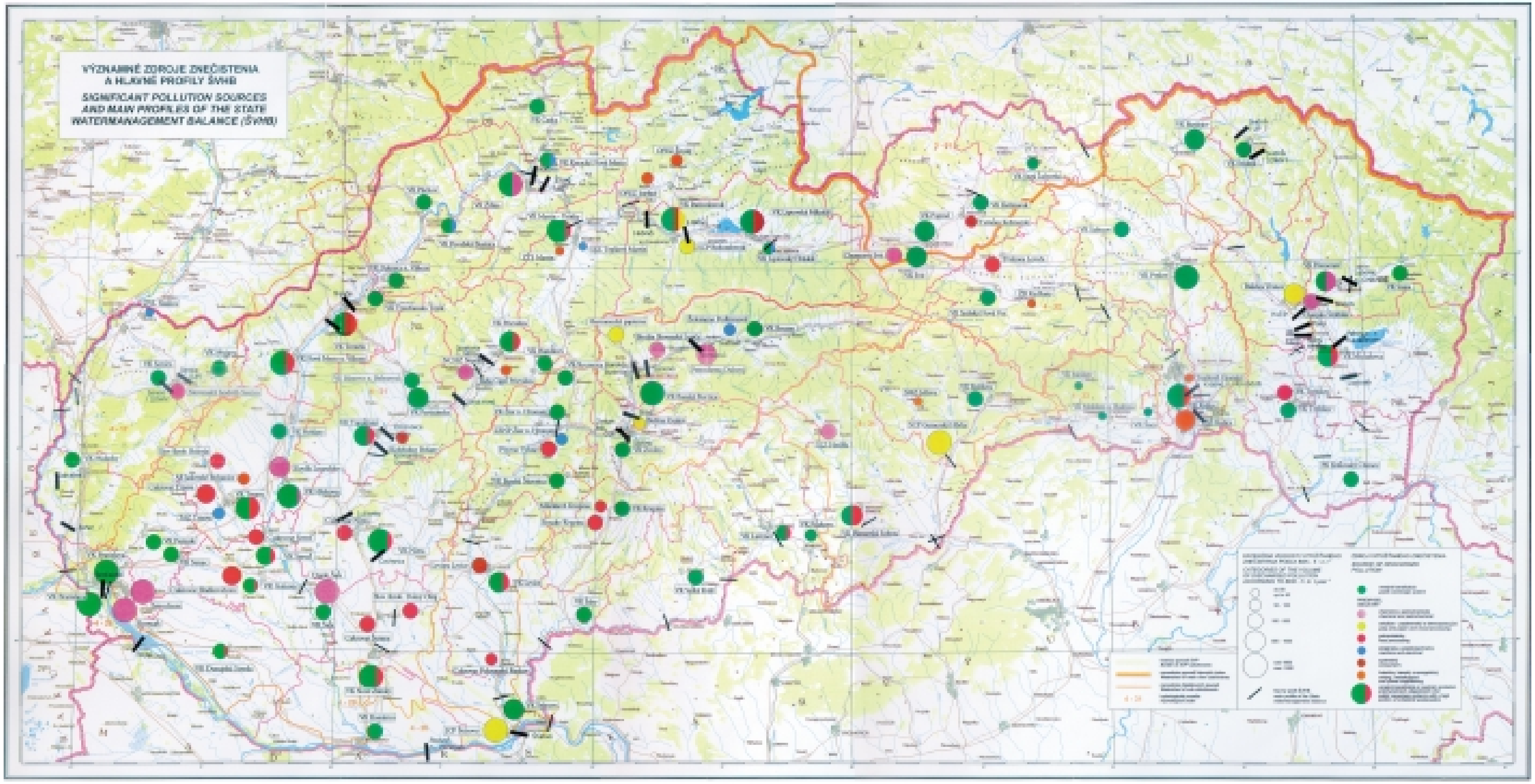
month **day**	**I.**	**II.**	**III.**	**IV.**	**V.**	**VI.**	**VII.**	**VIII.**	**IX.**	**X.**	**XI.**	**XII.**
1.	38,7	88,6	13,7	99,6	1004,0	66,3	11,1	135,8	152,9	59,6	13,2	15,4
2.	35,0	36,1	11,2	92,0	163,1	75,1	10,6	53,7	153,7	44,9	11,9	19,0
3.	47,5	31,9	25,9	156,3	1876,5	55,1	5,2	36,0	144,0	60,0	13,9	20,1
4.	34,7	31,0	28,7	460,4	509,8	43,3	29,6	73,1	129,7	34,9	12,1	17,1
5.	39,3	28,8	14,0	539,2	18,3	73,7	21,4	682,4	68,8	28,3	15,0	28,5
6.	34,8	25,0	13,0	636,8	143,2	47,1	13,7	201,9	70,8	44,7	11,5	27,6
7.	36,5	28,0	16,6	394,8	149,8	46,3	20,8	81,7	59,2	18,3	3,4	57,0
8.	37,2	32,3	17,4	286,2	243,1	26,2	36,9	71,6	190,9	18,6	9,9	45,5
9.	66,0	42,1	36,0	204,7	2004,2	6,4	26,5	40,9	107,2	24,1	13,7	17,7
10.	63,5	46,2	69,3	196,1	309,3	9,4	14,0	34,2	208,8	26,0	14,0	16,0
11.	31,5	45,7	44,0	105,0	275,3	14,6	15,1	24,2	77,0	20,7	9,0	1,0
12.	37,9	29,0	21,8	89,5	233,1	10,4	16,2	30,6	58,6	4,0	9,6	1,3
13.	66,4	14,5	20,3	77,5	118,5	10,9	44,0	30,2	62,3	0,3	9,2	0,6
14.	49,6	14,7	17,8	80,4	2217,8	13,4	48,4	27,0	91,9	11,8	13,3	2,4
15.	39,7	31,8	109,9	83,7	204,8	2,9	77,5	24,1	108,2	5,0	11,0	130,1
16.	62,1	15,0	348,6	136,6	126,0	20,3	46,3	36,9	96,4	5,7	13,9	6,6
17.	33,4	18,5	776,0	101,2	99,7	14,6	41,5	220,7	70,6	1,1	18,6	1,7
18.	33,3	13,5	948,2	99,5	101,6	2,5	627,3	262,6	57,3	3,7	17,8	1,0
19.	41,8	17,4	846,1	114,1	144,9	17,6	43,2	87,4	58,1	52,0	17,8	0,8
20.	33,2	16,1	1001,5	103,0	78,7	4,5	44,0	71,6	60,4	263,8	32,4	3,1
21.	31,4	21,7	676,1	111,2	87,1	9,8	43,1	61,2	53,1	79,6	35,2	20,1
22.	31,8	41,2	479,0	111,1	327,8	130,5	42,2	55,4	54,1	113,5	49,9	2,9
23.	30,2	18,3	370,7	105,6	163,7	34,5	52,3	55,4	45,5	25,1	37,8	80,6
24.	57,0	24,9	218,8	98,0	102,4	21,3	64,9	43,0	404,7	1,0	24,6	1,2
25.	42,9	18,2	287,4	79,9	104,4	39,2	66,6	44,6	211,1	6,9	21,3	0,6
26.	33,5	17,9	517,4	67,0	78,9	8,1	59,0	48,6	161,9	10,8	21,7	2,3
27.	37,4	22,7	212,7	56,0	81,2	30,5	79,0	42,6	83,4	28,6	22,3	14,8
28.	33,7	16,2	359,9	53,9	64,9	10,5	55,4	88,8	105,9	3,9	18,8	0,9
29.	31,0	15,6	200,6	48,9	105,3	91,5	37,8	53,1	88,5	4,1	15,7	11,5
30.	34,9		118,7	111,4	61,1	22,6	54,0	88,6	68,7	0,1	16,9	7,5
31.	39,8		113,6		90,3		612,4	38,8		4,0		1,7
sum	1265,4	802,8	7934,9	4899,4	11288,7	958,7	2359,8	2846,8	3303,2	1005,0	535,2	556,3
mean	40,8	27,7	256,0	163,3	364,2	32,0	76,1	91,8	110,1	32,4	17,8	17,9
MAX.	66,4	88,6	1001,5	636,8	2217,8	130,5	627,3	682,4	404,7	263,8	49,9	130,1
MIN.	30,2	13,5	11,2	48,9	18,3	2,5	5,2	24,1	45,5	0,1	3,4	0,6

year sum	37756	year max.	**2217,8**	DEŇ/MESIAC: 14/05
year average	103,2	year min.	**0,1**	DEŇ/MESIAC: 30/10

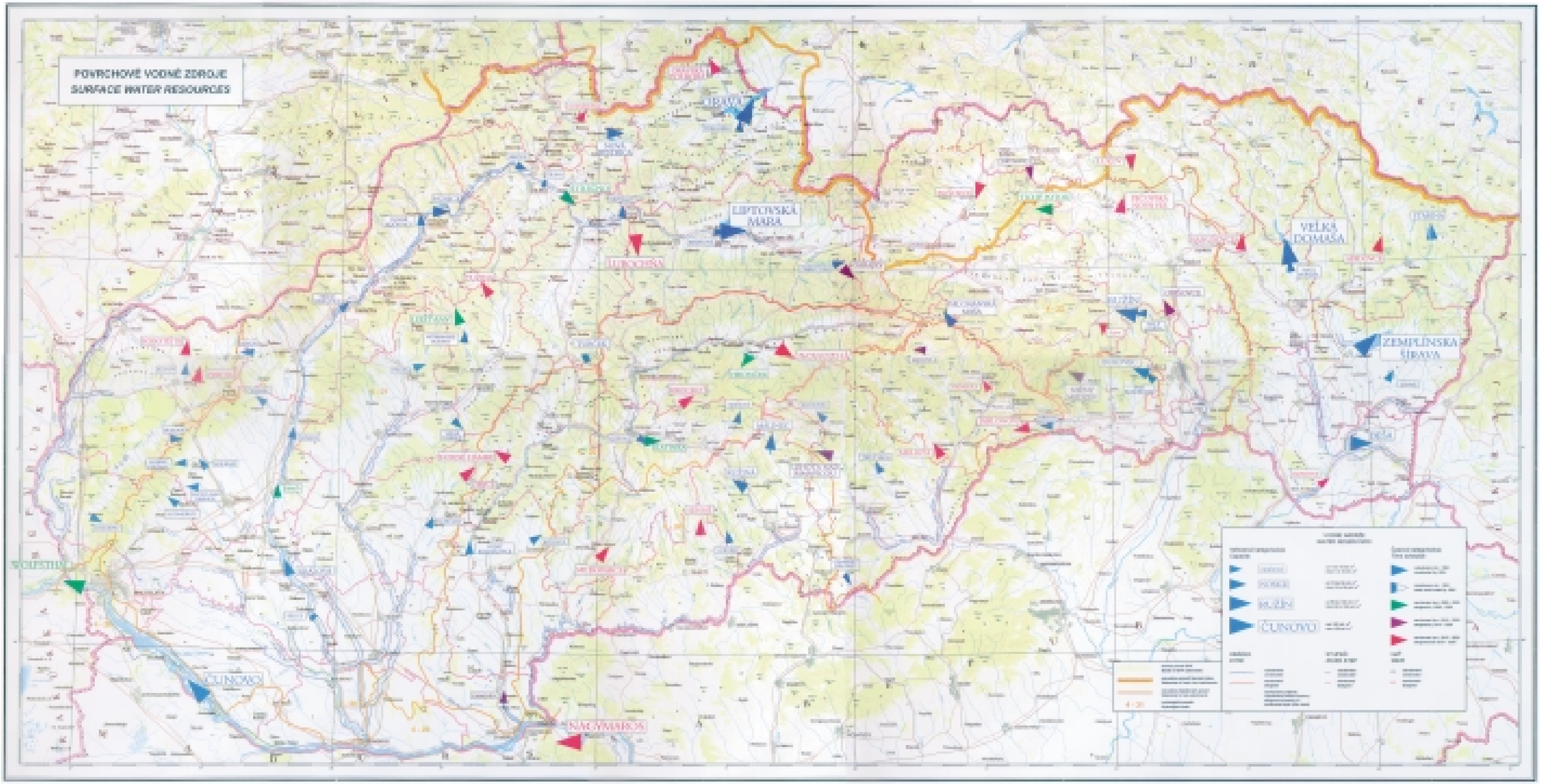
MSD	kg/s	:	5,330
YRSD	t	:	168445,0
SYRSD	t/km2	:	39,8



Maps



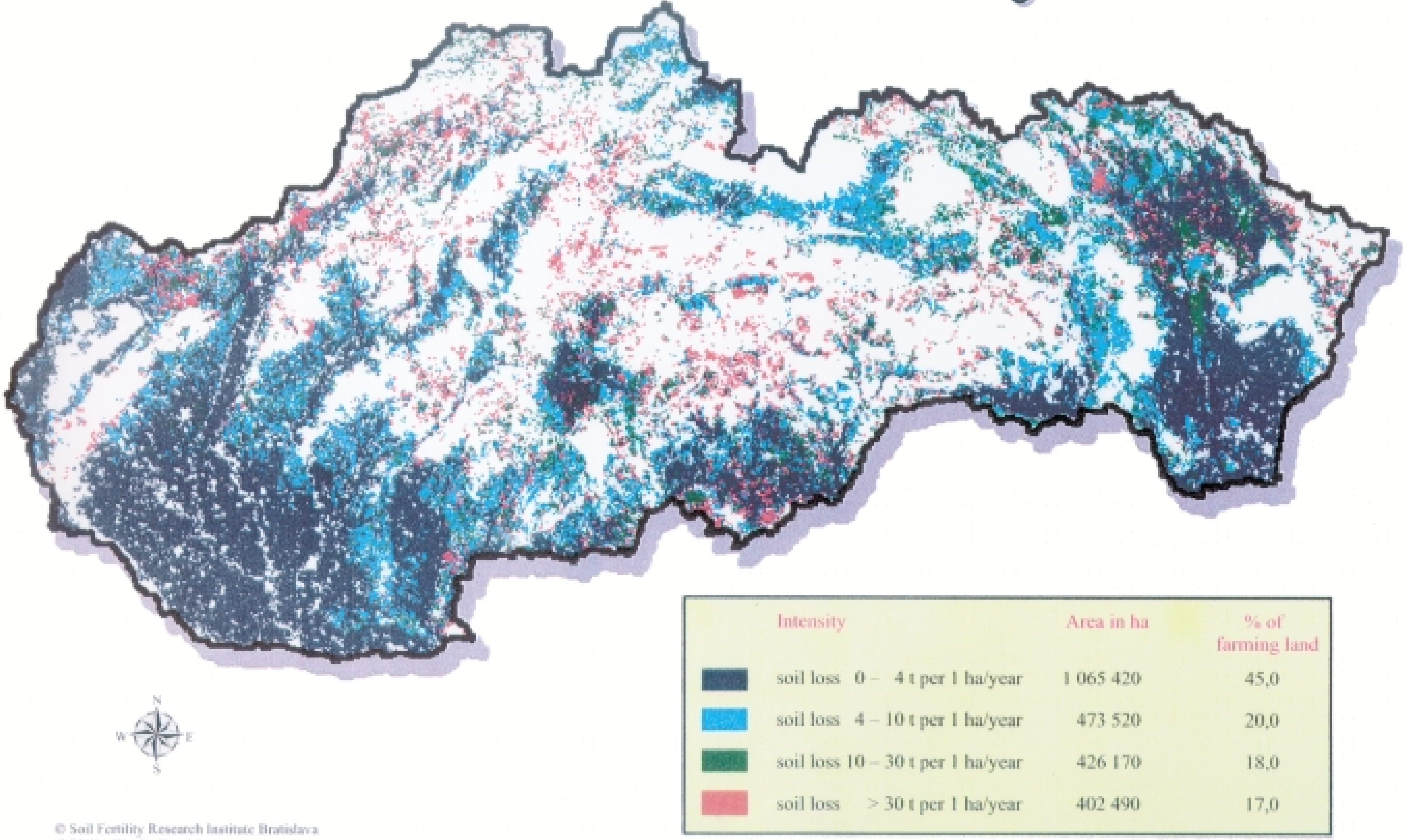
Surface water resources



Significant pollution sources and main profiles
of the State Water Management Balance

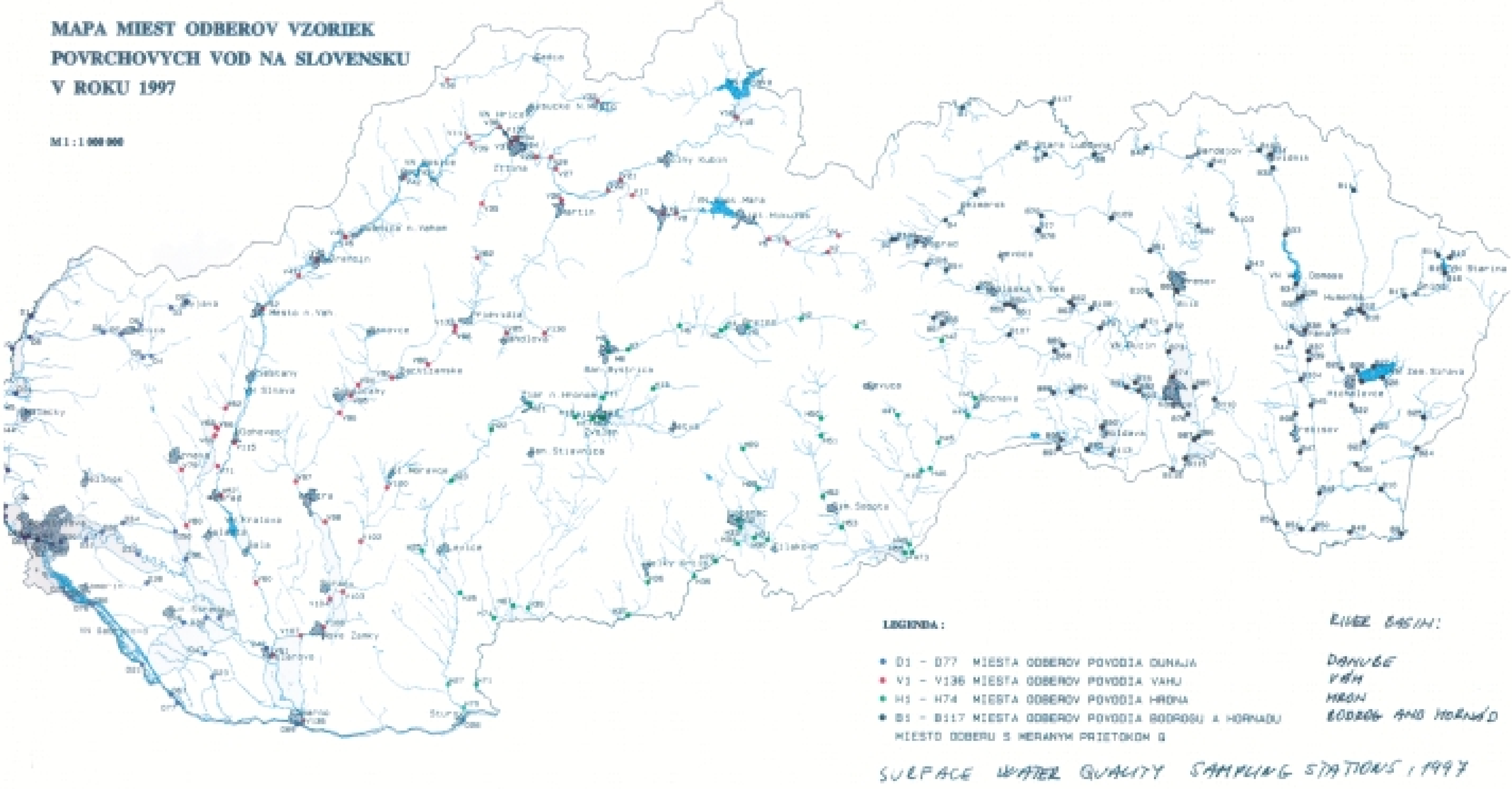
Surface water quality sampling stations
in year 1997

Potential Water Erosion Risk on Slovakia Agricultural Soils

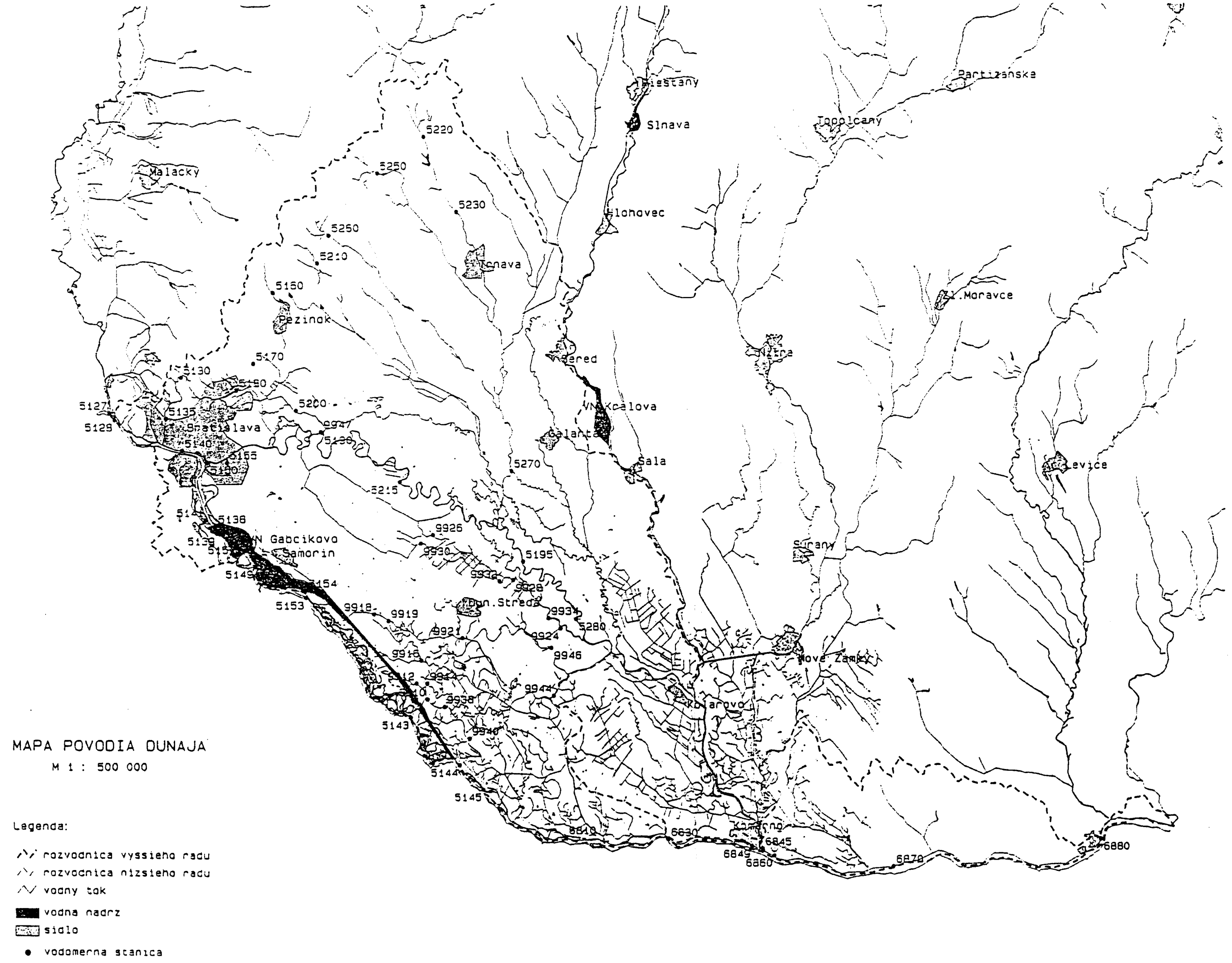


	Intensity	Area in ha	% of farming land
🟦	soil loss 0 – 4 t per 1 ha/year	1 065 420	45,0
🟦	soil loss 4 – 10 t per 1 ha/year	473 520	20,0
🟩	soil loss 10 – 30 t per 1 ha/year	426 170	18,0
🟥	soil loss > 30 t per 1 ha/year	402 490	17,0

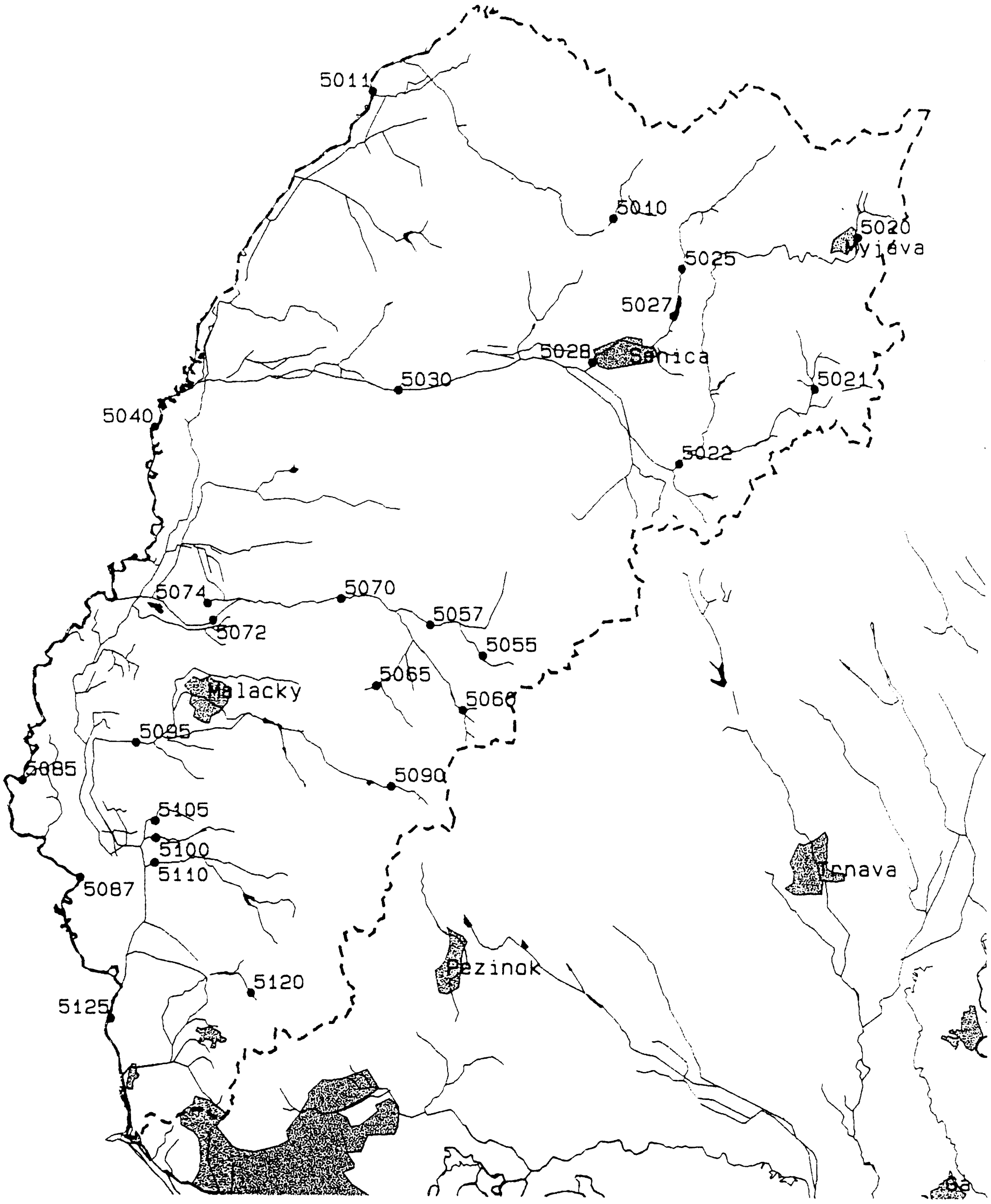
© Soil Fertility Research Institute Bratislava
© RNDr. Blanka Ilavská
Ing. Martin Granec



Gauging stations in Slovak part of Danube River basin (1997)



Gauging Stations in Slovak part of Danube River basin



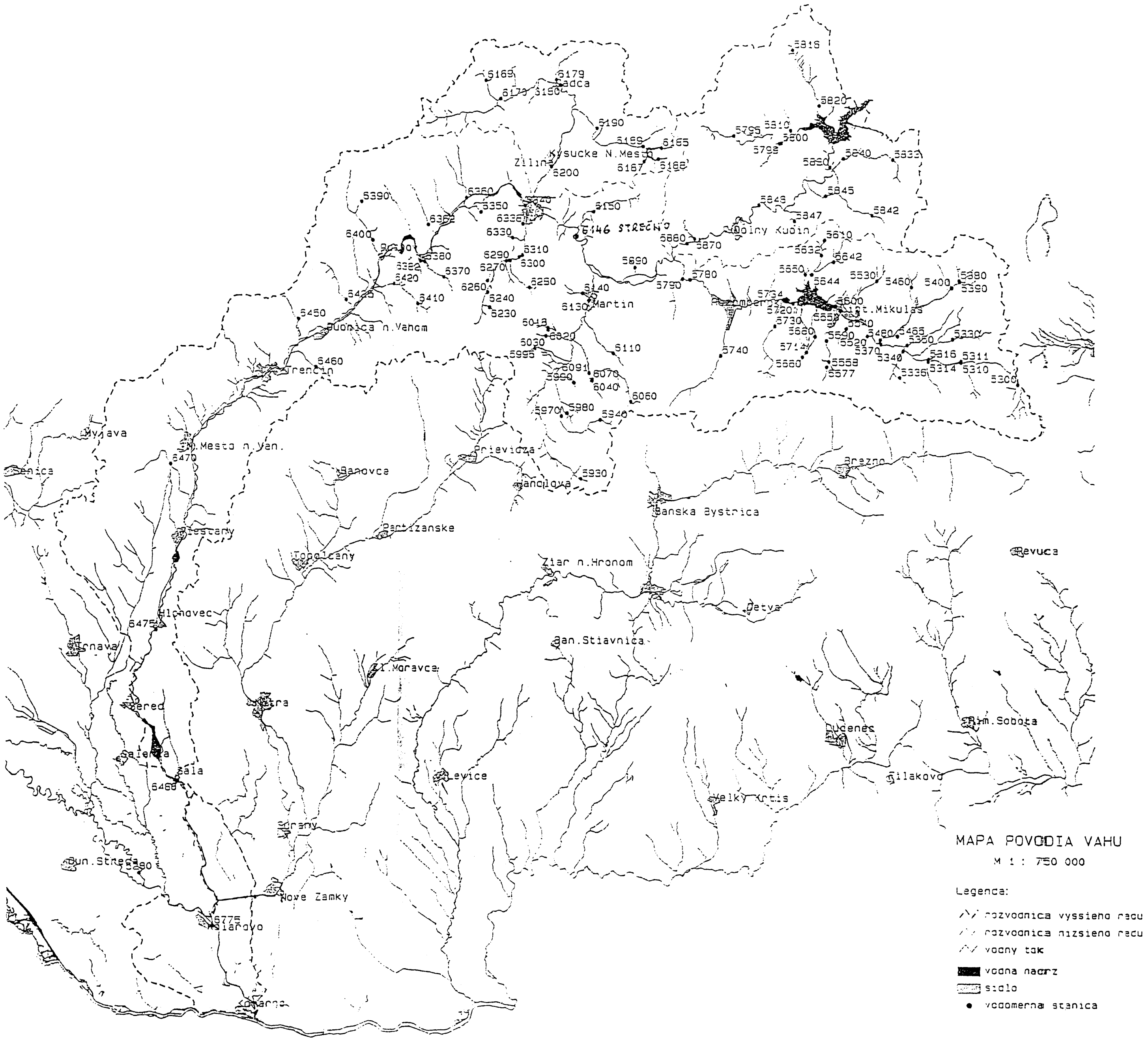
MAPA POVODIA MORAVY

M 1 : 500 000

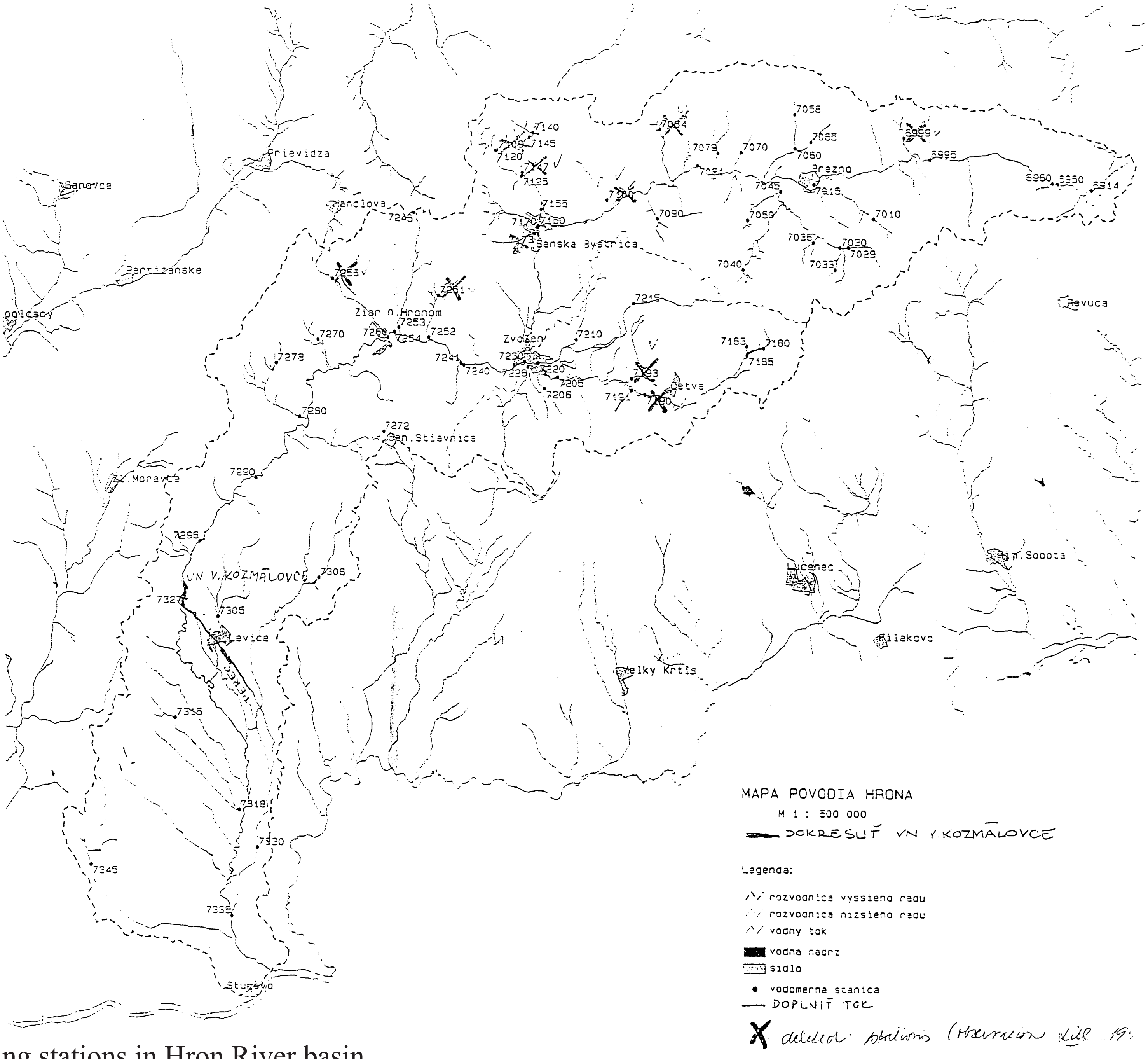
Legenda:

rozvodnica vyssieho radu
rozvodnica nizsieho radu
vodny tok
▬ vodna nadrz
▨ sidlo
● vodomerna stanica

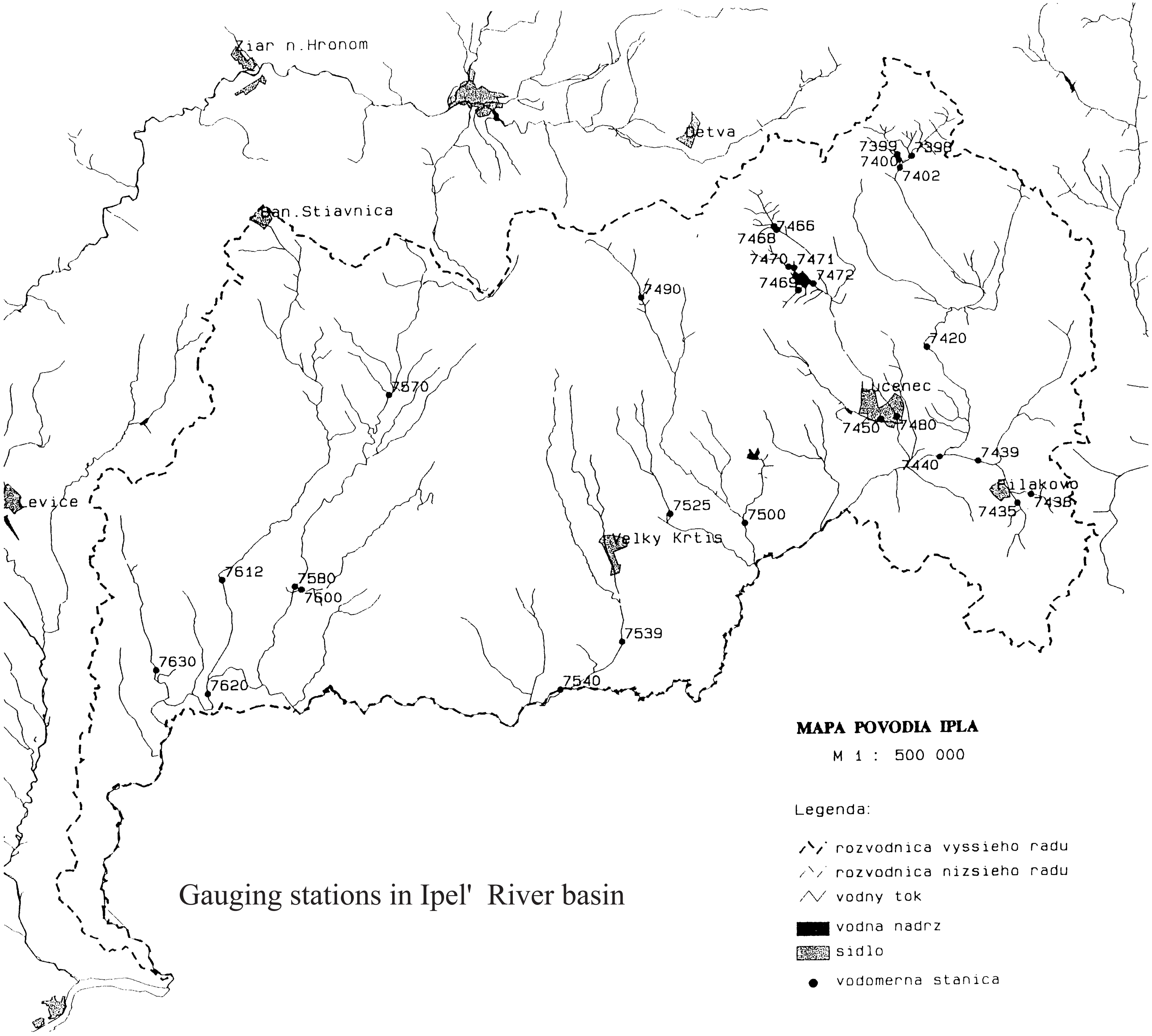
Gauging stations in Morava River basin



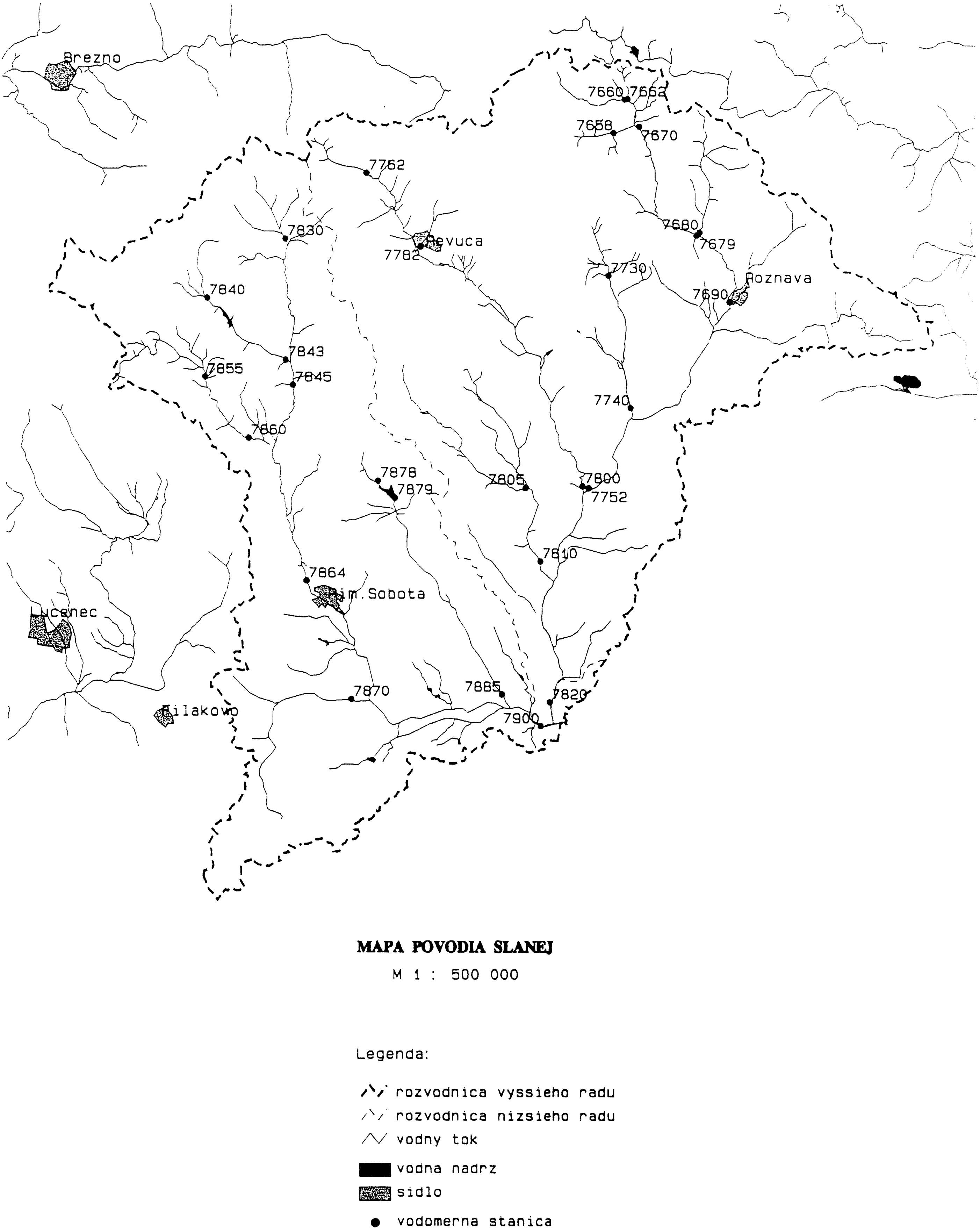
Gauging stations in Vah River basin



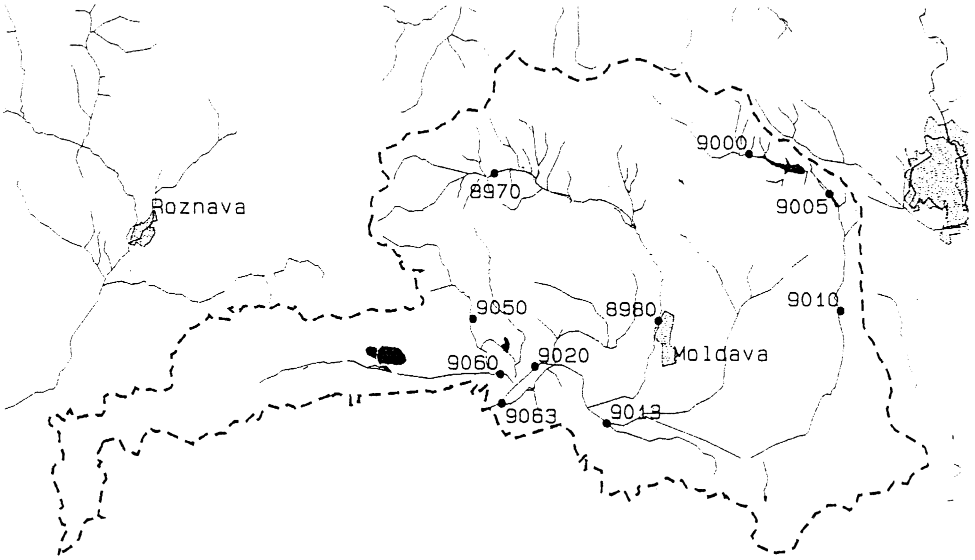
Gauging stations in Hron River basin



Gauging stations in Ipel' River basin



Gauging stations in Slana River basin



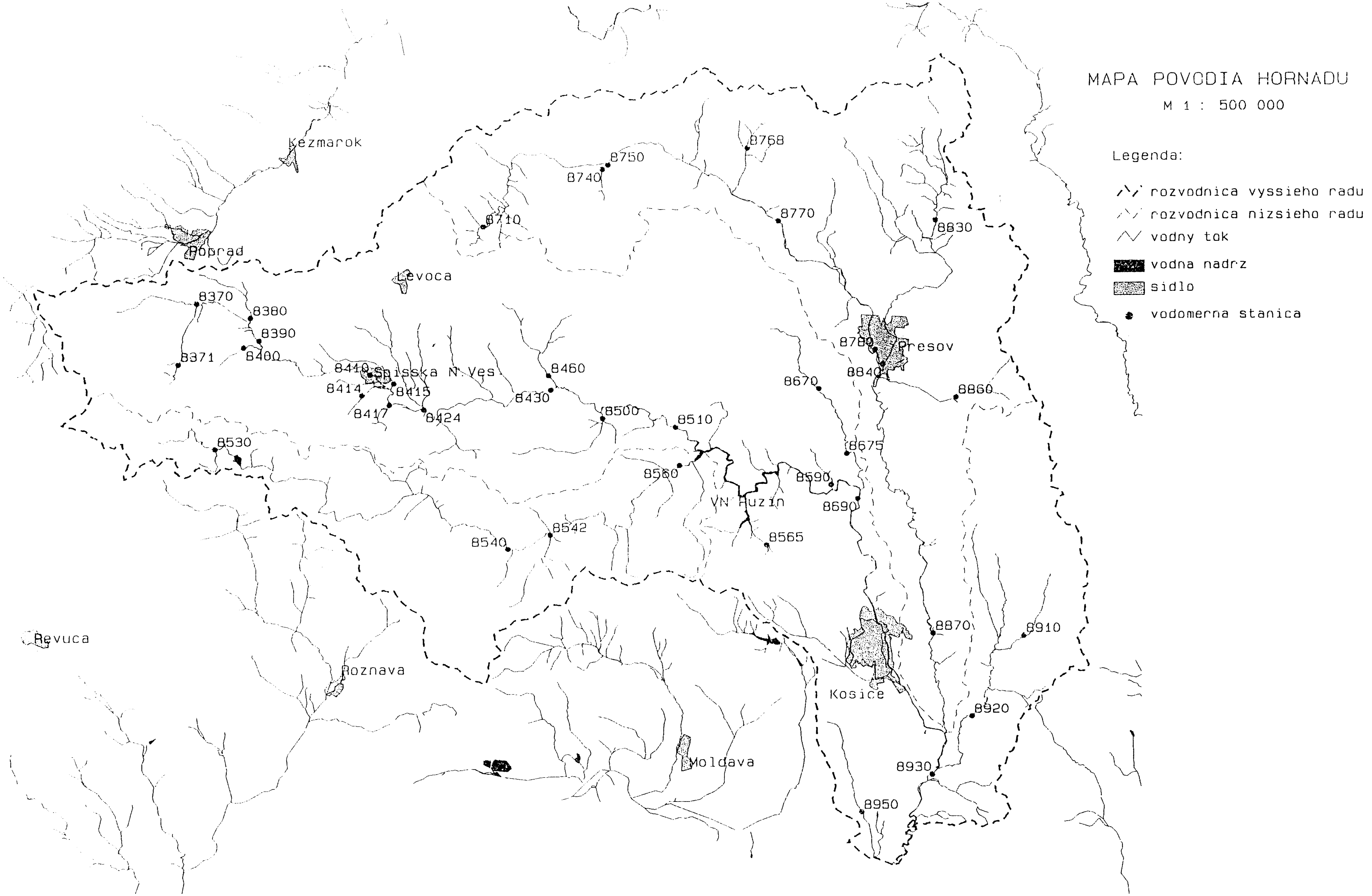
MAPA POVODIA BODVY

M 1 : 500 000

Legenda:

rozvodnica vyssieho radu
rozvodnica nizsieho radu
vodny tok
■ vodna nadrz
▨ sidlo
● vodomerna stanica

Gauging stations in Bodva River basin



Gauging stations in Hornad River basin

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Part D

Water Environmental Engineering

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Annexes

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List of Abbreviations
on Water Environmental Engineering

AOX	halogens compounds
BOD$_5$	biochemical oxygen demand (5 days)
CEN	European Commission for Standardization
COD	chemical oxygen demand
DO	dissolved oxygen
DS	dry solids
ECU	European Currency Unit; 1 ECU = 38,3 Sk
ES	European Standards
EU	European Union
GDP	Gross Domestic Product
GNP	Gross National Product
GIS	geographic information systems
ISO	international standardization organization
kg/kg/d	kilograms per kilograms per day
l/cap/d	liters per capita per day
l/s	liters per second
m^3/s	cubic meters per second
mg/l	milligrams per liter
MNC	millions in national currency
MUS$	millions in US$
NAP	Slovak National Action Plan for the Danube River Basin
ORP	oxidation-reduction potential
P.E.	population equivalent
Q$_{24}$	average flow rate
US$	1 US$ = 34,5 Sk
SAP	Strategic Action Plan for the Danube River Basin
Sk	Slovak crown: 34,5 Sk = 1 US$, 38,3 Sk = 1 ECU
SS	suspended solids
STN	Slovak Technical Standards
t/year	tons per year
TIN	total inorganic nitrogen
TN	total nitrogen
TP	total phosphorus
UN	United Nations
WWTP	wastewater treatment plant

Glossary
on Water Environmental Engineering

Activated sludge	apart of the living biomass, the suspended solids contain inorganic as well as organic particles. Some of the organic particles can be degraded by subjecting them to hydrolysis whereas others are inert
Activated sludge process	a process if the mass of activated sludge is kept moving in water by stirring or aeration. The amount of sludge is regulated through recycle of the suspended solids and by removing so called excess sludge.
Agrochemical	all chemicals used in agriculture (pesticides, herbicides, fertilizers, etc.)
Anaerobic process	processes where neither oxygen nor nitrate is present
Anoxic	lacking oxygen. A part of reactor usually uses for denitrification.
Best Available Techniques (BAT)	latest stage of development of processes emphasizing the use of non-waste technology, of facilities or the methods of operation, which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste.
Best Environmental Practice (BEP)	application of the most appropriate combination of sectoral environmental control strategies and measures. It is applied to non-point sources of pollution.
Biodiversity	the sum total of different species of flora and fauna in a given region, area or habitat
Biochemical Oxygen Demand (BOD)	a measure of the quantity of oxygen used in the biochemical oxidation of carbonaceous and nitrogenous compounds a specified time, at a specified temperature and under specified conditions. The standard measurement is made for five days at 20^{o}C and is termed BOD_5.
Danube Environmental Program	a programme of co-operation established by Danubian countries, bilateral and multilateral donors, international organizations and NGOs.
Denitrification	the process whereby nitrate is successively reduced to nitrogen, facilitated by bacteria in the presence of a carbon source and other nutrients
Discharge	the flow rate of a fluid at a given instant expressed as volume per unit of time
Ecological Agriculture	see Organic Farming
Ecosystem	a natural unit consisting of living and non-living parts interacting with each other, formed by the organisms of a natural community and their environment

Effluent standard	see emission limit
Emission	release of substances from a source
Emission limit	a numerical limit set on the emission of a substance from a source of pollution
End of pipe limit	see emission limit
Environmental Water Quality Standard (ambient)	the requirements, which must be fulfilled by a given environment or part thereof (e.g. ground water, surface water, etc.)
Eutrophication	the process of over-fertilization of a body of water by nutrients producing more organic matter than the self-purification processes can overcome
GDP	Gross Domestic Product - a measure of the total flow of goods and services produced by the residents within the country over a specified period, normally a year
GNP	Gross National Product - GDP + the income accruing to domestic residents from investment abroad less income earned in the domestic market accruing to foreigners abroad
Groundwater	all subsurface water
Hazardous Substances	substances which have adverse impacts on living organisms, e.g. toxic, carcinogenic, mutagenic, teratogenic, harmful for the environment.
Hot spot	a local land area, stretch of surface water or specific aquifer, which is subject to excessive pollution and which requires specific action to prevent or reduce the degradation caused
Hydrocarbons	petroleum products
Chemical Oxygen Demand (COD)	a measure of the quantity of oxygen used in the chemical oxidation of compounds in a specified time, at a specified temperature and under specified conditions
Immission	the concentration of pollutants in a surface water (see environmental quality standards)
Integrated water management	a participatory planning, decision making and implementation process that takes into account the specific water quality and quantity requirements of all users and uses
Karstic water	groundwater found in the heavily fissured exposed limestone rock formation very common in the Danube River basin
Landfill	disposal of solid waste materials at land based sites
Leachate	liquid which has percolated through a substrate (e.g. soil, ore, waste dump, etc.)
Load	the quantity of a substance or material carried or transported by a river (and its associated hydrological processes)

Microbiological contamination	pollution with microorganisms - such as viruses, bacteria, protozoa, etc. - that might cause diseases in humans or animals
Micro-pollutants	organic or inorganic substances such as PCB, dioxin, cadmium, mercury, etc. that will create negative health impacts or adverse ecological changes even when present in low concentrations
Nitrate	NO_3^-
Nutrient	a substance, element or compound necessary for the growth and development of plants and animals
Organic farming	agriculture production system where each farm is considered as a whole where all components - soil minerals, organic matter, micro-organisms, insects, plants, animals and human - interact without the use of synthetic fertilizers
Point Source, non-point source	a localized discharge of pollutants (e.g. from an industrial plant); diffuse pollution in a catchment area (agricultural run-off)
Polluter Pays Principle	principle that the polluter should carry the costs of the measures required to diminish or clean up pollution
Pollution	the discharge, directly or indirectly, of compounds from sources into the environment in such quantity as to pose risk to human health, living resources or to aquatic ecosystems, damage to amenities or interference with other legitimate uses of water
Population Equivalent (P.E.)	used as a measure of water pollution load based on figures of an average ‘pollution production’ of one person in one day. In Slovakia used figure is BOD_5 = 60 g per capita per day.
Primary treatment	a one-step treatment process of urban wastewater by a physical or chemical process involving settlement of suspended solids
Project File	a questionnaire about the ongoing, planned programme or project expected to reduce the Danube River pollution
Rehabilitation	improvement of a visual nature to a natural resource or, putting back infrastructure into good condition or working order
Restoration	return of an ecosystem to a close approximation of its condition prior to disturbance
Secondary treatment	treatment of wastewater by a process generally involving biological treatment with the secondary settlement or other process
Sludge age	the mean cell residence time of sludge (biomass) in the WWTP
Stakeholder	a person who holds a sum of money deposited by the buyer in a transfer of ownership of land or a building; the deposit will be paid to the seller only if the buyer agrees, and vice versa. Or, a person, organization or subgroup of an organization that have a common interest in a project or activity
Sustainable development	the use of resources in such a way that the possible needs of future generations are not seriously affected

Tributary	a river which ultimately flows into the river
Water Quality criteria	a scientific requirement on which a decision or judgement may be based concerning the suitability of water quality to support a designated use
Water Quality Standard	see Environmental quality standard

1. Summary

1.1. National Targets and Instruments for Water Pollution Reduction

Since 1990, political, economic and social changes in Slovakia have influenced almost every element of socio-economic life, including water management. The ongoing economic transition has also affected the generation and quality of wastewater as well as the receiving water.

The sewerage is constantly behind the development of water supply systems in Slovakia. Only 12,96 % of settlements have complete sewer systems, which is about 53,03 % or 2.850.000 inhabitants of the total Slovak population. Since the majority of settlements in Slovakia are smaller towns or villages, the typical sewer system is the separate, only larger towns are served by combined sewer systems.

The level of wastewater treatment also lags behind western standards. Only about 90% of all collected wastewater is treated in 363 municipal wastewater treatment plants (WWTPs). The most WWTPs consist of mechanical and biological treatment. It is known that an amount of conveyed wastewater to WWTPs is bypassed to reduce their overloading especially during wet period. In Slovakia the smaller plants prevail. Due to the demographic situation of Slovak population and due to the more realistic local investment possibilities it is expected, that the small plants will be those most frequently designed and constructed also in the near future. Upgrading and expansion of existing WWTPs is typical for towns and cities beyond 20.000 inhabitants.

Sludge treatment and disposal is tremendous problem in Slovakia. In 1997 municipal wastewater treatment plants produced $89{,}8.10^3$ tons of dry solids (DS) of sewage sludge for disposal per year. The current complex situation and the future production of sludge are affected by two dominant factors: the changes in effluent standards and newer tighter sludge disposal regulations. The actual quality of the sludge as well as sewage sludge disposal regulations have resulted in a significant reduction of its agricultural utilization.

The transformation of the water industry is based on Government Resolution N^{o}. 621/1995 and Acts of the National Council SR N^{o}s. 481/1992 Dig. and 192/1995 Dig., and to accelerate this process the Slovak Government approved Resolution No.657/1996. Resolution No.6327/1997 set the timetable of the transformation. In 1998 607 municipalities applied for the transfer of waterworks assets. Water and sewage works have already prepared five privatized projects and a few of them are under implementation process, now.

The national targets for Water Pollution Reduction for the Danube River Basin have already been set up in the Slovak National Action Plan (NAP). NAP focuses on these three problems, which are: high load of N and P nutrients and eutrophication; changes in the regimes of the sediments flow and transport; contamination with harmful substances, including the oil substances. According to NAP the following measures will be necessary to provide in Slovakia: revitalization of the streams and wetlands; management of their development, to maximize their accumulation effects for the N and P nutrients, and at the same time to maintain their natural health state and biodiversity.

In Slovakia the priority of present goals is to reduce municipal emissions, which often contributes dominantly on the total load of the catchment. The point sources are relatively easier to reduce because of easy defined and known polluter subject. On the other hand, the reduction of diffuse pollution needs comprehensive measures in legislation, cross-sectional co-ordination, in the setting of priorities of national economy and environmental policy, etc. In addition it is very complex to introduce all of these extensive measures during socio-economic transformation of post-communist country. Due to these mentioned problems as well as the temporally sharp industrial fertilizers decreasing consumption in agriculture (only about 49 kg/hec of agriculture soil/year in 1996) the technical measures leading to the reduction of diffuse pollution are difficult to accelerate.

Water quality management in Slovakia is based on the Water Act and government directives, further supported by technical standards. The present Water Act is based on the former Czechoslovak Water Act No.138 from 1973 and is currently being revised. The Government Decree No.242/1993 is a legislative norm for the effluent standards. It was prepared with the aim to correspond with European legislation, especially with Directive 91/271/EEC. It represents a fusion of ambient water quality standards and (end-of-pipe) effluent standards common in European countries. An important feature of this Decree is the step-wise approach of setting effluent standards: till December 31, 2004 and more stringent after January 1, 2005. In Slovakia the majority of watercourses are very sensitive due to their low dilution rate.

In spite of this fact that the SR is only affiliated member of the European Commission for Standardization (CEN) there is a tendency to take over the European Standards (ES) and incorporate them into Slovak Technical Standards (STN) in the field of water and wastewater management. The most important Standard will be the *STN 73 6707 Municipal Wastewater Treatment Plants from 1983* in the field of water pollution control.

It is expected that the significant cost implications on water management in SR will have the implementation of the EU Urban Wastewater Directive 91/271/EEC. The big cost implications of the Directive concerns with the requirements to ensure the construction of sewerage for the settlements with and more than 15.000 inhabitants till 31.12.2000 and after 31.12.2005 also for the settlements from 2.000 to 15.000 inhabitants. The most treatment plants, due to the fact that the Slovak territory is predominately sensitive, will have to be designed with nitrogen removal and larger ones with biological or even biological-chemical nutrient removal. All these treatment lines require the higher volumes of tanks, the higher level of automation and control and more sophisticate trained operators therefore not only the investment costs, but also operation and maintenance costs will dramatically increase.

1.2. Measures for Reduction of Water Pollution

The list of hot-spots have been prepared with the close co-operation with the *Water Quality National Expert* taking into consideration the list of hot-spots presented in Strategic Action Plan and National Action Plan for the Danube Basin of Slovak Republic. The projects and programmes identified actions for monitoring water pollution and water quality, wastewater treatment, protecting water resources, preventing environmental degradation, etc. The prepared list of hot spots supported by *Project Files* indicates the actual problems in the fields of municipal wastewater and industrial wastewater including partially the problems of waste disposal (landfills and lagoons).

The list of municipal hot spots using multi-criteria analysis are as follows: high priority: WWTP Košice, WWTP Nitra, medium priority: WWTP Malacky, WWTP Banská Bystrica, WWTP Michalovce, WWTP Svidník, Sewerage Trenčín right side, WWTP Humenné, low priority: WWTP Ružomberok, WWTP Topolčany, WWTP Liptovský Mikuláš, WWTP Ilava, WWTP Rožňava. All these projects are structural. WWTP Košice and WWTP Malacky have been identified as the most important municipal sources of transboundary pollution.

The group is presented mainly from the existing WWTP or WWTP under construction, upgrading and/or expansion. Their construction is often postponed for several years already, due to the lack of financial funds. Most of these plants are serving for larger towns and cities. The efficiency of the plants is designed according to Gov. Decree 242/93. This fact has the great impact on the of treatment line applied and thus on the reduction of point sources of nutrient discharges. Therefore most of them will be operated with nitrification and denitrification and the limited number with biological phosphorus removal. The small treatment plants are usually design as an extended aeration.

In the same way the list of the following industrial hot spots have been again prepared: high priority - NCHZ Nováky, Bukocel Hencovce; medium priority - PCHZ Žilina, Istrochem Bratislava, SH Senica nad Myjavou, Chemko Strážske; low priority - AssiDomän Štúrovo, Bučina Zvolen, Biotika Slovenská Lupča, Koželužne Bošany.

The project files document that there are two types of structural projects: the aims of the first group projects plan to implement the measures in the processes of industrial production of company (e.g. the reduction of water consumption, energy or chemicals savings, etc.), the second ones set the measures reducing the discharge pollution to surface receiving water or groundwater. This group contains the upgrading of existing treatment plant (a new aeration systems, expansion of biological treatment step, re-arrange of activation tanks to nitrification-denitrification, etc.), improving the state of existing sewer systems, connecting sewer systems to treatment plants or construction of basins to control the spills of chemicals to groundwater, etc.

The obtained results and the summary of recommended projects for landfill hot-spots are presented as follows: Krompachy - municipal and industrial landfill, Power plant Nováky-Kostoľany - final lagoon Chalmová, VSŽ Košice - reconstruction of wet waste tip, VSŽ Košice - reconstruction of dry waste tip and waste liquidation, Bukocel Hencovce - reconstruction of industrial landfill, Chemko Strážske - industrial landfill.

Most of these projects cover the protection of groundwater against the contamination with heavy metals and/or micro pollutants extracted from the site of landfill. The reconstruction of the landfills and/or their rehabilitation are also the typical measures included in the *Project Files.*

Only a small number of non-structural Project Files were obtained. Most of them are based on research and institutional programmes.

Generally more than *40 Project Files* were gained and the most of them were analyzed and utilized for the *Project Files* report.

1.3. Expected Regional and Transboundary Effects of Actual and Planned Measures

According to the effluent standards introduced by Gov. Decree N^o.242/1993 in many cases "hi-tech" treatment systems will have to become a standard technology in Slovakia. Because of the high loading of the biological step in majority of the larger treatment plants nutrient removal processes are ineffective at present.

The most of the existing municipal wastewater treatment plant are mechanical-biological. They are able to remove only easily biodegradable substrates (carbon substances). The present efficiency of nutrient removal in term of TN is about 25 % and TP about 35 %.

This fact reflects the designed treatment line in the most of Project Files obtained. Practically all the projects assume the treatment line with pre-denitrification and nitrification and a part of them includes also the biological phosphorus removal. The upgrading of the existing treatment plants has to consider with the nutrient removal to be able to reach the requirements of Gov. Decree 242/93. It was estimated, if the projects would be implemented, that the reduction of BOD_5 could be improved up to 35 % more, SS to 30 % and $N\text{-}NH_4^+$ about 10-15 % more. The reduction of TN and TP is very difficult to estimate, but if we assume that nowadays the efficiency of TN removal is about 25 % and TP is about 37 % we may assume that after pre-denitrification and nitrification the removal rate of treatment plant will be 60 - 70 % and in case of biological phosphorus removal (luxury-uptake) the concentration of TP could reduce to 20 - 25 % of total. If we assume that the total emission in terms of TN and TP discharged from the Slovakia territory drained to the Danube River Basin is about 59 KtN/year and 5 KtP/year, respectively, one may assume that after the implementation of the projects (including the municipal, industrial point sources and wetland project) the total impact of nutrients will be reduced to 55.374 tN/year and 4755 tP/year. The more significant impact on the reduction of nutrients can be pointed out if we only look at the reduction of point-source load in Slovakia. In this case the nutrient load would reduce from 20 ktN/year to 16.374 tN/year (reduction about 20 %) and 3 ktP/year to 2755 tP/year (reduction about 10 %). It is clear that the more significant reduction of nutrient pollution could be obtained if the problem of diffuse pollution was solved in Slovakia. Due to the fact that practically the total mass of pollution discharge to receiving water is flowing to Hungary the indicated reduction of nutrients will have the significant impact on transboundary effect, as well.

As far as the industrial pollution is concerned the reduction of nutrients could be similarly estimated as for municipal. However the significant impact on the aquatic environment would have the reduction of micro-pollutants, and hazardous substances such as caprolactam, methymethaclylate, hydroxylamin, ammonium, phenols, oil material, etc. From this point of view the important project (NCHZ Nováky) is the advanced treatment of the discharged wastewater contaminated by chlorinated hydrocarbons. The expected reduction is from 300 to 500 t/year. The present situation of many industrial sewer systems could be improved by their reconstruction as they are often defective and not only infiltration but also exfiltration should be considered.

The five industrial plants have the significant impacts on the transboundary pollution. There are Istrochem Bratislava, Slovhodváb Senica, Chemko Strážske (chemical factories), AssiDomän Packaging Štúrovo (paper industry), Bukocel Hencovce (wood company). All these plants (except Slovhodváb Senica) are covered by the projects defined in *Project Files*.

The theoretical estimation of discharged pollution and its reduction could be likely higher if the by-pass of many plants, even during dry period, would be excluded. The increasing of the treatment plant capacities, especially biological treatment step, could increase the portion of total treated wastewater collected in public or industrial sewer network.

The necessary measures in agriculture can reduce the transport of ammonium and phosphorus from manure and slurry to surface water. Over fertilization is a smaller problem in Slovakia.

The compilation of investment costs of the projects estimated in *Project Files* has revealed the huge requirements for investment costs in millions, as follows: municipal sector (10 projects)-105.512 US$, non-secured 53.278 US$, industrial sector (15 projects) - 101.662 US$, non-secured 85.461 US$, landfills (6 projects) - 43.501 US$, non-secured the same, non-structural (3) projects - 1.176 US$, non secured 1.102 US$.

It is expected that the privatization of water management, especially the transformation of water and sewage works, will also have the significant impact on the pollution discharge to surface water. The second expected influence on water quality will have the implementation of more stringent effluent standards set by Gov. Decree 242/93 after January 1, 2005, but the most important issues would be the approving of the new Water Act No.138, which is currently being revised.

2. National Targets and Instruments for Reduction of Water Pollution

2.1. Actual State of and Foreseeable Trends in Water Management with Respect to Water Pollution Control

Since 1990, political, economic and social changes in Slovakia have influenced almost every element of socio-economic life, including water management. The ongoing economic transition has also affected the generation and quality of wastewater. Increasing water prices have reduced and may continue to influence the decline of production of wastewater. Auspicious, these changes have positively improved the quality of particular parts of heavily polluted rivers in Slovakia by one or two water quality classes. However, it is expected that domestic wastewater discharges will not change significantly in spite of the liberalization of water price. Presently, state ownership is dominant in all sectors of water management; both the river basin authorities and the water boards are state owned enterprises. It is planned, however, that in the future only the strategically most important fields will remain in the hands of the state (e.g. most functions of the river basin authorities), utilities of both water and sewage works and river basin authorities will be privatized.

The territory of Slovakia is drained by ten major rivers, out of which nine belong to the Danube River basin. River Poprad (about 5 % of Slovakia) flows to the Baltic Sea. Nine basins (Lower Morava and Danube, Váh, Nitra, Hron, Ipeľ, Slaná, Hornád, Bodrog, Bodva) are fully described in *National Review, 1994*.

The most serious problem of the present is the water quality. The recent water quality does not satisfy all the requirements of users and the ambient water quality criteria.

The total river network in Slovakia covers 49.775 km of which 28.932,3 km are in the administration of river basin authorities. The systematic water quality monitoring has been performed on significant watercourses on a length of 3973 km i.e. 9 % of the total length of them. From 1994 Slovak Hydrometeorological Institute is a representative of regular monitoring of watercourses in 232 basic sample profiles and 7 particular ones. Number of monitored parameters varied form 70 to 30.

The most polluted watercourses in Slovakia are the Nitra River, the Trnávka, the Dolný Dudváh and the Čierna Voda.

Several years lasted the negative tendency of decreasing groundwater table level as an impact of long term deficiency of precipitation. Since 1982 the monitoring of groundwater quality is ensured by the Slovak Hydrometeorological Institute. Results of present water quality analysis indicate that there is a problem with the manganese and iron, nitrate, oil materials, phenols, trace substances and in some regions specific organic contaminants. In some Slovakian regions these substances have an impact on groundwater quality as a source for drinking water.

The population is **supplied** mainly by porous and fissure-karst **water**. From the 2.871 settlements in Slovakia, 1.820 have public water supply systems; expressed in percentage it is about 79,84% of the population (*Green Report, 1997*). Comparison with Western European values shows a significant lag in public water supply. The level of public water supply is different in particulate regions. Two districts have only 50 % of water supply and 5 have not reached 60 %. Per capita water consumption have decreased during the past six years from 433 l/cap.d (1990) including industry, to 301,5 l/cap.d (1996) in average. Water consumption in households decreased from 195,5 l/cap/day to the value of 134,6 l/cap/day, however in municipalities the specific household consumption was 83,3 l/cap/day in 1996, compared with the level of specific consumption in EU this value is seriously below the average and is close to the hygienic minimum (80 l/cap/day). The long-term trend of decreasing of drinking water was influenced also by price regulation for households (August 8, 1996 - 5 Sk/m^3). The major problem in water supply is losses from water mains, which could reach even 25% (22,2 % in 1996).

The situation is even worse in **sewerage**. It is constantly behind the development of water supply systems, which is typical for the most of CEE countries (*Somlyódy, 1993*). Only 12,96 % of settlements have complete sewer systems (372 communities from 2871 of total number of settlements and cities in Slovakia), which is about 53,03 % or 2.850.000 inhabitants of the total Slovak population (Green Report, 1997). The best situation is in the capital, Bratislava (96,34 %), in other regions/districts it varies from 27 % to 75 %. The lowest level of wastewater collection is in some northern and south-eastern regions with less then 30% of population served by sewerage, particularly the most negative situation is in districts Malacky, Komárno, Zlaté Moravce, Krupina, Poltár, Bytča, Námestovo, Turčianske Teplice, Košice-suburbia, Sobrance, Trebišov and Sabinov.

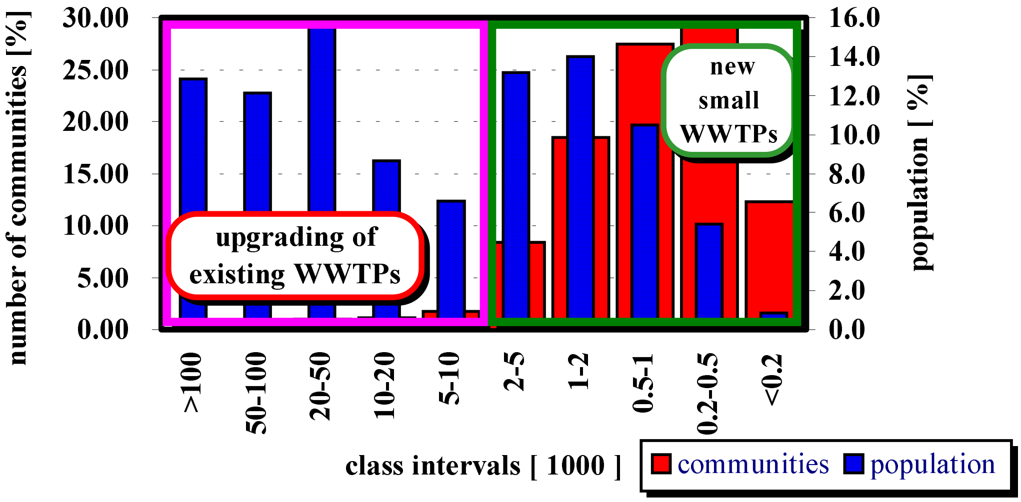

Figure 2.1. **Distribution of population and communities in Slovakia and their effect on sewerage**

In 1996 the length of sewer networks was more than 5.000 km long. Since the majority of settlements in Slovakia are smaller towns or villages (there are only 27 towns with a population equal to or higher than 25.000 - see Figure 2.1.) the typical sewer system is the separate, sanitary sewer system, only larger towns are served by combined sewer systems. Separate drainage of storm water by storm sewer systems is an exception. Mainly gravitational systems have been built, only a few villages in Southern Slovakia, due to a very high groundwater table (many times 0,5 m below the surface) and sandy soils, are planned to be served by pressure or vacuum systems. In general, urban drainage systems are defective, infiltration of groundwater causes problems in almost every settlement. Infiltration discharges are estimated about 10 to 30% of dry weather flow on average, but higher values are reported as well. Exfiltration of conveyed wastewater by sewer system is not an exception in Slovakia and it is dangerous problem especially in regions with high groundwater table and intense level of industrial development (contamination of groundwater by industrial wastewater, oil material, etc.).

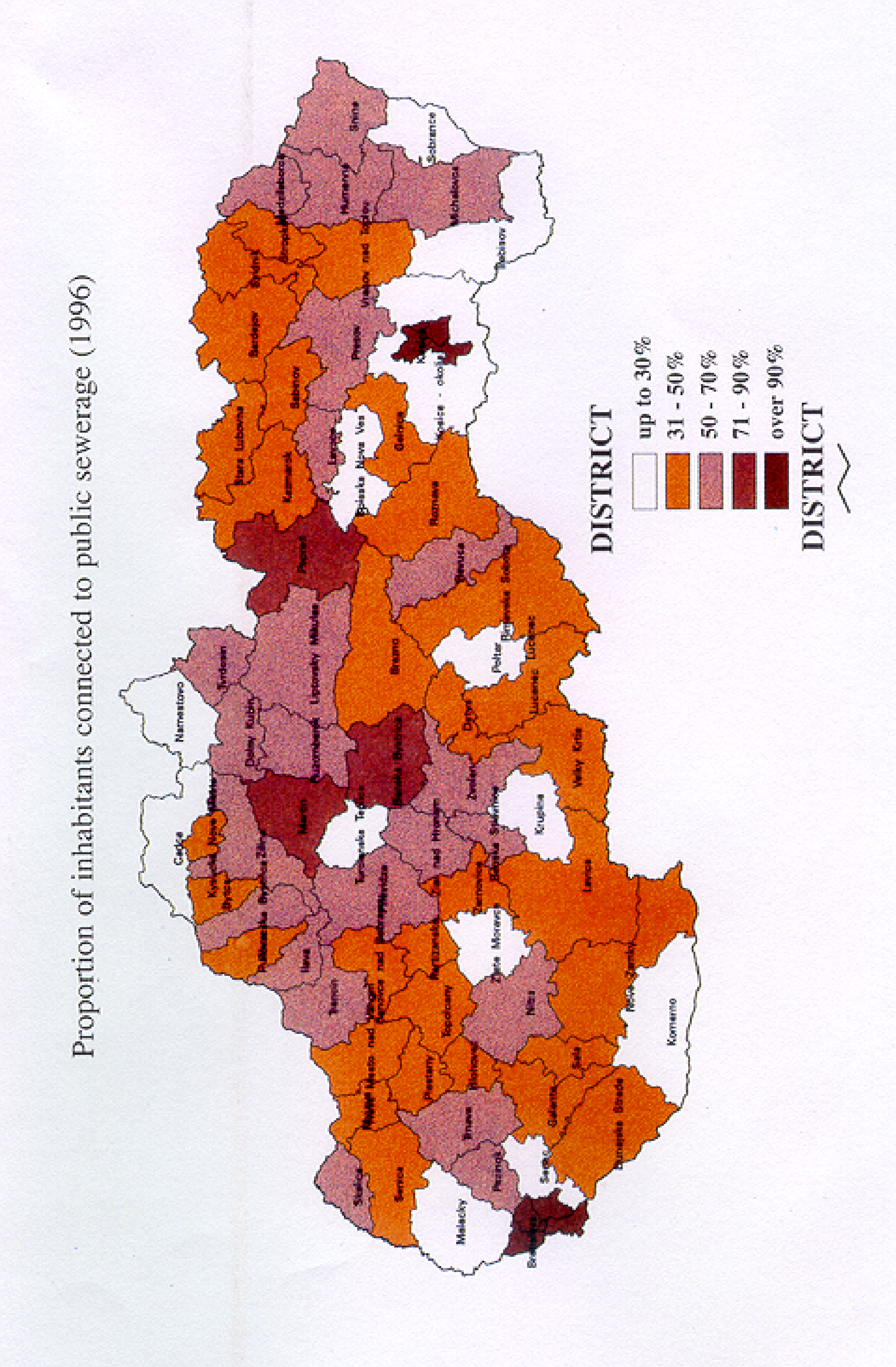

Figure 2.2. **Proportion of inhabitants connected to public sewerage in 1996 (Green Report, 1997)**

The majority of industrial wastewater is collected together with municipal wastewater and consequently it is treated at municipal treatment plants. Industrial wastewater influence was characterized by the following values:

- ratio of industrial and municipal flow rates Q_{ind} : Q_{mun} is higher than 1 in 45% of cities with more than 25.000 inhabitants
- ratio of industrial and municipal BOD_5 (BOD_{ind} : BOD_{mun}) is higher than 1 in 51% of municipal treatment plants,
- ratio BOD_5 : COD in raw wastewater is lower than 0,4 at 12 % treatment plants.

Recently these ratios have been dramatically changed due to the decline of the production of industrial wastewater (shutdown of many plants). The development of the sewered and treated municipal and industrial wastewater is described in Table 2.1. for the period of seven years (*Green Report, 1997*) and aerial distribution of the proportion of inhabitants connected to sewer systems is presented in Figure 2.2. Bodik, 1998 presented the higher number of sewered settlements as follows: number of settlements with sewerage 467, number of settlements with sewer system and wastewater treatment plants 363 (52,20 % in terms of population).

The level of **wastewater treatment** also lags behind western standards. Only about 90% of all collected wastewater is treated in 204 municipal wastewater treatment plants (WWTPs) running by waterworks and 77 by municipalities, however, only less than 50 % of all WWTPs meet recent environmental standards. The number of treatment plants with mechanical-biological treatment line is 89,22 %, with mechanical treatment 10,78 %. The sum total of treatment plants is probably higher because Bodik, 1998 obtained the different number 363.

The total capacity of wastewater treatment plants was 1917,6 10^3 m^3/day in 1996 (only mechanical treatment 17.049 m^3/day, mechanical-biological treatment 1.900.547 m^3/day, *Green Report, 1997*). *Rajczykova et al., 1997* presented the different number of treatment plants below 5000 P.E., as follows:

- 93 wastewater treatment plants running by waterworks,
- 175 wastewater treatment plants running by municipalities.

Most of these treatment plants are designed as the compact plants with the extended low loaded activated sludge system.

The main reason of insufficient treatment is hydraulic and mass overloading, the next problem being the quality of wastewater (impact of industry connected to public sewer systems). High portion of groundwater infiltration causes dilution of wastewater and decrease of its temperature, which causes problems at the treatment works.

Table 2.1. Development of wastewater discharges and WWTPs running by water and sewage works

Indicator	Unit	Year						
		1989	1990	1993	1995	1996	1997*	1998*
population connected to public sewers	10^3	2565	2622	2684	2740	2756	2780	2822
population connected to public sewers with WWTP	10^3	2203	2284	2497	2592	2610	2630	2660
length of sewer systems	km	4824	4942	5107	5200	5345	5400	5500
waste water discharged to surface waters	10^6m^3	490,4	491,0	397,1	343,5	330,5	321,4	315,3
Sewage	10^6m^3	220,4	225,5	214,9	166,2	160,3	158,5	156,8
Industrial and other waste water	10^6m^3	270,0	265,0	182,2	177,3	169,5	162,9	158,5
treated wastewater **	10^6m^3	495,8	514,0	459,4	501,1	504,6	507,0	510,0

*Note: * - estimated/expected, ** - including stormwater and infiltration.*

The age of the most of larger existing wastewater treatment plants varies from 15 to 20 years. Since now the quality of influent and flow rate has significantly been changed, however the treatment line and capacity of majority plants have not been adjusted. In Slovakia most WWTPs consist of mechanical and biological treatment (only about 90 % of collected wastewater is treated biologically) though it is known that an amount of conveyed wastewater to WWTPs is bypassed to reduce their overloading especially during wet period. There are four typical groups of WWTPs:

- primary treatment without biological one (less than 11 %);
- mechanical treatment in primary settling tanks or Imhoff tanks followed by biofilters (16%);
- mechanical treatment in primary settling tanks followed by high or medium loaded activated sludge process (48 %);
- low loaded activated sludge process with extended aeration (aerobic stabilization) (25 %).

The percentage of particular treatment technology was valid for the years from 1991 to 1993 (1994). At present the portion of treatment plants with extended aeration (typical treatment line of small treatment plants) has been dramatically increased.

Infiltration/inflow to sewer system has a significant impact on the quality of influent and simultaneously, the influence of industrial wastewater (very often connected to sewer systems without any pre-treatment) assists to increase hydraulic and mass loading in many WWTPs. The effluent quality achieves 15 mg BOD_5/l and less very rarely (~ 10 % of total WWTP) in spite of the fact that $BOD_5 < 100$ mg/l of influent is often a characteristic value (influence of infiltration). The abundance of WWTPs discharge the effluents to receiving waters with BOD_5 around 40 mg/l which represents about 50 % of total sewered inhabitants in Slovakia. The typical sludge loading rate for small WWTP varies about 0,15 kg/kg/day, but a quite number of plants treat wastewater with a value of 0,5 – 1,0 kg/kg/d. In addition, significant portion of WWTPs provide activation with sludge age bellow 5 days. Sludge volume index (SVI) is usually below 150 ml/g therefore recently the serious problem of MLSS separation is not typical in most of the WWTP. However it is anticipated that SVI may increase due to the necessity to ensure nutrient removal.

In Slovakia the smaller plants prevail. Due to the demographic situation of Slovak population (see Figure 2.1.) and due to the more realistic local investment possibilities it is expected, that the small plants will be those most frequently designed and constructed also in the near future. Upgrading and extension of existing WWTPs is typical for towns and cities beyond 20.000 inhabitants.

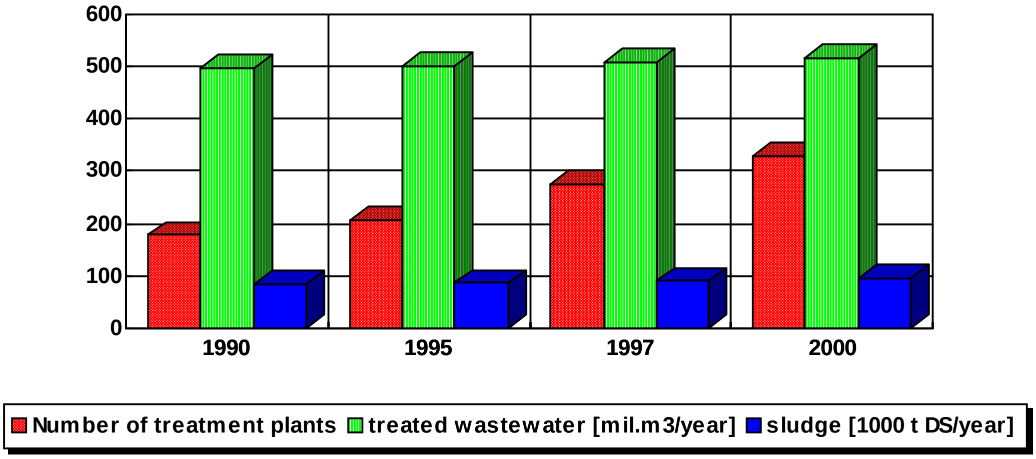

Figure 2.3. **The present and expected production of sludge, discharge of treated wastewater and number of wastewater treatment plants**

The serious problem concerns the monitoring of wastewater treatment plants and the regulation/optimization of the treatment process. At present, only fundamental wastewater characteristics are measured (BOD_5, COD, suspended solids, volatile solids, pH). Measurement of nitrogen and phosphorus forms in raw waste and treated water was rare and the basic information about these important compounds is still missing in particular WWTPs, however recently this situation have already been significantly improved. Upgrading of the monitoring, especially of activated sludge process, is predominantly solved by measurement of dissolved oxygen, which has been already applied at many plants. ORP is the next parameter, which should be applied in the near future very often in case of biological phosphorus removal. However, there is a lack of operational experience with these sensors.

Sludge treatment and disposal is tremendous problem in Slovakia. In 1997 municipal wastewater treatment plants produced $89{,}8.10^3$ tons of dry solids (DS) of sewage sludge for disposal per year (in 1996 92.090 t DS/year). The current complex situation and the future production of sludge are affected by two dominant factors: the changes in effluent standards and newer tighter sludge disposal regulations.

The reduction of organic pollution and nutrients discharged to receivers requires upgrading the existing treatment plants and building new ones for both phosphorus and nitrogen removal. This assumes a gradual increase of sewage sludge production. The Figure 2.3. presents expected trends in sludge production for particular time levels in Slovakia.

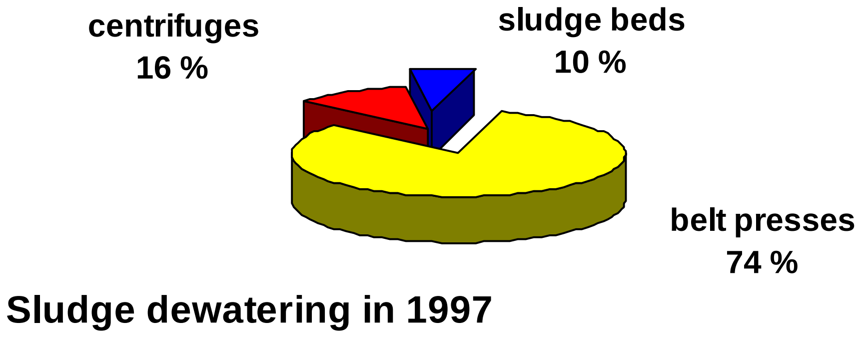

Figure 2.4. **Present situation in sludge dewatering for treatment plants with P.E 30.000 and more (75 % of total sludge production in municipal WWTPs in Slovakia)**

Anaerobic stabilization of sewage sludges prevails (68%), aerobic stabilization is applied at smaller treatment works (29%), 3% of sludge is not stabilized at all.

Figure 2.4. shows the various ways, in which sewage sludge is generally dewatered. The ratio of conventional methods (sludge beds and lagoons) is still relatively high as the climate conditions in many regions of Slovak Republic favor these processes, however their capacity is not sufficient. Mechanical dewatering is significantly increasing in the last years. Almost all new treatment plants are constructed with mechanical dewatering process. Most of these plants have belt filter presses made by Czech or Slovak firms. Filter presses are used less frequently. Centrifuges have to be purchased from foreign firms, therefore the price of them is much higher than the price of beltpresses. Dry solids content in filter cake usually varies from 20 to 25% or more.

Sludge disposal (see Figure 2.5.) is the main contemporary problem of sludge management. The actual quality of the sludge as well as sewage sludge disposal regulations have resulted in a significant reduction of its agricultural utilization. In 1997 20 % of total sludge production did not meet the requirements of Slovak Technical Standard (STN 46 5735 Industrial composts) for composting and according to the Guideline for agricultural use of sewage sludge and sediments all tested sludges did not fulfil its requirements in particular analyzed parameters *(Šumná, 1998).*

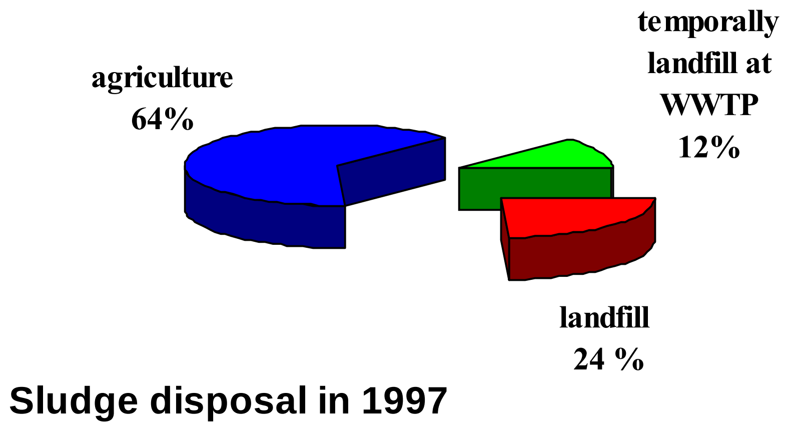

Figure 2.5. Present situation in sludge disposal in Slovakia

The main problem is contamination of sludge by heavy metals diffidence and unwillingness, which prevents sludge disposal to agricultural land, therefore landfilling has become the most frequent method of sludge disposal in Slovakia. This situation is not expected to change in future due to stringent sludge disposal regulations (unfortunately, present legislation practically has changed sludge from a fertilizer to a waste product even in the cases, where it is not necessary).

In many parts of the Slovak Republic, especially in the northern regions, there are possibilities of sludge disposal in forestry. Application of alternative disposal methods, like incineration, regulated co-landfilling with separated municipal solids waste, source of building material etc. is minimum.

Design, operational problems and upgrading of treatment plants. From the past until recently, comprehensive and sufficiently accurate data have frequently not been available on the design of sewerage and wastewater treatment plants. Thus, a number of treatment plants have been under or over designed. Specific problems are involved with the construction of treatment plants. They can be summarized as follows: a high level of groundwater, very flat (in southern Slovakia) or very sharp ground slopes (in northern of Slovakia) and complicated geology and hydrogeology conditions (mainly in southern and western Slovakia).

To reduce operational difficulties in treatment plants, several urgent problems need to be solved, but many of them are closely related to upgrading plants. However, since the total overloading of plants will be partially reduced due to the recent collapse of industry and the increase in the prices of public water and sewerage services, the pretentious investment costs will probably inhibit the reduction of infiltration or rehabilitation of sewer systems. Most of the upgrading concerns the modification of existing treatment processes. These main approaches should be considered: upgrading solid/liquid separation processes, modifying the activated sludge process with the aim of reducing the washout of sludge flocs from tanks to effluent (bulking sludge) and removing nutrients, and finally, upgrading sludge treatment with respect to anaerobic stabilization (digestion) and mechanical dewatering process.

Treatment processes, or modifications, with reasonable efficiency and low construction and operation costs are preferred. Upgrading existing primary treatment plants to chemically or precipitation plants seems to be one of the possible alternatives, serving as temporally enhanced step allowing for the later implementation of biological treatment methods for the removal of organics and nitrogen or phosphorus however in Slovakia this alternative is not preferred due to the higher production of sludge as well as the difficulties with sludge dewatering.

Perspectives of wastewater and sludge treatment in Slovakia

Uniform effluent standards generally lead to uniform technologies. However, this is not the case in Slovakia because the upgrading of existing facilities, often overloaded and performed with historically different developed treatment lines, requires viable alternative strategies resulting in technologies, which may vary from plant to plant. The priority of present goals is to reduce municipal emissions, e.g. in the most polluted parts of river basins. The diffuse pollution is more difficult to reduce because it needs not only financial investments, but also changes in legislation, cross-sectional coordination, improvement of environmental awareness of population, etc. Control and treatment of urban stormwater, upgrading the existing combined systems in this sense and consideration of the impact of combined sewer overflows on the water body in the context of catchment-wide integrated pollution control are on the edge of present focus in Slovakia from the point of view affordability. As stated before the most of the municipal treatment plants contain mechanical-biological processes. Application of physical-chemical methods is exceptional in municipal WWTPs. The range of applied technologies is relatively low and this fact will be a serious problem according to the new legislation demands on nitrogen and phosphorus removal (see chap.3.2.).

Because of the high loading of the biological step in majority of the larger treatment plants nutrient removal processes are ineffective. Only the recently finished treatment plants are applying nitrification - denitrification or biological phosphorus removal. The largest treatment plant (capacity more than 100.000 population equivalents) with controlled biological nitrogen and phosphorus removal was upgraded in Rimavská Sobota. Because of the lack of investments, probably future upgrading of existing treatment plants will be oriented on modification of treatment processes (upgrading of biofilters and activated sludge reactors, application of new aeration systems, combination of fixed-film and suspended biomass processes, improvement of final clarifiers etc.). In any case, according to the effluent standards introduced by Decree N^o.242/1993 in many cases "hi-tech" nutrient removal systems will have to become a standard technology in Slovakia (in contrary to "low-tech and low-cost" systems very often recommended for Central and Eastern European countries).

An interesting fact is connected with the application of non-conventional technologies. In spite of a significant production of high-loaded wastewater, e.g. high ratio of wastewater from agriculture, food processing and chemical industry etc., application of anaerobic treatment technologies is minimal (less than 10 plants in Slovak Republic).

The effluent quality required by the legislation (Decree 242/93 - see the next chapter) affects the selection of adequate treatment lines. As the required effluent quality depends on the size of a pollution source, each particular category will demand specific treatment. In Slovak condition one may expect the following trends in wastewater treatment:

- **<50 to 500 P.E.:** Within this range of WWTP capacities it is assumed to apply mostly extended aeration package treatment plants with thickener/holding tank for aerobic digestion and sand drying beds or for smaller sources (50 P.E.) rotating biological contactors. Sequencing batch reactor or oxidation ditch may be considered as feasible treatment technology, too. Natural treatment systems, such typical for this range of sewered areas, are designed very rarely due to the complex geological conditions, the higher requirements on area and often extreme climate conditions in Slovakia.
- **< 5000 P.E.:** The treatment line has to ensure relatively low concentration of BOD, COD and SS therefore the attention should be devoted to properly designed and/or operated clarifier otherwise the achievement of effluent standards may be indecisive. The level of $N\text{-}NH_4^+$ will depend on the quality of influent. It is assumed that low loaded activated sludge process with nitrification would be applied if the concentration of $N\text{-}NH_4^+$ overtop 30 mg/l. Biofilters (trickling filters) should be ignored in this case.

Essentially for smaller plants (< 5000 population equivalents) fixed-biomass reactors (trickling filters, rotating bio-contactors etc.), low-loaded activated sludge reactors with aerobic stabilization (oxidation ditches or Carousel plants, SBR system, activation with separate stabilization etc.) are recommended.

- **< 25.000 P.E.:** It is assumed that the classical low rate activated sludge process with nitrification will be able to fulfil the requirements of the Decree N^{o}. 242/1993. The requisite value for TP will be probably achievable without biological or chemical phosphorus removal.
- **< 100.000 P.E.:** This category requires to consider complete nitrification and denitrification. To accomplish the required effluent value of TP, biological phosphorus removal would be adequate. Activated sludge systems with simultaneous nitrification-denitrification may be applied for this range of WWTP capacity.

  Generally for medium size plants (25.000 – 100.000 population equivalents) except of organic pollution removal systems also nutrient removal processes are topical. For this purpose simultaneous (Carousel, oxidation ditch) and pre-denitrification processes are preferred. Application of alternative denitrification or SBR denitrification is exceptional. Sludge is stabilized in separate aeration tanks or by means of psychrofilic or mezophilic methanization.
- **> 100.000 P.E.:** These effluent standards could be achieved only by treatment lines with nitrification, denitrification and phosphorus removal (with preceded anaerobic zone, often compartmentalized to control the growth of filamentous microorganisms). It seems that chemical precipitation of phosphorus removal will have to be considered together with biological removal. Sludge is stabilized mostly by mezophilic mechanization and mechanically dewatered. This type of treatment plant requires a higher level of monitoring and automation to ensure stable operation.

Perspectives in sludge treatment and disposal

Sludge disposal is the main problem of sludge management. The agricultural use of sludge in Slovakia is subjected to relatively strict standards, guidelines and laws, which set limits on the heavy-metal content of sludge and on the maximum quantity, which may be applied per hectare per year.

Šumná,1998 analyzed the selected sludges (this experiment represents 70 % of total production of sludges in Slovakia per year) and revealed that Cr, Cd, and Pb, Zn are the most common heavy metals accumulated in sludge. Mercury is usually a limit in case of implementation the Guideline as well as the specific pollutant (PAU) may cause the problems (less than 80 % of the total sludge production is contaminated by it). The actual quality of the sludge and sewage sludge disposal regulations have resulted in a significant reduction of its utilization in agriculture. The same situation has occurred with the reuse of sludge in preparation of compost. In many cases, providing a sludge landfill may be the only possible solution.

Minimization of the volume of sewage sludge is becoming increasingly important. Thus, improvement of the mechanical dewatering of sludge and reduction in the quantity of sludge cake solids by composting, drying or incineration are anticipated. The optimal integration of sludge management processes may help solve this serious problem in particular cases. The major strategic question of sludge treatment and disposal is to reduce the heavy metal content of it, therefore it is necessary to remove the absence of proper pre-treatment of industrial wastewater connected to public sewer system. This is a precondition for using sludge in agriculture as a most cost-effective solution.

It is known that the European Union has created several regulations concerning the treatment sewage sludge (e.g. 91/689/EEC, 86/278/EEC). In the framework of European environmental policy also Slovakia laid down the new regulations: Waste Law and List of Wastes. These legislative materials together with Decree 242/1993 have caused more sludge by requiring more extensive sewage treatment and simultaneously they have made sludge disposal more difficult.

According to the general European philosophy Slovakia classifies sludge as a waste from origin, but it can be changed into products having different characteristics (List of Wastes defines raw sludge as *dangerous waste* however digested sludge is *particular waste*). To solve the serious and very complex situation in sludge treatment and disposal Slovakian sludge disposal policy set the following priorities in order of preference :

- prevention or reduction of production and its harmfulness,
- uses/utilization (agricultural, horticultural, forestry, woodland use, land reclamation or treatment, etc.),
- incineration,
- landfill.

Agricultural use is accepted as the best way of disposing sludge. Incineration must not be seen as a final disposal step. Three main different options of incineration may be considered: sludge incineration, co-incineration with municipal waste incineration and co-incineration in industrial furnaces with energetic or material uses Landfill has to assume as the lowest step in priorities of disposal alternatives.

Transitions problems of water and sewage works

With the progress of market economy in Slovakia, reform of the water and sanitation sector is being considered as a way to improve sectional performance. The role of government in the implementation and operation of services is intended to be changed, and the direction of the reforms is toward decentralization and privatization of all utilities with an ultimate goal of introduction of a competitive market in the field of water services. These fundamental changes of the water sector are suggested with the aim to improve quality of services to the customers and financial performance of utilities, and to reduce negative environmental impacts of utility operations. Transformation of utilities will also include a financial reform, the emphasis where is shifting towards an approach, in which drinking water is treated not only as a basic need but also as an economic good. In practical terms this means that water utilities need to be reoriented to perform as semi-commercial and financially autonomous enterprises with primary focus on the consumer and his requirements.

The transformation of the water industry is based on Government Resolution N^{o}. 621/1995 and Acts of the National Council SR N^{o}s. 481/1992 Dig. and 192/1995 Dig., which state that:

- municipalities shall gain responsibility for water supply services, wastewater collection and treatment services,
- it is expected therefore, that municipalities will group into associations and will hire water management enterprises in order to achieve sustainable services in water supply and sanitation,
- the superior water mains shall remain in state ownership to ensure sustainable services in water supply of regions with no or scarce water resources in accordance with Act No. 192:1995 (Coll.).

According to the conditions stated in the Acts, the newly created organizations should function on a non-profit principle, as well as on a principle of re-investments of profits and assurance of sustainable services both for the public sector and industry. It is assumed that the associations of municipalities will also be responsible for water prices.

As was stated before the assets of superior water supply systems remain in the ownership to ensure strategic state interests. As the final solution it is assumed the incorporation of the assets of superior water supply systems into stock companies, and the state will join them as stock holder. Remaining material and immaterial investment assets used for operation, maintenance of waterworks, which are not transferred to municipalities, are an exception. They remain in the administration of state waterworks for providing operation of their facilities till the date of approving a new act on water and sewage works. At the end of this process the property will be sold to the respective company running the water supply and sewerage.

To accelerate this process the Slovak Government approved Resolution No.657/1996. Resolution No.6327/1997 set the timetable of the transformation of this industry.

In 1998 607 municipalities applied for the transfer of waterworks assets. The following table summarized these municipalities for particular regional water and sewage works.

Table 2.2. Number of municipalities applied for privatization of waterworks

Water and Sewage Works	Sewered municipalities	No. of municipalities apply for privatization
Bratislava	2	0
Central	311	88
Western	453	152
Northern	277	218
Eastern	506	149
Total	1549	607

Water and sewage works have already prepared five privatized projects. Among these privatization projects was as the first pilot project implemented in Trenčín water and sewage works with the association of 41 municipalities with property of 610 mil. Sk.

The total assets of waterworks are 27.807 billion Sk. The assets of superior water supply systems represent 7,6 billion Sk. The assets with the value 19,1 billion Sk should obtain the municipalities and the rest of total is operational assets with the value 1,1 billion Sk.

2.2. National Targets for Water Pollution Reduction

Slovak National Environmental Policy has been established during the years 1992 and 1993. The national environmental policy is based on the 1st September 1992 Constitution of the Slovak Republic. The principles, priorities and strategies of the national environmental policy are based predominantly on the following documents :

- *the UN Conference on the Environment and Development (Rio de Janeiro, 1992), the World Strategy for Sustainable Life,*
- *the Environmental Action Programme for Central and Eastern Europe,*
- *multilateral international environmental conventions and bilateral treaties on environmental co-operation,*
- *the Maastricht Convention on European Union.*

In 1993 The Ministry of the Environment prepared the document National Environmental Policy and it was approved by the Resolution of the Government and lately by the Parliament in the same year. This document set the strategy, orientation, principles and priorities of national environmental policy. There are defined long-term, medium and short-term objectives and financial aspects of national environmental policies.

In 1996 National Environmental Action Plan was approved by the Slovak Government.

In 1997 the implementation of Strategic Action Plan of the Danube River Basin 1995 - 2005 was finished and submitted to the Slovak Government as National Action Plan for the Danube River Basin. This document was prepared with respect the objectives of approved Slovak National Environmental Policy and National Environmental Action Plan. The Slovak Government approved this document where the strategies, priorities and objectives of national environmental policy with respect to water pollution reduction are concerned.

Implementation of targets and strategies of the water management policy set by the *Ministry of Soil Management* is based on fundamental documents as follows:

- *Programmatic Declaration of the SR Government,*
- *Principles of the Water Management Policy of the SR Government,*
- *Strategy of the Water Management Policy of the SR Government,*
- *General Water Management Plan,*
- *General Schedule of Protection and Rational Water Utilization in SR,*
- *Water Management Master Plans.*

As it is stated before the national targets for Water Pollution Reduction for the Danube River Basin have already been set up in the Slovak National Action Plan. The Strategic Action Plan, which determines common goals, policies, and strategies in solving main environmental problems in the Danube Basin, its delta and the Black Sea, was the base for elaboration of the Slovak National Action Plan (NAP). In NAP key subjects involved in the environmental protection are:

- state central bodies (ministries);
- state administration in field of the environment;
- municipal authorities of towns and villages, companies and entrepreneurial subjects;
- non-governmental organizations and public.

After the thorough analyze of the state of natural environment in the Slovak Republic, the problems, which relate to its influencing by the human activity, and which create an important part of the NAP, have been defined. The following environmental problems belong to them:

- acidification of the natural environment (soils, surface and ground water);
- eutrophication of surface water;
- geo-factors of the environment;
- point and diffuse pollution of the environment;
- handling the waste;
- decrease of ground water level by dewatering.

Every of the mentioned problems of the natural environment runs at all levels, starting from local up to the national one. The following levels are actual for the National Action Plan of the Slovak Republic, relating to the problems of water in the Danube Basin:

- local level (mainly local pollution of the air and water, smog accidents, odor and noise in urban areas of towns),
- regional level (treatment and disposal the waste, eutrophication of surface water, fluctuation and decrease of ground water level, accumulation of stable organic substances in natural environment, and degradation of relatively untouched areas),
- level of the main river basins (the problems of acidification, eutrophication, soil erosion, and the pollution of flows and basins of the Morava, Váh, Nitra, Hron, Hornád, Bodrog and Ondava, resistant chemical substances with the high degree of malignancy, including the radioactive pollution, important is also the risk of pollution, which may come from accidents).

The present state of the river ecosystems and of the Black Sea, as a recipient of polluted water, is logical result of the pollution, produced in the Danube Basin. Therefore also in the NAP, the attention focuses on these three problems, which are:

- high load of N and P nutrients and eutrophication;
- changes in the regimes of the sediments flow and transport;
- contamination with harmful substances, including the oil substances.

According to NAP the following measures will be necessary to provide in Slovakia:

- revitalization of the streams and wetlands;
- management of their development, to maximize their accumulation effects for the N and P nutrients, and at the same time to maintain their natural health state and biodiversity.

Strategy, principles and priorities of state environmental policy have been approved by the Resolution of the Slovak National Council, from 18th November 1993, N°. 339, and by the Resolution of the Government of the Slovak Republic, from 7th September 1993, N°. 619. Long-term goals of the state environmental policy should became real after 2010, medium-term by 2010, and short-term ones by 2000. Taking into consideration, that the priorities and principles in the document Strategy, principles and priorities of state environmental policy, are quantified according to the actual situation in 1993, it is necessary to update the quantification of the goals, based on new knowledge.

Orientation of the state environmental policy

In the framework of the protection of the quantity and the quality of water and its rational exploitation, the environmental policy is focused on:

- increase the proportion of polluters and disturbers of environment at improvement of its state;
- thrifty exploitation of natural sources;
- final formation of the system of economical tools.

Priorities of state environmental policy:

- ensure sufficiency of drinking water and reduction of pollution of other waters under the acceptable limit;
- rational exploitation of natural sources.

Principles of state environmental policy:

- prefer preventive actions than remedy ones;
- consider the solution of the environmental problems as a solutions of the economical problems of society.

Long-term goals of state environmental policy:

- formation of economical barriers and systems, which will have preventive impact, and will not allow activities, which endanger and damage the environment, over the acceptable limits;
- applying the increased protection and rational exploitation of natural sources, evaluated also in accordance with their environmental value and public-beneficial function;
- harmonization of economical, environmental and social interests;
- applying the prohibition of ground water use for other than drinking purposes, where the abstractions of ground water may be replaced with the withdrawals of surface water;
- ensure the treatment of 80 - 90 % of discharged wastewater, and reducing the difference between the water supply and sewerage to minimum;
- reduction of pollution from watercourses with IV. - V. class of water quality consequently to the liquidation of the pollution sources, implementation of the system of measures for their revitalization, and total decrease of pollution of water streams also with II. - III. class of water quality by one class.

Particular goals of the state environmental policy with respect to water quality pollution control are summarized in the three time terms, as follows.

Short-term goals:

- reduction of the quantity of pollution in discharged wastewater by 25 %, especially in the districts with water deficit, and in the areas with its highest rate of pollution;
- minimizing the exploitation of ground water for industrial purposes to 5 - 10 % of current state, where ground water abstractions may be replaced by the withdrawals of surface water, except the food and medicine production and exploitation of geo-thermal energy;
- implementation of the measures (for example afforestation and other suitable land regulations, building reservoirs etc.) to support the accumulation of water, mainly in the districts of Veľký Krtíš, Lučenec, Rimavská Sobota, and to solve completely the water deficit in this region of southern Slovakia;

- implementation of measures for measuring the water consumption and its reduction, reduction of the water losses in public water supply network, and average number of cases of accidental pollution of water streams with IV. - V. class of water quality by 10%;
- support the building of wastewater treatment plants, sewerage, and facilities to accumulate the water by municipalities, as well as by other legal subjects;
- realization of Environmental Program in the Danube Basin;
- preparation, acceptance and implementation of the new Law on Water and related executive provisions, mainly the Government Decrees, which establish the effluent standards and ambient water quality criteria.

Medium-term goals:

- reduction of the quantity of pollution in discharged wastewater by 50 %;
- halting the increase of the difference between the water consumption and the quantity of discharged treated water at the sites, where the abstractions of ground water may be replaced by surface water withdrawals;
- reducing the exploitation of ground water for other than drinking purposes to 3 - 5 %, with the exemption of food-processing and pharmaceutical industries, feeding the live stock, and exploitation of geo-thermal water;
- increasing the proportion of high-effective methods of treatment (biological, chemical and small wastewater treatment plants) at total quantity of treated waste water by 20 %;
- reduction of drinking water consumption by 30 %, mainly by implementing its measuring to 10 - 15 % and by more rational management of consumers;
- prefer the completing of wastewater treatment plants under construction and the construction of wastewater treatment plants at the places, where it is not possible to reduce water pollution at its place of generation (e.g. in municipal sphere);
- increasing the quantity of treated wastewater to 60 %;
- solving of the problems of drinking water deficit in 16 districts, mainly in the districts of Veľký Krtíš, Lučenec, Rimavská Sobota, Prievidza, Spišská Nová Ves, Rožňava and Košice-vidiek;
- implementation of the measures (afforesting and other land regulations, reservoirs, ponds, etc.) to support the natural, as well as artificial retaining of water at the area of the Slovak Republic, and total retention of the water run-off mainly from the basins of deficit areas;
- reduction of pollution of watercourses with IV. - V. class of water quality by one third;
- creating of the conditions for revitalization of dead water streams and lakes, where the sources of their pollution have been eliminated;
- reduction of the number of cases of accidental pollution through more strict prevention control of potential pollution sources and through other preventive measures;
- constructing the sewer network, so that 60 % of inhabitants is connected to it;
- specification and elimination of the causes of impairment of the ground water quality, monitoring the development of its quality at more important sources of ground water with building indication systems;
- more efficient exploitation of mutual influencing of the ground water sources in the framework of broader water management complexes, mainly if there are the conditions (Eastern Slovakian, Rožňava, Spišskopopradská, Mid-Slovakian, Northern Slovakian water management complexes);
- completing the modern system of legal instruments on the protection and sustainable use of water, comparable and harmonized with the jurisdiction of EU countries, and its implementation into the practice.

Long-term goals:

- applying the prohibition of ground water use for other than drinking purposes, where the abstractions of ground water may be replaced with the withdrawals of surface water;
- ensure the treatment of 80 - 90 % of discharged wastewater, and reducing the difference between the quantity of water supply and sewerage to minimum;
- reduction the pollution of watercourses with IV. - V. class of water quality consequently to the elimination of the pollution sources, implementation of the system of measures for their revitalization, and total reduction of pollution of water streams also in II. - III. class of water quality by one class.
- reduction of water pollution to acceptable determined rate;
- applying the increased protection and sustainable use of water sources, evaluated also according to their environmental value and public-beneficial function;
- reduction of water consumption to the average level of EU countries;
- reduction of the quantity and types of carcinogen, teratogen, mutagen and other harmful substances (polychlorinated biphenyl, nitrites, nitrates, heavy metals, poly-aromatic hydrocarbons, etc.) in water, in the contact with human and other organisms with special attention to their removal, respectively for reducing of some of them to previously determined acceptable rate;
- completing the Complex monitoring and information system of environment of the Slovak Republic;
- formation of legal, economical, ethical and managing barriers and systems, which will have prevention impact, and will not allow for activities endangering and harming the environment and water, over the acceptable limits, and their irrational exploitation.

The NAP has set also the list of particular measures for the sectors of nature, water, soil, air, solid waste as well as defined the utilization of legislative and economic tools to achieve these measures.

2.3. Technical Regulations and Guidelines

Water quality management in Slovakia is based on the Water Act and government directives, further supported by technical standards.

The present Water Act is based on the former Czechoslovak Water Act No.138 from 1973 and is currently being revised. The Act is still being considered to be progressive, since it satisfies even the existing needs of water pollution control in the country, except the articles concerning the state ownership in water management. Regarding wastewater treatment, the most important requirement is that all subjects discharging wastewater or special water into surface or ground water must ensure treatment in a manner corresponding with the contemporary state of technical development to ensure the quality of receiver (Article 23, par. 1). The Water Act (same article, par. 2) also authorized the Government to specify the *present level* of the technical development as well as effluent standards according to the level of knowledge and technical possibilities by means of Government Decrees. However, the former Water Act did not deal with the question of urban storm runoff.

Technical regulations for water quality standards.

The first Slovak Government Decree concerning water quality came into force in 1975 (No. 30/1975). It was based on ambient (environmental) water quality standards, which defined the quality of receiving water after mixing with the discharged effluent. The following equation had to be applied to determine the required effluent quality:

$$c_{effl}. = ((Q_{355} + Q_{effl}) \,.\, c_{es} - Q_{355} \,.\, c_{riv})./Q_{effl} \qquad (2.1.)$$

where Q_{355} is the 355 days discharge in the receiving water, $Q_{effl.}$ is the discharged effluent flow estimated as follows: Q_{effl} = (total flow rate of discharged wastewater per year)/(number of days per year of discharged wastewater to the receiving water), c_{effl} is the required effluent concentration, c_{riv} is the concentration of a given parameter in the receiving stream (corresponding to Q_{355}) before mixing with the discharged effluent and c_{es} is permitted concentration of a given parameter in the receiver after mixing with discharged effluent (ambient water quality standard).

Effluent quality standards were set up for most parameters describing the quality of surface waters such as pH, DO, BOD_5, COD_{Mn}, inorganic forms of nitrogen, organic nitrogen, the most important heavy metals, organic compounds, bacterial indicators, etc.

The main drawback of the list from Gov. Decree No. 30/1975 was that it defined no ambient water quality standard for any of the forms of phosphorus.

Soon after the introduction of this Gov. Decree, everyday practice has shown, that the approach and also the numeric values of individual ambient water quality standards were not realistic according to the existing possibilities, especially to the lack of investments. The government "solved" this problem by a system of "exceptions" (consents for effluent discharges differing from the Water Act) based on the article 23, par. 3 of Water Act No. 138/1973. After 1989, the new Slovak Government decided to cancel the validity of exception consents. Therefore it was necessary to prepare a new legislative norm, which would follow more realistically the financial possibilities of polluters and the necessary requirements of the water environment.

The latest Slovak legislative norm for effluent standards was issued in November 1993. The Government Decree No.242/1993 was prepared with the aim to correspond with European legislation, especially with Directive 91/271/EEC. It represents a fusion of ambient water quality standards and (end-of-pipe) effluent standards common in European countries and it contains two kinds of standards:

- end-of-pipe limits (maximum acceptable level of pollution in the discharged effluent), which are defined both for municipal (see Table 2.3.) and selected industrial wastewater,
- ambient (environmental) water quality standards, which are defined again for the receiving water using eq. (2.1.). Watercourses utilized for water supply and watercourses used for other purposes have similar water quality standards like in Gov. Decree No. 30/1975. However, total phosphorus and a complete list of nitrogen compounds have been added to this list.

The local water authorities, which in the Slovak Republic are the Environmental Bureau of particular District Councils, are authorized to issue stringent (but not weaker!) consent contracts for individual effluent limits (e.g. if it is necessary to improve the present quality of water body). Effluent standards are set up for 8 hours composite samples collected with a maximum interval of 1 hour between individual spot samples or by automatic samplers, with an absolute maximum, which may not be exceeded.

The effluent standards presented in Table 2.3. were set up for typical domestic and municipal wastewater. Their numerical values are based on the capacity of the treatment plant expressed in population equivalents (1 P.E. = 60 g BOD_5 per day).

An important feature of this Decree is the step-wise approach of setting effluent standards: till December 31, 2004 and more stringent after January 1, 2005. This realistic way has left necessary time to polluters to get prepared to fulfil the more stringent effluent requirements without *exceptions*.

Table 2.3. Effluent Standards in Gov. Decree No.242/93

Pollution source size in P.E.	Effluent standard [mg/l]				
	BOD_5	COD	SS	NH_4^+-N	TP
	*/**	*/**	*/**	*/**	*/**
<50	80/60	-	65/50		-
<500	60/50	-	55/40		-
<5 000	50/40	170/140	45/35	-/20	-
<25 000	45/35	150/120	35/30	25/15	-/5
<100 000	35/30	125/100	30/25	15/10	5/3
>100 000	30/20	110/90	25/20	10/5	3 /1,5

Note: At treatment plants with more than 25 000 P.E. even partial nitrogen and phosphorus removal is expected; (*) - valid till 2005, (**) - valid after 2005; parameter BOD_5 *with suppressed nitrification by ATU.*

In Slovakia the majority of watercourses are very sensitive (according to the classification of sensitive areas in the sense of ANNEX II of Directive 91/271/EEC) due to their low dilution rate. Therefore the Gov. Decree No.242/93 also set up new ambient water quality standards to give the water authorities a tool for protection of these sensitive receiving bodies. Selected ambient water quality standards valid for municipal wastewater are given in Table 2.4. Water authorities have the right to enforce effluent standards calculated from eq. (2.1.) based on the ambient standards if it is *«the interest in water pollution control and is required by local water management conditions»*.

It is evident that the new Government Decree No.242/1993 has given great power to water authorities, particularly to the Bureau of Environmental. Nowadays each polluter has to apply at a local Bureau of Environment for a consent contract for effluent discharges.

Table 2.4. Selected ambient water quality standards in Gov. Decree No.242/1993 for municipal effluents

Parameter	Unit	Permitted concentration of ambient water quality standards	
		Receivers used for drinking water supply	other receiving waters
pH	-	6,0 - 8,5	6,0 - 8,5
DO	mg/l	min, 6	min, 5
BOD_5	mg/l	≥ 4	≥ 8
COD_{Cr}	mg/l	25	35
NH_4^+ - N	mg/l	0,5	1,5
NO_2^- - N	mg/l	0,05	0,02
NO_3^- - N	mg/l	3,4	7,0
Norg.	mg/l	1,0	2,5
Ptot.	mg/l	0,05	0,4
NPES*	mg/l	0,01	0,1

** non-polar extractable substances*

According to the Manual No. 796/1993 OOV issued by the Ministry of Environment to Government Decree No.242/1993 the water authority has to specify in the consent contract the following issues:

- maximum permitted flow of discharged effluent expressed in [l/s] and [m^3/year],
- maximum pollution flux for given effluent parameters in [kg/d] and [t/year],
- maximum concentration limits for individual effluent parameters in [mg/l] or in the other units (these limits will be controlled by 8 hours composite samples),
- determination of the range of sampling and choice of sampling sites.

Failure to comply with the consent contract is considered to be an offence, which may results in a fine. According to the Slovak Government Decree No. 31/1975 about the penalties in water management two authorities have the right to penalize the polluter: local bureau of Water Pollution Control Inspectorates of the Slovak Inspection of the Environment and the Bureau of Environment of the particular District Council.

It is known that the finances accumulated from the fines create a basic income of the State Fund of Environment. In addition, the polluter must pay for the discharged effluent pollution to the river basin authorities. The payment is based on article 8 of Government Decree No.2/1989, which is a practical expression of the Polluter Pays Principle within the Slovak Water Act. At present the polluters are penalized in case of exceedance of the following effluent quality standards: BOD_5, suspended solids, acidity/alkalinity, salinity and non-polar extractable substances.

The last two legislative norms are old fashioned and they do not reflect the new economic situation such as inflation, changes from planned to market economy, etc. Especially the Slovak Government Decree No. 31/1975 does not fulfil the expected effect and is together with Government Decree No.2/1989 in the process of amendment. The system of estimation of fines as well as the Polluter Pays Principle would be included directly in the newly prepared Water Act. It is expected that in the future the fines will be collected by the local Environmental Bureau and not by river basin authorities as in the past.

Nowadays the Gov. Decree No.242/1993 seems to be the most important legislative norm and it will hopefully influence the perspectives of wastewater treatment in the Slovak Republic for a long time. However, it contains many problematic parts and therefore at present is under preparation the amendment of this Decree. The new Decree has evaluated the experience of water authorities with this legislative norm, the comments of plant owners and operators as well as design engineers, the changes in water management (privatization of water industry) and water pollution control in Slovakia and to approach as closely as possible the requirements of Directive 91/217/EEC. (e.g. missing the effluent standard for the form of nitrite nitrogen; system of sampling, etc.). Experience from the Czech Republic with very similar conditions described by Wanner *et al.* (1995) has been utilized in the concept of amendment and thus a new parameter to the table of effluent standards, the so-called Total Inorganic Nitrogen (TIN - a sum of ammoniac, nitrite and nitrate nitrogen), is assuming to be added.

Technical Standards Related to Water Management.

In spite of this fact that the SR is only affiliated member of the European Commission for Standardization (CEN) there is a tendency to take over the European Standards (ES) and incorporate them into Slovak Technical Standards (STN) in the field of water and wastewater management. Except of the discussed Gov. Decree new technical Standards corresponding with the contemporary state of knowledge and technical development are being prepared. The most important Standard will be the *STN 73 6707 Municipal Wastewater Treatment Plants from 1983*, especially with regard to the problem of nitrogen and phosphorus removal processes and improving the clarifier design.

Although, wastewater treatment probably represents the most important part of urban water management, attention is also being focused on urban drainage. Basically, the technical questions of sewerage have been successfully answered in the past, recently a philosophical question of storm water management is in the focus of attention of most professionals dealing with sewerage and urban hydrology (*STN 73 6701 Sewer systems*). The list of technical standards related to water management is summarized in *Table 2.5*.

Technical regulations for drinking water, irrigation, surface water, etc.

The quality of receiving waters is evaluated according to the following documents: STN 75 7221 and Gov. Directive No.242/1993. STN 75 7221 Water Quality. Classification of Surface Water Quality classifies the quality of surface waters into 5 classes, the Directive into two classes. Both of them have their own criteria for water pollution control (according to the Directive classification e.g. water supply watercourses should have BOD5 less than 8 mg/l - compare with *Table 2.4.*). Wastewater effluent data can be relatively easily obtained, however, one of the greatest problems is a total lack of real world data on storm runoff quantity and quality. The drinking water quality is controlled regularly by the laboratories of water waterworks in order to ensure the requirements *STN 75 7111 Water Quality. Drinking Water*. Recently this standard is revised and amendment of this one is under preparation. The same situation is with the standards determining the quality of water for irrigation (*STN 75 7143 Water Quality. Water Quality for Irrigation*) and surface water (*STN 75 7221). STN 83 0615 Requirements for Water Quality Transported in Pipes* defines the water quality in networks.

Legislation regarding sewage sludge disposal.

In Slovakia municipal treatment plants currently produce about 84,4 thousands tons of dry sewage sludge solids per year (Šumná, 1997).

Table 2.5. List of Slovak Technical Standards (STN) in water management

N^o.	Set of Standards	Number of issued STN
750	Water Management	13
751	Hydrology	4
752	Hydraulic Structures	4
753	Water Pollution Control	4
754	Melioration	4
755	Water Supply	12
756	Sewerage	9
757	Water Quality	61
83	Environment Protection	
83 0520	Physic-chemical Analysis of Drinking Water	40
83 0521	Microbiological Analysis of Drinking Water	5
83 0530	Chemical and physical Analysis of Surface Water	44
83 0531	Microbiological Analysis of Surface Water	4
83 0532	Biological analysis of surface water	8
83 0540	Chemical and Physical Analysis of Wastewater	29
83 0550	Physico-chemical Analysis of Sludges	5
83 06/07	Water Quality	2
83 09	Water Resources Protection	4
83 71	Protection of Nature. Hydrosphere	1
73	Design and Erection of Structures	3
73 65	Structures for Water Management, Generally	11
73 66	Water Supply	6
73 67	Sewerage	8
73 68	Water Courses and Dams	10
73 69	Ponds, irrigation, melioration	2
36	Electronic (level measurement instruments)	2
25	Instruments for Measurement and Control	
25 77	Gas and Fluid Flow Measurement in Closed Profiles	6
25 93	Fluid Flow Measurement in Open Channels	4

Future production and disposal of sludge will be affected by two dominant factors: the changes of effluent standards and new, tighter sludge disposal regulations. In any case, a gradual increase in sewage sludge production is expected.

The EU directive 86/278/EEC established the basic legislation on agricultural use of sludge in EU. In addition to this, other guidelines have invoked the handling of sewage sludge if agricultural use is not possible. They are as follows: Hazardous waste No. 91/689/EEC, Landfills No. 5953/91 ENV 136; KOM (91) 102, Incineration of hazardous waste No. 5761/92 ENV 88 KOM (92) 9.

The directive on agricultural use of sludge represents minimum requirements and allows each country to set up a more stringent legislation. At present only allowable concentrations of heavy metals in composted sludge are issued.

In Slovakia the rules for sludge disposal and utilization are predetermined in the following legislative documents:

Solid Waste Law 238/91, Categorization and catalogue of solid wastes, STN 46 5735 Industrial composts and Guidelines for agricultural use of sewage sludge and sediments, 1997.

Table 2.6. Limits for heavy metals in mg.DS kg^{-1}

Contaminant	EU 86/278/EEC	STN 46 5735	Guideline
Pb	750-1200	500	1000
Cd	20-40	13	10
Cr	1000-1500	1000	1000
Cu	1000-1750	1200	800
Ni	300-400	200	400
Hg	16-25	10	2
Zn	2500-4000	3000	2000
Se			10
As		50	20
Mo		25	
PCB			0,2
PAU			1
NPES			2000
Tenzides			20

The above guidelines (similarly to Germany) set the restrictions in relation to the heavy metals concentrations in sludge, concentrations of harmful organic components which are usually difficult to degrade in the soil (PCB, halogens compounds (AOX), dioxin/furane) and nutrient consumption of the crops. The basic information is summarized in Table 2.6. Comparison of Slovakian limits with limits applied in EU countries is provided in Table 2.7.

Direct application of sewage sludge on arable soil is only possible if the concentration of harmful compounds contained in it is below the maximum limits listed in Table 2.6. and, simultaneously, the dosage of sludge must be estimated on the basis of limits listed in Table 2.7.

This guidelines has solved the problems of heavy metals content in sewage sludge and its impact on the quality of soils as well as the maximum permitted amount of sludge applied on farmland during one year. Almost all countries in EU have recently changed their own legislation on sludge disposal and handling. In Slovakia, there is a tendency to utilize sludge in agriculture more intensively in the future. Incineration and landfill disposal of sludge are only alternative solutions.

Table 2.7. Max. limits of contaminants in sewage sludge applied as fertilizers [kg/ha]

Contaminant	Guideline	STN 465735
Pb	50	20 t DS/ha
Cd	0,5	
Cr	50	
Cu	30	
Ni	15	
Hg	0,1	
Zn	100	
Se	0,5	
Zn_{eq}.	100	

Zn_{eq}. = (Zn) + 2(Cu) + 8(Ni)

Emission limits: 30 - 60 t/ha

Legal instruments on national level for monitoring, control, remediation.

The Government of the Slovak Republic stated in its resolution No. 623/1990 the need for integrated monitoring of environment in the Slovak Republic. The fundamental activities for monitoring of environment are an observation and a subsequent evaluation of the environmental state. Monitoring of environment consists of three basic and related levels with considerable overlapping of spatial, temporal and other aspects, as follows:

- aerial monitoring,
- regional monitoring,
- purposeful monitoring.

Aerial monitoring has a character of a complete monitoring system organized by Ministry of Environment. Regional monitoring is spatially limited but a permanent system. It is organized by regional institutions in close co-operation with the Ministry of Environment. The purposeful monitoring is a tailor-made monitoring usually a time limited monitoring, as well. This is organized by scientific research institutions and/or experts.

The concept of environmental information system for the Slovak Republic, approved by the Slovak Government in 1992, defined the system of collection, processing, storing and dissemination of environmental information. This system is based on two principles: it is a distributed information system and GIS oriented.

The Ministry of Environment directs the district authorities for environment and **the Slovak Inspectorate of Environment.** The following institutions are also directly managed and financed by the Ministry:

- Slovak Agency for Environment, Banská Bystrica
- Slovak Hydrometeorological institute, Bratislava,
- National Parks of Administration of the Nízke Tatry, the Slovenský Raj and Malá Fatra.

The Slovak Inspectorate for Environment performs the state supervision of environmental protection. It was established by the Act No.595/1990 Coll. It is divided on:

- section of water management inspection,
- section of air protection,
- section of waste management inspection.

Inspections of water and waste management are situated in Bratislava, Nitra, Žilina, Banská Bystrica a Košice. Inspectorates exert supervision in extent and under conditions given by autonomous regulations. The inspectorate imposes penalties for break down of juridical duties. The penalties present the incomes of the State Fund of Environment.

The Slovak Hydrometerological Institute is organization directed and financed by the Ministry of Environment of the Slovak Republic. The activity of Institute is mainly to obtain data about the state and regime of water and air, to process them, analyze, interpret and store them. On this basis institute provides especially:

- provides regime and real-time information about surface and ground water, about their quantity and quality, provides information and forecasts of water levels and discharges,
- provides meteorological and climatological information, predictions,
- observes and evaluates the level of pollution and radiation of air, cooperates on the conception preparation and measures of air protection, provides professional activities and operational activities in hydrology, climatology, meteorology, water and air protection,
- systematically acquires, records and stores the documentation in the above mentioned fields.

In the domain of construction and operation of environmental information system on the territory of the Slovak Republic it fulfils the function of the Center of Environmental Information of the Slovak Republic. It processes the water quality information as one of the most important basis for the management and water resources protection, and its rational exploitation.

Water Research Institute in Bratislava is directed by the Slovak Ministry of Soil Management. The Institute deals with the problems related to water quality monitoring and wastewater treatment. It also provides hydrological characteristics for water management planning and hydraulic parameters of different water structures. It is also responsible for the preparation of the technical standards, legislative norms in the field of water pollution control and exploitation. The Institute solves the research tasks dealing with the surface and ground water assessment and control, their exploitation for the drinking purposes, navigation and hydropower production.

The Decree of the Slovak Republic No. 638/1996 appointed the Institute National Reference Laboratory, i.e. function of the highest methodological center for executing analytical water examination, determination of sediments, sludge, various matters and chemicals, being in contact with water. The laboratory has competence within the scope of all sections of the Ministry of Soil Management SR, of the Ministry of Environment SR and the Ministry of Health SR.

The state authorities for administration of significant basin are the state enterprises established according to the Water Act No. 38/1973 Coll. Four **river basin authorities** have been established:

- The Danube River Basin Authority,
- The Váh River Basin Authority,
- The Hron River Basin Authority,
- The Bodrog and Hornád River Basin Authority.

The duties of river basin authorities are to:

- administration, operation and maintenance of watercourses, water engineering works and facilities constructed on them,
- supply of surface water to all sectors of management, including new water resources development
- fulfil the duties given by the flood operational plan,
- maintain the water ways,
- monitoring surface and irrigation water quality and measures focused on water pollution control,
- creation of conditions for utilization of the hydropower potential of water streams and conditions for navigation,
- administration, operation, maintenance, upgrading, modernization and new construction of stated owned hydromelioration systems.

The river basin authorities are obliged pursuant § 33 of the Water Act No. 138/1973 Dig. in wording of later provisions to carry out following :

- monitoring and evaluation of water quality, as well as withdrawals, discharging of wastewaters and other activities on water courses,
- co-operation in improving emergency surface water quality deterioration and elimination of its consequences,
- drawing up a plan of complex care concerning water quality, propose measures for water quality improvement in watercourses,
- carry out systematic control of water quality in specified cross-sections.

The Ministry of Soil Management SR decided with efficiency from 1st July 1997, pursuant respective regulations of the Act No. 111/1990 Dig. on the state enterprise, including its later provisions, to established from the river basin authorities the Slovak Management Enterprise. It is state enterprise for meeting public-benefit interests placed in Banská Štiavnica. It should ensure profitability of all enterprises within the water management with the trend of decreasing the claims and state subsidies coming from the state budget and state funds, and a uniform standard of attendance for watercourses and water engineering works, as well as water resources development.

State enterprises **Water Supply and Sewerage Works (waterworks)** are responsible for the following:

- supply for drinking water to the population and other consumers,
- public sewerage and wastewater treatment.
- providing development of water resources, technical and investment development in sanitary engineering,
- administration, operation and maintenance of waterworks, water supply networks, sewerage systems and wastewater treatment plants,
- administration, operation, admittance, repair, upgrading and modernization of facilities.

In addition, waterworks are engaged in a multitude of secondary and auxiliary activities, e.g. erection of structures and installation services. Waterworks posses their own laboratories serving for the analysis of supplied water quality and for the control of wastewater treatment plants.

2.4. Expected Impacts of EU-Directives to Water Pollution Control

The Ministry of Soil Management together with the Ministry of Environment SR in water management and water pollution control field support the preparation of legislative measures, focused on completing the formation of total modern system of legal provisions on protection and rational use of water, comparable and harmonized with the legislation of EU countries, and their implementation into the practice. The most important of those are (NAP, 1997):

- issuing of a new Water Act, which will be harmonized with EU legislation, and relevant directives and decrees or guidelines as follows :
- Decree of the Government of the Slovak Republic, which establishes the effluent standards and ambient water quality criteria,
- Decree, which regulates the details on water plans and state water balance,
- Decree, which regulates the details on the content of water book and the method of making the records into it,
- Decree, which determines the list of substances, harmful for water and their categorization into basic groups and details on measures for water protection, when used for mining, production, processing, storage and transportation of substances, harmful to water,
- Decree, which regulates the details and tasks of water manager and proving the professional ability for their performing,
- Decree, which regulates the details on procedures for inspection, during identification and evaluation of the water pollution, and during elimination of accidental endangering of water,
- Decree, which regulates the details on organization and tasks of water guard, on its appointing and on assumptions of the execution of its activities,
- issuing of the Parliamentary Law on Fees and Charges for Water Exploitation;
- arranging the tasks, following from interstate agreements on water management issues;
- standardization activity in the field of water quality protection, creation of new Slovak technical standards.

The water management department of the Ministry of Soil Management SR has been providing in the course of 1997 incorporation of five guidelines of the Council of EU, specifying rules in the field of aquaculture, into the prepared Act of Fishery and other legal rules. Other material being in preparation at present are (Green Report, 1997):

- Water Management policy of the European Community (information of the European Commission of the Council, and for the European Parliament of February, 1996),
- Action Programme for Integrated Protection and Management of Groundwater (Draft of the European Commission for the Council and for the European Parliament of July 10, 1996),
- Principles of the water management policy of the European Union (Draft of the guideline of the Council submitted by the European Commission).

To study the expected impacts of EU directives to water pollution control in Slovakia the following ones have to be taken into account:

- 1st group of priorities:
  - Draft of Water Framework Directive,
  - Urban Wastewater Directive 91/271EEC,
  - Nitrate Directive 91/676,
  - Dangerous Substances Directive 76/464,
  - Integrated Prevention and Pollution Control (IPPC)
- 2nd group of priorities:
  - Drinking Water 80/788
  - Bathing Directive (Recreational)

However the draft of Water Framework Directive is still under negotiation by EU members, in our opinion, it is valuable to compare its requirements with Slovak water management policy. In general, this Directive requires to identify river basin on national level and to apply integrated river basin approach in water management (river basin plan). In SR we had identified the river basins in 18th century and in 1966 the river basin authorities was established (description of their competencies are described in chapter 2.3.). Similarly the identification, registration and monitoring of surface and groundwaters suitable for drinking water purposes and the legal instruments for the water pollution control of them have already been set in SR. SR established and registered the protected areas for the drinking water purposes, too. The drawback of these activities is that the list of all these protected areas is not in one common file.

According to the draft of Directive it is necessary to established the river basin plans based on assessment of water needs, impact of human activities and objectives for water quality and quantity. In SR we have elaborated Hydroecological plans, Water Management plans and Master plans with the similar specifications of contents. In this case the problem is that EU Directive requires one river basin plan for one river basin to ensure clear co-ordination of goals or objectives which are set in plan. The second problem is concerning with the time period of plan binding: in SR we have 5 years cycle, in EU 6 years cycle. The different approach in the preparation of river basin plans, from the point of view of EU water management policy, can be summarized for the Slovak conditions in the following items:

- carry out economic analysis to established charging levels, at which full cost recovery is achieved,
- establish and implement a legally binding programme of measures to achieve the objectives agreed in the river basin plans,
- involve stakeholders in approval of river basin plans (plans to be published in draft at least 12 months before taking effect).

It is expected that the significant cost implications on water management in SR will have the implementation of the EU Urban Wastewater Directive 91/271/EEC. From the point of water pollution control view in this Directive we can recognize two areas: sensitive and less sensitive in the sense of ANNEX II of Directive 91/271/EEC. In Slovakia we already have identified these types of areas and they are also legally treated, but practically it is possible to state that the most of Slovak territory belongs to the sensitive area.

The big cost implications of the Directive concerns with the requirements to ensure the construction of sewerage (art. 3) for the settlements with and more than 15.000 inhabitants till 31.12.2000 and after 31.12.2005 also for the settlements from 2000 to 15.000 inhabitants. This problem is dramatically accelerated with the requirement of Directive (art. 4) for the treatment of collected wastewater by public sewer systems. Again, there is set-wise approach of setting effluent standards for treated wastewater: till December 31, 2000 and more stringent after December 31, 2005. The most treatment plants, due to the fact that the Slovak territory is predominately sensitive, will have to be designed with nitrification and larger ones with biological or even biological-chemical nutrient removal. All these treatment lines require the higher volumes of tanks, the higher level of automation and control and more sophisticated trained operators, therefore not only the investment costs, but also operation and maintenance costs will dramatically increase in this sector.

There are several studies, which have tried to estimate the expected cost implications of the Directive requirements in Slovakia. These estimations significantly varied, but the amount from 25 to 35 milliard Sk seems to be more or less realistic. It should be stressed that there is not included the inflation rate, therefore this estimation may be very different for particular year.

Note: The above mentioned cost estimations are based on actual level of sewerage, level of wastewater treatment, etc. (for more information see chapter 2.1.).

2.5. Law and Practice on Water Pollution Control

The Ministry of Soil management requests restriction on the issue of licenses to operate water mains and sewers to juridical persons. Such issue would established the legal framework for the operation of water supply and sewerage systems by other subjects and thus conditions for competition in the relevant field. Assessment of applications and issues of licenses would remain in the competence of the Ministry of Soil Management Adjustment of mutual relations in respect to supplying drinking water and sewerage is no longer included in the Water Act No. 369:1990 (Digest) on municipalities, as amended and supplemented by later legislation. Competence in the filed of public-benefit activities will be transferred to municipalities. The prepared transformation of the existing water supply and sewage works would create conditions for enterprising, showing specific characteristics.

The Ministry of Soil Management has prepared the draft of the regulation on Competence’s of the National Reference Laboratory. This regulation follows from the Act No. 272/1994 Dig. on public health and from the Act No. 238/1991 Dec. on wastes, in wording of later practices. On the basis of the Decree No.638 of September 24,1996 SR the National Reference laboratory in the Slovak Republic was established at the Water Research Institute Bratislava (see chapter 2.3.). The laboratory is the superior methodological center for providing the quality of water analyses, tests of sediments, sludge, materials and chemicals, occurring in water medium. It belongs to the system Analytical Quality Assurance (AQA), to the subsystem Water, developed according to internationally valid standards ISO 9000 and European Standard 45000.

3. Actual and Planned Projects and Policy Measures for Reduction of Water Pollution

This chapter summarizes the list of hot spots and projects or programmes in the Slovak Republic. Using the *Project Files* questionnaire we addressed the selected institutions to get a comprehensive picture about the ongoing as well as planned programmes and projects concerning the reduction of water pollution. The list of hot spots have been prepared with the close co-operation with the *Water Quality National Expert* taking into consideration the list of hot-spots presented in Strategic Action Plan and National Action Plan for the Danube Basin of Slovak Republic. The projects and programmes identified actions for monitoring water pollution and water quality, wastewater treatment, protecting water resources, preventing environmental degradation, etc. The prepared list of hot spots covered by *Project Files* indicates the actual problems in the fields of municipal wastewater and industrial wastewater including partially the problems of waste disposal (landfills). The agriculture problems are described in general, but they are not covered by any *Project Files*.

The National Action Plan for the Danube Basin of SR has prepared the list of measures focused on the reduction of pollution of discharged wastewater treated in WWTPs including small WWTPs. The principle aim of these measures is to improve effluent quality of the treated wastewater.

Based on the requirement from the Ministry of Environment of the Slovak Republic, the study, which contains the order of pollution sources, which significantly cause impairment of the surface water quality in the Slovak Republic, and hence from the point of view of urgency to solve suitable treatment method, has been elaborated. The study was completed in the beginning of 1998 and the results were utilized in this Report and especially in selection of hot spots ranking.

3.1. Reduction of Water Pollution from Municipalities

The list of municipal hot spots has been prepared with co-operation of Water Quality National Expert using multi-criteria analysis of ranking the assumed problems. The results of this approach are presented in the following Table 3.1.

Table 3.1. Selected municipal hot spots

No.	Locality	Project file	Water and Sewage Works
HIGH PRIORITY			
1.	WWTP Košice	yes	VVaK
2.	WWTP Nitra	yes	ZsVaK
MEDIUM PRIORITY			
3.	WWTP Malacky ***	no	ZsVaK and municipality of Malacky
4.	WWTP Banská Bystrica	yes	StVaK
5.	WWTP Michalovce	yes	VVaK
6.	WWTP Svidník	yes	VVaK
7.	Sewerage Trenčín right side	yes	ZsVaK
8.	WWTP Humenné	yes	VVaK
LOW PRIORITY			
9.	WWTP Ružomberok ****	no	SeVaK
10.	WWTP Topolčany	yes	ZsVaK
11.	Švábovce **	no	Municipality Švábovce
12.	Kišovce-Hôrka **	no	Municipality Kišovce-Hôrka
13.	WWTP Rožňava	yes	VVaK
14.	WWTP Liptovský Mikuláš	yes	SeVaK
Project obtained, partially analyzed, but not included in list of municipal hot-spots :			
15.	WWTP Banská Štiavnica @	yes	StVaK
16.	WWTP Krompachy	yes	VVaK
17.	WWTP Ilava	yes	SeVaK
18.	WWTP Hlohovec *	no	ZsVaK, municipality Hlohovec
19.	WWTP Zvolen @@	yes	StVaK
20.	WWTP Lučenec &	yes	StVaK
21.	WWTP Nové Zámky	yes	ZsVaK
22.	WWTP Čadca	yes	SeVaK
23.	WWTP Kysucké Nové Mesto	yes	SeVaK
24.	WWTP Turzovka	yes	SeVaK

Note:

** - WWTP is under construction and during this year will be in test operation,*

*** - sensitive area, but they are small settlements. There is necessary to build only small wastewater treatment plants,*

**** - WWTP is under construction, the civil structures are financed by the Programme Phare, the investment costs for the technology is covered by the municipality of Malacky. This year the 1st stage of the upgrading and expansion of treatment plant will finish. The 2nd stage of construction is not covered by investment costs, yet.*

***** - WWTP completed upgrading of treatment processes - replacement of existing aeration system to fine bubble one. The project of raw sludge treatment and its hygienization has already completed. At present the WWTP is under privatization project and the relationship between owners is not clear therefore this project is not included in Project Files,*

@ - WWTP is under construction and the necessary investment costs are only partially secured.

@@ upgrading of aeration system was completed in 1997, at present the project of WWTP is under preparation,

& - the project of expansion and upgrading of WWTP was completed this year, the construction of WWTP is prepared.

The most numerous group is created from the existing WWTP under construction, which are upgraded and/or expanded. Their construction is often postponed for several years already, due to the lack of financial funds such as with WWTP Košice, WWTP Humenné, WWTP Svidník, WWTP Michalovce, WWTP Krompachy, WWTP Banská Štiavnica, WWTP Banská Bystrica, WWTP Nitra. Most of these plants are serving for larger towns and cities. The efficiency of the plants is design according to Slovak effluent standards. That means that the design of treatment line depends on the requirements set by Governmental Decree 242/93. This fact has the great impact on the technology applied and thus on the reduction of point sources of nutrient discharges. Therefore most of them will be operated with nitrification and denitrification and only the limited number with biological phosphorus removal. The small treatment plants are usually design as an extended aeration.

Table 3.2. The planned WWTP upgrading, expansion or construction of new ones (*National Action Plan, 1997*)

Name of construction	Expected years of of construction	/ mil. Sk /	
		Total costs	Volume 1997 - 1999
Košice, 2nd WWTP construction	1988-99	873,5	318,1
Prešov - Sekčov, sewerage (4th construction)	1989-98	444,0	106,6
Krompachy, sewerage and WWTP	1990-98	246,0	153,5
Svidník, sewerage and WWTP	1989-98	304,0	121,6
Upgrading of WWTP Michalovce	1993-99	104,0	83,9
Humenné, expansion of WWTP	1989-99	524,0	310,8
Čadca, reconstruction of sewerage and WWTP	1991-98	179,0	92,8
Banská Štiavnica, sewerage and WWTP	1990-99	339,2	196,1
Šafárikovo, sewerage and WWTP;	1990-98	72,0	50,7
Nitra, WWTP	1991-2001	548,0	168,0[1]
Banská Bystrica, reconstruction and expansion of WWTP	1988-98	593,0	243,4
Banská Bystrica, sewerage collector „A«	1998-2002	940,0	370,0[2]
Zvolen, expansion of WWTP	1998-2000	300,0	230,0[3]
Kováčová, sewerage collector	1996-97	9,3	4,1

Note:

The volume of investment after 1999 for individual constructions presents:

[1] - 207,7 mill. Sk; [2] - 570,0 mill. Sk; [3] - 70,0 mill. Sk

Totally, there is almost 300 actions by the end of 2000, 16 actions by the end of 2005, 19 actions after 2005. The realization will be undertaken dependently on financial sources of polluting subjects, and in accordance with valid legal provisions. Many of mentioned WWTPs should be finished by the end of 2000, taking into consideration the importance of influencing the water quality from national, as well as transboundary point of view. Based on the need of construction of selected WWTP, as well as from possibilities and status of preparation of the constructions, the Ministry of Soil Management of the Slovak Republic, in order to reduce the amounts of polluting substances in the field of municipal wastewater, has proposed to include the new, or ongoing constructions in years 1997 - 1999 (*National Action Plan, 1997*). They are summarized in Table 3.2. Realization of listed investment is conditioned by the subvention from the state budget, because these funds create the biggest part. Another part of the costs will be covered from state funds, and part from own financial funds of the enterprises.

It is transparent that the list of hot-spots (see Table 3.1.) is generally covered by the proposal of the planned constructions (see Table 3.2.) approved by the Ministry of Soil Management. The list of completed *Project Files* for municipal point sources is enclosed in Annexes. The obtained results and the summary of recommended projects for municipal hot spots are presented in Table 3.3.

Table 3.3. Summary of recommended projects for municipal hot spots

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
HIGH PRIORITY						
WWTP Košice & Hornád & Košice	The expansion of the capacity of biological treatment step & to reach the effluent standards according to Gov.Decree 242/93	High	Košice-expansion of wastewater treatment plant 2nd stage of construction & structural	The construction and expansion of the existing treatment plant, 90 % of civil structures are completed, the aeration system of activated sludge system will have to be installed, the implementation of nitrification - denitrification is considered.	The implementation of the project would reduce the pollution of the Hornád river and thus it would have positively effect on transboundary pollution transported to Hungary. The upgrading of treatment line to biological nutrient removal will have reduce the discharge of the mass loading of TN to surface water and partially also TP.	East Slovakian Water and Sewage Works, the municipality of Košice city
WWTP Nitra & Nitra & Nitra	To complete the construction of a new treatment plant, to treat the total amount of discharged municipal wastewater during dry period, the project can not be completed due to the lack of finances.	High	Nitra-wastewater treatment plant & structural	The construction of the new treatment plant, about 40 % of civil structures are completed, the project of biological treatment step has been re-designed with possible utilization of the structures of the old existing plant. The treatment line consist of nitrification-denitrification and biological phosphorus removal	The main benefit of the project would be the reduction of pollution discharged to highly polluted the Nitra river. The absence of treatment of the large portion of discharged wastewater is the limit of the development of the Nitra city. The new treatment line would reduce the total mass loading of the Nitra river not only in terms of carboneus pollution but also in terms of nutrients.	Municipality of Nitra city, West Slovakian Water and Sewage Works

Table 3.3. continued

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
MEDIUM PRIORITY						
WWTP Banská Bystrica & Hron & Banská Bystrica	The expansion of existing treatment plant with the capacity able to cover the wastewater conveyed by main sewer «A». The existing treatment plant is mass and hydraulic overloaded ,therefore the effluent standards set for the plant are not fully reached.	Medium	Expansion of wastewater treatment plant Banská Bystrica & structural	Expansion of existing treatment plant with the capacity of 1500 l/s. The treatment line will be with capacity for 110 000 P.E. The treatment line will change to the pre-denitrification - nitrification and biological phosphorus removal with possible chemical precipitation.	The implementation of the project will improve the total efficiency of treatment line on 30 % more and it will remove also the nutrients (TP 90- 95 %, N-NH_4^+ 90 - 95 %). The chemical precipitation of phosphorus is considered, as well.	The Central Slovakian Water and Sewage Works, the municipality of Banská Bystrica
WWTP Michalovce & Laborec & Michalovce	The existing treatment plant is mass and hydraulic overloaded, therefore a part of discharged municipal wastewater cannot be treated. The upgrading started in 1993, but the lack of finance is the limit of completing the ongoing project.	Medium	Upgrading of wastewater treatment plant Michalovce & structural	The expansion and upgrading of existing treatment plant Michalovce would cover the increased wastewater production and the required effluent standards. The existing treatment plant would be enlarged from the capacity 133 l/s to 350 l/s in two consecutive stages.	The project will implement the treatment line with pre-denitrification and nitrification. The existing activated sludge tank will serve as an regeneration tank. The designed capacity of the treatment plant will be able to cover the total production of discharged municipal wastewater, therefore the significant reduction of pollution also in terms of TN is assumed.	The Eastern Slovakian Water and Sewage Works, the municipality of Michalovce city

Table 3.3. continued

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
WWTP Svidník & Ondava & Svidník	Collection of wastewater of municipal wastewater of Svidník city and adjacent settlements. At present the city and these settlements do not have any treatment plant. The wastewater discharge to the Ondava river have the significant impact on the river water quality.	Medium	Svidník - sewer network and wastewater treatment plant & structural	The construction of sewer network and mechanical-biological treatment plant. The treatment line is designed as a regeneration denitrification and nitrification with anaerobic stabilisation of sludge. The capacity of treatment line will cover the production of wastewater not only from Svidník city, but also from adjacent settlements.	The wastewater generated in the territory of Svidník city are not treated at present and therefore the impact on the water quality of the Ondava river is very negative. The implementation of the project significantly reduce the discharged pollution to the river and also will protect the main water resource serves for Svidník public water supply distribution system..	The Eastern Slovakian Water and Sewage Works, the municipality of Svidník city
WWTP Trenčín right side & Zlatovský creek & Trenčín	At present the right side of city does not have any treatment plant. The wastewater discharge to the Váh river basin has the significant impact on the river water quality.	Medium	Trenčín - sewer system and wastewater treatment plant & structural	The construction of new treatment plant with mechanical biological treatment line has been designed for the capacity of 41 830 P.E. The capacity of mechanical and biological treatment line is 200 l/s. The implementation of the project will construct a new treatment plant covers the treatment of total production of wastewater on the right side of Trenčín .	The wastewater generated in the right side of Trenčín city are not treated at present and therefore the impact on the water quality of the Váh river basin is very negative. The implementation of the project significantly reduce the discharged pollution to the Zlatovský creek. The present situation also limit the development of the locality The designed treatment line will reach the requirements of Slovak Gov.Decree 242/93 and EU effluent standards.	The municipality of Trenčín city

Table 3.3. continued

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
WWTP Humenné & Laborec & Humenné	The present capacity and the level of treatment of the existing plant is not sufficient. The project started in 1987, but the production of wastewater during its implementation has significantly changed and therefore the design project has had to be re-designed.	Medium	Expansion of wastewater treatment plant Humenné & structural	The existing treatment plant is mass and hydraulic overloaded. The expansion of treatment line was corrected according to new situation with respect to decreasing of wastewater production. In 1996 the capacity of treatment plant was estimated on 380 l/s. The treatment line is designed as nitrification denitrification.	The main goal of the project is to improve the effluent quality parameters, to reduce pollution impact of treated wastewater discharged to the river Laborec. The impact of discharged pollution has also the transboundary effect. (Hungary). The locality may be classified as a sensitive because this region is utilized for the public water supply, as well (there are two water resources for the settlements Strážske and Michalovce).	The Eastern Slovakian Water and Sewage Works, the municipality of Humenné city
LOW PRIORITY						
WWTP Topoľčany & Nitra & Topoľčany	The present capacity of existing treatment plant is not sufficient and the treatment line is not able to reach the required effluent quality. The treatment plant is in poor conditions with old and defective installations. The upgrading of plant has already started (12/96) however the lack of finances is the limit of completing the project	Low	Topoľčany - wastewater treatment plant upgrading & structural	The upgrading of the treatment plant will be implemented in two subsequent stages. The treatment line is designed as a pre-denitrification and nitrification system.	The main goal of the project is to reach the Slovak and EU effluent standards because of highly polluted receiving water - the Nitra river. All collected wastewater by sewer system will be treated in wastewater treatment plant after implementation of the project during the dry period.	The West Slovakian Water and Sewage Works, the municipality of Topoľčany city

Table 3.3. continued

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
WWTP Rožňava & Slaná & Rožňava	The capacity of 63 l/s of the existing treatment plant is not sufficient to ensure the required effluent quality. The present flowrate is from 140 to 160 l/s. The construction of a new treatment plant was started with the capacity of 162 l/s.	Low	Rožňava - expansion of wastewater treatment plant & structural	The new treatment plant with capacity of 162 l/s has already constructed however only 1/3 of the total capacity of plant is in operation due to lack of finances necessary for technology supply. The civil part of the project is practically completed. The treatment line is represented by carrousel.	The main goal of the project is to complete the whole treatment plant and to improve the effluent quality and in this way to reduce the discharged pollution to the Slaná river. At present this reduction represent about 10 t/year less than before in terms of BOD_5 and SS. This region is very sensitive because of covering the protected region Slovenský Kras including the protected natural sources of water. The transboundary pollution plays the important role in this case, too.	The East Slovakian Water and Sewage Works, the municipality of Rožňava city
WWTP Liptovský Mikuláš & Váh & Liptovský Mikuláš	The existing treatment plant does not reach the required effluent standards. The existing biological treatment line is not able to manage the treatment of the mass loading and to reduce the nutrients in effluent.	Low	Liptovský Mikuláš - reconstruction of wastewater treatment plant 2nd stage & structural	The project covers the reconstruction of aeration system with fine bubbles, pumping station for sludge recycling , upgrading of biological step to pre-denitrification and nitrification and expansion of the capacity of final clarifiers.	The implementation of the project will help to reach the required effluent standards, reduce the discharged pollution to the Váh river and sensitive region nearby the Liptovský Mikuláš - reservoir Liptovská Mara. This fact will have a positive impact on aesthetic, recreational and fishing characteristics of Liptovská Mara reservoir.	The North Slovakian Water and Sewage Works, the municipality of Liptovský Mikuláš city

Note:

WWTP Malacky and WWTP Ružomberok are not included in Table 3- 3 in spite of the fact that they are included in the list of municipal hot-spots. Please see the explanation in the part C - Water Quality.

3.2. Reduction of Water Pollution from Agriculture

Agriculture is one of the most important pollution sources of aquatic environment in Slovakia. It is responsible for the nutrient input into surface water, for the sedimentation of soil solids in reservoirs, it threats or deteriorates groundwater, as well. The agriculture practices combined with the canalization of watercourses, which were often implemented in the past, are the reasons of impacts on landscape nature and negative biodiversity changes.

Basic information concerning agricultural soil, production and fertilizer application in Slovakia shows the following tables:

Table 3.4. The basic agricultural characteristics of the river basins

River basin	Length of Stream [km]	Length of border Stretch [km]	River basin area [km^2]	Total Agricult. Land [km^2]	Arable Agricult. Land [km^2]	Forest Area [ha]	Water Area [ha]
Morava	107,2	107,2	2 282	119 642	95 876	79 332	3 897
Danube	172,0	149,9	1 138	195 264	169 881	40 544	13 004
Vah	367,2	-	14 268	581 843	332 166	492 758	22 491
Nitra	168,4	-	4 501	314 449	258 169	144 068	10 868
Hron	278,3	-	5 465	265 342	120 866	259 041	5 616
Ipel	197,9	108,7	3 649	157 349	91 700	132 132	3 879
Slana	92,5	-	3 217	150 542	70 597	171 708	2 956
Hornad	178,5	10,4	4 414	174 032	96 851	175 581	4 414
Bodrog Tisa	153,8 5,2	 5,2	7 265 7	381 550	217 648	271 288	19 827
Bodva	48,8	-	858	40 306	30 336	N/A	1 244

Note: Data concerning Morava, Danube, Bodrog and Tisa rivers are related only to Slovak territory

References to the Table 3.4.: Length of the streams, river basin areas and length of bordering water courses - Statistical Office of the SR, 1997.Structure of Land -Office of Geodesy, Cartography and Land Register of the SR, 1997

Danubian Lowland (765.000 ha of agricultural soil and 678.000 ha of arable land) may be considered as relatively most intensive part of Danube Catchment Area.

Table 3.5. Average yield of selected agricultural products within period 1990 to 1996

Year	Winter wheat	Barley	Grain maize	Potatoes	Sugar beet	Legumes	Oil crops
-	[tons/ha]						
1989-90	5,00	4,82	3,56	14,12	30,82	2,16	1,90
1990-91	5,22	4,59	5,40	12,26	31,07	2,26	2,22
1991-92	4,80	4,13	4,50	12,86	29,35	2,42	1,90
1992-93	3,85	3,33	4,62	18,15	34,26	1,88	1,70
1993-94	4,85	3,67	4,14	9,67	34,53	2,91	1,78
1994-95	4,44	3,40	4,90	10,07	34,26	2,17	1,90
1995-96	4,13	3,18	5,75	21,54	39,54	2,09	1,89

Since 1993 pastureland has been statistically estimated together with permanent grass-field. The area of permanent grassland in 1996 was 840.000 ha and pasture represents approximately one third of this area.

Typical pastureland dominates in hilly area of the Slovak Republic. In the year 1995 on 1 ha of agricultural soil was in average 0,55 of cattle number.

Table 3.6. The development of fertilizer consumption in Slovakia

Year	Sum of N, P, K	N	P	K
-	[kg/ha/agricultural soil]			
1986 - 1987	251,6			
1990 - 1991	123,1	62,8	30,7	29,6
1991 - 1992	63,9	39,5	12,6	11,8
1992 - 1993	41,6	28,4	7,2	6,0
1993 - 1994	43,5	30,1	7,3	6,1
1994 - 1995	45,0	30,6	7,8	6,6
1995 - 1996	48,9	32,8	8,8	7,3

3.2.1. Prevention of Pollution from Agricultural Point Sources

After 1989 year the live stocks have significantly decreased and those types of farms have reduced their production very sharp. At present they are not more important as the point sources of pollution. However it is assumed that they could be source of diffuse pollution with respect known level of water pollution control (e.g. percolation from holding sewage tanks may represent about 40 % of the collected wastewater in the particular territories). In Slovakia there exists the regulation concerning handling of manure, but in reality inspection of the level of fulfil of these specified requirements does not exist. We only know about the problems if the water quality has been already contaminated and the Slovak Water Inspectorate must start solving this serious situation. In addition it is necessary to stress that in Slovakia officially the septic tank is not allowed to be constructed because this structure does not reach the requirements of present level of wastewater treatment. The aim of this regulation is to control the withdrawal the sewage from the holding tanks, but it was stated that in fact this control is not efficient. Summing up, the prevention to reduce the contamination of water from the agriculture point sources practically does not exist due to the absence of regular inspection. The handling with fertilizers, manure etc. depends on man behavior, responsibility or environmental awareness. This problem should be solved in agricultural sector more intensively.

It is estimated that about 20 - 25 % of the total N and P loads of surface waters are due to the manure discharges. A strong focus is needed in the future to handle and utilize the manure in the agriculture properly. In Slovakia the guidelines for these activities are summarized in the material released by the Ministry of Soil Management of the Slovak Republic:

- Guideline for balance of soil organic mass and determination of organic manure demand
- Principles of fertilizers dosages calculation and their application
- Regulation of the Ministry of Soil Management of the Slovak Republic No. 5000/82-OŽP about water protection against pollution from agriculture
- Regulation of the Ministry of Soil Management of the Slovak Republic No. 5001/82-OŽP about the handling and fertilization with manure and silage sap disposal

Final Report Nutrient Balances for Danube Countries (1997) summarized in Slovakia the following inputs from agriculture.

Table 3.7. Estimated nutrient inputs from agriculture in Slovakia, 1992

INPUT GOODS	Nitrogen [Kt/year]	Phosphorus [Kt/year]
mineral fertilizer	169	24,6
feed for livestock	44	13,4
sewage sludge	6	1,5
irrigation water	0	0,0
Deposition	60	2,7
N-fixation	27	0,0
Others	0	0,0
total input	307	42,2

3.2.2. Prevention of Pollution from Agricultural Non-point sources

Pollution from diffuse sources can be related to weathering of minerals, erosion of lands and forest including residues of natural vegetation, or artificial or semiartificial sources. The last one can be related to human activities such as fertilizer application or use of agricultural chemicals controlling weeds or insects, erosion of soil materials from agricultural farming areas and animal feedlots, construction sites, transportation cumulating of dust and litter on urban surfaces, strip mining, and others.

One of most important diffuse pollution sources with strong negative impact to water quality is agriculture in Slovakia. Greatness of pollution depends on the extent and utilization of soil. The structure of the land in the relation to river basins is marked in Table 3.4.

The decline of agriculture production and the reduction of artificial nutrient sources applied on agricultural soils have reflected the decreasing of nitrogen and phosphorus concentrations in surface waters in the last years. The application of pure nutrients (N, P and K) was 251,6 kg/ha in years 1986/87, but in years 1991/92 dramatically reduced to 63,9 kg/ha only (farming lands). The fertilizer consumption is varied around 45 kg/ha/agricultural soil in the Slovak Republic now (see Table 3.6.).

There are several reasons of decreasing the fertilizer and pesticide consumption. The significant role plays the transient period of national economy, impact of inflation, increasing the prices, etc. This phenomenon can be identified in improvement of surface water quality (in terms of nutrients), but is not so evident on groundwater quality. The impact of this fact on groundwater quality is difficult to estimate because of long term changes in water quality in this case. As far as the pesticides are concerned there are no available data about their consumption, now.

It is known that a part of nutrients from agriculture applied to land penetrates into surface water by erosion, in Slovakia particularly by water erosion. This aspect is studied by the Research Institute of Soil Fertility. The results are summarized, as a comprehensive information, in graphical form on a map «*Water Erosion Risk on Slovakia Agricultural Soils*». Based on the results described in the map the following table has been prepared.

Table 3.8. Water erosion risk of agricultural soils in Slovakia

Rate of soil losses [t/ha/year]	Area [ha]	Farming land [%]
0 - 4	1 065 420	45,0
4 - 10	473 520	20
10 - 30	426 170	18
more than 30	402 490	17

Calculation (based on the Table 3.8.) of nutrients transported into surface water is difficult from the next viewpoints:

- the term “farming land” includes the arable soils and pastures, as well. From the point of view of application of fertilizers there are the great difference
- the nutrient run-off from arable land is higher than from pasture.
- in addition it is not possible to include the whole part of nutrient transport from the farming land because the eroded soil is not transported only into surface water.

The second source of erosion (wind erosion) has less significant impact on water quality in our country and therefore it is not monitored regularly in Slovakia. Using the results of the Final Report on *Nutrient Balances for Danube Countries (1997)* the data about diffuse pollution have been compiled. Note that the data are valid for the year 1992. The following results have been presented in this Report (the data valid for the whole Danube River Basin):

In 1992 the respective contribution of different sectors to N and P emissions were as follows: agriculture 51 % and 55 %, households 19 % and 24 %, industry 10 % and 13 %, and others 19 % and 8 %.

Major paths are: base flow coming from groundwater (35 % and 6 % for N and P, resp.), erosion/runoff (20 % and 32 %), direct discharges of manure (12 % and 19 %), effluents of wastewater treatment plants (20 % and 29 %).

The diffuse source contribution is about 60 % for nitrogen, while 40 % for phosphorus. It is evident that in terms of N and P emissions, agriculture is the most important sector in Slovakia (see Table 3.9.).

Table 3.9. Input and output nutrients into surface waters in Slovakia, in 1992 (adopted according to the *Final Report Nutrient Balances for Danube Countries (1997)*)

INPUT GOODS	Nitrogen	Phosphorus
	[Kt/year]	[Kt/year]
direct discharges industry	8	1,0
direct discharges private households	5	1,1
storm weather overflow	1	0,2
effluents from WWTP	8	1,2
base flow	28	0,3
erosion/runoff	10	1,4
discharge of manure	0	0,0
surface runoff from forests + others	0	0,0
N-fixation	0	0,0
total national input	59	5,3
total national output	50	2,4

The total emissions of T and P were estimated to 820 KtN/year and 105 KtP/year for the whole Danube River basin. The Slovak Republic shares in N and P emissions in 1992 are 7% and 5 %, respectively.

Table 3.10. Nutrient emission into surface water from Slovak part of Danube River basin

Emission	Nitrogen	Phosphorus
Diffuse sources [Kt]	39	2
the contribution of diffuse sources to the total load [%]	66	37
point sources [Kt]	20	3
the contribution of point sources to the total load [%]	34	63
total [Kt]	59	5
area specific emission [kg/ha/year]	12	1,2
head specific emission [kg/cap/year]	11,8	1,0

Note: assumptions made by National Team for the estimation of N and P emissions are as follows:

- *erosion, including fertilizer washout: 1t/ha/year and N, P content therein.*
- *fertilizer washout: 20 % of the rest of applied N on agricultural soil (2,5-10 kgN/ha /year) and 2-3 % of the rest of P is washed out*
- *percolation (agriculture): 10-20 kg N/ha/year and 0,5-1,0 kg P/ha/year*
- *percolation (holding sewage tanks): 40 % of the collected waste water percolates*

The contribution of *diffuse sources* were defined as the ratio of: base flow + erosion/runoff + surface runoff from forests + storm weather overflow + N-fixation in surface waters divided by the total input. *Point sources* were defined as: the ratio of effluents from wastewater treatment plants + direct discharges from households + direct discharges from industry + direct discharges of manure.

It is clear that for P the importance of agriculture is even greater than for N. The data clearly show that if Slovakia would develop future emission reduction strategies agriculture plays a key role. Almost 60 % of the total P stemmed from agriculture. In the case of P the paths erosion/runoff and direct discharges of manure should be underlined.

Groundwater contamination plays an important role from the viewpoint of nitrogen balance and impact of diffuse pollution on it. In the Report there were recognized three main input flows of N into groundwater in the whole Danube River Basin: percolation from

- agricultural soils (about 50 %),
- forestry soils (about 25 %),
- septic or sewage holding tanks (about 15 %).

From the above-mentioned it is clear that a significant load nutrient reduction should be considered in order to protect the Delta and the Black Sea. The wastewater management contributes to a desired reduction only at a small extent, thus the development of an integrated approach with a strong focus on agriculture is of crucial importance.

Taking into account these facts also in Slovakia it is necessary to apply policy and measures focused to the prevention of pollution from agricultural sources (both that means point sources and diffuse pollution). Therefore the list of actual guidelines, manual of practices and/or research reports have been prepared with co-operation of the Ministry of Soil Management of the Slovak Republic to document the ongoing process of the implementation of the measures with the aim to reduce negative impact of agriculture on aquatic environment:

A. Measures to reduce the erosion/runoff of the soil:

- Guideline for the reduction of soil erosion applying its proper cultivation

  This guideline is under preparation and it should be approved during the summer this year.

  The additional measures are dealt with the forest shelterbelts on riverbanks along the watercourses and reservoirs with the aim to reduce nutrient run-off. The suitable forest vegetation was proposed to improve the biological protection of riverbanks. The results are summarized in several research reports but they have not been implemented in Slovakia in general, yet.

B. Pollution reduction from point and diffuse sources (see also chap.3.2.2.):

- Guideline for balance of soil organic mass and determination of organic manure demand
- Principles of fertilizers dosages calculation and their application
- Regulation of the Ministry of Soil Management of the Slovak Republic No. 5000/82-OŽP about water protection against pollution from agriculture
- Regulation of the Ministry of Soil Management of the Slovak Republic No. 5001/82-OŽP about the handling and fertilization with manure and silage sap disposal
- Guideline for the application of stabilized sludges and sediments on soils.

C. Sustainable and ecological agriculture:

- Direction of the Ministry of Soil Management *Rules for ecological agriculture*

  As a support of sustainable development in agriculture and ecological farming, a new Act on ecological agriculture is under preparation. At present mentioned instruction is valid. Research Institute of Soil Fertility deals with co-operation with agricultural sector in the area of fertilizer, waste and pesticide rations and their application conditions, but does not provide inspection activities. Weakness of this policy is that handling with fertilizers, manure etc. depends on human behavior, which is in relationship to his awareness.

Regarding to pesticides applications, all of them are assessed from hygienic-toxicology point of view by the Ministry of Health of the Slovak Republic. This body is responsible for reduction of those chemical substances, which deteriorate or threat environment.

Applications of lindan and DDT were prohibited since January 1976 in Slovakia.

The protection and cultivation of agriculture land is provided through legislative, agro-technical and organizational measures, namely Act 307/1992 (The Agricultural Land Protection Act). Further to this act, The Ministry of Soil Management issued Resolution No. 531/1994-540 (dated January 1995), which prescribes acceptable levels of deleterious substances in soil and stipulates the institutions entitled to measure the levels of these substances. Nevertheless, certain adverse influences on the fertility of land continue, for which reasons, it is necessary to upgrade the protection of land through support from the State Fund for the Protection and Cultivation of Agricultural Land (SFPCAL). Since 1995 SFPCAL has supported the fertilization measures, however this still falls short of being sufficient to ensure noticeable progress as no funds were released for this purpose previously.

From the viewpoint of environmental improvement and protection of agricultural land, the Ministry of Soil Management specified objectives of its environmental policy in a document entitled: The Concepts and Principles of Agricultural Policy in Slovakia. The main goal of the policy is to cultivate and protect agricultural land, to promote environmental management and to prevent the penetration of alien substances into the food chain. The priorities are as follows:

- to sow grass on steeply sloping and erosion-endangered arable land,
- to utilize damage soil for the production of non-food crops,
- to implement organic method farming on agricultural land,
- to support entrepreneurial activities aimed at improving the condition of agricultural land.

The monitoring of alien substances in the soil covers the entire territory of Slovakia. In 1995, the monitoring expanded to include the movement of heavy metals in the soil and plants.

Within last years, organic farming covered an area of about 15.000 hectares of agricultural land (it is less than 1 % of total). The rules concerning ecological farming have already been published in the Bulletin No.9 of the Ministry of Soil Management. In July, the Government approved the Concept for Organic Farming Development. This document imposes the task upon the Ministry of Soil Management to ensure that the percentage of organically farmed land increases to 5 % by 2010 year.

3.2.3. Reduction of Water Pollution through Improved Land Management

In Slovakia from the total length 8.437 km of important river channels 3.156 km (41%) were regulated. Flood protection measures have caused decreasing of floodplains, from entire area of 7.856 km^2 of floodplains only 2.970 km^2 persist (38%). Big areas of wetlands were drained for farming purposes - more than 5.000 km^2. Totally, almost 20% of territory of Slovakia was affected by diking, damming and drainage.

The rivers were typically meandering, had close contact with their floodplains and passed through extensive areas of riparian wetlands. In recent times these natural streams have been modified. Tile draining of agricultural fields has had particularly detrimental effects: reducing the stream-land interaction, decreasing groundwater levels and limiting extent of hyporheic zone, which surrounds streams. Canalization of streams and drainage of riparian wetlands resulted in the widespread destruction of streams and their riparian floodplains.

Reduced contact between river channel and surrounding ecosystems has led to the following drawbacks:

- reduced nutrient retention capacity,
- greater peak discharges,
- rapid movement of both ground and surface waters (decreasing of self-cleaning capacity),
- increasing of bank erosion, sediment transport and deposition
- decreasing of original diversity fauna and flora around and within river channel

It is clear that in Slovakia the restoration of riverine ecosystems has to be considered. It is assumed that four principal measures should be applied for specific Slovak's conditions to restore riverine ecosystems, as follows:

a. *Recreation of buffer strips* - riparian ecotones: one of the most significant effects of the reintroduction of riparian ecotones along the margins of a river is that it can reduce input of nutrients entering streams by surface and ground flow. Buffer strips provide shade, improve channel stability and enhance fauna and flora.

b. *Alteration of tile drainage:* many agricultural lands were originally developed from floodplain wetlands. To facilitate agricultural land drainage, river and stream channels were frequently lowered and surrounding lands underlain by tile drains. These drains now carry nutrient-laden waters below floodplain to empty directly into streams. A method, which can be used to decrease point-source pollution, is to open up the drainage pipes before they enter the stream.

c. *Restoration of riverine wetlands:* along many canalized agricultural streams there are areas, which are seasonally wet and often difficult to plough. These swamps areas are usually relicts of former wetlands. Where it is possible to reclaim them, they can be valuable enhancement sites for both wildlife conservation and nutrient retention.

d. *In-channel modification:* in canalized streams, bank failures along the channels sides are a major source of stream sediment. Sedimentation can be so great that canalized watercourses often have to be dredged every few years to maintain flood capacity. In many canalized rivers bank slopes are steep. Reducing these slopes and stabilizing them with vegetation can have several benefits.

In 1997 the Government of Slovak Republic agreed Programme of Wetland Conservation in Slovakia. In the framework of the *Programme* the Action Plan for 1997-2002 was released. It consists of nine following strategic goals:

1. to prevent loses and degradation of wetlands and their biological diversity,
2. to secure wise-use of wetlands,
3. to foster wetland restoration,
4. to strengthen of increasing of awareness on wetland functions and values,
5. to strengthen of building institutions responsible for conservation and wise-use of wetlands,
6. to secure protection of all Ramsar sites,
7. to add to Ramsar list the sites which fulfil criteria of Ramsar Convention,
8. to develop international co-operation by protection and wise-use of wetlands,
9. to plan and secure financial sources for realization of goals of Programme of Wetland Conservation in Slovakia.

All these goals are closely connected with protection and restoration of riverine wetland ecosystems.

In addition the Government of Slovak Republic recognized the importance of biological diversity and signed the Convention in 1993. In 1994 it had been approved by the Slovak Parliament. In 1997 The National Strategy of Conservation of Biological Diversity was approved. In the same year started preparation of Action plan to implement biodiversity strategy, which was prepared with multisectoral effort and finished in February 1998. Summing up, the proposed actions for conservation and restoration of riverine wetland ecosystems are concentrated in Strategic goal 2 - Manage threatening processes (strengthen the application of appropriate mitigation measures), Strategic goal 3 (strengthen in-situ conservation biodiversity), Strategic direction 4 (to improve network of protected areas to achieve representative coverage of all types of habitats) and Strategic direction 5 (to introduce a national restoration programme).

Present state and functions of wetlands in Slovakia can be characterized in the following way.

In the last ten years, global attention has increased to save threatened wetlands. In Slovakia wetlands are very important for biodiversity conservation. Wetlands are also a very important component in the cycling of nitrogen. Nitrates and other chemicals from fertilizers decompose in wetlands and are retained from entering the groundwater. In Slovakia the regularly mowed meadows in the Morava River Floodplains are a unique ecosystem not only for their high biodiversity value, but also because they act like huge nutrient sinks. After rough estimations it is predicted that 290 tons of nitrogen and 30 tons of phosphorus are removed by hay annually, but the potential only for this area is 480 tons and 50 tons respectively. Wetlands also slow floodwaters allowing sediments, nutrients, pesticides, heavy metals and other toxic metals to be trapped and absorbed into the soil. In Slovakia, the part of the river basins land is, under natural conditions, protected against floods by wetlands. They catch surges of flooding water, and slow down running water. Captured water is then slowly released. In this way wetlands help with flood control, because the flood peaks on the tributaries do not reach the main stream at the same time. In Slovakia most of wetlands serve as transitional areas between terrestrial and aquatic habitats, which protect the land against erosion. Wetland vegetation can reduce bank erosion in different ways: root systems, which stabilize the bank, reduce the effect of flooding waters and slow down a stream by friction. Mainly trees act as stabilizers for riverbanks.

It is possible to summarize the most significant wetland functions, typical in Slovak conditions, into the following items:

- ➢ Biodiversity conservation
    - habitat for an enormous diversity of micro-organisms, plants and animals
- ➢ Environmental functions
    - water quality control, removal of nutrients from water,
    - purification of water from chemical and organic waste,
    - removal of sediments,
    - biomass and oxygen production,
    - water retention in the soil.
- ➢ Socio-economic functions
    - flood control
    - erosion control,
    - water supply,
    - wood, hay and reed production,
    - cattle and sheep grazing areas,
    - fishing and hunting,
    - recreation,
    - education and research.

The following part of this chapter describes the short survey of the most important wetlands types in Slovakia.

The **willow-poplar forests** belong to the one of the most threatened types of wetlands. Only a few of them remain around the big rivers like Danube. Their biggest threats arise from dams and in the regulation of river basins. A noted example is the Gabcikovo Dam, which caused the destruction of about 40 km^2 of floodplain forest. Another threat to willow-poplar forests is the penetration of alien species, which quickly become dominant and suppress the indigenous species.

In the lowlands and rolling hill country there is another type of lowland wetland with an oak, elm and ash forest composition. It is situated on the upper elevated terraces of the rivers, creeks and dryer places out of the reach of regular floods. The hardwood from oak and elm is highly valued by foresters. The decline of the water table, due to drainage, influenced the succession from a willow-poplar composition to an oak-elm-ash composition. This is the reason why it is not as rare as the willow-poplar forest composition. They are endangered by plantation of high productive, non-native poplar or elm monocultures.

Riparian Alder Wood. The most important function of alder forests on banks is to stabilize and to protect the bank against erosion. The root systems of vegetation help to stabilize the soil and retain nutrients. Bank vegetation along rivers is suitable places for many different vegetative and animal species.

The alder forests were influenced by many human activities. Over a wide territory, but mostly on the floodplains, alder forests were destroyed and changed into pastures and meadows. There are fields of potatoes, cabbage, barley, oats growing on the higher terraces without the influence of floods. Well-preserved vegetation is rarely presented, only on few places of original distribution.

Wet Meadows. The most important factors influencing the life of wet meadows are floods, the level of groundwater and the frequency of mowing. The height above sea level is another factor influencing the distribution of plant and animal species. Grassland ecosystems provide a large number of habitat types that are important for both ecological and economical reasons.

It is probably not a well-known fact that wet meadows are also perfect "water treatment plants." During a successful year the production of biomass exceeds 10 tons per hectare. For example, when farmers collect hay from 1 km^2 of wetlands, they will also gain about 20 tons of nitrogen and 2 tons of phosphorous, all brought by polluted water.

In the past, wet meadows used to be dried out and ploughed in lowlands. In the mountain zone, wet meadows were destroyed by intensive grazing. Restoring wet meadows and re-introducing original vegetation species is not an easy task. Farmers have tried doing so with a mixture of hybrid grass and clover; however, these species are not originally found in wetlands, so they did not survive. The meadows deteriorated as these weaker species were quickly replaced by weeds.

Reed Swamp. Reed swamps are one of the most striking plant communities, but they are very poor in species diversity. The reed (Phragmites australis) is such a competitive plant that it creates almost a monoculture. Its root system is very dense and other plant roots can not survive. They live in the overgrown vegetation of river branches, depressions with a high level of ground water, and very often on the banks of dams. They are mainly in the lowland areas, but it is possible to see them up to the mountain zone.

Reed has the ability to spread very easily to places like dams, banks of rivers and ponds. It is very benevolent to the changes in the level of ground water, so it is attracted to artificial habitat made by humans such as: ditches near roads and railroad tracks. In the last two cases they are not considered to be part of a wetland system. It provides good nesting habitat for many bird species.

Aquatic Vegetation. The growth of hydrophytes in the water fluctuates during the year and they can exist at a maximum depth of 2 meters. They can tolerate changes of light, nutrients and hydrological conditions. We can find them in stagnant or slow-flowing waters such as depressions, oxbow lakes, shallow lakes, slow-flowing brooks, canals and artificial ditches or pits.

Water plant communities are threatened by regulations, drainage or by the construction of large dams. If a meander is cut off from the main river, it is no longer influenced by the dynamics of the river and gradually becomes overgrown.

Eutrophication, a high concentration of nitrogen and phosphorous, then becomes a danger. Under these conditions there is an increase of the biomass of some species, which displaces less competitive species. This results in communities with low diversity.

Bogs and Fens. Bog and mire fens are created by an overgrowth of water habitats or saturated shallow depressions, which contain an accumulation of dead and decaying plants. Bogs and fens function as water reservoirs and influence the hydrologic regime. These areas are important for the conservation of species diversity. These systems are fragile and easily disturbed by negative influences. Among the most serious influences are drainage and agriculture as a result of human activities.

The natural purification of water in different landscapes is the most important function of fens. In the past, these areas were mown and used for hay. Not being of a high quality, it was more often used as bedding for cattle. These areas were often drained despite the low fertility of the soil.

Springs. Springs are areas where due to a high level of groundwater, water is coming up from the ground to the surface naturally. Springs are located between 400-2000 m in elevation. Many activities threaten springs such as the harvesting of trees, drainage, and intensive agriculture using pesticides and chemical fertilizers.

Ramsar Convention. The aim of the Convention, which was signed by the Slovak Republic in 1990, is to ensure the protection and sustainable use of wetlands, which greatly contribute to biodiversity. Member states are responsible for protection, preparation and implementation of management plans for wetlands in their countries. A special commitment lies in the registration of wetlands into the list of wetlands of international importance, the adoption of special measurements for conservation and to ensure international cooperation.

The Slovak Republic has nominated the following locations: Šúr, Parížske močiare, Čičovské mŕtve rameno a Senné rybníky. In 1993, other extensive wetlands were included in the Morava, Danube and Latorica River floodplains. The wetlands areas of the Orava, Turiec, Ipeľ and Rudava Rivers are now proposed for nomination. Slovak wetland areas included in the Ramsar Convention cover 25 519 hectares of country.

One of the conditions of the Ramsar Convention is to complete an inventory of wetlands in the member countries. Since 1991 the Slovak Union of Nature and Landscape Protectors has been coordinating the mapping of Slovak wetlands. The main goal was to categorize wetlands according to their importance. The result of 5 years of work is about 1900 registered areas, from which 1379 are categorized as:

- 12 wetlands of international importance
- 69 wetlands of national importance
- 4 wetlands of super-regional importance
- 383 wetlands of regional importance
- 911 wetlands of local importance

The following are wetlands in Slovakia that are considered internationally unique wetlands, wetlands important for biodiversity, containing ecological or hydrological functions.

Šúr (Nature reserve) - forest and meadow wetlands. Located between the Danube Lowland and Small Carpathian Mountains. Total area is 831,39 ha.

Paris Swamps (Nature reserve) - extensive wetland system with reeds and sedges. The Paríž steam is located in the southeast part of the Danube Lowland. This area is an important habitat for nesting and migrating birds and others animals. Total area is 140,59 ha.

Číčov Oxbow Lake (Nature reserve) - Danube oxbow lake, which was cut from the main stream by the creation of a dike. This area is a meadow and bush community. The area is dominated by reeds, cat-tales, sedges and water plants. Important habitat for rare plants and animals. Total area is 79,87 ha.

Senné Ponds (Nature reserve) - A series of ponds built in a previously flooded area of the Okna River in the Eastern Slovakian Lowland. This is one of the most significant areas for nesting and migrating birds in Slovakia. This area consists of wet meadows and pastures around ponds with rare vegetation and animal species. Total area is 213,31 ha.

Morava River Floodplain (Protected landscape area of Záhorie) - situated along the Slovak part of the Morava River between the village Brodské and the confluence of the Morava and Danube Rivers. This area preserves a unique system of oxbow lakes, wet meadows and floodplain forests which maintain a species-rich community of plants and animals. Total area is 4971 ha.

Danube River Floodplain - area of wetland forests, oxbow lakes and wet meadows. Within this total area of 14.335 ha are 19 small protected areas.

Latorica Floodplain - a 22 km stretch along the Latorica River in the Protected Landscape Area Latorica. This area is located in the southern part of the Eastern Slovakian Lowland and is composed of wetland forests, oxbow lakes and wet meadows. The total area is 4.358 ha.

The restoration of floodplain meadow in the Lower Morava River is the important problem therefore is covered also by the *Project File* Report.

3.3. Reduction of Water Pollution from Industries

Among the sources of water pollution, which are significant from whole-Slovakia point of view, respectively also with transboundary influence to the water quality, there are also the sources from the companies under competence of the Ministry of Economy of the Slovak Republic. There are constructions and actions, shown in the following Table 3.11., which are planned in selected enterprises in 1997 -1999.

Table 3.11. Measures of the Ministry of Economy of SR in water pollution control field

Enterprise - Action	Term of realization	Financial costs [SK}	
		1997-99	Total
NCHZ Nováky			
Pumping station for sewage wastewater	1997	1,1	1,1
Reduction of the production of wastewater from the VC/EDC production	1996 - 1998	1,85	2,55
Reduction of salinity in wastewater, from the production of caustic soda	1999	18	18
Solving of the problems of waste technological water, from the production of propylenoxide. (Modernization of propylenoxide production)	1997 - order 1998 - 2002		approx. 350
	total	20,95	371,65
Bukocel Hencovce			
Realization of the ECF and TCF cellulose production	1995 - 1997	9	36,7
Installation of oxygen delignification	1999	150	150
Reconstruction of the mechanical WWTP	2000 - 2001		150
	total	159	336,7
Istrochem Bratislava			
Construction of biological WWTP	1996 - 1999	315	350
	total	315	350
Slovhodváb Senica nad Myjavou			
Reduction of wastewater production	1997	0,8	0,8
Completing of the technology for refining the viscose fibre	1997		
Reduction of the loss in pipe lines	1997 - 1998	3,61	3,61
Increasing the effectiveness of chemical part of WWTP	1998 - 1999	25	25
Change in the treatment technology to biological WWTP - final treatment	1999 - 2000		25
	total	29,41	54,41
Chemko Strážske			
Solving to the method of processing the alkaline water from formation of apparatus from the production site of cyclohexanone	1997	6	6
Realization of new racking site for racking the raw substance for production site of phenocol - phenol, NaOH	1997 - 1998	16	16

Table 3.11. continued

Enterprise - Action	Term of realization	Financial costs [SK}	
		1997-99	Total
Adjustment of the operation of collecting centers and decomposition of bound formaldehyde for the winter period, and repair of decomposition cisterns	1997 - 1999	11	11
Reconstruction of formaldehyde storage facility	1997 - 2002		12
Reconstruction of neutralization raw substances storage facility(CHÚV II.)	1998 - 1999	17	17
New way of filling the glues into railway cisterns	1999	12	12
New way of filling the formaldehyde into railway cisterns	1999	15	15
General reconstruction of A1 and A2 activation	1999 - 2000		16
Increasing the Poša sludge bed capacity	2000		40
	total	77	145
ZVL Skalica *			
WWTP construction – testing operation	1997		
	total	0	75
AssiDomän Štúrovo			
Ecological program (EP) years 1995 - 2002 : reconstruction of Racking station for primary asphalt	1995 - 2002	15,4	15,4
EP : Reconstruction and modernization of the NSSC production		697,7	697,7
EP : Reconstruction and expansion of WWTP capacity	after year 1999	-	300
	total	713,1	1013,1
VSŽ Košice			
Dosing the lime milk at WWTP Sokoľany	1997 - 1998	13	13
II. stage of Continual Monitoring of waste water	1997 - 1998	20	20
Completing of biological WWTP			295
	total	33	328

Note:

75 mil. SK present total realization costs for the construction of WWTP by the end of 1996. No other investment costs are expected within the operation (year 1997).

The sources for financial funds, needed for realization of mentioned measures, will come from own sources of enterprises, and loans from domestic, respectively from foreign financial institutions.

The list of industrial hot spots have been again prepared with co-operation of Water Quality National Expert using multi-criteria analysis of ranking the particular problems. The results of this approach are presented in the following Table 3.12.

The list of prepared hot spots generally coincides with the table developed by the Ministry of Economy of SR (see Table 3.11.).

The obtained results and the summary of recommended projects for industrial hot spots are presented in Table 3.13. and the Project Files.

Oil and grease

The most important shipping transporters in Slovakia are SPaP and River Basin Authority. Both of them collect the bilge oils in holding tanks and based on contract with particular private firms, the contaminated water by oil materials is transported to MCHB treatment plant in Slovnaft Bratislava. Sewage water is discharged to recipient without any treatment.

Table 3.12. Selected industrial hot spots

No.	Locality	Number of Projects Files	Project File or letter
HIGH PRIORITY			
1a-b -I	NCHZ Nováky	2	yes
2 -I	Bukocel Hencovce	1	yes
MEDIUM PRIORITY			
3a-d -I	PCHZ Žilina	4	yes
4.	Istrochem Bratislava*	1	yes
5.	SH Senica nad Myjavou**	0	no
6a-d -I	Chemko Strážske	4	yes
LOW PRIORITY			
7- I	AssiDomän Štúrovo	1	yes
8- I	Bučina Zvolen	1	yes
9- I	Biotika Slovenská Lupča	1	yes
10- I	Koželužne Bošany	1	yes
11- I	HP Harmanec	1	yes
12- I	VSŽ Košice	1	yes

Note:

** - in this plant the significant changes have been applied in process technology, therefore the flow rate as well as the wastewater characteristics have been altered. The present construction of biological treatment plant has stopped and nowadays the design project is redesigned to the new actual state,*

*** - in spite of several call phones, utilized the personal contacts and polite requirements to fill in the Project File (during two and half months), since the time of completing this report we have not obtained any respond.*

According to the Slovak Environmental Inspectorate the most of the accidents on the Danube River are caused by the oil material. The sources of these accidents are probably the ships however it is very difficult to approve it. During the time period 1988 - 1997 the Inspectorate recognized 106 accidents. All of them were caused by oil.

In Slovakia, due to the relatively high number of existing water dams and reservoirs, the problem of sediments and their contamination has to be considered, as well. The sediments play important role at the quality of surface water and groundwater. Correct way of sediments dredging and disposal is the important problem with respect to water quality of rivers and has to be solved in Slovak conditions. The *Project File No. 2-O* Analysis of sediments quality and disposal of extracted sediments within the Slovak part of the Danube river basin plans to study these problems.

Table 3.13. Summary of recommended projects for industrial hot spots

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
HIGH PRIORITY						
Novácke chemické závody Nováky & Nitra & Nováky	The most important industrial point source of pollution in the Nitra River Basin. In 1992 the construction of new mechanical -biological WWTP has started. The changes in production programme have required the redesign of plant The construction of WWTP was not accomplished because of financial constraints.	High	Management of wastewater in NCHZ Nováky. a.s., Removal of chlorinated hydrocarbons in the production of propylen oxide & structural	The aim of the project is to develop the water pollution control model and to set up the optimal warning system of un-controlled flow of particular organic substances to the sewer system. The second project will reduce the discharge of chlorinated hydrocarbons generated in the production of propylen oxide.	The reduction of possible risk of accidents in company's sewer system and the acute pollution of the river. It is estimated that the reduction of chlorinated hydrocarbons would be from 300 to 500 t/year less.	NCHZ, a.s. Nováky
Bukocel Hencovce & Ondava & Vranov	The existing treatment plant is in poor conditions (it was constructed in 1956) with old fashion treatment line. The reconstruction of sewer system to collect and treat all the wastewater generated in the territory of company is considered, too. At this time a part of wastewater is discharged to the receiving water without any treatment.	High	Reconstruction of wastewater treatment plant in Bukocel, a.s. & structural	The project has already started in 1992 however because of lack of investments it was stopped. The project implements the construction of pumping station. settling and thickening and dewatering of suspended solids and sludges, respectively. The reconstruction of sewer system to collect and lift a part of wastewater to the treatment plant is planed in this project, as well.	The main goal of the project is to reduce the pollution discharged to the Ondava river from the present 305.5 t BOD_5/year to 203.1 t BOD_5/year. In addition all collected wastewater in the territory of company will be treating on the existing treatment plant. The reduction of pollution will positively improve the fish management, hygienic and water quality of irrigation system under the effluent discharge point.	Bukocel, a.s. Hencovce

Table 3.13. continued

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
MEDIUM PRIORITY						
Považské chemické závody Žilina & Váh & Žilina	The present state of holding tanks for chemicals does not achieve the requirements of groundwater protection. These problems are deal with barrelling, pumping or handling of chemicals and there is a low protection against the possible accidents. The age of these tanks is about 30 years. The reconstruction of the existing treatment plant is focused on the reduction of nutrients (TN) due to the construction of a new water dam Žilina.	Medium	Reconstruction of ammonium storehouse Varín, Reconstruction of caprolactam holding tanks, Reconstruction of methylmethacrylate holding tanks, Reconstruction of treatment plant & all these projects are structural	Reconstruction of holding tanks for chemicals and storehouse Varín intends to improve the groundwater protection and to ensure the higher level of reduction the possible risk of spill accidents. These projects will construct the water pollution control basin under the existing holding tanks as well as under the barrelling stations. Reconstruction of wastewater treatment plant will reduce the emission of nutrients using nitrification-denitrification processes. The project includes the following measures : reconstruction of existing activated sludge tanks, expansion of their volumes, reconstruction of aeration system to fine bubble one, re-arrange of existing treatment line to denitrification-nitrification.	The projects will reduce the groundwater pollution and subsequently the Váh river contaminated by hazardous organic and inorganic substances. The projects will reduce the possible risk of accidents caused by spills. There is a risk of pollution of contamination by cyclohexanon, trichlorethylen, caprolactam, sulphur ammonium, hydroxylamin, ammonium and etc. The present situation is more complex than before because of constructing the Žilina water dam. The water dam will change the present receptor to very sensitive receiving water especially with respect to nutrients, chemicals and micropollutants. This problem (in case of nutrients reduction) is solved by the project of the reconstruction of wastewater treatment plant as well.	Považské chemické závody Žilina

Table 3.13. continued

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
Istrochem Bratislava, a.s. & Dunaj & Bratislava	Existing wastewater treatment plant has only mechanical-chemical treatment line. There is a need of upgrading of treatment to biological treatment system. Istrochem has already started the implementation of the project of biological treatment plant however at this time is re-evaluated due to the significant changes in process technology of company.	Medium	Upgrading of wastewater treatment plant with biological treatment step & structural			Istrochem, a.s. Bratislava
Chemko Strážske & Ondava & Strážske	The present mass and energy consumption in the process technology is very high and the impact on the environment. The dominant role plays the production of cyclohexanon. In addition the protection of the sites where the barrelling the chemicals (Phenols, NaOH) is taking place and the reduction of the leakage to the groundwater is considered. The existing activated sludge tanks are in poor conditions therefore the reconstruction of them is necessary. The existing combine sewer system is necessary to upgrade, as well.	Medium	Project 2000. Barrelling the chemicals for production, Reconstruction of activated sludge tanks of wastewater treatment plants, Reconstruction of sewer system & structural	The project 2000 will replace the oxidation process of cyclohexanon production to non oxidation one. The project for barrelling of chemicals assumes to construct a new basin under the site where the manipulation with chemicals is provided to collect and reuse the spills and/or leakage. A new pumping station and holding tanks will have to be constructed . Upgrading of treatment plant is planned to install the fine bubble aeration system to improve the operation of present carrousels. Reconstruction of sewer system includes the separation of sewage from the combine sewer system, the construction a new sewer system for collecting sewage flowing from the old part of company and pumping station to lift these wastewater to the existing treatment plant.	The project 2000 will improve the safety factor of this process, reduce energy requirements, production of wastewater and wastes. Barrelling the chemicals will improve the protection of groundwater contamination. The economic benefit of wastewater plant upgrading is possible to estimate in terms of energy savings - 1600 MWh/year. The effluent parameters of treatment plant will be improved, as well. The reconstruction of sewer system will decrease the amount of pollution discharge to the Laborec river - 18.85 kg BOD_5/h.	Chemko Strážske, a.s.

Table 3.13. continued

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
LOW PRIORITY						
AssiDomän Packaging Štúrovo & Obidský channel & Štúrovo	The existing mechanical - biological treatment plant is not able to reach the required effluent standards. The necessity of upgrading of combine sewer system is considered, too.	Low	The reduction of discharged wastewater pollution to the Danube river & structural	The project is planned to implement in 3 stages. The upgrading of treatment plant and collecting of wastewaters includes the expansion and reconstruction of activation, the replacement of aeration system to fine bubble one, the upgrading of final clarifiers, connecting the existing combine sewer to treatment plant, construction of stormwater tank.	The main target of the project is to reduce of effluent pollution to reach the effluent standards set by Gov. Decree 242/93. This is very important issue because of the problem of transboundary pollution. At the site of the company the Danube creates the natural border between Hungary and Slovakia. The sensitivity of the Danube will improve if the waterworks Gabčíkovo-Nagymaros would be completed.	AssiDomän Packaging Štúrovo
Bučina Zvolen & Hron, Slatina, Zolná & Zvolen	The existing sewer network in Bučina Zvolen is not complete and some parts of it are in poor conditions or even defective. A part of collecting wastewater are not connected to treatment plant and are discharging to receiving water without any treatment. The upgrading and expansion of the existing treatment plant is considered, as well. The reduction of groundwater and soil contamination is assumed, too.	Low	Construction of wastewater treatment plant with reconstruction and expansion of sewer network & structural	The project should cover the reconstruction the old sewer network (separation of sewage) with the connection to biological treatment plant, expansion and completing storm and sewage sewer network in the northern part of company with the connection to the biological treatment plant, expansion of biological treatment step to treat wastewater after the pre-treatment at the electroflotation unit.	The project helps to improve the water quality in the creeks Zolná and Slatina and finally in the Hron river. The final solution could improve situation in groundwater and soil contamination in the territory as well as in the vicinity of the company.	Bučina, a.s. Zvolen

Table 3.13. continued

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
Biotika Slovenská Lupča & Istebník creek - Hron & Slovenská Lupča	The existing treatment plant was upgraded during the last four years, however the age of civil constructions is more than 25 years. The part of these old structures in poor conditions and aeration system of activation. There are also the odor problems.	Low	Wastewater treatment plant reconstruction & structural	The reconstruction of aerobic part of biological treatment step will increase the present water level in tanks, it will change the aeration system to fine bubble one, and it will reduce the odour problems by covering the tanks and treatment the air in biofilters.	The project will improve the situation in aerobic part of treatment plant. The present efficiency of the first two tanks is low due to the critical state of mechanical aerators. The effluent quality will improve (BOD_5 form 210 to 50 mg/l) situation in the Hron river .	Biotika Slovenská Lupča
Koželužne Bošany & Nitra & Bošany	At present the sludges generated at treatment plant are highly contaminated by chrome. The high consumption of wastewater in the process and their contamination by heavy metals is due to the old fashion process technologies used.	Low	Centralise the collection and treatment of wastewater polluted by chrome & structural	Optimisation of tannery processes, the reduction of water consumption and contamination of wastewater and sludges is considered in the project. The aim is to collect wastewater polluted by Cr3+ and treat with the change of pH to precipitate and separate Cr in the form of Cr(OH)3. This product will be recycle and utilise in the plant processes.	Implementation of the project will enable to solve the problem of sludge utilisation in agriculture. At present the disposal of sludge is the tremendous problem and it is a regional problem. It is supposed the reduction of operational costs, reduction of material use and Cr^{3+}, reduction of water consumption and finally reduction of energy requirements.	Koželužne Bošany, a.s.

Note :

The Project Files are enclosed in Annexes. In addition there are the Project Files of HP Harmanec and VSŽ Košice ranking of the problems with low priority.

3.4. Reduction of Water Pollution from Dump Sites

The comprehensive overview of solid waste disposal including the maps and the problems concerning with landfills has already been described in *National Review, 1994*. However from this time the significant improvements in this filed could occur in Slovakia. Therefore the short questionnaire was developed and filled in co-operation with the Slovak Inspectorate for Environment, section of waste management inspection. According to this questionnaire the following table was developed.

This list of the landfills or dumps presented in table was selected by the regional inspections on waste management in Bratislava, Nitra, Žilina, Banská Bystrica and Košice. We assume that the employees of these inspections are the most familiar with the considerable and significant problems concerning with the possible impact of existing landfill on the groundwater and surface water pollution. The table presents only the brief characteristics of the selected landfills.

Table 3.14. Selected landfills with the possible impact on groundwater or surface water

Locality/Responsible-Legal Body	Impact on River	River Basin	Type of landfill	Definition of Problem
Dunajská Streda-Veľké Dvorníky/PURE, Dunajská Streda	Protected Region Žitný Ostrov	Danube	municipal	the monitoring and control of landfill exist
Dunajská Streda-Mliečany /Municipality of Dunajská Streda	Protected Region Žitný Ostrov	Danube	municipal	Contamination of groundwater, landfill is controlling, monitoring and control of run-off and leachate is not ensured, landfill is closed.
Gabčíkovo/Technical Services Gabčíkovo	Protected Region Žitný Ostrov	Danube	municipal	new landfill (1996) constructed and controlling according to legislation
Iža-Bokroš/Reko, Ltd. Komárno	Protected Region Žitný Ostrov	Danube	municipal	landfill constructed and controlling according to legislation
Holíčov vrch Myjava/Technical Servicies, Myjava	Myjava	Morava	municipal	monitoring and control of landfill exist, however the problem with run-off and leachate is not solved
Piesky/A.S.A. Zohor, Ltd.	Morava	Morava	municipal	the monitoring and control of landfill exist
Šulekovo/Drôtovňa, a.s. Hlohovec	Váh	Váh	industrial (ferric sludges)	monitoring of landfill exists, local impact on groundwater pollution
Locality/Responsible-Legal Body	Impact on River	River Basin	Type of landfill	Definition of Problem
Trnovec nad Váhom/Duslo Šaľa, a.s.	Váh	Váh	industrial (ash, dust, mud, etc.)	monitoring of landfill exists, measures to reduce contamination of ground-water are going to be solved

Table 3.14. continued

Locality/Responsible-Legal Body	Impact on River	River Basin	Type of landfill	Definition of Problem
Dolná Streda/FERROMIN, a.s. Bratislava	Váh	Váh	industrial (residues from the treatment of ferric - nickel raw material)	monitoring of landfill exists, landfill is controlled and rehabilitated
Sučany/Ekopolis, Ltd. Martin	Váh	Váh	municipal	the impact of landfill on groundwater and Váh river is not controlled
Považský Chlmec/City of Žilina	Váh	Váh	municipal	the groundwater contamination, the Váh river by particular contaminants (oil material, B), the landfill is controlled
Podstránie/Ledrov, Ltd. Lednické Rovné	Váh	Váh	municipal	the monitoring and control of landfill exist
Bytča-Mikšová-Ratlianky/Renol,Ltd. Bytča	Váh	Váh	municipal	the monitoring and control of landfill exist
Čadca - Podzávoz/JOKO, Čadca	Kysuca	Váh	municipal	the monitoring and control of landfill exist
Predajná1, 11/Petrochema, a.s. Dubová	Hron	Hron	industrial	landfill in liquidation - the old environmental loading
ZSNP, a.s. Žiar nad Hronom/ZSNP, a.s.	Hron	Hron	industrial	the monitoring and control of landfill exist, the latest measures protect the impact of landfill on environment
Kovohuty a.s. Krompachy/Kovohuty, a.s.	Hornád	Bodrog and Hornád	industrial and municipal	landfill is controlled, groundwater is contaminated and the run-off is not controlled
VSŽ Košice/Slag-Scrab, a.s. Košice	Sokoľanský creek, Gombošský chanel, Idanský creek	Bodrog and Hornád	industrial	landfill is controlled and monitored, groundwater and surface water is contaminated by landfill
Chemko Strážske/Chemko, a.s. Strážske	channel Duša	Bodrog and Hornád	industrial	landfill is controlled and monitored, there are indications of groundwater contamination
Lipany/Technical Services, Ltd. Lipany	Torysa	Bodrog and Hornád	municipal	landfill is controlled and monitored
Lovinobaňa/LOVINIT, a.s. Lovinobaňa	Krivánsky creek	Ipeľ	industrial	landfill is not controlled and monitored
Tisovec/COMBIN, Ltd. Banská Štiavnica	Rimava	Slaná	industrial	landfill is controlled but not monitored
Plešivec/Municipality of Plešivec	Slaná	Slaná	municipal	non controlled landfill, the landfill is not monitored, the risk of transboundary pollution

In addition the above mentioned questionnaires the selected hot spots were asked to fill in the Project Files (see Table 3.15.). The obtained results and the summary of recommended projects for landfill hot spots is presented in Table 3.16. and the Project Files.

Table 3.15. Selected hot spots of landfills and dumps

No.	Locality	No. of project file or letter
1.	Krompachy - municipal and industrial landfill	1-L
2.	Power plant Nováky-Kostoľany - landfill	2-L
3.	VSŽ Košice - reconstruction of wet waste tip	3-L
4.	VSŽ Košice - reconstruction of dry waste tip and waste liquidation	4-L
5.	Bukocel Hencovce - reconstruction of industrial landfill	5-L
6.	Chemko Strážske - industrial landfill*	6e - I
7.	Hlinikáreň Žiar nad Hronom - landfill/lagoon for utilized bauxite **	letter

Note:

* - *included in industrial hot-spots,*

*** - the project has been already completed and it is under test operation. The description of deletion of this hot spot from the list, please see the Part C - Water Quality.*

Table 3.16. Summary of recommended projects for landfill hot spots

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
Kovohuty Krompachy & Hornád & Krompachy	Protection of the groundwater by contamination with heavy metals coming from the landfill and the revitalisation of the site of landfill	High	Reduction of contamination of groundwater and revitalisation of landfill Krompachy & structural	protect the site of landfill and to reduce contamination of groundwater and river Hornád	Reduction of the risk of contamination of the Hornád river by polluted groundwater	Municipality of Krompachy, Kovohuty Krompachy, a.s.
SE Zemianske Kostoľany & Nitra & Chalmová	Ensuring the sufficient capacity of landfill site for residual ash produced by thermal power plant, to control the groundwater and soil contamination by leachate water.	Medium	Final landfill Chalmová - VI. construction & structural	The treatment of slurry - its thickening. The slurry flows from the power plant with the ratio 1:20 (ash: water) and then it is thickening to the ratio 1: 2 with utilisation of pumping station in the site of power plant.	The primary effect is to eliminate the leakage of leachate to groundwater from the landfill and to protect the landfill site and finally the Nitra river against the contamination	SE, a.s. Elektrárne Nováky, o.z. Zemianske Kostoľany
Chemko Strážske, & Laborec, Ondava & Strážske	Disposal of PCB wastes	Low	Disposal of wastes from the PCB production & non-structural	The development of general methodology of PCB waste disposal for the whole territory of Slovakia.	reduction of possible impact on the environment of this type of waste, the results of this project will have effect for the whole territory of Slovakia and CEE countries.	all producers of this type of waste, Chemko Strážske, a.s., Ministry of Environment
Bukocel & Ondava & Hencovce	The reconstruction of the existing industrial landfill	Low	Reconstruction of industrial landfill & structural	The solidification of the dam with the length 400m and the height 8 m. It is necessary to carry out geological survey, draining of the landfill and solidified the dam.	The protection of groundwater and surface water quality against the impact of pollution coming from the landfill.	Bukocel, a.s. Hencovce

Table 3.16. continued

Hot Spot Name & River & Location	Parameters & Values which Define the Problems	Ranking of the Problem	Name & Type of Project	Project Strategy & Targets	Parameters & Values which Define Project Benefits	Project Beneficiaries
VSŽ oceľ, Ltd. Košice &groundwater & Košice	The disposal the wastes and by-products from furnace with the aim to eliminate the groundwater pollution	**Low**	Reconstruction of dry waste tip and waste liquidation &structural	The elimination of the secondary dustiness, the effective utilisation of the existing dump, the protection of the groundwater quality.	The existing lagoon will be sealed by geomembranes. The run-off will be collected and transported to neutralisation station. The construction of the hydrosealing and sealing walls is considered.	VSŽ Oce1,Ltd. Košice.
VSŽ oceľ, Ltd. Košice &groundwater & Košice	The reconstruction of slag-ash mixture lagoon to protect groundwater.	**Low**	Reconstruction of wet waste tip & structural	The sealing of existing lagoon, construction of waste dump for slag and ash with the sealing system.	The existing lagoon will be protected by sealing wall with the length of 1650 m. The sealing will be made from the plastic geomembranes.	VSŽ Oce1,Ltd. Košice.

3.5. Special Policy Measures

It is assumed that the following legislative measures and norms may have the most important impact on the improving of present status in the water quality in Slovakia.

Improvement of water management legislation

Government Decree No.242/1993 was prepared with the aim to correspond with European legislation, especially with Directive 91/271/EEC. It represents a fusion of ambient water quality standards and effluent standards. Nowadays the Gov. Decree No.242/1993 seems to be the most important legislative norm and it will hopefully influence the perspectives of wastewater treatment in the Slovak Republic for a long time. However, it contains many problematic parts and therefore at present is under preparation the amendment of this Decree.

It is assumed the amendment will have to solve the following problems:

- to introduce the term of TN or TIN to effluent standards in order to force the operators control the removal of nitrogen (introduction of denitrification in the treatment line),
- to decrease the concentration of effluent standard in term of TP to be compatible with EU Directive.

It is known that the finances accumulated from the fines create a basic income of the State Fund of Environment. In addition, the polluter must pay compensation fee for the discharged effluent pollution to the river basin authorities. The last two legislative norms are old fashioned and they do not reflect the new economic situation such as inflation, changes from planned to market economy, etc. Especially the Slovak Government Decree No. 31/1975 does not fulfil the expected effect and is together with Government Decree No.2/1989 in the process of amendment.

Legislation regarding to sewage sludge disposal

The EU directive 86/278/EEC established the basic legislation on agricultural use of sludge in EU. Slovakia has two legislative norms to control the utilization the sludge in agriculture. The latest manual of application of sludge in agriculture has been already released, however at present the re-evaluation of several standards in it is going on to create the better conditions (more realistic) for sludge disposal in agriculture.

Improvement of technical standards related to water management

The most important Standard is the *STN 73 6707 Municipal Wastewater Treatment Plants from 1983*. At present the amendment of the standard is prepared with regard to the problem of nitrogen and phosphorus removal processes and improving the clarifier design.

The problem of washing powders

In the Slovak Republic the amount of detergents used is about 25.000 t/year. In households is used 22.700 t/year: P-containing 90 %, P-free 10 % and in industry 2300 t/year (liquid detergents P-free). The firm Henkel Palma is a dominant producer of detergents in Slovakia. Approximately 50 % of used detergents are imported to Slovakia. Pišoft, O. et al. (1996) has estimated the P-emission load of surface water from the detergents for three time levels, as follows: 1032,5 t/year (in 1992), 869,7 (in 2000) and 915,4 (in 2005). In Slovakia there is no legislative tool to encourage the using or producing P-free detergents. It is expected that in the near future the relevant legislation will be prepared to control the content of P in detergents. The different situation is in the water sector because of the existence of the Gover. Decree 242/93 where the effluent standards are set also in terms of TP for the treatment plants ranking according to P.E. (see Table 2.3.).

It is expected that the significant impact on the water management will have the **transformation of water and sewage works.** The comprehensive analysis of the conditions of transformation and the actual state of institutional development of self-government bodies is needed to secure a support for the communities as partners of the state in process of transformation with the final target to improve quality management in water sector. The project target of the *Project File No. 3-O* fully coincides with these objectives. This Project File with the title Water management transformation process - the support of municipal authorities is in *Project Files* report.

4. Expected Effects of Current and Planned Projects and Policy Measures

This chapter summarizes the results and expected effects of the projects supported by the Project Files. In general the *Project Files* questionnaires have been obtained almost from all addressed institutions. The level and the quality of the Project Files vary in spite of the fact that they were several times updated and usually by phone completed. The wastewater treatment plant Nitra was visited personally because of the high priority of the project and very complex situation at this treatment plant. Similarly WWTP Košice and NCHZ Nováky were consulted with responsible persons during the arranged meetings.

Within the preparation of the Project Files the following actions were identified: monitoring of water pollution control, upgrading of wastewater treatment lines, protecting of water resources, reduction, groundwater pollution control and protection, changes in process technologies to environmental sound ones, improving the protection and operation of landfills, restoration of wetlands, institutional and research projects, etc.

4.1. Reduction of Nutrient Emissions

Reduction of nutrient emissions from hot spots after the implementation of projects described in the Projects Files is mostly covered by the pollution discharged from municipal wastewater treatment plants. The summary of the activities concerned with the reduction of nutrient emissions is as follows:

- all the projects are structural,
- upgrading, expansion or completing WWTP are typical goals of the projects,
- upgrading of treatment line to pre-denitrification , nitrification or R-D-N process and biological phosphorus removal are the typical measures of the Project Files,
- replacement of the existing aeration system (usually represented by mechanical aerators) to fine bubble is considered very often, as well.

It is assumed that in case of point source pollution the driving force in reduction of nutrient emissions has been and will be Gov. Decree 242/93. This impact may be accelerated after the implementation of amendment of this legislative tool if the effluent standard TN or TIN (total inorganic nitrogen) are introduced.

The different situation is in case of diffuse pollution. Due to the lack of data in this field (*see part C Water Quality*) and the problems with the identification of responsible institutions able to submit the ongoing or planned projects solving these problems, this report does not include any project covering these issues. In fact, it is not possible to estimate the expected effects of nutrient reduction in the case of diffuse pollution with respect to a project. However it is necessary to note that the significant reduction of industrial fertilizers, e.g. the total consumption in tones decreased from 562.496 in 1989 to 102.233 in 1995, and consumption per hec. of agriculture land in kgs from 231,2 in 1989 to 41,8 in 1995, *Green Report, 1996*). Recently the consumption of industrial fertilizers is more or less stable, it varies around 46 kg/hec of agriculture land/year. It seems that the problem of over-fertilization is less important in SR than before from the point of view of diffuse pollution. Except for municipal emissions as the main source of TN and TP (see the estimation of reduction in the next paragraph of this chapter) the Project of *Floodplain Meadow Restoration in the Lower Morava River* could improve the present status especially in the Lower Morava River Basin. According to this project one may estimate that the growing vegetation removes nutrient from water. The rough estimation predicts the reduction of 290 t/year of TN and 30 t/year of TP if this project is implemented (see the Project File No. 1-O).

A comprehensive analysis based on the *Project Files* has been prepared to estimate the effect of implementation of the projects on the nutrient removal. As it is stated before we estimated this reduction only for municipal wastewater treatment plants. Note that these results are valid only if these projects are completed and they are not valid for the whole territory of Slovakia draining to the Danube River Basin.

In spite of the fact that we obtained the data about the present quality of wastewater in particular hot spots, the range of water quality of parameters, flow rates etc. were not sufficient for the required estimation. The additional data were asked from the institutions operating treatment plants. We tried to complete the tables using the different sources of data (Database of LABOD, Database of Slovak Hydrometeorological Institute) however still we were not able to obtain the complete database. Therefore a part of data are estimated or calculated based on the different available data (e.g. BOD_5, P.E., etc.). Unfortunately we have got the table with non-compatible or non-consistent data, therefore the «strange» results are summarized at the bottom of the table. The problems can be explained as follows:

Most of Slovak existing treatment plants are overloaded and therefore the capacity of them is not sufficient. Due to this fact the collected wastewater have to be very often by-passed at treatment plants and therefore the actual total efficiency of plant would be different if the effluent quality is measured in the outlet of WWTP. However most of the data are based on effluent quality measured after the final clarification (before the confluence with the by-passed wastewater). Due to the difficulties with the interpretation of obtained results, the second scenario has been proposed. This scenario is based only on influent quality of wastewater. The capacity of treatment plant is the same at present (theoretical) and in the future if the project is implemented. We changed only the treatment line from mechanical-biological treatment plant (at present) to treatment line planning according to the requirement of Project File. In most projects the denitrification-nitrification have been applied.

The following assumptions were considering:

- quality of influent in TP, TN was calculated based on P.E. or BOD_5 and known flow rate
- the same capacity of WWTP was assumed for present and future state,
- the following emission factors were considered in Table 4.1.

Table 4.1. Estimated emission factors for particular treatment lines

Treatment line used	Emission Factors	
	residue of TN	residue of TP
Mechanical-biological *	75 %	63 %
only nitrification	75 %	63 %
Nitrification-denitrification **	30 %	69 %
nitrification-denitrification and biological phosphorus removal (luxury uptake)	30 %	22 %

Note:

** sludge age 5 d, influent: BOD5 ~ 200 mg/l, typical composition of untreated municipal wastewater, 1 P.E. is 60 gBOD5/cap./day, TN = 11 g/P.E./day, TP = 2,5 g/P.E./day,*

*** due to the higher sludge age the phosphorus removal is less efficient if only assimilation of phosphorus is taken into account.*

According the above estimated assumptions the Table 2 has been developed and it is enclosed in Annexes with the following final results:

about 60 % TN reduction and 22 % TP reduction.

This estimation is on our opinion more less the realistic. Note that these results are valid only for the municipal WWTP projects defined by Project Files.

In industrial sector only the upgrading of treatment plant in PCHZ Žilina will reduce TN from 167,9 t/year to 32,85 t/year. The flux of TP in this case is not interesting because TP concentration is not sufficient for the biological treatment processes. The rest of the plants do not have to assume the implementation of the measures leading to the reduction of nutrients. In fact, they should not be so important that they should be considered in this analysis.

If we assume that the total emission in terms of TN and TP discharged from the Slovakia territory drained to the Danube River Basin is about 59 KtN/year and 5 KtP/year, respectively (see Table 3.10.), one may assume that after the implementation of the projects (including the wetland one) the total impact of nutrients will reduce to 55.374 tN/year and 4755 tP/year.

Table 4.2. Summary of the reduction of nutrient emissions if the projects defined in Project Files would implement

	At present	after the implementation of the project	reduction	at present	after the implementation of the project	reduction
Sector	TN [t/year]			TP [t/year]		
municipal	5 279	2 078	3 201	1 010	795	215
industrial (PCHZ Žilina)	168	33	135	the same	the same	-
agricultural (wetland project)	N/A	290 less	290	N/A	30 less	30
Total reduction TN			3 626	Total reduction TP		245

The more significant impact on the reduction of nutrients can be pointed out if we only look on the reduction of point-source load (see again Table 3.10.). In this case the nutrient load would reduce from 20 ktN/year to 16.374 tN/year (reduction about 20 %) and 3 ktP/year to 2 755 tP/year (reduction about 10 %). It is clear that the more significant reduction of nutrient pollution could be obtained if the problem of diffuse pollution is solved in Slovakia.

4.2. Hazardous Substances

In general, it is assumed that only industrial emission discharges can contain the hazardous substances. The results of the projects in industry sector can be summarized as follows:

- changes in process technology in several plants to environmental sound technologies,
- significant reduction in mass and hydraulic loading of existing WWTPs, e.g. NCHZ Nováky, Chemko Strážske, Istrochem Bratislava,
- most of effluent water quality parameters set in consent contracts are regularly reach,
- the measures in process technology to reduce the consumption of water and influent pollution,
- monitoring of water pollution and improvement of process water quality management,
- reduction of possible risk of accidents and establishment of warning system in plants.

It is not possible to define generally the reduction of hazardous substances therefore the selected industrial plants and expected reduction of them is described in the next paragraphs:

PCHZ Žilina: reduction of NH_3 spills, caprolactam and methymethacrylate. At present the impact on the groundwater quality is significant e.g. the average concentration of NH_4-N is about 1000 mg/l and COD 120 mg/l in the vicinity of holding tanks for these chemicals.

Bučina Zvolen: it is expected the reduction of phenols - less 0,147 t/year and 4,75 t/year of NES compared to the present state.

Tannery Bošany: The project should reduce the contamination of water and mainly the sludge by heavy metals especially by chromium.

NCHZ Nováky: The project will treat the discharged wastewater contaminated by chlorinated hydrocarbons. The expected reduction is from 300 to 500 t/year. This project is very important because this measure could significantly improve the water quality in highly polluted the Nitra River.

Reduction of water pollution from dumpsites also can improve the situation in particular river basins, but predominantly the ground water quality. Most of the projects in this sector are structural serving for upgrading the protection of the groundwater, monitoring and control and/or treatment of leachate. The revitalization of landfills and sealing of the existing landfill sites with integrated monitoring system of landfill are the typical activities proposed in these projects.

4.3. Microbiological Contamination

The reduction of microbial contamination is very difficult to estimate because the accessible effluent water quality monitoring does not include any parameters in terms of microbiology, therefore we do not have any available information in this field. However it could be assumed that after the implementation of the projects the portion of untreated wastewater will reduce (the reduction of by-passed wastewater) and the advanced treatment technologies (e.g. nutrient removal) usually required the higher sludge age, lower sludge loading and thus less organic portion in MLSS with more stabilized activated sludge. Based on this assumption we may expect the reduction of microbial contamination however at this time it is not possible to quantify the range of this reduction.

4.4. Adverse Environmental Effects

Transboundary pollution has been studied by the Water Quality Expert and identified according to several indicators (see part C Water Quality). The results have been utilized in the following analysis and combined with the information obtained from the Project Files. In addition we have introduced also the source of pollution (AssiDomän Štúrovo), which is not so important from the point of view of ambient water quality criteria, but knowing that it might have impact on the water resources utilized for Budapest situated nearby downstream from the Štúrovo, it was recognized, to take into account also the Slovak foreign environmental sound policy, as the transboundary hot spot.

This approach defined the five industrial plants having the significant impacts on the transboundary pollution. The first one is a chemical plant **Istrochem Bratislava**. The discharged of wastewater is to the Danube River (r.km. 1863,6). At this time this source of pollution does not reach the requirements of Gov. Decree in particular effluent standards because of only mechanical-chemical treatment. Therefore the construction of biological treatment step has started but this year this construction was stopped due to the significant changes in process technology. At present the situation at this plant is under solution and it is necessary to wait for the decision of the company executive board. The second plant is **AssiDomän Packaging Štúrovo**. This paper company intends to improve the situation in wastewater treatment. The expected results can be characterized in term of emission pollution, as follows:

effluent quality	at present [t/year]	after the implementation of the project (in 2005) [t/year]
BOD_5	2228	611
COD	4400	3058
SS	1570	611
DS	9800	9785
NES	23	37

The third one is **Bukocel Hencovce,** fourth **Slovhodváb Senica** and finally **Chemko Strážske.** All these plants (except Slovhodváb Senica) are covered by the projects defined in *Project Files*.

Bukocel Hencovce: the main goal of the project is to reduce the pollution to the Ondava River from the present 305,5 t BOD_5/year to 203,1 BOD_5/year.

Chemko Strážske: separation and treatment of wastewater conveyed by the existing combined sewer system the plant will reduce discharged BOD_5 to the Laborec River by 165,1 t/year compared to the present state (~ 310 t/year of BOD_5).

Slovhodváb Senica: as it was stated before, this point source of pollution is not covered by any projects.

Municipal pollution has also the significant impact on the transboundary pollution. Košice wastewater treatment plant is the most important problem from this point of view in Slovakia. At present the civil construction of new treatment plant is an almost finished. If the biological treatment step could be completed the plant in very short time would start the operation with the significant reduction of pollution discharged to the Hornád River. Recently only mechanical treatment step is operated. Since this time the term of the project completing has not been accomplished because of financial constraints.

The total discharge of wastewater is about 1250 l/s. The quality of wastewater discharged to the Hornád River deteriorates especially oxygen regime, however the increasing of nutrient content is also significant. The wastewater discharge has also an impact on microbiological pollution of water (number of coliform and psychrophilic bacteria increases downstream from the outlet from 2051 CFU/ml to 11.083 CFU/ml in 1996).

The Malacky wastewater treatment plant is the second serious transboundary source of pollution. The treatment plant discharges the partially treated water to Malina River. It is the tributary of the Morava River. Fortunately at this time Malacky plant is under construction and at the end of this year the 1st stage of its construction should be finished.

A relatively new adverse environmental effect with the direct impact on the present state of wastewater treatment can be documented in case study of PCHZ Žilina. The existing treatment plant has to upgrade its efficiency because of construction of new water dam. Due to the fact that the effluent will be discharged to the reduced flow rate than before the new more stringent effluent standards have been set. The present receptor will change to very sensitive one especially with respect of nutrients and micro-pollutants. In spite of this fact that this adverse environmental effect will cause the new investments these additional costs were not included in the capital cots of the hydropower and PCHZ Žilina has to solve this upgrading itself.

5. Cost Estimation of Programmes and Projects

Using the information obtained in Project Files the four tables with cost estimation of ongoing or planned projects have been prepared.

The tables are categorized in four groups:

- Table 5.1. summarizes the costs in municipal sector,
- Table 5.2. identifies the costs in industrial sector,
- Table 5.3. recapitulates the projects costs necessary for landfills and lagoons,
- Table 5.4. presents the required costs for non-structural projects or programmes.

The compilation of these data required the particular simplification to be able to present data in this report therefore the headings of tables are organized in the following way:

the number of project coincides with the number in *Project Files* used. In addition the same assignments have been used in the *hot spot* tables (see Table 3.1., 3.5. and 3.8.). Utilizing this system of the projects labeling one may find out the necessary information about the particular program or project. The ranking of the projects has been included in these tables, as well.

Analysis of the cost estimation in the **municipal sector** indicates that the National Environmental Fund and Water Management Fund for the required investment costs are supposed to be mostly used. Public loans covered by central or regional budget is the second important group of expected source of fund. The equity of owner is less important source of financing. The total requirement costs in this sector are about 3640 mil. Sk (105.5 mil. US$). At this time it is expected that only about 50 % of the required investment costs could be covered from the domestic funds (about 53 mil. US$ is required for this sector). At present the situation in this field is quite complex because of the privatization of water and sewage works and reducing the net profit of these institutions during two last years. At present water and sewage works practically do not have any own source for investment costs.

The different situation is in **industry** because now most of the companies are shareholding companies with minor state influence on their management, economy, etc. If we do not take into account the Project 2000 (No. 6a - I, Table 5.2.) the significant source of expected financing, except commercial bank and international loans, plays important role also the equity of the owner. In this case the total expected capital costs of the projects are 3507,4 mil. Sk (101,7 US$) and the requested or non-secured amount is about 85,5 US$. These huge costs are more realistic if we do not consider the costs required for the Project 2000 (6a-I). Then the total capital costs will reduce to 1092,4 mil. Sk (31,66 mil. US$) and the requested funds to 29,5 US$.

Unfortunately in case of projects for **landfills or lagoons** (Table 5.3.) we obtained only the estimation of capital costs without any specification of the sources of financing. The total investment costs in national currency is about 1500 mil. Sk (43,5 US$) and the same amount is non-secured, yet.

Interesting status can be found in Table 5.4. All the proposed projects assume only the international grants and a small part can be covered from National Environmental and Water Management Fund. In this matter the requested sum is 38 mil. Sk or 1,1 US$. The projects with the expected significant impact on the transboundary pollution are summarized in the Table 5.5. The more comprehensive description of the projects could be found in *Project Files*, also in Tables 3.3., 3.6. and 3.9., and/or in text of the chapters 3 and 4 of this report.

Table 5.1. Summary of the cost estimation of the proposed programmes and projects in municipal sector

No. of project	Wastewater treatment plant locality	Ranking of the projects	Total capital costs	Total capital costs	National Funding Sources				total requested or non-secured	
					Equity of Owner	National Envir. Fund	Water Manag. Fund	Public loans Centr.+ Reg.		
		[priority]	[MNC]	[MUS$]	[MNC]	[MNC]	[MNC]	[MNC]	[MNC]	[MUS$]
1- M	Košice	high	900,000	26,087	30,000	100,000	30,000	130,000	290,000	8,406
2- M	Nitra	high	552,000	16,000					373,676	10,831
4- M	Banská Bystrica	medium	593,461	17,202			38,000	131,106	169,106	4,902
5- M	Michalovce	medium	114,000	3,304	10,000	20,000		25,000	55,000	1,594
6- M	Svidník	medium	410,000	11,884	16,000	86,000		110,000	212,000	6,145
7- M	Trenčín right side	medium	267,000	7,739					257,000	7,449
8- M	Humenné	medium	597,806	17,328	35,000	100,000		200,000	335,000	9,710
10- M	Topoľčany	low	34,298	0,994	28,298				28,298	0,820
13- M	Rožňava	low	91,605	2,655	16,000	30,000			46,000	1,333
14- M	Liptovský Mikuláš	low	80,000	2,319	22,000	20,000	30,000		72,000	2,087
	Total		**3640,170**	**105,512**	157,298	356,000	98,000	596,106	**1838,080**	**53,278**

Note :

MNC - millions in national currency - Slovak crowns

MUS$ - millions in US$

exchange rate used : 34,5 Sk = 1 US$

Table 5.2. **Summary of the cost estimation of the proposed programmes and projects in industrial sector**

No. of project	Plant locality	Ranking of the projects	Total capital costs	Total capital costs	National Funding Sources						Commerc. Bank Loans	total requested or non-secured	
					Equity of Owner	National Envir. Fund	Water Manag. Fund	Public grants Centr.+ Reg.	International				
									Loans	Grants			
		[priority]	[MNC]	[MUS$]	[MNC]	[MNC]	[MNC]	[MNC]	[MNC]	[MNC]	[MNC]	[MNC]	[MUS$]
1a -I	NCHZ Nováky	high	12	0,348		1	1			3		5	0,145
1b -I	NCHZ Nováky	high	30	0,870	3	2	5	5	5	5	5	30	0,870
2 -I	Bukocel Hencovce	high	200	5,797								200	5,797
3a -I	PCHZ Žilina	medium	21,93	0,636							21,93	21,93	0,636
3b -I	PCHZ Žilina	medium	68,681	1,991							66,481	66,481	1,927
3c -I	PCHZ Žilina	medium	57,464	1,666							55	55	1,594
3d -I	PCHZ Žilina	medium	28,809	0,835							27,509	27,509	0,797
6a -I	Chemko Stážske	medium	2415	70,000	483	1207,5			724,5			1932	56,000
6b -I	Chemko Stážske	medium	16	0,464	8	8						8	0,232
6c -I	Chemko Stážske	medium	15,05	0,436	7,5	7,5						15	0,435
6d -I	Chemko Stážske	medium	100	2,899	50	50						100	2,899
7 - I	AssiDomän Packaging Štúrovo	low	317,7	9,209								317,7	9,209
8 - I	Bučina Zvolen.	low	94	2,725								94	2,725
9 - I	Biotika Slovenská Lupča	low	50	1,449	10	15			25			50	1,449
10 - I	Tannery Bošany	low	80,702	2,339	8,8	17						25,8	0,748
	Total		**3507,336**	**101,662**	570,3	1300,5	6	5	754,5	8	175,920	**2948,420**	**85,461**

Note : MNC - millions in national currency - Slovak crowns, MUS$ - millions in US$, exchange rate used : 34.5 Sk = 1 US$

Table 5.3. Summary of the cost estimation of the proposed programmes and projects for landfills

No. of project	Landfill or Lagoon/Locality	Ranking of the projects	Total capital costs	Total capital costs	total requested or non-secured	
		[priority]	[MNC]	[MUS$]	[MNC]	[MUS$]
1 - L	Kovohuty Krompachy	High	N/A	N/A	N/A	N/A
2 - L	Power plant Nováky- Kostoľany	Medium	335,160	9,715	335,160	9,715
3 - L	VSŽ Oceľ Košice	Low	212,550	6,161	212,550	6,161
4 - L	VSŽ Oceľ Košice	Low	503,062	14,582	503,062	14,582
5 - L	Bukocel Hencovce	Low	50,000	1,449	50,000	1,449
6e - I	Chemko Strážske	Low	400,000	11,594	400,000	11,594
	Total		**1500,772**	**43,501**	**1500,772**	**43,501**

Note:

MNC - millions in national currency - Slovak crowns

MUS$ - millions in US$

exchange rate used: 34,5 Sk = 1 US$

Table 5.4. Summary of the cost estimation of the proposed programmes for non-structural projects

No. of project	name of the project	Ranking of the projects	Total capital costs	Total capital costs	National Funding Sources			International		total requested or non-secured	
					Equity of Owner	National Envir. Fund	Water Manag. Fund	Loans	Grants		
		[priority]	[MNC]	[MUS$]	[MNC]	[MNC]	[MNC]	[MNC]	[MNC]	[MNC]	[MUS$]
1 - O	Restoration of wetlands	high	14,408	0,418					11,873	11,873	0,344
3 - O	Transformation of water boards	medium	6,156	0,178					6,156	6,156	0,178
2 - O	Analysis of quality sediments and their disposal	low	20,000	0,580	3,000	2,000	1,000		14,000	20,000	0,580
	Total		**40,564**	**1,176**	3,000	2,000	1,000	0,000	32,029	**38,029**	**1,102**

Note:

MNC - millions in national currency - Slovak crowns

MUS$ - millions in US$

exchange rate used: 34,5 Sk = 1 US$

Table 5.5. Summary of the cost estimation of the proposed programmes or projects with significant impact on transboundary pollution

<table>
<tr><th rowspan="2">No. of project</th><th rowspan="2">name of the project</th><th rowspan="2">Name of the project</th><th rowspan="2">Description of the project</th><th>Ranking of the projects</th><th>Total capital costs</th><th>Total capital costs</th><th colspan="2">total requested or non-secured</th></tr>
<tr><th>[priority]</th><th>[MNC]</th><th>[MUS$]</th><th>[MNC]</th><th>[MUS$]</th></tr>
<tr><td>1 - M</td><td>WWTP Košice</td><td>Košice-expansion of wastewater treatament plant 2nd stage of construction</td><td>In 1991/92 years a new WWTP has started. At present the civil construction of plant is finished and the mechanical treatment is already running. The biological treatment step is not finished due to the financial constraints. The completing of aeration tanks and clarifiers is the main goal of the project.</td><td>High</td><td>900,0</td><td>26,087</td><td>290,0</td><td>8,406</td></tr>
<tr><td>3 - M</td><td>WWTP Malacky</td><td colspan="2">WWTP is under construction, the civil structures are financed by the Programme Phare, the investment costs for the technology is covered by the municipality of Malacky. This year the 1st stage of the upgrading and expansion of treatment plant will finish. The starting and implementation of the 2nd stage of construction has not been clarified and therefore it is not covered by investment costs, yet. The design project for the 2nd stage was already done.</td><td>Medium</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>2 - I</td><td>Bukocel Hencovce</td><td>Reconstruction of wastewater treatment plant in Bukocel, a.s.</td><td>The reconstruction of treatment plant consists of construction sedimentation tanks, thickeners and upgrading of dewatering process. It is expected the reduction of pollution discharged to the Ondava river.</td><td>High</td><td>200</td><td>5,797</td><td>200</td><td>5,797</td></tr>
<tr><td>6d - I</td><td>Chemko Strážske</td><td>Reconstruction of sewer system</td><td>The project assumes to separate the sewage from the combine sewer system, its collection and transporting to the existing treatment plant.</td><td>Medium</td><td>100</td><td>2,899</td><td>100</td><td>2,899</td></tr>
</table>

Table 5.5. continued

No. of project	name of the project	Name of the project	Description of the project	Ranking of the projects	Total capital costs	Total capital costs	total requested or non-secured	
				[priority]	[MNC]	[MUS$]	[MNC]	[MUS$]
7 - I	AssiDomän Packaging Štúrovo	The reduction of discharged wastewater pollution to the Danube river	The project should be implemented in 3 stages. The existing plant is not able to reach the effluent standards therefore its upgrading is necessary. At the company site the Danube river creates the natural border with Hungary and the sensitivity Danube is effected by the planned waterworks Gabčíkovo-Nagymaros.	Low	317,7	9,209	317,7	9,209
1 - O	Restoration of wetlands	Floodplain Meadow Restoration in the Lower Morava River	The project should identified the degraded meadows, to restore about 1000 ha of degraded meadow, to establish the system of monitoring. It is predicted that about 290 t of TN and 30 t of TP would be removed by hay annually.	High	14,408	0,418	11,873	0,344
	Total				**1532,108**	**44,410**	**919,573**	**26,655**

6. Planning and Implementing Capacities

6.1. Planning Capacities

In the Slovak Republic the planing activities and thus the capacities can be divided into several levels:

- planing capacities on the country level presented mainly by the Ministries,
- planing capacities on the river basin level represented by river basin authorities,
- planning capacities on the regional level.

As far as the purely planning capacities are concerned it is assumed that they are sufficient with respect to water pollution reduction. Some problems are expected in preparation of bankable projects because of problems concerning the economics. The professional level according to BAT or BEP is comparable to Western European standard.

6.2. Implementing Capacities

6.2.1. Implementing Capacities for Structural Projects

In Slovakia after 1989 has started the process of privatization and transformation of state companies. During this period a number of new firms have been established or they have been created from the previous state companies. It is typical that the previous huge state corps split to the smaller private or share holding firms. This trend has been typical also in water management. At present a number of new firms exist and they are engaged in this field. The Catalogue of Firms Dealing with Ecology in the Slovak Republic summarizes the names of about 250 firms working in water industry. Most of these firms are purely Slovak firms, however a part of them are partially controlled by foreign investors.

There are several typical categories of firms as follows:

- design and consulting firms such as Hydroconsult (state firm) Bratislava, Hydrocoop, Ltd. Bratislava, Chempik, a.s. Bratislava, Hydroeko, a.s. Banská Bystrica, Keramoprojekt Trenčín, Unipid, Ltd. Trenčín, Celprojekt Ružomberok, etc.,
- complete design and delivery of particular structures in water management (e.g. wastewater treatment plants) including treatment plan services concerning with their operation, start-up, etc. such as ČOVSPOL, Ltd. Bratislava, Hydrotech, a.s. Bratislava, AQUIPUR, Ltd., PROX.T.E.C. , Trenčín, etc.,
- typical civil engineering firms such as: Hydrostav, a.s. Bratislava, Inžinierske stavby Košice, Stredoslovenské stavby, a.s. Žilina, Váhostav, a.s. Žilina, Vodohospodárske stavby Bratislava, Záhorácke vodohospodárske stavby, Malacky, etc.
- typical consulting firm is very difficult to find in water management, because most investors prefer to construct the structure without complete evaluation of the problem, which is typical for the prefeasibility studies in western European conditions.

At present the reasonable efficiency, low construction and operation costs of new and upgraded existing structures or processes in water management are required. Many treatment plants should be expanded or upgraded in several steps resulting in more complicated treatment lines.

From this point of view it is clear that there is the trend to apply the new technologies as well as the latest reliable equipment (blowers, mixers, pumps, engines etc.). In Slovakia the most of these equipment have to be imported. Therefore there is several headquarters of known firms not only in the field of engineering but also in monitoring, chemistry etc. (e.g. suppliers of blowers, pumps, mixers, aeration systems, flow meters - devices, probes, sensors for monitoring, chemicals used in water management e.g. for conditioning of sludges, for precipitation of phosphorus, etc.). During last years the significant portion of the necessary technique for treatment plants is also produced in Slovak Republic or Czech Republic, such as making the bridges for clarifiers or settling tanks, beltpresses, pressfiltress, centrifuges for thickening, plastic pipes and fittings, screenings, etc. There are several small firms, which are predominantly specialized in production of special products for the water management. As far as the innovated technology treatment lines are concerned the significant number of biological treatment systems are designed and constructed by Slovak companies. Many of these technologies with positive references are of Slovak or the former Czechoslovak origin, e.g. selector activated sludge system (compartmentalized activation reactors, kinetic and metabolic selection), R-D-N and AN-R-D-N process (nutrient removal systems with compartmentalized anaerobic and anoxic reactor and with regeneration of recycled sludge), activated sludge system with integrated clarifier ODKAL (high recirculation ratio of activated sludge by means of pressure air, without recirculation pumps), etc.

The civil firm have a huge amount of capacities for the constructing the treatment plants, upgrading the existing ones and/or uncontrolled landfills etc.

There is potential space for co-operation with foreign companies for turnkey projects especially in the field of industrial wastewater and waste disposal. It is expected that the foreign firm would be able to deliver not only the know-how of BAT but also to ensure the quality of latest technologies and installations made in EU.

6.2.2. Implementing Capacities for Non-structural Projects

There are several consulting and design firms with the high professional level. The most of them were created from the former employees of universities, research institutes, ministries or water and sewage works. The ability of these firms to speak in foreign language is very good. Therefore we do not expect the language barrier, which is important fact to overcome the problems concerning with international co-operation. In Slovakia we assume that except the foreign investments we need especially the international co-operation for implementation of non-structural projects.

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