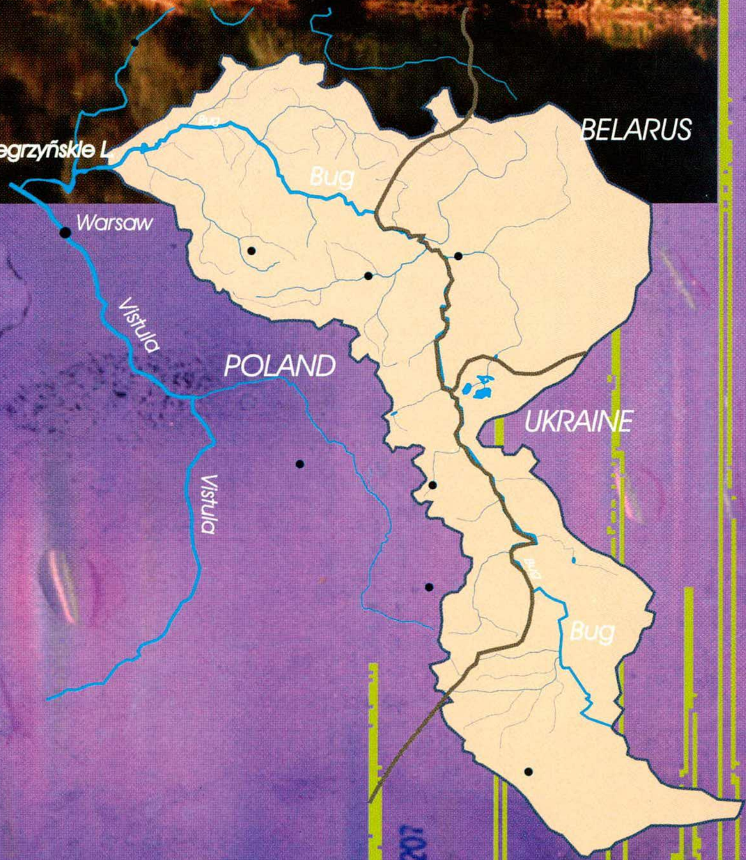
Working Group on Monitoring and Assessment under the UNECE Water Convention
Pilot Project Programme on Transboundary Rivers



BUG

Report No. 3

Recommendations for Improvement of Monitoring and Assessment Activities

November 2003

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Financial support for the publication of these reports has been provided by the consortium partners Mott MacDonald and ARCADIS Euroconsult, currently implementing the EU Tacis Inter-State funded Joint River Management Programme (JRMP) in seven NIS countries.

Joint River Management Programme
The overall objective of this programme is to support the prevention, control and reduction of adverse pollution impact caused by the quality of the rivers in four transboundary basins: Pripyat (Belarus, Ukraine), Seversky Donetz (Russia, Ukraine), Tobol (Russia, Kazakhstan) and Kura (Georgia, Azerbaijan and Armenia). Demonstrating the application of the 2000 Guidelines on Monitoring and Assessment of Transboundary Rivers, promoting and assisting with the upgrading of the monitoring services in the involved countries in accordance with the Guidelines, and evaluating and recommending improvements to the Guidelines are all common objectives. The Project also includes work towards joint development of a draft river basin management plan for the Pripyat River in accordance with the requirements set out in the EU Water Framework Directive.

Notably, the Project is a contribution to the ongoing effort directed by the UN Economic Commission for Europe (ECE) Task Force on Monitoring and Assessment, established under the Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes, to develop effective guidelines for the monitoring and assessment of transboundary waters.

Following the adoption of the river guidelines in 1996, it was agreed by the Task Force to establish a series of pilot projects on transboundary rivers in the UN ECE region with three main objectives:

- to *demonstrate* the application of the guidelines on monitoring and assessment of transboundary rivers
- to *support* countries in the application and implementation of the guidelines
- to *learn* from the experience gained in the pilot projects to identify gaps or weaknesses in the guidelines to be taken account of in their review

Eight river basins were proposed and five 'western' pilot projects have now been implemented. The three 'eastern' pilot basins are being implemented through the JRMP (Seversky Donetz, Tobol and Kura). Following a first review of the Guidelines in 1996, a second and final evaluation has now been completed with the five western pilot projects drawing to a close. The outcome of this general evaluation is presented in these reports.

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PREFACE

This report entitled *Bug: Recommendations for Improvement of Monitoring and Assessment Activities* is the third in a series of reports from a programme of pilot projects on the monitoring and assessment of transboundary rivers established under the UNECE Water Convention.

Author of the report was Malgorzata Landsberg (Inspection of Environmental Protection in Poland, Voivodeship Inspectorate of Environmental Protection in Szczecin).

The report was prepared in co-operation with expert teams of the three countries.

The Ukrainian team consisted of: Natalia Tchijmakova (Ministry of Environment and Natural Resources of Ukraine), Alexei Yaroshevich (expert on water management for EU/TACIS -projects in Ukraine and Belarus) and Oxana Manturova (Ukrainian Ministry of Ecology).

The Belarusian team consisted of: Sviatlana Utochkina (Ministry of Natural Resources and Environment Protection of the Republic of Belarus) and Vladimir Korneev (Central Research Institute of Complex Use of Water Resources).

In the Polish team the following people participated: Teresa Zan (Regional Water Management Board in Warsaw), Rafalina Korol (Institute of Water Management and Meteorology in Wroclaw), Joanna Zurawska (Voivodeship Inspectorate of Environmental Protection in Szczecin) and Pawel Blaszczyk (Institute of Environmental Protection in Warsaw).

The report has also benefited from discussion and suggestions by members of the Core Group for the Rivers Pilot Projects established under the UNECE's Working Group on Monitoring and Assessment: John Chilton (British Geological Survey – latterly the leader of the programme of pilot projects), Jos Timmerman, Rob Faasen and Paul Frintrop (Netherlands Institute for Inland Water Management and Wastewater Treatment – RIZA), David Nieuwenhuis (formerly at RIZA and now with Arcadis) and Martin Adriaanse (formerly at RIZA and the leader of the pilot projects, now with UNEP).

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I. INTRODUCTION

I.1. Pilot projects under the UNECE Water Convention

This report *Recommendations for Improvement of Monitoring and Assessment Activities* for the basin of the Bug River is the third in a series of reports from one of the pilot proje cts on monitoring and assessment of transboundary rivers under the UNECE Water Convention.

Historically, a joint monitoring programme has been one of the first activities in the co -operation between countries on a transboundary river. Formerly, the monito ring data used to be concentrated on the border crossing and/or on the section where the river forms the common border between the countries. In more recent years, achievements in water management have been mainly due to a change in emphasis towards integrated river basin management. Reference can be made to joint action plans established under river basin conventions for rivers such as the Rhine, the Elbe and the Danube, as well as to other legal instruments like the UNECE Water Convention (1992) and the E C Water Framework Directive (2000). These developments have begun to change the way of thinking about the information that is needed for the management of an international river basin.

The UNECE *Convention on the Protection and Use of Transboundary Watercourses and International Lakes* was established in 1992 at Helsinki and entered into force in October 1996. Already by 1994 the signatory countries had decided to start a work programme on monitoring and assessment, so as to be able to give guidance and support in this field. A Task Force on Monitoring and Assessment was established with the Netherlands as lead country (since 2000 it has been renamed as the Working Group on Monitoring and Assessment). About 25 countries and international organisations have t aken part in its activities during the last nine years.

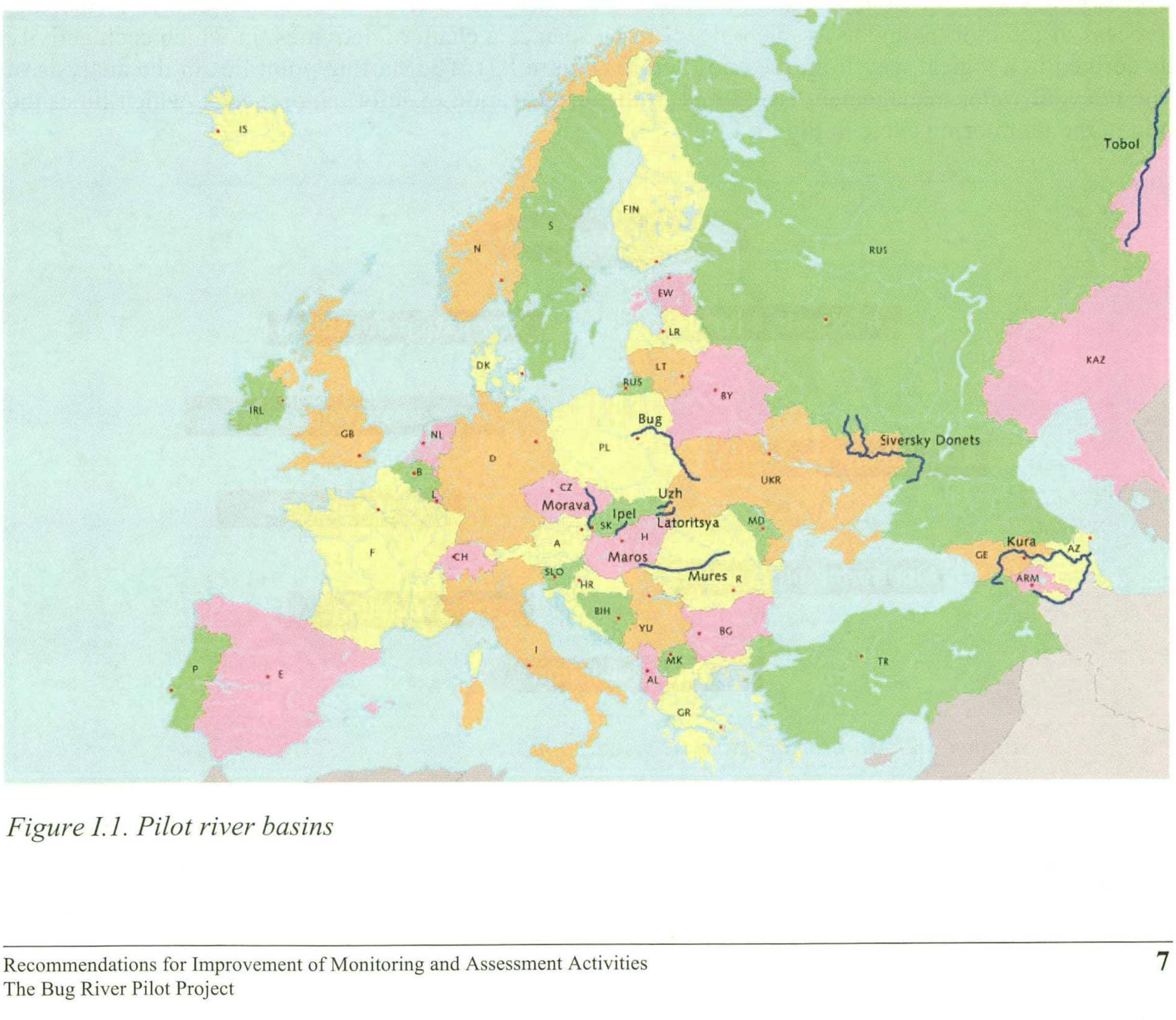


Figure I.1. Pilot river basins

In 1996 the *Guidelines on Water Quality Monitoring and Assessment of Transboundary Rivers* (UNECE, 2000) were issued as the first product of the Task Force, together with a series of supporting technical reports on specific subjects. The first review of the Guidelines was made in 2000. Also in 2000 the *Guidelines on Monitoring and Assessment of Transboundary Groundwaters* were completed and endorsed by the Meeting of the Parties to the Water Convention, and they have been issued together with four technical background reports on groundwater issues.

After the adoption of the river guidelines in 1996, it was agreed to start a series of pilot projects on transboundary rivers in the UNECE region. The objectives of the pilot projects were as follows:

- to demonstrate the implementation of the adopted river guidelines;
- to support countries with the implementation of these guidelines;
- to learn from pilot projects experiences for the review of the guidelines.

The wider objectives of the programme of pilot projects were to:

- initiate and/or improve bilateral and multilateral co-operation, leading to institutional strengthening and capacity building under the Convention;
- prepare effective and efficient monitoring and assessment programmes which are sustainable in the specific economic contexts of the countries concerned;
- support approximation to European Union environmental legislation in CEEC countries.

Eight river basins were proposed by countries to be included in the pilot project programme (Figure I.1.). Five were taken up in the UNECE programme and the others by the Tacis Joint Rivers Management Project. One of the former was the Bug River which is shared by Belarus, Ukraine and Poland (Figure I.1).

I.2. Guidelines: a recommended approach

An essential element of the Guidelines prepared under the UNECE Water Convention is that the process of monitoring and assessment needs to be seen as a chain of activities, in which each activity is derived in a logical way from the ones before (Figure I.2). The starting point lies in the analysis of the relevant water management issues and in the specification of information needs, which lie at the top of the monitoring cycle in Figure I.2.

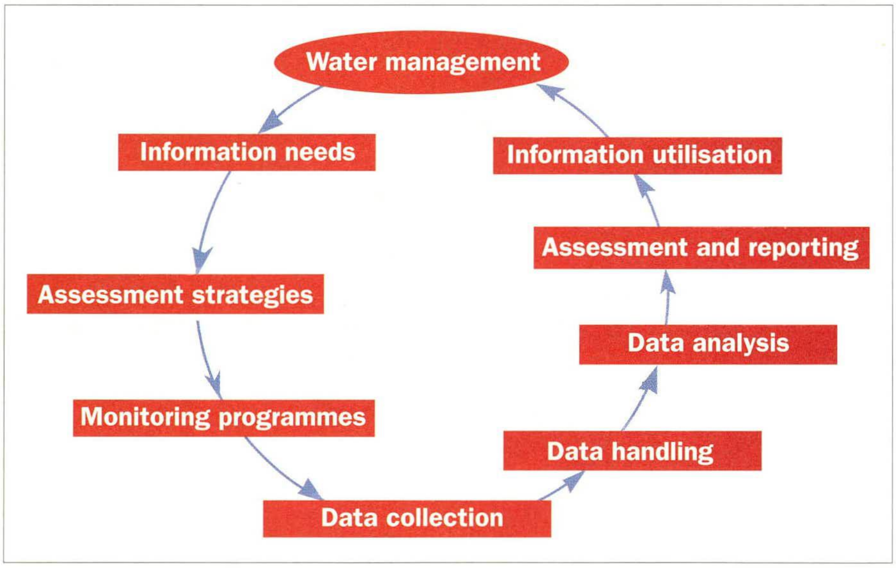


Figure I.2. Monitoring cycle (UNECE, 2000)

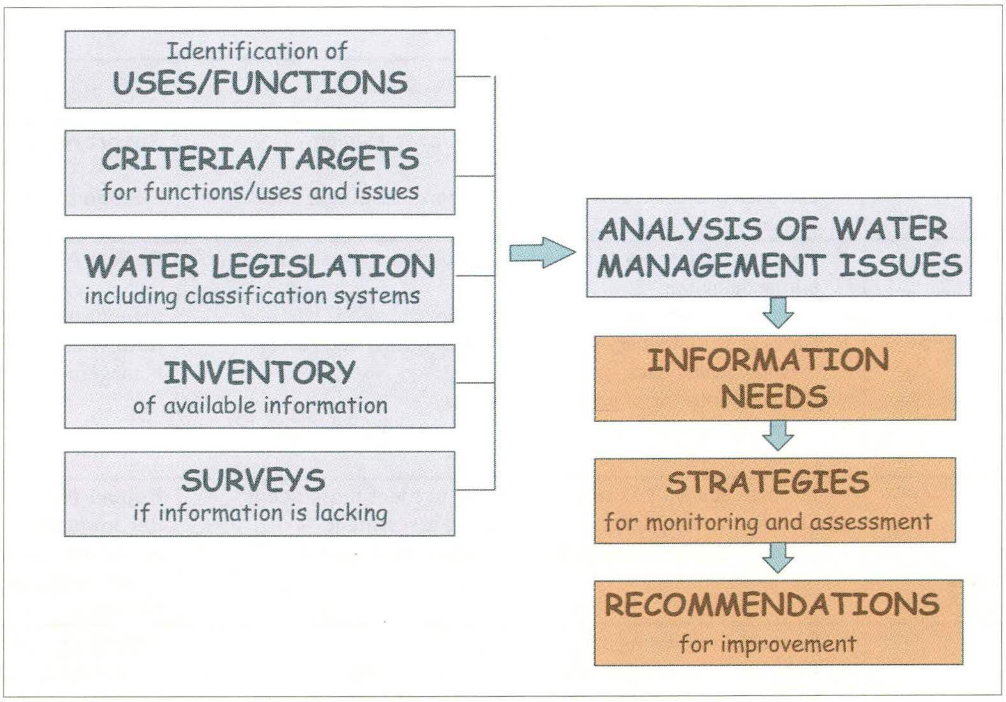


Figure I.3. Analysis of Water Management Issues (UNECE, 2000)

The steps in the analysis of water management issues are expanded in Figure I.3. The key general principle for both the Guidelines and the pilot projects is to move logically through the successive activities, which are strongly related to each other;

- 'Uses/functions and issues' indicate which information should or should not be included in the inventory;
- From the results of the inventory, it can be learned what information is lacking and what analysis should be included in the surveys;
- The uses and issues indicate which elements require assessment criteria to be defined.

I.3. Pilot projects – phases, activities and reports

It was planned that the pilot projects would consist of Preparatory and Implementation Phases. As shown in Table I.1, the first part of the Preparatory Phase was inception, the second part was the analysis of water management issues and the third part the recommendations for improved monitoring and assessment. Amongst the first activities in a pilot project is the establishment of a Memorandum of Understanding (MOU) between the riparian countries through their responsible ministries for co-operation within the project. Co-ordination with the relevant transboundary commission is an important aspect in this respect.

Since early 1997 a Core Group on Pilot Projects for Rivers, in which the project leaders of the involved countries participated, has held regular meetings to prepare and guide the programme. The pilot project activities are summarised in Table I.1. For practical reasons, the actual pilot projects will end with recommendations for improvement, because for the implementation of recommendations additional institutional and administrative decisions have to be made and further funds have to be raised.

Separate reports were prepared for the respective activities of inventory, review of legislation and specification of information needs by the country project leaders and their teams. For each pilot project, the results of these activities are summarised in three formal, published reports issued under the work programme of the UNECE Water Convention:

Table I.1 Phases, activities and reports of rivers pilot projects

Phase	Activity	Report
Preparatory – Inception	• Prepare and agree Memorandum of Understanding • Prepare funding proposal • Establish project teams and organizational responsibilities • Prepare work plan and inception report	**Report No 1** Inception Report
Preparatory – Analysis of monitoring and assessment needs	• Carry out inventory of basin and establish main water uses and human activities • Review and evaluate existing legislation • Carry out preliminary surveys of water quality and review existing quality data • Make inventories of polluting activities • Identify main water quality and water management issues • Specify information needs accordingly	**Report No 2** Identification and Review of Water Management Issues
Preparatory – Develop recommendations	• Evaluate ability of existing monitoring to meet these needs • Develop strategies for monitoring and assessment • Recommend improvements and prepare cost estimates	**Report No 3** Recommendations for Improvement of Monitoring and Assessment
Implementation	• Redesign monitoring programmes • Implement recommended sampling and analytical methodologies, data handling and data exchange • Procure additional equipment as required • Develop quality assurance programmes • Train required staff at all levels • Make reports on water quality forall stakeholders	Beyond the scope of the pilot projects

- the **Inception report** (including a description of the river basin, the MOU, project organisation and financial proposal);
- the **Identification and Review of Water Management Issues** for the river basin (including the Identification of Functions/Uses and Issues of the river basin and results of Inventories, Evaluation of Legislation, Surveys and Water Management Analysis);
- the **Recommendations for Improvement of Monitoring and Assessment Activities** (including Information Needs, Strategies for Monitoring and Assessment, Evaluation of Current Monitoring and Recommendations for Improvement and Cost Estimates).

The present report is the third of these.

I.4. Relations between pilot projects and EC Water Framework Directive

The EC Water Framework Directive came into being during the lifetime of the pilot projects. There is a close relationship between the UN/ECE Water Convention (1992) and the EC Water Framework Directive (2000/060/EC). In 1995 the Water Convention was ratified by the EC (Council Decision 95/308/EC) and in Consideration no. 35 of the Directive it is explicitly stated that the Directive must contribute to the implementation of the Water Convention. Whereas the Water Convention deals with both water quality and quantity aspects, the Water Framework Directive has its main emphasis on water quality. Reduction and control of emissions are the main tools for both the Water Convention and the EC, with the ultimate goal of reaching good ecological status of water systems. Whereas the Water Convention does not give any time-scale, the Framework Directive contains a strict time-schedule for a number of steps to obtain the desired water quality by the end of 2015.

The relationship between the Water Convention and the Water Framework Directive is reflected in the *Guidelines for Monitoring and Assessment of Transboundary Rivers* and subsequently also in the reports *Identification and Review of Water Management Issues* of the different pilot project basins. Operational monitoring is the most important tool in the EC-WFD for obtaining information about improvement of the quality status of the waters as a result of the measures (to be) taken. The operational monitoring programme should be derived from the River Basin Management Plan, and should include parameters that are indicative for the pressures identified in the water management analysis. A similar approach is found in the Guidelines for Monitoring and Assessment of Transboundary Rivers, and hence in the reports of the Pilot Projects, i.e. the analysis of water management issues provides a basis for monitoring and assessment.

Report No 2, *Identification and Review of Water Management Issues* can be regarded as the first step in the development of a River Basin Management Plan. It describes the river basin, the functions and uses of the river and its tributaries, the actual quality status compared to the requirements of the functions and the main problems and causes identified from this comparison. The present report No 3, *Recommendations for Improved Monitoring and Assessment Activities,* sets out the information needs, provides the selection of indicative parameters and a critical evaluation of the existing monitoring programmes to meet the information needs, and gives recommendations for strengthening monitoring and assessment programmes where necessary to meet these information needs.

I.5. The pilot project as part of international co-operation in the Bug river basin

Within the overall programme, the Bug pilot project was initiated in 1997. In 1998 the Ministry of Environment Protection and Nuclear Safety of the Republic of Ukraine, the Ministry of Environment of Belarus and the Ministry of Environment of Poland signed a Memorandum of Understanding on co-operation for the pilot project for monitoring and assessment of the River Bug under the UNECE Convention. Activities in the pilot project commenced in Poland and Ukraine in 1999 and in Belarus in 2000. Ukraine completed its contribution in 2001 and Poland and Belarus in 2002.

The project has been co-ordinated and supported since 1997 by the Core Group on Pilot Projects under the UNECE Water Convention. In regular meetings, activities were prepared and agreed, and the results discussed. The reports were prepared by the project teams. In Ukraine, the project lead was provided by the Ministry of Environment and Natural Resources, in Belarus by the Ministry of Natural Resources and Environment Protection, while in Poland the project was led by the Regional Water Management Board in Warsaw. The pilot project was supported by two EU Tacis projects in Ukraine and Belarus. The project teams consisted of:

- For Ukraine: the Ministry of Environment and Natural Resources, experts from the EU Tacis projects for Belarus and Ukraine and the Ministry of Ecology;
- For Belarus: the Ministry of Natural Resources and Environment Protection and the State Institute for Complex Water Resources;
- For Poland: the Ministry for Environment, the Voivodeship Inspectorate of Environmental Protection in Szczecin, the Regional Water Management Board in Warsaw, the Institute of Meteorology and Water Management (IMGW) in Wroclaw and the Institute of Environmental Protection.

II. INFORMATION NEEDS

The results of monitoring programmes support the development of an environmental protection strategy at various levels of management, the assessment of compliance with environmental quality standards, observation of progress in the policy, plans and programmes in the basin, assessment of the performance of legal instruments (i.e. permits), assessment of the influences on the environment and supply of information to society.

To satisfy these requirements, a monitoring strategy and programmes should be developed based on the relevant information needs. This step is a most important one in "the monitoring cycle" [1]. To be able to specify adequately the information needs, analyses of existing policy, water and land use, problems, functions and uses of water in the basin were undertaken. Institutions responsible for management and monitoring, and the potential users of the information were identified.

According to the identified functions/uses and problems, information relevant for water management in the basin should be delivered. For each problem, indicators can be derived which characterize the respective cause-effect relationships (driving forces, pressures, state, impacts and responses). Thus, the required information can be specified in different categories (monitoring, survey programmes, methods for estimation/calculation, inventories and data from statistical offices). All of these are very important for assessing water management policy and evaluating programmes in the basin.

II.1. Potential users of Information from monitoring programmes

Institutions and their responsibilities for water management in the Bug river basin were described in more detail in *Report No.2.* Some of these institutions are responsible for water monitoring (producers of monitoring data) and some are directly or indirectly responsible for water resource management. All are potential users of information from monitoring programmes. One of the main information users is the Polish – Ukrainian Commission for co-operation on bordering waters, which was created in 1999.

Table II.1. Information users in the Bug Basin

Institution	Water management	Monitoring - coordinating (C) or implementing (I)
Ukraine		
Cabinet of Ministers of Ukraine, Government of the Autonomous Republic of Crimea, local councils of people's deputies and their executive committees	+	
Ministry of the Environment and Natural Resources of Ukraine	+	C
State Committee for Water Management	+	C
State Sanitary and Epidemiological Service of theMinistry of Health Care and its oblast branches	+	C, I
State Committee of Construction, Architecture and Housing Policy	+	C
Volyn and L'viv Regional State Ecosafety Boards	+	I
Other institutions involved in water resources management: Ministry of Agricultural Policy State Committee for Fisheries State Committee for Land Use State Directorate of National Parks and Conservation Ministry of Health Hydrometeorological Centers and Regional Water Committees State and local authorities of different levels	+	 C I
Other users of information State Committee for Statistics Institute of Hydrobiology – National Academy of Science Institute of Ecological Problems – National Academy of Science Non-governmental organizations		

Institution	Water management	Monitoring - coordinating (C) or implementing (I)
Belarus		
Council of Ministers	+	
Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, (in relation to the Bug river basin -Central Analytical Laboratory -Minsk, Brest Regional Committee of Natural Resources and Environmental Protection, Department of Hydrometeorology) and their local bodies and other state bodies according to legislation	+	C, I
Other ministries involved in water management and policy: Ministry of Emergencies Ministry of Agriculture Ministry of Health Protection, (Brest Regional Centre for Hygienic Epidemiology) Ministry of Housing and Municipal Services Concern 'Belmeliovodchoz' Ministry of Forestry State Committee on land use, geodesics and cartography	+	 C, I C
Scientific institutions involved in water resources management on behalf of the Ministry of Natural Resources and Environment Protection: Central Scientific and Research Institute of Complex Use of Water Resources – Belarusian Scientific and Research Center 'Ecology' Belarusian Scientific and Research – Geological Prospecting Institute Institute of the Problems of Natural Resources and Ecology of the Academy of Sciences of Belarus.	+	I
Poland		
Ministry of Environment	+	
Plenipotentiary of the Minister of Environment for Boundary Waters	+	
Regional Water Management Board in Warsaw	+	
Voivodeship and Marshal Offices in Lublin, Bialystok and Warsaw	+	
Powiats/District Offices, Communes in Bug basin	+	
Inspection of Environmental Protection with Chief Inspectorate of Environmental Protection and Voivodeship Inspectorates of Environmental Protection in Lublin, Bialystok and Warsaw	+	C, I
State Sanitary Inspection with the Chief Sanitary Inspectorate and Voivodeship Sanitary Inspections	+	C,I
State Forest Estates	+	
National Parks, Landscape Protection Parks	+	
Ministry of Agriculture and Rural Development	+	
Other institutions involved in water resources management: Ministry of Health and Social Care, Ministry of the Interior and Administration Institute of Meteorology and Water Management, State Institute of Geology, Institute of Environmental Protection Non-governmental organizations Society	+	I

II.2. Water uses and issues

A comprehensive overview of water uses, functions and problems in the Bug river basin leads to the conclusion that the water quality of the Bug basin should be sufficient for good ecological functioning, supply of drinking water, supplies for agriculture, recreation and angling and also high enough to minimize the impact on Lake Zegrzynskie. Its function as a medium of sewage transport is also very important.

The most significant problems that disturb the functioning and use of the river are pollution by nutrients causing eutrophication, the bad sanitary state of water and organic pollution. To illustrate this it is worth repeating the table reflecting conflicts between water uses/functions and problems from *Report No 2*, which is a good starting basis for recommendations for improvement of monitoring and assessment.

Table II.2. Relationships between water uses and functions, and problems occurring in the basin

Problems	Uses/Functions							
	Ecological function	Supply of drinking water*	Agriculture**	Fish-farms	Recreation and angling	Supplies for industry**	Transport medium, including sewage	Impact on Lake Zegrzynskie
Pollution by nutrients and eutrophication	+++	+++***		+	+++	+	+	+++
Microbiological pollution	+	++	+	+	+++		+	+++
Organic pollution	+++	++		+	+		+	+++
Accidental pollution	+	+	+	+	+		+	+
High variability of flows	+				+		+	
Flood hazard	+	+		+	+	+	+	+
River regulation, damming and draining	++				+		+	
Pollution by toxic substances****	+	+	+		+		+	+

strongly, moderately, not important as a common concern

* groundwater and intake from Lake Zegrzynskie
** groundwater and surface water
*** eutrophication is not taken into account for groundwater
****including pollution by radionuclides (Chernobyl accident)

+++, ++, + high, medium and moderate stress

The main problems within the river basin were identified and agreed between the countries during the inventory as being:

- inadequate methods of sewage collection and treatment in cities and towns, especially lack of processes for nutrient removal,
- lack of facilities for rainwater purification in urban areas,
- lack of sewage collection systems and sewage treatment plants in rural areas,
- the poor operational state of sewage treatment plants,
- use of fertilizers in agriculture causing diffuse pollution,
- droughts and floods, which might destroy the biocenosis and cause excessive pollution of the water of the Bug River and of particular tributaries,
- pollution discharged into the soil and then infiltrating groundwater,
- poor water quality in several of the Bug tributaries,
- possible leaching from sludge ponds,
- overloaded urban landfills,
- storage of toxic substances,
- mismanagement of land and erosion,
- industrial livestock farming causing pollution of ground and surface water,
- the impact of pollution on groundwater, protected zones and water reservoirs.

Further, the risk of accidental pollution was identified. Such pollution might be caused by:

- accidental oil spills,
- emergency discharges of industrial and municipal sewage,
- accidents during the transport of hazardous substances,
- inflow of pollutants from uncontrolled municipal and industrial solid waste disposal sites and storage sites for toxic substances.

II.3. Summary of management goals

One of the major goals of water management policy in Europe is the conservation and, wher e possible, restoration of aquatic ecosystems to a state of good or even high ecological quality. These aspects can be found in national policies and strategies for environmental protection in the three riparian countries:

Ukraine, Belarus and Poland. The focus of the three countries in the field of water protection is on urban sewage management and reducing nutrient pollution from diffuse and point sources. The management goals and their connections with issues are summarized in Table II.3.

Table II.3. Management goals and issues

Management goals	Issues and their most important aspects
I. Good state of water ecosystems	Eutrophication of waters, organic pollution.
	Biodiversity is not balanced.
	Pollution by toxic substances.
	Possibility of accidental pollution.
	Floods and droughts.
	Regulation of rivers (tributaries of the Bug) and utilization of their valleys.
II. Securing supplies of drinking water in the required quantity and of the required quality from groundwater resources and Lake Zegrzynskie	Bacteriological pollution.
	Eutrophication of waters, organic pollution.
	Pollution by toxic substances.
	Possibility of accidental pollution.
	Pollution of groundwater by farmlands, leaching landfills and sludge ponds.
	Overexploitation of groundwater resources.
	Flood hazard.
III. Possible use for recreation (swimming, angling and water sport)	Bacteriological pollution.
	Eutrophication of waters.
	Pollution by toxic substances.
IV. Securing surface water for agricultural irrigation	Bacteriological pollution.
	Pollution by toxic substances.
	Accidental pollution.
	Water deficits might occur during low water levels.
	The retention capacity of reservoirs is not sufficient.
V. Securing water for fish-breeding	Pollution by nutrients and organic materials.
	Bacteriological pollution.
	Flood hazard.
	Possibility of accidental pollution.
VI. Securing water supply for industry	Pollution by nutrients and eutrophication.
	Flood hazard.
VII. Protection against floods and droughts	Insufficient possibilities of water retention in reservoirs.
	The technical condition and length of flood banks at particularly threatened sites.

II.4. Monitoring objectives

The monitoring objectives are derived from national and international policy in the field of water protection. The policy of the European Union is declared in the Water Framework Directive. The objectives of the monitoring and assessment of water quality and quantity are described in Annex 5 of the Directive. In the Ukraine, the legislative act which regulates water protection, water use and restoration of water resources is the Water Code of the Ukraine (1996). In Belarus, it is the Water Code of the Republic of Belarus (1998) and in Poland the Water Law (2001). According to the legislation in each country, water should be suitable for different uses – fishery, recreation and drinking water supply and should be protected against pollution from point and diffuse sources.

European Union legislation has been implemented into Polish Water Law, including the "philosophy" of the Water Framework Directive, and the Directives of the European Council relevant to national water protection policy – 76/160/EEC; 78/659/EEC; 75/440/EEC; 79/923/EEC; 86/280/EEC; 91/271/EEC, 91/676/EEC.

The basic role of monitoring is to help control water quality and sewage discharges in accordance with policy objectives in the field of water management for the countries in the basin and with respect to functions and uses, problems and measures. Monitoring of the Bug River is required for:

- assessment of whether the current water conditions are adequate for the various function and uses;
- assessment of conformity with environmental quality standards and classification of water quality;
- assessment of the pollution load crossing the borders and discharging into Lake Zegrzynskie;
- assessment of changes in water quality in response to remedial activities in the basin and natural variations;
- long term assessment of the ecosystem;
- quantitative assessment of the interaction between groundwater and surface water;
- determination of the possibility for introducing changes in the monitoring system and to design an innovative monitoring system;
- qualitative specification of the reference conditions (undisturbed waters or almost undisturbed by anthropogenic effects) of surface waters for assessment of susceptibility to anthropogenic effects.

II.5. Indicators for water uses, issues and measures

The state of the water quality is only one part of the causality chain from driving forces through pressures and impacts to the responses of society. Thus, the information needs should not only focus on the state of the watercourses but also on any other information to support the analysis of water management problems. For policy-making and policy evaluation, it is essential that environmental information is derived from indicators that are representative for the cause-and-effect relationships in water management. Indicators are used for reporting the state of the environment, evaluation of the effectiveness of policy measures, comparison between countries/regions or between functions/uses, and as a communication tool between policy makers, "monitors", and the public.

The scheme of DPSIR indicators (Driver, Pressure, State, Impact, Response) is recommended, and should be used with the following meanings:

Driver: an anthropogenic activity that may have an environmental effect (e.g. agriculture, industry).

Pressure: the direct effect of the driver (e.g. a change in flow, a change in the pollution load).

State: the condition of the water body resulting from both natural and anthropogenic factors (i.e. physical, chemical and biological characteristics).

Impact: the environmental effect of the pressure (e.g. fish killed, ecosystem modified)

Response: the measures taken to improve the state of the water body (e.g. restricting abstraction, limiting point source discharges, developing best practice guidance for agriculture.)

Besides expressing these effects, indicators can have either a general character, reflecting the broad socio-economic aspects of water and land use, or be more specific - directly related to the state of the water ecosystem. Based on the established priorities of water uses and factors that make the functioning of the Bug River complex and difficult, a list of important indicators has been made (Tables II.4, II.5 and II.6). After verification with respect to the possibilities for accumulating the data needed for them, access to data and repeatability, these indicators have been divided into three sets; general indicators for all problems/issues and water uses (Table II.4), indicators that are matched with adequate management goals (Table II.5) and economic response indicators (Table II.6).

Table II.4. General indicators for management targets and identified issues

Driving Force and Pressure Indicators			Response time
1	**Point and diffuse sources of pollution**	Land use in the basin: urban areas, afforested areas, protected areas, agricultural areas, meadows, pastures and others, in km^2.	3 years
2		Inventory list of industrial plants using toxic substances, amount of toxic substances used, stored or discharged, in mass units per year	1 year
3		Water consumption index, in m^3/person/year	1 year
4		% population connected to water supply network (rural and urban areas)	1 year
5		% population connected to sewage network (rural and urban areas)	1 year
6		Water consumption for industrial use, municipal use, irrigation, fish breeding, for surface water and groundwater separately, in hm^3/year.	1 year
7		Volume of untreated municipal sewage discharged into water and soil, in hm^3/year	1 year
8		Volume of untreated industrial sewage discharged directly into water and soil, in hm^3/year	1 year
9	**Point sources**	Volume of municipal sewage discharged into water after different types of treatment, in hm^3/year	1 year
10		Volume of industrial sewage directly discharged into water after different types of treatment, in hm^3/year	1 year
11		Volume of mixed - industrial and municipal sewage discharged into water after different types of treatment, in hm^3/year	1 year
12	**Diffuse sources**	Animal unit equivalents per hectare	3 years
13		% farms connected to sewage system (individual and industrial separately)	1 year
14		Quantity of artificial fertilizers used in agriculture, in mass units per surface units yearly and composition of artificial fertilizers.	1 year
15		Quantity of manure used in agriculture, in mass units per surface units yearly.	1 year
16		Quantity and type of pesticides used, in mass per surface units yearly.	1 year
17		% degraded land and degree of erosion	3 years

Table II.5. Indicators related to specific issues and management targets

Management goals **I. Good state of water ecosystems,** **II. Securing supplies of drinking water in the required quantity and of the required quality from groundwater resources and from Lake Zegrzynskie,** **III. Possible use for recreation (swimming, angling, water sports),** **V. Securing water quality for fish-breeding** **VI. Securing water supply for industry**			
Problems/issues - *Eutrophication of waters, organic pollution*			
18	Pressure	BOD_5, phosphorus and nitrogen loads discharged from sewage treatment plants, separately for municipal, industrial and mixed sewage treatment plants, in T/year.	1 year
19	Pressure	BOD_5, phosphorus and nitrogen loads delivered with surface run-off, in T/km^2/year.	1 year
20	State	Concentration of nutrients, organic substances, oxygen regime and chlorophyll a.	1 month
Management goals **I. Good state of water ecosystems**			
Problems/issues - *Biodiversity is not balanced*			
21	Impact	Composition and abundance of benthic invertebrate fauna, fish, macrophytes, phytobenthos, phytoplankton (frequency and intensity)	6 months, for fish and macro-phytes 3 years
22	Impact	Supporting parameters for biology measured at the same time: temperature, DO, nutrients, pH, river flow, depth, width, chlorophyll a.	
23	Impact	Quantity and dynamics of water flow	in-situ, real time
24	Pressure	River continuity	5 years
25	Impact	River depth and width variation	1 year
26	Impact	Structure and substrate of the river bed	1 year
27	Impact	Structure of the riparian zone	1 year
28	Pressure	Connection to groundwater bodies	6 months
29	Pressure	Ice phenomena	1 year

Management goals **I. Good state of water ecosystems,** **II. Securing supplies of drinking water in the required quantity and of the required quality from groundwater resources and from Lake Zegrzynskie,** **III. Possible use for recreation (swimming, angling, water sports)** **IV. Securing surface water for agricultural irrigation**			
Problems/issues - *Pollution by toxic substances*			
30	State	Heavy metals (in water and sediments)	survey is needed
31	State	Pesticides	survey is needed
32	State	Other specific pollution	survey is needed
33	Pressure	Number, capacity and location of solid waste storage sites and point sources recognized as threats for the environment.	1 year
34	Pressure	Load of dangerous substances discharged from point sources.	1 year
Management goals **I. Good state of water ecosystems,** **II. Securing supplies of drinking water in the required quantity and of the required quality from groundwater resources and from Lake Zegrzynskie,** **IV. Securing surface water for agricultural irrigation**			
Problems/issues - *Potential possibility of accidental pollution*			
35	Pressure	Amount of dangerous substances stored, used or produced, location.	1 year
36	Pressure	Range and frequency of hazardous substance transport (railway, roads).	1 year
Management goals **I. Good state of water ecosystems,** **II. Securing supplies of drinking water in the required quantity and of the required quality from groundwater sources and from Zegrzynskie Lake,** **IV. Securing water quality for fish-breeding** **VI. Securing water supply for the industry** **VII. Protection against floods and droughts**			
Problems/issues - *Floods and droughts*			
37	Pressure	Relation between the capacity of retention reservoirs and run-off volume.	3 years
38	Pressure	Drought and flood periods and their frequency.	1 year
39	Pressure	Length of existing flood embankments in relation to the needs.	3 years
Management goals **I. Good state of water ecosystems**			
Problems/issues - *Regulation of rivers (Bug tributaries) and utilization of their valleys*			
40	Pressure	Length of regulated river stretches.	3 years
41	Pressure	Area of ameliorated valleys.	3 years
42	Pressure	Number of dams.	3 years
Management goals **II. Securing supplies of drinking water in the required quantity and of the required quality from groundwater resources and from Lake Zegrzynskie,** **III. Possible use for recreation (swimming, angling, water sports),** **IV. Securing surface water for agricultural irrigation**			
Problems/issues - *Bacteriological pollution*			
43	State	Coliform bacteria (at 37 C)	1 month (minimum)

Table II.6. Economic indicators

44		Cost of investments needed to minimize the load of pollution brought by rainfall in Euro/year.	1 year
45		Cost of construction and modernization of the sewage system in Euro/year.	1 year
46		Cost of bringing the Code of Good Agriculture Practices into effect.	3 years
47		Cost of modernization of industrial sewage treatment plants in Euro.	1 year
48		Cost of investments in reservoirs building in Euro/year.	3 years
49		Cost of flood embankment building in Euro/year.	1 year
50		Economic losses in Euro due to flooding.	if needed

II.6. Evaluation of present monitoring and assessment practices

The main features of the present monitoring and assessment arrangements in the Bug river basin can be summarized as:

- The water monitoring systems in Belarus, Ukraine and Poland are significantly different in each country with respect to sampling location, frequency of sampling, list of parameters, assessment methodology and standards used and methods of laboratory analyses. These major variations lead to different interpretations of water quality.
- International monitoring and assessment and the exchange of information in the Bug basin is limited and has the character of direct co-operation between administrative units in each country.
- Taking into account the size of the Bug basin, the total number of sampling points is very high, 281 of which 81 are on the course of the Bug and 200 on its tributaries, and national networks in the three countries consist of 53 sampling points.
- The location of sampling points and the range of measured parameters are not in line with the water uses, problems and issues identified in the basin.
- The correlation of water quality sampling with hydrological observation is rather weak, and in general existing hydrological measurement locations should be adjusted to conform with the water quality observation network.
- The results of the surveys undertaken in the basin in 1999 – 2001 indicated that inter-laboratory and inter-country correlations between the results of analyses for even the basic parameters were not always good and the reasons for this were not always clear. The large number of laboratories involved in routine monitoring activities in the basin makes it difficult to resolve this.
- The analytical detection limits, especially for metals and micropollutants are variable, even between laboratories taking part in the monitoring activities in a particular country, and are not adequate for international standards. This situation is only partially related to the economic difficulties of the countries, which limit the introduction of "state of the art" technique into the laboratories.

II.7. Missing information

From the inventory of accessible information and the surveys undertaken in 1999-2001 the following conclusions about missing information can be made:

- further recognition of the toxicological effects of sediments, effluents, water and hazardous solid waste disposal is necessary;
- deeper knowledge about the concentrations of specific parameters, such as heavy metals, pesticides and oil derivatives in water and sediments is required;
- assessment of the impact of priority solid waste disposal sites and sludge storage sites is needed;
- assessment of the stored amount of unused pesticides and the amount of applied fertilizers is needed;
- more insight and knowledge is necessary about the relationship between groundwater and surface water in the river basin, and a monitoring programme for groundwater (both quality and quantity) including the interaction between surface water and groundwater should be developed in the basin;
- for assessment of cause-effect relationships, indicators relevant to the information in the basin should be developed and be accessible;
- additional information on the use and storage of toxic substances in the basin is essential;
- risk assessments should be performed for the whole basin;
- the pollution loads causing major problems from point sources need to be measured;
- reliable information on the effectiveness of sewage treatment plants is required;
- a common method of diffuse pollution assessment should be applied for the basin and verification of emission factors in the computational method for diffuse pollution is essential. The main indicators need to be defined;
- hydromorphological information is required;
- development of a methodology for ecological assessment (in accordance with the WFD) including typological diversity of the basin is needed.

III. STRATEGY FOR MONITORING AND ASSESSMENT

The framework strategy for monitoring and assessment in the Bug basin is aimed at:

- redesigning the monitoring network to ensure continuity of measurements but at the same time allowing incorporation of requirements and changes to meet the demands of recent developments in water policy and management;
- from a cost-efficiency point of view, a reduction in the existing sampling points would be desirable;
- finding a proper balance between continuity of the measurements of certain parameters, reduction of the total number of parameters and inclusion of new parameters and new sampling media;
- possible implementation of Water Framework Directive requirements;
- including water quality and quantity elements, all components needed for ecosystem assessment (biology, hydromorphology and chemistry), screening of hazardous substances;
- developing propositions for assessment tools and information exchange.

III.1 Selection of media and parameters for monitoring programme

Because contaminants are present in water, sediments and organisms, selection of proper media is based on the following criteria:

- parameters and media should be representative for all problems and water use/functions;
- parameters could occur at critical levels;
- the distribution of contaminants in individual media;
- existing criteria and standards for individual media;
- the possibility of detecting the pollution in different media with adequate precision.

Assessment of river sediment quality is important as sediment pollution can affect human health and ecosystems (e g. during river dredging). Sediment quality becomes more significant for water where sedimentation of suspended matter is important – water reservoirs, overflow lands, erosion, lower parts of side streams or where infiltration by polluted sediments takes place (e.g. Zegrzynskie Lake). The analysis of contamination of organisms becomes important when problems with toxic substances are evident and threaten their health and life.

The selection of parameters and media for the monitoring programme in the Bug basin was made in accordance with the main problems identified for the Bug River basin and the results of the surveys of 1999-2001. The range of parameters is general, and it can be modified at designated sampling points in the detailed monitoring programme (e.g. the entry to Zegrzynskie Lake).

Table III.1. Proposed chemical, physical, biological and hydromorphological parameters for the monitoring system in the Bug basin.
yellow colour – possible reduction in frequency in the case of financial constraints for monitoring, green colour – first priority parameters if the economic situation constrains monitoring..

Proposed quality element	Unit	Frequency	Remarks	Present status of monitoring*					
				Ukraine		Belarus		Poland	
				W	Sew	W	Sew	W	Sew
General parameters									
Water temperature [1]	°C	monthly	Generally the number of variables can be reduced in all three countries, but conductivity added in Belarus	+	+			+	+
Total suspended matter	mg/l	monthly		+	+			+	+
pH		monthly		+	+			+	+/–
Conductivity at 20 °C	µS/cm	monthly		–	–	–		+	+/–
Cl				+	+			+	+/–

Proposed quality element	Unit	Frequency	Remarks	Present status of monitoring*					
				Ukraine		Belarus		Poland	
				W	Sew	W	Sew	W	Sew
Pollution by nutrients									
Ammonia as $N\text{–}NH_4$	mg N/l	monthly	The range of parameters needs to be extended in Belarus and Ukraine	+	+	+		+	+
Kjeldahl Nitrogen	mg N/l	monthly		–	–	–		+	
Nitrates as $N\text{–}NO_3$	mg N/l	monthly		+	+	+		+	+
Nitrites as $N\text{–}NO_2$	mg N/l	monthly		+	+	+		+	+
Total Nitrogen	mg N/l	monthly						+	+
Orthophosphates	mg PO_4/l	monthly		+	+	+		+	
Total phosphor	mg P/l	monthly		+	+	–		+	+
Eutrophication of waters									
Chlorophyll "a"[2]	µg/l	monthly	Not performed in Ukraine	–		+		+	
Bacteriological Pollution									
Total coliforms [3]	MPN/ 100 ml	monthly	Currently not included in Belarus	+		–		+	–
Faecal coliform bacteria		monthly[8]							
Faecal streptococci		monthly[8]							
Salmonella		monthly[8]							
Entero–viruses		monthly (March to September inclusive)							
Organic pollution									
Dissolved oxygen	mg O_2/l	monthly	TOC not included in Belarus and Ukraine	+	+	+		+	–
BOD_5	mg O_2/l	monthly		+	+	+		+	+
COD–Cr	mg O_2/l	monthly		+	+	+		+	+
Total organic carbon (TOC)	mg C/l	monthly		–	–	–		+	–
Pollution by metals and toxic substances[4]									
Manganese	µg Mn/l	monthly	Numbers of metals needs to be increased in Belarus, but for Ukraine there is a reduction of parameters	+	+			+	–
Iron	µg Fe/l	monthly		+	+			+	–
Chromium	µg Cr/l	monthly		+	+			+	+/–
Copper	µg Cu/l	monthly		+	+			+	+/–
Zinc	µg Zn/l	monthly		+	+			+	+/–
Cadmium	µg Cd/l	monthly		+	+			+	+/–
Mercury	µg Hg/l	monthly		+	+			+	+/–
Lead	µg Pb/l	monthly		+	+			+	+/–
Dissolved or emulsified hydrocarbons (after extraction by petroleum ether)	µg /l	4 times per year	Currently not analyzed in Belarus and Ukraine	–	–	–	–	+	–
Chlorinated pesticides and other hazardous substances [5]	µg /l	2 times per year		–	–	–	–	+	–
Sediments[6]									
					Sed		Sed		Sed
Grain size distribution	g/kg or %	yearly	Sediment sampling currently is not included in the monitoring programme in Ukraine and Belarus						
Kjeldahl Nitrogen	g/kg or %	yearly							
Total Organic Carbon	g/kg or %	yearly							+
Total Phosphorus	g/kg or %	yearly							+
Copper	mg/kg	yearly							+
Zinc	mg/kg	yearly							+
Lead	mg/kg	yearly							+
Chromium	mg/kg	yearly							+
Cadmium	mg/kg	yearly							+
Mercury	mg/kg	yearly							+
PAH (Annex X WFD, numbers 15 and 28)	mg/kg	yearly							+

Proposed quality element	Unit	Frequency	Remarks	Present status of monitoring*					
				Ukraine		Belarus		Poland	
				W	Sew	W	Sew	W	Sew
Chlorinated pesticides and other hazardous substances		yearly							+
Hydrobiology									
Benthic invertebrates – abundance and diversity		twice per year	Currently not included in any of the three countries	–		–		–	
Phytoplankton (biomass)		4 times per year	Performed by all three countries	+		+		+	
Macrophytes – abundance and diversity		every 3 years	Currently not included in any of the three countries	–		–		–	
Fish– abundance, diversity, presence of sensitive taxa, life cycle/age structure		every 3 years	Currently not included in any of the three countries	–		–		–	
Hydromorphology									
Quantity and dynamics of water flow		real time, in situ	Should be reorganised in all three countries	+/–		+/–		+/–	
Inter–connection to groundwater bodies [7]		twice per year, winter and summer	New for all three countries.	–				–	
River continuity [7]		every 5 years	New for all three countries.	–				–	
River depth and width variation [7]		yearly	Only carried out in a few places in Poland	–				+/–	
Structure of riparian zone [7]		every 5 years	New for all three countries	–				–	

* *W – water; Sew – sewage; Sed - sediments*

[1] *necessary for determination of the dissolved oxygen saturation factor*

[2] *only during the relevant months*

[3] *Total Coliform Bacteria is selected as the most general parameter for microbiological pollution. and can indicate this type of pollution in the whole basin. For some uses (recreation and drinking water supply), a wider range of microbiological parameters needs to be analyzed.*

[4] *The sampling frequency of 6 months (2 times/year) for metals and PAH is regarded as an absolute minimum requirement.*

[5] *Chlorinated Pesticides (= HCH, DDT, DDE, DDD) and EU-WFD Priority (Hazardous) Substances will be analyzed by GC-MS in an investigative monitoring programme (=Screening), the relevant compartment for measurement – water and/or sediment - will be selected according to the proposals for Environmental Quality Standards (EQS), to be expected by the end of 2002.*

[6] *Once per year within the first 3 years, and then possible reduction to once per 2 years.*

[7] *A common methodology for measurements and assessment should be developed for the basin by the three countries; a frequency of once per year is recommended for "biological" sampling points.*

[8] *The frequency can be reduced to one sample in spring (April), summer (July) and autumn (September).*

Unification of methods should help to improve the comparability of data. During the pilot project it was agreed that the three countries should select international methods for sampling and analysis. However, it is not always possible to have international standards either for economic reasons or simply because they do not exist. In such cases, national methods can be applied. E xisting methods were extended by additional methods prepared within the TACIS CBC Bug River Project [2].

Table III.2. Proposed methods for water quality parameters

1. Basic Methods	
Activity/Parameter	**Standard**
QA/QC test laboratories	ISO 170 25, ISO 2602, ISO 2854
Sampling of water	ISO 5667-1, 2, 3, 6, 14
Sampling of sediments	ISO 5667-12
Hydrology	Guide to hydrological practices. Data acquisition and processing, analysis, forecasting and other applications. World Meteorological Organization. Fifth edition, 1994.

2. Methods for Water Quality Parameters			
	Parameter	**Principle**	**Standard**
1	Temperature	Potentiometry, in-situ	
2	Hydrogen ions	Potentiometry, in-situ	ISO 10523
3	Conductivity	Conductometry, in-situ	ISO 7888
4	Dissolved oxygen	Iodometric method Electrochemical method	ISO 5813/83 ISO 5814/83
5	Chloride	Titrimetric with $AgNO_3$ and chromate indicator Liquid ion chromatography with conductivity detector	ISO 10304-4/97 ISO 9297/89
6	Sulphate	Liquid ion chromatography usually with conductivity detector Gravimetric with $BaCl_2$	ISO 10304-1/92 ISO 9280/90
7	Total dissolved solids	Gravimetry	BSM, V2, N2.2.87.1 КНД 211.1.4.042-95PN-78/C-04541
8	Ammonium Nitrogen	Spectrometric method at 655 nm	ISO 7150-1 КНД 211.1.4.030BSM,V1, N2.2.1.1PN-76/C-04576.01
9	Nitrite Nitrogen	Spectrometric at 540 nm	ISO 6777
10	Nitrate Nitrogen	Spectrometric using sulfosalicylic acid	ISO 7890-3
11	Kjeldahl Nitrogen	Selenium mineralization or other	ISO 5663 or other
12	Phosphate	Photometric using ammonium molybdate	ISO 6878
13	Total Phosphorus	Mineralization with persulfate	ISO 6878
14	Iron	Optical Emission ICP Flame AAS, total content	ISO 11885/96 ISO 8288/86 (AAS)BSM, MH1137-99PN-92/C-04570.01СЭВ-83,Ч.1, T2, c.53
15	Manganese	Optical Emission ICP Flame AAS, total content	ISO 11885/96 ISO 8288 /86 (AAS)BSM, MH1137-99PN-92/C-04570.01СЭВ-83,Ч.1, T2, c.54
16	Copper	Optical Emission ICP Flame AAS, total content	ISO 11885/96 ISO 8288/86 (AAS)BSM,MH1137-99PN-92/C-04570.01СЭВ-83,Ч.1, T2, c.55
17	Zinc	Optical Emission ICP Flame AAS, total content	ISO 11885/96 ISO 8288/86 (AAS)BSM,MH1137-99PN-92/C-04570.01СЭВ-83,Ч.1, T2, c.56
18	Lead	Optical Emission ICP Flame AAS, total content	ISO 11885/96 ISO 8288/86 (AAS)BSM,MH1137-99PN-92/C-04570.01СЭВ-83,Ч.1, T2, c.57
19	Chromium	Optical Emission ICP Flame AAS, total content	ISO 11885/96 ISO 8288/86 (AAS)BSM,MH1137-99PN-92/C-04570.01СЭВ-83,Ч.1, T2, c.58

	Parameter	Principle	Standard
2. Methods for Water Quality Parameters			
20	Cadmium	Optical Emission ICP Flame AAS, total content	ISO 11885/96 ISO 8288/86 (AAS)BSM,MH1137-99PN-92/C-04570.01СЭВ-83,Ч.1, Т2, с.59
21	Mercury	Flameless AAS flow system	ISO 5666/99
22	Biological Oxygen Demand	Determination of dissolved oxygen before and after incubation	ISO 5815/89
23	Chemical Oxygen Demand	Oxidation with potassium dichromate	ISO 6060/89
24	Oil products**	GC with extraction by a solvent, boiling point between 36°C and 69°C	ISO 9377-2
25	Detergents	Spectrometric with methylene blue	ISO 7875
26	Total Chlorinated Pesticides**	Gas chromatography	ISO 6468
27	Screening for priority substances	Gaschromatography, ICP	ISO 6469, ISO 11885/96
3. Methods for Sediments			
	Parameter	**Principle**	**Standard**
1	Grain size distribution		ISO 11277
2	Total carbon		ISO 10694
3	Total organic carbon		ISO 14235/10694
4	Total Phosphorus		ISO 11263
5	Aluminium		
6	Copper		ISO 11047
7	Zinc		ISO 11047
8	Lead		ISO 11047
9	Chromium		ISO 11047
10	Cadmium		ISO 11047
11	Mercury		
12	Total Polycyclic Aromatic Hydrocarbons		ISO 13877
13	Total Chlorinated Pesticides		
14	Screening for priority substances		
15	Extraction		ISO 11466

4. Methods for Microbiology

Belarus and Ukraine use the same former soviet standards, while Poland has implemented European ISO standards. Discussions between Belarussian, Ukrainian and Polish experts agreed that the standard methodologies for all three countries were in principle the same, and therefore results were directly comparable.

Belarus/Ukraine

MI2285-81 (Methodologies for sanitary and microbiological analysis of surface waters);
SanPiN 4630-88 (Protection of surface water from pollution, if the related water is used for cultural purposes – bathing, sports, recreation and within inhabited areas);

Poland

PN-EN 25667-2:1999 (Sample collection – Guidelines for sampling techniques);
PN-ISO 5667-6 (Sample collection – Guidelines for sampling from rivers and streams);
PN-EN ISO 5667-3:2002 (Sample collection); PN-75/C-04615/07 (Analysis techniques);
PN-77/C-4615/05 (Analysis techniques)

5. Hydrobiology

Only methods of sampling for benthic macro-invertebrates have been developed:
ISO 7828: 1985,
ISO 8265: 1988,
ISO 9391: 1993.
Sampling methods for other elements (macrophytes, fish) and standards for ecological assessment are currently under development

III.2. Information and specific parameters collected during surveys

Surveys identify problems in the basin and help to design an effective and economical monitori ng system. Inventories and surveys should provide the necessary information about water use, presence and use of toxic substances (previously unmonitored), effects of toxicity and variability of pollution in time and space. In addition to the surveys of 1999-2001, listed below is the information that should be collected in the next surveys.

The concentration of heavy metals in water and sediments should be further investigated. Especially for cadmium and mercury, suitable methods should be selected in accor dance with the content of these metals in the water phase.

Chlorinated pesticides and WFD priority hazardous substances should be analyzed in an investigative monitoring programme (screening). The relevant compartment for measurement – water and/or sediment – will be selected according to the proposals for Environmental Quality Standards (EQS).

Continuing ecotoxicological investigations are important to develop common standards for assessment and to clarify any discrepancies between chemical investigation r esults and ecotoxicological assessment.

Knowledge of the relationship between groundwater and surface water in the river basin is needed, and a proper survey of this relationship will support the hydrological monitoring programme by identifying adequate sa mpling or measurement locations.

Assessment of the influence on the environment of harmful solid waste disposal sites and sludge storage sites should be undertaken by surveys.

Additional information on the use and storage of toxic substances in the basin a nd their impact on water quality can be collected by surveys and inventories.

Developing common approaches for ecological assessment for water quality and identification of reference conditions for very good ecological status in the basin are recommended t o be part of the survey programme.

III.3. Information from statistical data

Most of the general indicators listed in Tables II.4 and II.6 can be derived from statistical data. In all three riparian countries, statistical information is collated according t o administrative units. Additional effort is needed to adjust (recalculate) such information as basin (the Bug and tributaries) indicators.

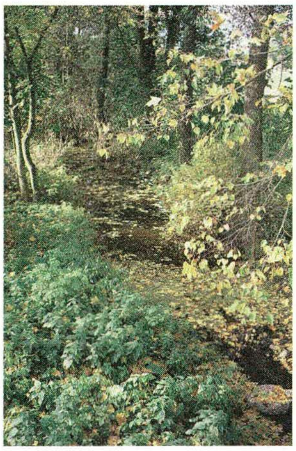
III.4. Identification of monitoring locations

The recommended sampling points were identified on the basis of the s urvey conducted in the years 2000 – 2001 and during the joint field visit to the Bug catchment. This field visit included inspection of the selected stations on the Bug River and its tributaries. The criteria used for selection of monitoring points are listed below:

- adequate to assess the pollution distribution in the Bug River itself and the basin,
- representative of the various water uses,
- adequate for assessment of the pollution loads discharged by the main Bug tributaries,
- adequate for assessment of the pollution load discharged to Zegrzynskie Lake,
- adequate for the calculation of the pollution load from particular countries,
- adequate for assessment of the influence of the main sources of pollution,
- accessibility of the sampling points,
- possibility to perform common sampling,
- hydrological unification (stable river flow),
- representative for the dominant potential anthropogenic impacts along the joint stretches of the river.

Taking these criteria into account, within the system of monitoring in the Bug basi n it is recommended to consider seven First Order sampling locations on the Bug River. These should not be restricted to the boundary section of the Bug River, but also located downstream of the basin. These seven sampling points will create the basic monitoring network for the assessment of water quality and pollution load in the Bug River. The monitoring parameters and frequencies should follow those given in Table III.1.

Second order sampling points should be located at the mouths of significant tributaries, taking into account the size of the sub-basin and the amount of discharged pollution, and Third Order sampling points can be used to assess the pollution load and quality of water carried by the small transboundary tributaries which are generally not very polluted, or to find undisturbed ecological conditions. The monitoring requirements for Second and Third Order points can be significantly reduced in terms of parameters, frequency and sampling media. The names and locations are given in Table III.3, and shown on Map 1 and Chart 1.



Mysla River

Both keeping existing points and including new monitoring stations are envisaged within the recommended monitoring network. Thus:

1. The existing sampling profiles at **Krylow and Lytovetz** should be kept for the reasons listed below:
    - the Bug River flows through the area of the basin in Ukraine and discharges into Polish territory at Krylow, and these profiles are thus the closest points to the Polish and Ukrainian border;
    - long-term studies have been conducted since 1979 at Krylow and Lytovetz;
    - there are water-gauges at both sampling points, although the gauge at Krylow is not in operation at present and should be re-activated;
    - Lytovetz is the last sampling point on the Ukrainian part of the Bug, up to the area of Novovolynsk. Krylow is below this area;
    - the convenient location of the points with good access.
2. It is recommended to continue sampling at **Dorohusk/Yahodin** for the following reasons:
    - determination of water quality of the Bug before it leaves joint Ukrainian-Polish territory is possible;
    - historical data exist since 1978;
    - a water-gauge exists in the vicinity of the point and is close enough to the sampling profile to properly reflect its hydrological conditions;
    - the profile is located below the Bug tributaries: Studianka, Luha, Welnianka, Neretwa, Gapa and Udal, so that observation of pollution discharging through these tributaries to the Bug is possible;
    - the convenient location of the point on the border bridge on the road connecting Poland and Ukraine.

Several new profiles are recommended to be included in the monitoring network, for example:

3. **Wlodawa/Hrabove/Tomashovka**. In reality these are three sampling points located close to each other. The reason for this recommendation is:

- sampling at Wlodawa (PL) and Tomashovka (BY) will allow determination of Bug water quality where it enters joint Belarus – Polish territory, and will serve as a reference for the monitoring data of downstream stations;
- sampling at Hrabowe will provide an indication of the quality of Bug water leaving Polish – Ukrainian territory;
- there is easy access – location of the profile is available for both the Belarus and Polish sides at the old railway track;
- common sampling for the three countries from a boat is suggested. Samp ling from the Ukrainian side can be performed above this profile (Hrabowe – 15 km of the Ukrainian course of the Bug, where the Ukrainian – Belarusian border begins), taking into account the water movement in time.

From the Polish side, the sampling point was located at Orchowek, above the waste disposal site at the Leather Works "Polesie" (tannery, pollution by chromium compounds). Moreover, access to the point was not convenient. The new location at Wlodawa is below the "Polesie" tannery but above the Wlodawka tributary.

4. **Horodlo**. This site is recommended to determine the impact of the polluted tributaries Studianka and Luha. The sampling will be performed only by a Polish laboratory.

5. **Terespol**. The present location of the sampling point too close to the Mukhavets outlet is not representative because the water of the Mukhavets is not fully mixed with Bug water. This was shown by the survey results and, for this reason, a new profile location is suggested, which:

- will be moved from a weir below the Mukhavets outlet, to the stretch at the boundary crossing above the Mukhavets;
- will permit observation of the influence of the wastewater treatment plant of Brest on the Bug water;
- will have samples taken from three places in the profile: at the left bank (Po lish side), from the river current and at the right bank (Belarus);
- has a water-gauge located at the profile, where observations should be conducted.

6. **Stary Bubel/Novosyolky**. This new point is recommended for inclusion in the monitoring network because it is the last border point between Poland and Belarus and has not been monitored so far. Using this point, it will be possible to determine the overall changes in water quality of the Bug River along the joint Belarusian – Polish stretch. Moreover:

- the profile takes account of the influence of the tributaries Lesna, Pulva, and Czyzowka on the Bug water;
- the location is convenient for sampling from both river banks;
- the closest water-gauge is located in Novosyolky (Belarus), at which the hydrology can be measure by Belarus.

7. The sampling profile at **Wyszkow** closes the whole of the Bug catchment and can be used to determine water quality and discharge of pollution by the Bug River to the Zegrzynskie Lake, where the water intake for Warsaw is located. Long ter m hydrological and water quality observation are available for this sampling location. This sampling point is located above the pollution discharge from the municipal wastewater treatment plant of Wyszkow. It is therefore recommended to apply continuous measurements of the pollution load from this plant and investigations of water quality should be conducted by periodical survey at Popowo (11.7 km), where a sampling point can be located at the Bug outlet to Lake Zegrzynskie.

Table III.3. Locations of transboundary monitoring sampling points in the Bug river basin.
Yellow colour – water gauges should be installed or hydrological observation should start.

	River			Country, name of monitoring section			Remarks
	Name of river/ lenght [km]	Water-gauge [km]	Sampling point [km]	Ukraine	Poland	Belarus	
First order sampling points							
1	Bug 775 (acc. to PL)	536 (PL/ ? UA	602 (UA) 578.1 (PL)	Lytovezh	Krylow	–	Krylow is below mining area in Novovolynsk, Lythovetz is above this area. Sampled separately by Polish and Ukrainian laboratories. Hydrological observations from the Polish side should start.
2	Bug	–	514.7 (PL)		Horodlo		Below Luha, Studianka (very polluted) and Huczwa, hydrological measurements should be installed. Sampling on the Polish side only.
3	Bug	457 (PL)	448 (UA) 456.2 (PL)	Jahodin	Dorohusk	–	Existing sampling by Polish and Ukrainian laboratories separately, but common sampling will be organized. Bridge at the border checkpoint.
4	Bug	378 (PL)	417 (UA) 378.9 (PL) 390 (BY)	Hrabove	Wlodawa	Tomashovka	Border location between all three countries, existing sampling separately by the three countries, but common sampling will be organized.
5	Bug	283 (PL)	291	–	Terespol	Terespol	Up to Mukhavets, below Brzesc WWTP, below Terespol. Sampling from the left side, in the middle and at the right side, common sampling can be organized. Bridge at the border checkpoint.
6	Bug	225 (BY)	~220		Stary Bubel	Novosyolky	The Polish-Belarusian border, last part of the common stretch of the Bug. Sampling by Polish and Belarusian laboratories, common sampling can be organized.
7	Bug	33.8 (PL)	33.8	–	Wyszkow	–	Closure point for the Bug basin, inflow to Zegrzynskie Lake where the water intake plant for Warsaw is located. Moreover, long term hydrological and water quality observation s are available for this sampling location .
Second order sampling points							
1	Poltva/60	2	2	Busk			Extremely polluted, area of the basin 1440 km^2
2	Solokija/ 90.3	–	48 (UA) 52.4 (PL)	Uhniv	Wierzbica		Basin size 933 km^2. In Tomaszow Lubelski a solid waste disposal side is located which should be observed. Polish-Ukrainian border. High heavy metals concentrations and high toxicity confirmed during the surveys. Hydrological observations needed.
3	Solokija/ 90.3	0.5	3.1	Chervonohrad			Size of the basin – 933 km^2. Polluted river.
4	Rata/76	0.5	0.5	Mezhyrichchia			Size of the basin - 1770 km^2
5	Huczwa/ 75.8	16.9	1.0		Grodek		Size of basin –1394 km^2. High toxicity observed during the survey. Toxic wastewater discharged from WWTP in Hrubieszow. The water gauge should be moved.
6	Luha/84	0.5	0.5	Ustiluh			Size of basin – 1340 km^2, very polluted river.
7	Uherka /45	9.1	3.1		Rudka		Size of basin – 577 km^2. High toxicity at outlet. Water gauge should be moved.
8	Wlodawka / 31.5	4.6	3.6		Wlodawa		Size of basin – 724.7 km^2. Pollution by PAH observed during the survey. Water gauge should be moved.
9	Mukhavets/ 124	16.9	1.3			Brest	Size of basin – 6594 km^2. The biggest tributary of the Bug, catchment area is fully on the Belarusian side.

	River			Country, name of monitoring section			Remarks
	Name of river/ lenght [km]	Water-gauge [km]	Sampling point [km]	Ukraine	Poland	Belarus	
10	Krzna/113	7.7	1.8		Neple		Size of basin – 3353 km^2. Toxicity observed at outlet. The second largest sub-basin area of the tributaries.
11	Lesna/68.4	18	18			Tikhinichy	Size of basin – 2650.7 km^2. Moderately polluted river.
12	Bug/775 (acc. to PL)	163	163.2	–	Frankopol		Long term hydrological observation below the Toczna River, quite polluted, Kamianka, Sarenka and Mysla. Total area of the sub-basins is about 730 km^2.
13	Nurzec/104	42.8	1.5		Tworkowice		Size of basin – 2102 km^2. One of two water gauges should be moved to the outlet.
14	Cetynia/38.5	14.7	2.1		Bialobrzegi		The Bug river sediments below the Cetynia inflow showed increased concentration of metals. Sokolow Podlaski WWTP has toxic discharges. The water gauge should be moved.
15	Brok/86.5	6.2	0.8		Zamoscie		Size of basin – 810 km^2. Polluted river.
16	Liwiec/140.5	77	0.3		Kamienczyk		Size of basin – 2779 km^2. Water gauge should be moved to the outlet. Polluted river.
				Third order sampling points			
1	Pulva/52.8	28	244.8	~ 43 (PL ~ 28 (BY)	Wyczolki	Wysokie	Border between Poland and Belarus. Basin area – 536.2 km^2.
2	Kopayivka/ 30	–	330	Pischa		Cherek	Basin area – 486 km^2. River is not polluted, border with Ukraine, sampling point can be used for harmonization of monitoring activities between Belarus and Ukraine.
3	Bug/785 (acc. to UA)	785		Sasiv			Possible reference sampling point for the upper course of the Bug River, slight anthropogenic influence.
4	Lesnaya/106			Topilo			The area of Belovezhskaya Puscha. Possible reference point for the middle course of the Bug River.
5	Mysla/15			Szkopy			Possible reference point for the lower part of the Bug River course.

Table III.4. Recommended media and parameters for particular sampling points

	River		Water					Sediments
	Name of river	Sampling point	C	H	HB	ET	M	
			First order sampling points					
1	Bug	Lytovezh/Krylov	x	x		x	x	
2	Bug	Horodlo	x	x		x		
3	Bug	Jahodin/Dorohusk	x	x	x		x	x
4	Bug	Hrabove/Wlodawa/ Tomashovka	x	x		x (only Poland)	x	
5	Bug	Terespol/Terespol	x	x		x (only Poland)	x	x
6	Bug	Stary Bubel/Novosyolky	x	x	x		x	
7	Bug	Wyszkow*	x	x	x	x	x	x
			Second order sampling points					
1	Poltva	Busk	x	x	x	x		x
2	Solokija	Uhniv (48 km) Wierzbica (52.4 km)	x	x		x		x
3	Solokija	Chevonohrad	x	x				
4	Rata	Mezhyrichchia	x	x	x			
5	Huczwa	Grodek	x	x	x	x		x
6	Luha	Ustiluh	x	x	x			x
7	Uherka	Rudka	x	x		x		x
8	Wlodawka	Wlodawa	x	x		x		x
9	Mukhavets	Brest	x	x	x	x	x	x

	River		Water					Sediments
	Name of river	Sampling point	C	H	HB	ET	M	
10	Krzna	Neple	x	x	x	x	x	x
11	Lesna	Tikhinichy	x	x	x		x	
12	Bug	Frankopol	x	x				
13	Nurzec	Tworkowice	x	x	x			
14	Cetynia	Bialobrzegi	x	x		x		x
15	Brok	Zamoscie	x	x				
16	Liwiec	Kamienczyk	x	x	x			x
Third order sampling points								
1	Pulva	Wyczolki (43 km) Wysokie (28 km)	x	x				
2	Kopayivka	Pischa/ Chersk	x	x				
3	Bug	Sasiv	x	x	x			
4	Lesnaya		x	x	x			
5	Mysla		x	x	x			

** Ecotoxicology for WWTP in Wyszkow*

C-chemistry, H-hydrobiology, ET-ecotoxycology, M-morphology

Second order sampling points for hydrobiological investigations

These points were selected according to two conditions: size of the river catchment (>1 000 km^2) and their location in the lower course of the river. It is assumed that in such conditions hydrobionts, and especially phytoplankton, are dominant in the river and in reflecting the quality of the river.

Third order sampling points for hydrobiological investigations

These stations can be used as possible reference points for the upper, middle and lower course of the Bug respectively. For these stations, investigations only of macroinvertebrates are recommended.

III.5 Hydrological network

The water gauging network should provide data for assessing river flows and collecting information on changes in the river beds. The measuring stations are usually installed for practical reasons such as predicting flood hazards, and also to establish the hydrological conditions of the respective countries. However, the present number of water level gauging stations is not sufficient to characterize the hydrological conditions in the whole of the Bug basin, and particularly in the sub-basins of its tributaries. Having in mind the requirements of managing water resources in sub-basins, there appears to be a great need for reorganising and expanding the existing water gauging network.

The number of gauging stations is also insufficient for correct water quality assessment in the boundary part of the Bug basin. The existing network does not guarantee proper field control for the assessment of:

- pollution loads inflowing in the Bug river waters at the Krylow section;
- pollution loads in the Bug river before the Mukhavets tributary;
- pollution loads carried by the rivers Nurzec and Liwiec as the water level gauging stations are located too far from the outlets;
- pollution loads leaving Polish territory with the waters of Solokiia and Lesna.

Taking into account the need for calculation of pollution loads, completion of the water-gauging network is necessary to change the present situation. In many cases moving the observations to adequate sampling points or restarting observations will be enough.

Map 1. Location of the proposed monitoring points in the Bug River basin

	River			Country, name of monitoring section			Remarks
	Name of river/ lenght [km]	Water-gauge [km]	Sampling point [km]	Ukraine	Poland	Belarus	
10	Krzna/113	7.7	1.8		Neple		Size of basin – 3353 km^2. Toxicity observed at outlet. The second largest sub-basin area of the tributaries.
11	Lesna/68.4	18	18			Tikhinichy	Size of basin – 2650.7 km^2. Moderately polluted river.
12	Bug/775 (acc. to PL)	163	163.2	–	Frankopol		Long term hydrological observation below the Toczna River, quite polluted, Kamianka, Sarenka and Mysla. Total area of the sub-basins is about 730 km^2.
13	Nurzec/104	42.8	1.5		Tworkowice		Size of basin – 2102 km^2. One of two water gauges should be moved to the outlet.
14	Cetynia/38.5	14.7	2.1		Bialobrzegi		The Bug river sediments below the Cetynia inflow showed increased concentration of metals. Sokolow Podlaski WWTP has toxic discharges. The water gauge should be moved.
15	Brok/86.5	6.2	0.8		Zamoscie		Size of basin – 810 km^2. Polluted river.
16	Liwiec/140.5	77	0.3		Kamienczyk		Size of basin – 2779 km^2. Water gauge should be moved to the outlet. Polluted river.
Third order sampling points							
1	Pulva/52.8	28	244.8	~ 43 (PL ~ 28 (BY)	Wyczolki	Wysokie	Border between Poland and Belarus. Basin area – 536.2 km^2.
2	Kopayivka/ 30	–	330	Pischa		Cherek	Basin area – 486 km^2. River is not polluted, border with Ukraine, sampling point can be used for harmonization of monitoring activities between Belarus and Ukraine.
3	Bug/785 (acc. to UA)	785		Sasiv			Possible reference sampling point for the upper course of the Bug River, slight anthropogenic influence.
4	Lesnaya/106			Topilo			The area of Belovezhskaya Puscha. Possible reference point for the middle course of the Bug River.
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Table III.4. Recommended media and parameters for particular sampling points

	River		Water					Sediments
	Name of river	Sampling point	C	H	HB	ET	M	
First order sampling points								
1	Bug	Lytovezh/Krylov	x	x		x	x	
2	Bug	Horodlo	x	x		x		
3	Bug	Jahodin/Dorohusk	x	x	x		x	x
4	Bug	Hrabove/Wlodawa/ Tomashovka	x	x		x (only Poland)	x	
5	Bug	Terespol/Terespol	x	x		x (only Poland)	x	x
6	Bug	Stary Bubel/Novosyolky	x	x	x		x	
7	Bug	Wyszkow*	x	x	x	x	x	x
Second order sampling points								
1	Poltva	Busk	x	x	x	x		x
2	Solokija	Uhniv (48 km) Wierzbica (52.4 km)	x	x		x		x
3	Solokija	Chevonohrad	x	x				
4	Rata	Mezhyrichchia	x	x	x			
5	Huczwa	Grodek	x	x	x	x		x
6	Luha	Ustiluh	x	x	x			x
7	Uherka	Rudka	x	x		x		x
8	Wlodawka	Wlodawa	x	x		x		x
9	Mukhavets	Brest	x	x	x	x	x	x

Table III.3. Locations of transboundary monitoring sampling points in the Bug river basin.
Yellow colour – water gauges should be installed or hydrological observation should start.

	River			Country, name of monitoring section			Remarks
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3	Bug	457 (PL)	448 (UA) 456.2 (PL)	Jahodin	Dorohusk	–	Existing sampling by Polish and Ukrainian laboratories separately, but common sampling will be organized. Bridge at the border checkpoint.
4	Bug	378 (PL)	417 (UA) 378.9 (PL) 390 (BY)	Hrabove	Wlodawa	Tomashovka	Border location between all three countries, existing sampling separately by the three countries, but common sampling will be organized.
5	Bug	283 (PL)	291	–	Terespol	Terespol	Up to Mukhavets, below Brzesc WWTP, below Terespol. Sampling from the left side, in the middle and at the right side, common sampling can be organized. Bridge at the border checkpoint.
6	Bug	225 (BY)	~220		Stary Bubel	Novosyolky	The Polish-Belarusian border, last part of the common stretch of the Bug. Sampling by Polish and Belarusian laboratories, common sampling can be organized.
7	Bug	33.8 (PL)	33.8	–	Wyszkow	–	Closure point for the Bug basin, inflow to Zegrzynskie Lake where the water intake plant for Warsaw is located. Moreover, long term hydrological and water quality observation s are available for this sampling location .
				Second order sampling points			
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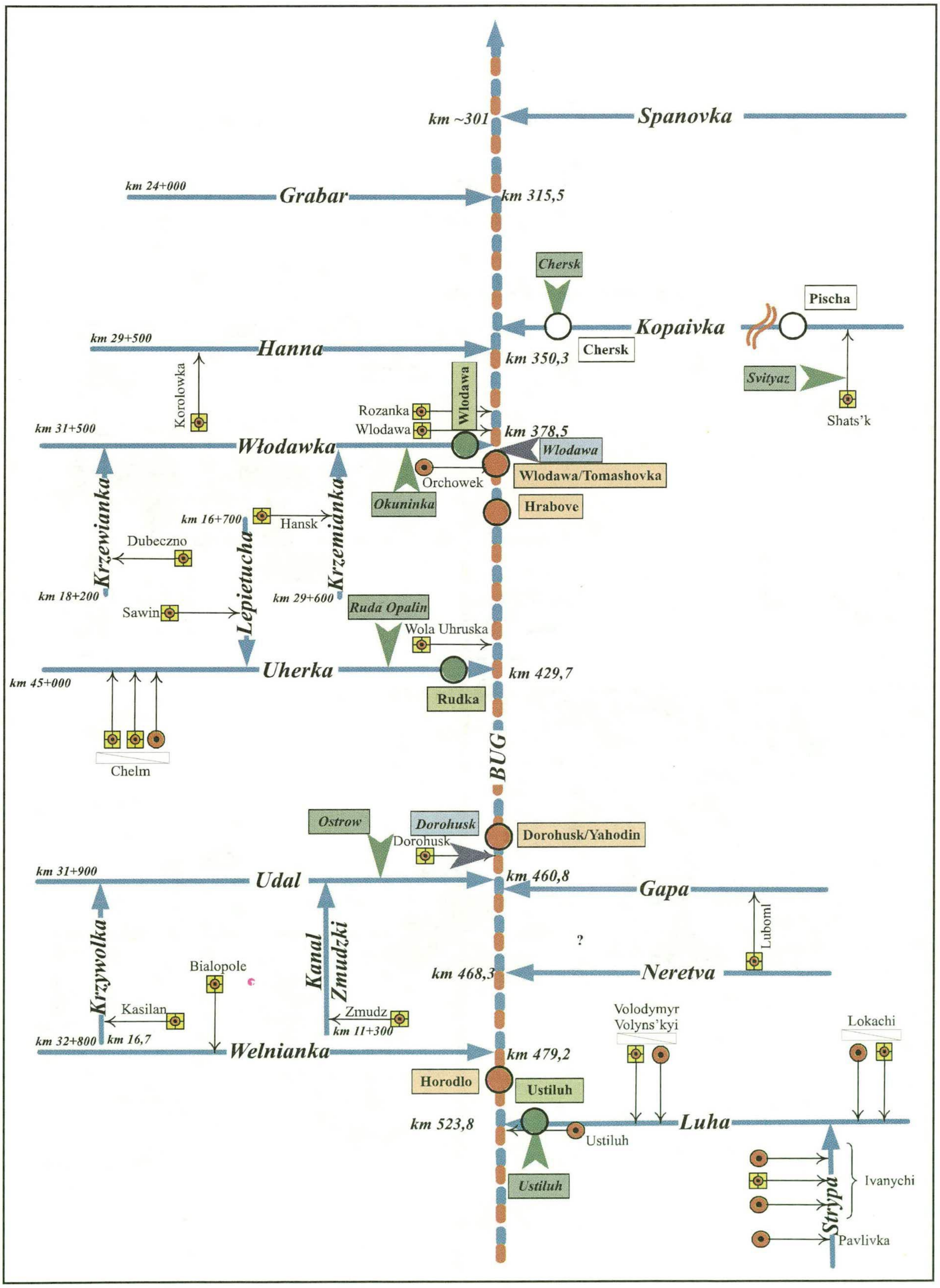
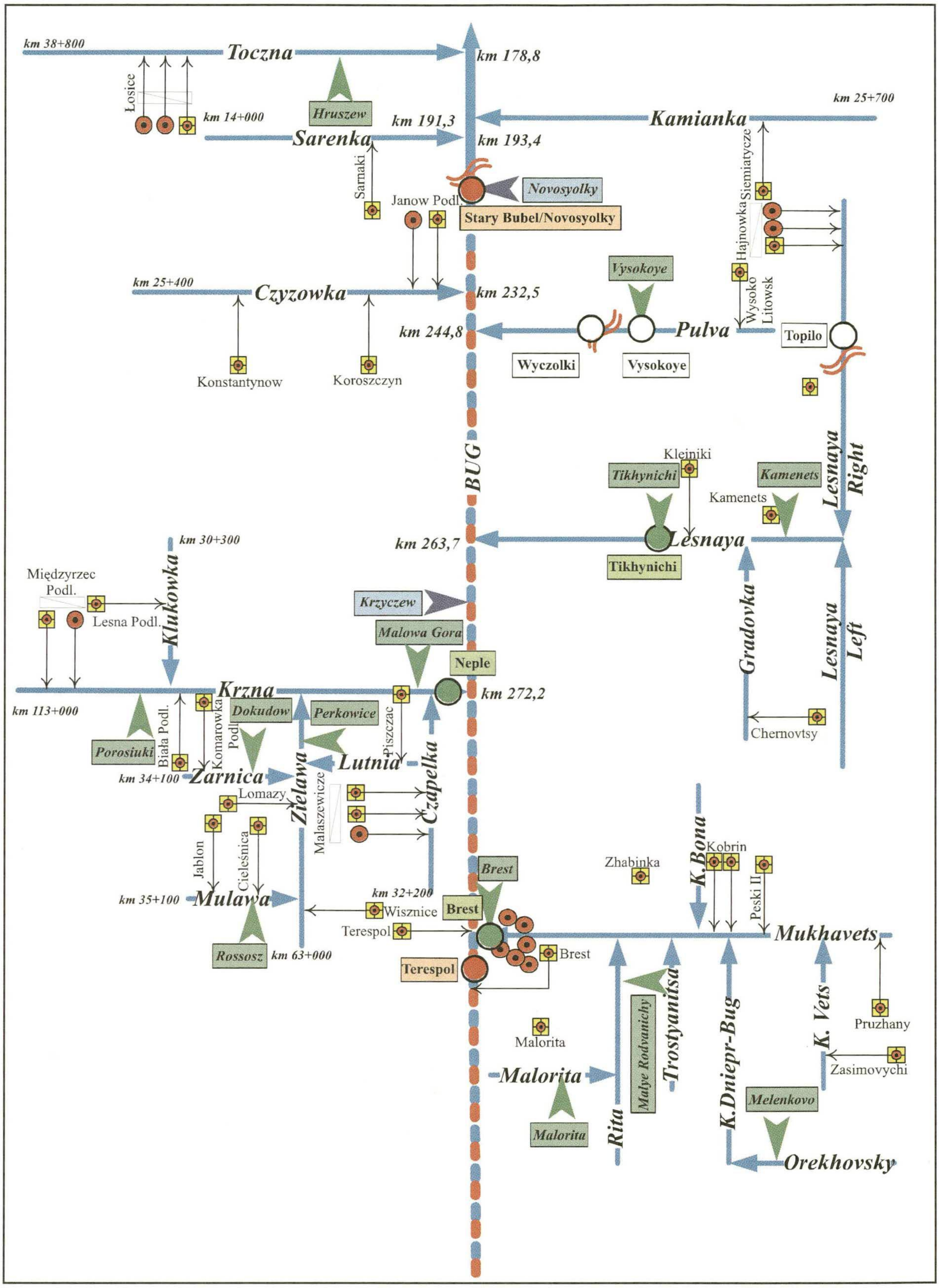
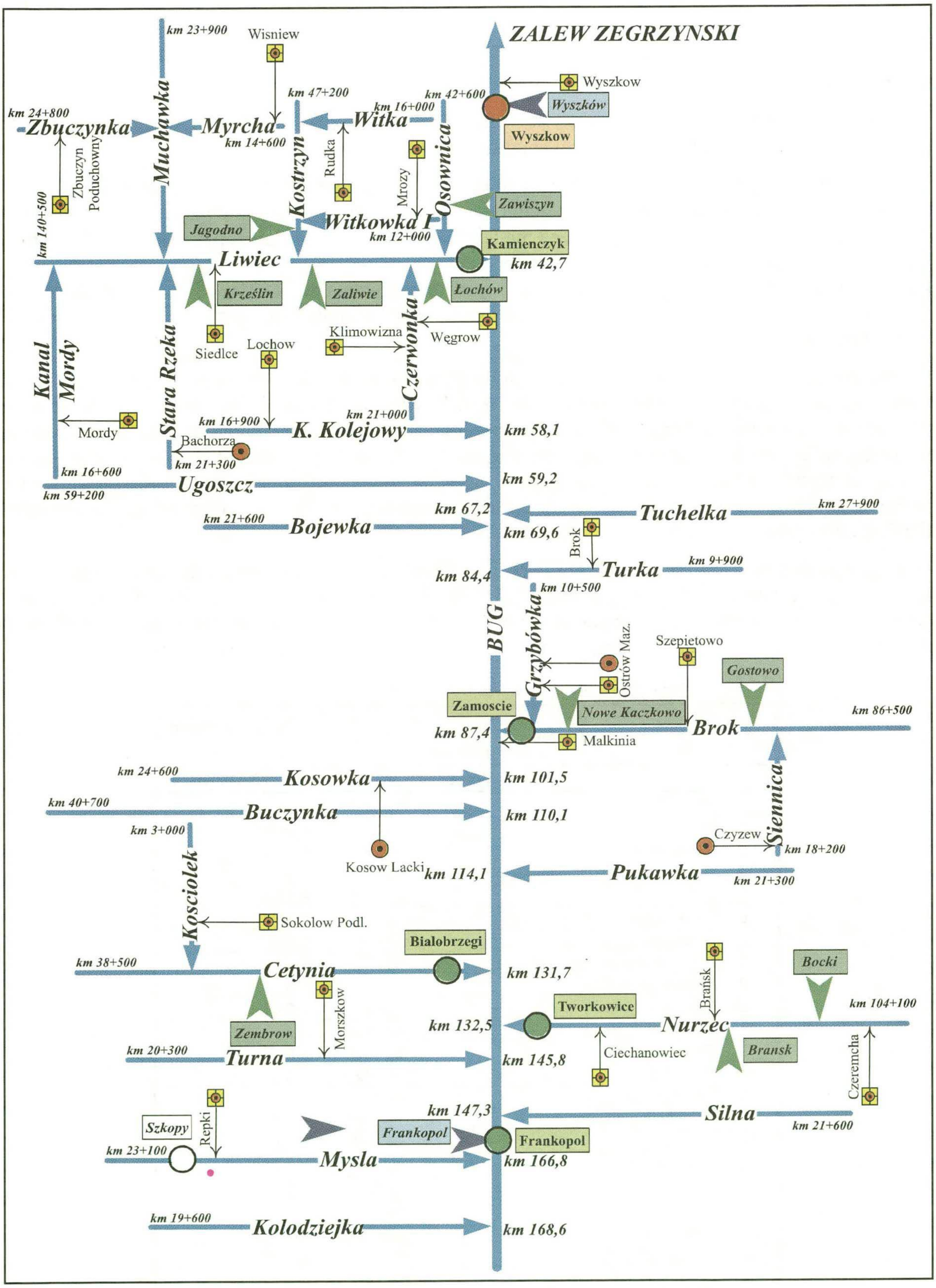
2	Solokija/ 90.3	–	48 (UA) 52.4 (PL)	Uhniv	Wierzbica		Basin size 933 km^2. In Tomaszow Lubelski a solid waste disposal side is located which should be observed. Polish-Ukrainian border. High heavy metals concentrations and high toxicity confirmed during the surveys. Hydrological observations needed.
3	Solokija/ 90.3	0.5	3.1	Chervonohrad			Size of the basin – 933 km^2. Polluted river.
4	Rata/76	0.5	0.5	Mezhyrichchia			Size of the basin - 1770 km^2
5	Huczwa/ 75.8	16.9	1.0		Grodek		Size of basin – 1394 km^2. High toxicity observed during the survey. Toxic wastewater discharged from WWTP in Hrubieszow. The water gauge should be moved.
6	Luha/84	0.5	0.5	Ustiluh			Size of basin – 1340 km^2, very polluted river.
7	Uherka /45	9.1	3.1		Rudka		Size of basin – 577 km^2. High toxicity at outlet. Water gauge should be moved.
8	Wlodawka / 31.5	4.6	3.6		Wlodawa		Size of basin – 724.7 km^2. Pollution by PAH observed during the survey. Water gauge should be moved.
9	Mukhavets/ 124	16.9	1.3			Brest	Size of basin – 6594 km^2. The biggest tributary of the Bug, catchment area is fully on the Belarusian side.



Spanovka
km ~301
km 24+000
Grabar
km 315,5
Chersk
Pischa
Kopaivka
Chersk
km 29+500
Hanna
km 350,3
Svityaz
Shats'k
Korolowka
Wlodawa
Rozanka
Wlodawa
km 31+500
Włodawka
km 378,5
Wlodawa
Wlodawa/Tomashovka
Orchowek
Okuninka
Hrabove
Krzewianka
km 16+700
Hansk
Krzemianka
Dubeczno
Lepietucha
km 18+200
km 29+600
Ruda Opalin
Sawin
Wola Uhruska
Uherka
km 429,7
km 45+000
Rudka
Chelm
BUG
Ostrow
Dorohusk
Dorohusk/Yahodin
Dorohusk
km 31+900
Udal
km 460,8
Gapa
Krzywolka
Kanal Zmudzki
Luboml
?
Bialopole
km 468,3
Neretva
Kasilan
Zmudz
km 11+300
Volodymyr Volyns'kyi
Lokachi
km 32+800
km 16,7
Welnianka
km 479,2
Horodlo
Ustiluh
km 523,8
Luha
Ustiluh
Ustiluh
Ivanychi
Strypa
Pavlivka


km 38+800
Toczna
km 178,8
Losice
km 14+000
Hruszew
km 191,3
Sarenka
km 193,4
Kamianka
km 25+700
Siemiatycze
Sarnaki
Novosyolky
Janow Podl.
Stary Bubel/Novosyolky
Hajnowka
Wysoko Litowsk
Vysokoye
km 25+400
Czyzowka
km 232,5
km 244,8
Pulva
Topilo
Wyczolki
Vysokoye
Konstantynow
Koroszczyn
BUG
Kleiniki
Tikhynichi
Kamenets
Kamenets
Lesnaya Right
km 30+300
km 263,7
Lesnaya
Tikhynichi
Międzyrzec Podl.
Klukowka
Lesna Podl.
Krzyczew
Malowa Gora
Gradovka
Lesnaya Left
Neple
Krzna
km 272,2
km 113+000
Dokudow
Perkowice
Biała Podl.
Komarowka Podl.
Piszczac
Porosiuki
Lutnia
Chernovtsy
km 34+100
Zarnica
Zielawa
Lomazy
Malaszewicze
Czapelka
Jablon
Cieleśnica
K.Bona
Kobrin
Zhabinka
Brest
Peski II
km 35+100
Mulawa
km 32+200
Wisznice
Brest
Terespol
Mukhavets
Rossosz
km 63+000
Brest
Terespol
Malorita
Trostyanitsa
Malye Rodvanichy
K.Dnieper-Bug
K. Vets
Pruzhany
Zasimovychi
Malorita
Malorita
Rita
Melenkovo
Orekhovsky


ZALEW ZEGRZYNSKI
BUG
Wyszkow
Wyszków
km 42+600
km 23+900
Wisniew
km 47+200
km 16+000
km 24+800
Zbuczynka
Muchawka
Myrcha
km 14+600
Witka
Osownica
Zbuczyn Poduchowny
Rudka
Mrozy
Kostrzyn
km 140+500
Zawiszyn
Jagodno
Witkowka I
km 12+000
Kamienczyk
Liwiec
km 42,7
Krześlin
Zaliwie
Łochów
Czerwonka
Węgrow
Klimowizna
Siedlce
Lochow
Kanal Mordy
Stara Rzeka
Mordy
km 16+900
km 21+000
K. Kolejowy
km 58,1
Bachorza
km 21+300
km 16+600
Ugoszcz
km 59,2
km 59+200
km 67,2
Tuchelka
km 27+900
km 21+600
Bojewka
km 69,6
Brok
Turka
km 9+900
km 84,4
km 10+500
Grzybówka
Szepietowo
Ostrów Maz.
Gostowo
Zamoscie
Nowe Kaczkowo
Brok
km 86+500
km 87,4
Malkinia
km 24+600
Kosowka
km 101,5
km 40+700
Buczynka
km 110,1
km 3+000
Siennica
Czyzew
km 18+200
Kosow Lacki
km 114,1
Pukawka
km 21+300
Kosciolek
Sokolow Podl.
Bialobrzegi
km 38+500
Cetynia
km 131,7
Bocki
Branśk
Morszkow
Tworkowice
km 104+100
Zembrow
km 132,5
Nurzec
Bransk
km 20+300
Turna
km 145,8
Ciechanowiec
Czeremcha
km 147,3
Silna
Szkopy
Repki
km 21+600
Frankopol
Frankopol
km 23+100
Mysla
km 166,8
km 19+600
Kolodziejka
km 168,6

III.6. Water quality assessment

Chemical status

The objective for the Bug river basin is to achieve good ecological status of water. This will be possible only when the following general conditions are fulfilled:

- temperature, oxygen balance, pH, capability of buffering acids and salinity do not exceed the limits set for proper functioning of a certain ecosystem type and for good status of biological quality elements;
- concentrations of nutrients do not exceed the levels set for good ecosystem functioning and reaching sufficient values of biological quality elements;
- concentrations of specific synthetic and non-synthetic pollutants do not exceed the standards defined in accordance with acute and chronic toxicity assessments, without infringement of the provisions of EC Directives 91/414 and 98/8.

For the assessment of chemical water quality, a set of target/limit values were developed by the project team and published in the Bug Report No. 2 [3]. The target values are based on the strictest concentrations for the "bathing", "drinking water production" and "fish" directives. Recommendations for target values for selected parameters are presented in Table III.5. It should be noted that the tar get values for metals differed significantly in some cases compared with those used in other basins. One of the most important recommendations for future cooperation is to develop target values for metals in the Bug basin water.

One recommendation from the TACIS project in Belarus was to analyze metals as "total". Taking into account the weakness of the comparability of data (from the survey) and a lack of "state of art" equipment in laboratories, this recommendation is reasonable. Both dissolved and total concentrations should be analyzed at selected sampling points to deliver information in line with the needs.

Table III.5. Target values for chemical assessment

No.	Parameter	Unit	Recommended values*
	Water		
1	Water temperature	°C	≤ 22
2	PH	pH	6.0- 8.5
3	Conductivity	μS/cm	tbd
4	BOD_5	mg O_2/l	≤ 3
5	COD_{Cr}	mg O_2/l	≤ 25
6	Total organic carbon - TOC	mg C/l	≤ 10
7	Ammonia as N-NH_4	mg N/l	≤ 0.8
8	Nitrogen by Kjeldahl method	mg N/l	1.0
9	Nitrate as N-NO_3	mg N/l	≤ 5
10	Nitrite as N-NO_2	mg N/l	≤ 0.01
11	Dissolved oxygen	mg O_2/l	≥ 6
13	Phosphate	mg P_2O_5/l	≤ 0.4
14	Phosphate	mg PO_4/l	≤ 0.2
15	Total phosphorus	mg P/l	≤ 0.1
16	Dissolved manganese	mg Mn/l	≤0.05
17	Dissolved iron	mg Fe/l	≤1.0
18	Chromium**	mg Cr/l	≤ 0.05
19	Copper**	mg Cu/l	≤ 0.05
20	Zinc**	mg Zn/l	≤ 0.2
21	Cadmium**	mg Cd/l	≤ 0.005
22	Mercury**	mg Hg/l	≤ 0.001
23	Lead**	mg Pb/l	≤ 0.05
24	Total suspended matter	mg/l	≤ 25
25	Chlorinated pesticides	mg/l	0.001
26	Other hazardous substances	tbd.	
27	Dissolved or emulsified hydrocarbons (after extraction by petroleum ether)	mg/l	≤ 0.05

No.	Parameter	Unit	Recommended values*
Sediments			
1	Grain size distribution	tbd.	
2	Total carbon	tbd.	
3	Total organic carbon	tbd.	
4	Total phosphorus	tbd.	
5	Aluminium	tbd.	
6	Copper**	mg/kg	50
7	Zinc**	mg/kg	200
8	Lead**	mg/kg	30
9	Chromium**	mg/kg	50
10	Cadmium**	mg/kg	1
11	Mercury**	µg/kg	500
12	Total polycyclic aromatic hydrocarbons	tbd.	
13	Total chlorinated pesticides	tbd.	
14	Screening for priority substances	tbd.	
Microbiology			
1	Coliform bacteria at 37°C	/100ml	500
2	Faecal coliform bacteria (E. coli)	/100ml	100
3	Faecal streptococci (Enterococcus)	/100ml	100
4	Salmonella	/1l	0
5	Enteroviruses	/10l	0

* *Accuracy level for analytical results should be half of the target value. Implementation of obligatory accuracy levels will necessitate changes of methods used in some laboratories, which may involve changes of instrumentation or decisions on re-organization of works in particular laboratories towards specialization in conducting costly sampling or sampling substances requiring special equipment.*

Uniform accuracy levels should be the basis for defining the interpretation of value "below accuracy" – as half of the value of the accuracy level, which is a common rule in water quality assessment and calculation of pollution balances.

** *Developed in the CBC TACIS Bug Project*

Assessment of chemical status can be made by calculation of the ratio between the target concentration and the values corresponding with the 90 percentile for parameters measured 12 times a year. For lower frequency of the examinations the result will be the highest measured value.

Assessment of biological parameters [4,5]

The proposed biological parameters are listed in Table III.1.

Hydrobiology

Ecosystems containing waters of good quality are those with balanced and abundant species. Water organisms can therefore be used for water quality assessment, and complexes or associations of benthic macro-invertebrates are particularly useful for biological assessment of flowing water. The advantage of using the macrozoobenthos is that it consists mostly of long life-cycle organisms, which reflect well any long-term changes in the environment.

The complexes of organisms inhabiting a given stretch of the river adapt to the level of pollution that is characteristic for this stretch and to its long-term fluctuations, reacting with changes in species composition, disappearance of some species or changes in the frequency their occurrence. For hydrobiological assessment of waters based on macrozoobenthos, it is recommended to use two index types: the biotic index and saprobity index.

Biotic indices measure trophic level, which indicates the intensity of primary production in the water. The biotic index BMWP/ASPT is recommended for this assessment. The index was developed by a group of British researchers, and the name derives from Biological Monitoring Working Party/Average Score per Taxon. This index assumes that biological gradation of benthic macro-invertebrates gives an overall view of the state of the ecosystem. The assessment system in this method is to assign a score to more than 80 families of macro-benthic species, depending on their susceptibility to pollution: beginning with 1 for the least sensitive species to 10 for the most sensitive ones. Thus the BMWP index is created, being the total of all scores assigned to the taxon families found in the sample. The final biotic index of this method is the total ASPT index, which is calculated in the following way:

$$ASPT = BMWP\ index/Number\ of\ families$$

For the requirements of this method, the organisms should be identified at genus or family level, which is safer (taking into account possible mistakes) than their classification at a lower taxonomic level (e.g. species). The BMWP index is thus recommended because of its simplicity (based on taxonomic identification at family level). Results in the survey of the Bug River conducted in 2000 and 2001 with this method provided an adequate range of variability to usefully distinguish water quality. Moreover, this method is widely used in European countries, which gives an opportunity to compare the assessment results with those for other rivers.

Apart from the BMWP index, it is also recommended to include the biodiversity index in the assessment. This index is a function of two elements: number of species in the community and their structure. It has also been suggested to include the saprobity index (Pantle-Buck's index) in biological assessments. The saprobity index is used to determine the intensity of decomposition of dead organic matter and measures water pollution. Assessments which use this method are based on comparison with detailed lists containing the saprobity of particular species, but this requires accurate identification of organisms at species level. For the biological assessment of benthic macro-invertebrates, analysis of the qualitative and quantitative structure of species should be performed. Samples should be taken twice a year, in spring and autumn.

Phytoplankton is an important biological group in water ecosystems which also gives an indication of long-term changes. This group of organisms can exist in specific hydromorphological conditions in the river. Therefore sampling stations for phytoplankton should be located in the lower stretches of tributary rivers or in locations where the water flow is slow and the hydrological conditions are similar to those of stagnant waters. Sampling is recommended four times per vegetative season between April and October. The assessment of phytoplankton should be based, just as in case of benthic invertebrates, on Pantle-Buck's saprobity index and Shannon's biodiversity index. Quantitative and qualitative analysis of the phytoplankton species composition, as well as biomass measurements should be performed.

Macrophytes demonstrate strong seasonality and sensitivity to pollution. Determination of their composition and abundance is important for the determination of flow conditions and of the habitat structure for other biotic elements of the ecosystem. Therefore it is recommended that macrophytes should be included in the biological assessment of water as an element of the characteristics of the various habitats. The assessment should include the species composition and abundance of plants submerged in the water, as well as riverside vegetation and the characteristics of the riparian zone. The best period for conducting these investigations is May and June. The examination of species abundance should be performed in an area of riverbed coverage on a one hundred metre long stretch of the river.

Ichtyofauna is sensitive to both pollution and to poor biological water quality. This sensitivity results in changes in species composition, population size, age structure and growth rates. Because of the long life cycles, the simplicity of species identification and the fact that this group includes representatives of several trophic levels, ichtyofauna is a good indicator of long-term changes in habitat conditions. For the assessment, it is recommended to use the Index of Biotic Integrity (IBI), which incorporates species composition, abundance, size, weight and age structure of the fish.

The suitability of the methods is summarised in Table III.6. It is important to set the level of identification and the standards for particular taxonomic groups, and to choose a classification method (five-grade scale), which will allow assessment of the ecological state of the river and presentation of the results.

Table III.6. Recommended methods of biological assessment

Method	Benthic invertebrates		Phytoplankton	
	Quantitative	Qualitative	Quantitative	Qualitative
BMWP Index	x	x		
Saprobity Index (Pantle-Buck's Index)	x	x	x	x
Biodiversity Index (Shannon's Index)	x	x	x	x
Biomass			x	x

Ecotoxicology

Ecotoxicological monitoring should be included in the regular water quality monitoring programme in the Bug river basin. This type of monitoring concerns surface water, wastewater and river sediments. For ecotoxicological monitoring, standardized methods should be used for the co llection and preparation of samples and for testing.

For surface water monitoring, a set of chronic toxicity tests is recommended, including the *Daphnia magna/Ceriodaphnia affinis* chronic test (reproduction) and the freshwater algal growth inhibition test. To represent the complete trophic levels of the ecosystem, the following additional methods are proposed; the *Brachydanio rerio* acute fish toxicity test and the *Lemna minor* higher plants test.

Analysis of bottom sediments is important for evaluation of t he long-term impact of pollution. The following tests are recommended: the *Daphnia magna/Ceriodaphnia affinis* test (reproduction), the freshwater algal growth inhibition test and the inhibition of reproduction of *collembola - Folsomnia candida*.

Control of point sources of pollution is an integral part of surface water management. For determination of the toxicity of discharged wastewater, the following tests are recommended: inhibition of the bioluminescence of *Photobacterium phosphoreum*, the *Daphnia magna/Ceriodaphnia affinis* acute toxicity test (reproduction) and the freshwater algal growth inhibition test. Sampling for ecotoxicological tests should be carried out twice a year, in spring and autumn.

Microbiology

The waters of the Bug River are intensively used for recreation (e.g. bathing areas), particularly in Ukraine and Belarus. They are also used for drinking water purposes in rural areas of Belarus. Poland uses the waters of the Zegrzynskie Lake as a source of drinking water. Therefore the list of microbiological indicators must conform with the requirements for the protection of drinking water resources and for water used for recreational purposes:

- Coliform count at 37°C,
- Faecal coliform count (*E. coli*),
- Faecal streptococci (*Enterococcus*),
- Salmonella,
- Enteroviruses PFU (Enteroviruses).

Examinations of these parameters will be conducted 12 times per year. Of these, the frequency of the examinations of faecal streptococci and salmonella can be reduced, and these can be carried out in April, July and September.

Hydromorphology

For hydromorphological survey it is recommended to use the English system of assessment – the *River Habitat Survey system* (RHS). RHS includes the assessment of the physical structure of watercourses, the characteristics of the riparian zone (within 500 m) and the assessment of watercourse quality as a habitat. RHS recommends inclusion of a 500 m long river stretch in the survey, based on watercourse characteristics at 10 cross sections, located every 50 m. To record the changes of fe atures between the cross sections, it is also recommended to survey the characteristics of the riparian zone along the designated stretch of the river. It is suggested to proceed with the RHS survey only at the sites designed for biological examinations.

Hydrological regime

The physical structure and water flow dynamics of the river significantly influence the ecological quality of the waters. The elements of biological quality tend to vary depending on their habitat requirements and the hydromorphological features of the watercourse. The flow dynamics strongly determine the diversity and abundance of animal and plant complexes. These elements are particularly dependent on the type of substratum, decomposition of organic matter and the area of interaction wi th the riparian zone. The hydrological assessment should also take into account the relationship between surface waters and groundwater.

River continuity

The assessment of river continuity should incorporate an inventory of barriers (dams, weirs, canals) located on the watercourse, so that the ecological functioning of the ecosystem can be determined and ways of diminishing the impacts of these structures on biological water life can be found, such as creating fish-passes.

Morphological conditions

The physical assessment system for the waters should include:

- the longitudinal profile (distance from the source; slope and gradient),
- physical features of the watercourse channel (depth, width, sandbars, ripple/pool sequences, habitat availability e.g. macrophytes etc.),
- shape of the channel and the river valley,
- structure of the river bed and banks.

The Riparian zone

Riparian areas are valuable aspects of nature and of the landscape, and they remain in direct contact with the processes taking place in the watercou rse. They provide habitat for many plant and animal species, they perform the role of ecological corridors (connecting scattered habitats, they facilitate animal migrations). They also interact with the watercourse, reduce soil erosion, protect the banks a nd diminish the influence of diffuse sources of pollution.

The evaluation of the riparian zone can take the form of field observation and assessment of the size of the buffer zone separating the watercourse from agricultural or industrial areas. The presen ce of natural vegetation along the banks of the watercourse should be also considered. The riparian zone should be observed on at least a 100 m long stretch of the river.

III.7. Quality assurance and control

Monitoring and assessment of water quality and water quantity in the Ukraine, Belarus and Poland is a task for various institutions and their laboratories. In spite of the fact that quality assurance and quality control systems are already developed in Ukraine, Belarus and Poland, the results of the inventory and the surveys have indicated differing requirements for improvement in each country. One of the aims of the surveys performed in 2000 and 2001 was to check the comparability of data. Significant differences were recorded in many of the results from common sampling points, even though each national laboratory used accredited methods. Differences were observed even for traditional parameters. This situation indicates that either the sampling methodology was not uniform or the methods of analysis produce results that are not comparable. With regard to heavy metal pollution, the situation is generally unsatisfactory. It can be concluded from the data that antiquated equipment and methods are used and detection limits were often too high for water-quality assessment.

The results of both inventory and surveys showed the varying necessity for improvement in each country. Not all laboratories implement international standard such as EN ISO 17025 or EN 13530. Only the Polish laboratories are following this standard according to national rules for accreditation (PN-EN 45001 and ISO/IEC 25).

The following general recommendations for the improvement of QA/QC procedures are given [2]:

- Senior management of the laboratories must commit themselves to the implementation of quality assurance and quality control measures. About 30% of the total time should be available for this task and the appropriate facilities should be supplied where necessary;
- The implementation of all kinds of quality measures initiated under the EU-TACIS project should continue, and time should be made available and be used to extend QA/QC to all laboratory methods and procedures. This is in line with ISO 17025 and will result in known and quantified quality of the present procedures;
- Each laboratory should designate a quality manager (*the person responsible for the quality policy in the laboratory)* to facilitate the implementation of this process. Quality managers of the various laboratories should meet on a regular basis to coordinate their work and exchange information;
- For parameters which show large variations in results, intercalibration and a stepwise learning and improvement process should be organized;
- At least one common sampling programme each year with attendance of the laboratories from all three countries is recommended (the common sampling points at Terespol, Krylow, Wlodawa/ Hrabove/Tomashovka, (Table III.1);
- A laboratory intercalibration programme is necessary. A limited number of parameters (including also some well matched ones) should be selected for inter-laboratory testing. The need for including reference material with known concentrations becomes obvious, but is expensive;
- One of the elements of the control of the examination quality is the participation of the laboratories in comparative studies: both international – (metals in the waters and sediments, micropollutants) and national;
- Special attention should be paid to biological analyses and sampling procedures (specially concerning biological investigations), because these have not been established in the three countries and are under development in the countries of the European Union.

The laboratories should carry out their quality policy by:

- obeying the recommendations and regulations of the Books of Quality (each of the laboratories should have its own book);
- using modern and precise measuring equipment;
- systematic improvement of the qualifications of the staff by regular training;
- maintaining internal inspection of examination quality;
- the staff employed in the laboratory should have adequate professional skills and work experience.

III.8. Pollution loads

Assessment of pollution loads must provide information about short-term, mid-term and long-term changes related to activities in the basin which are aimed at reducing pollution, and must help to distinguish sources of pollution. The objectives of discharge load assessment should be as follows:

- to determine the quality of disposed sewage to issue proper permits;
- to support the supervision and regulation of discharge permits (obligatory measurements of quality and quantity of the sewage discharged by water users);
- to check if the parameters of the discharged sewage meet the requirements of the permits;
- to determine the effectiveness of treatment by comparison with the expected reduction range and the impact on the receiving waters;
- to provide early-warning against accidental pollution.

Present situation

Effluent monitoring in **Ukraine** is divided into state monitoring and special types of monitoring. State monitoring of effluents is conducted by the Regional Boards of the Ministry of Environment and Natural Resources. Special monitoring is conducted by enterprises that are water users. In some cases, special monitoring can be performed by organisations authorised by the ministry.

Regular checks on water quality above and below wastewater discharge points in the **Belarusian** part of the basin are carried out under the supervision of the Analytical Control Department of Brest Regional Committee on Natural Resources and Environmental Protection. In Belarus, individual water supplies and wastewater discharges play an important role, especially in the countryside. The most common treatment system for wastewater is the use of biological filter fields. Often there is no measurement of flows into and out of the works.

Monitoring of loads discharged into surface waters in **Poland** functions in a very limited way. Information on the types and loads of discharged pollutants comes mainly from water law permits and measurements that are sporadically performed by the Voivodeship Inspectorates of Environmental Protection and by the laboratories of water users. Data are collected mainly by Regional Water Management Boards and Statistical Offices. Maximum admissible values of pollution parameters in the sewage discharged to water and soil are set and regulated by decree of the Minister of Environment.

The most common parameters measured in the three countries include the loads of COD-Cr, BOD, suspended matter and nutrients. In many cases, these are enough to identify and quantify the main issues and problems in the Bug basin. However, often only the order of magnitude of the loads can be assessed by the existing rather limited pollution monitoring system.

Selection of parameters

To enable the issue of discharge permits, general sewage examinations should be required. The recommended steps are firstly to review the technology, together with a mass balance of resources and products, followed by an analysis of amounts or concentrations of chemical substances, and risk assessments to determine whether other examinations are needed. General and relevant parameters should be used as much as possible. Chemical analysis is sufficient to provide data for control of the basic substances discharged. For more complicated effluent mixtures, chemical analysis can only provide basic information, and many toxic substances may remain unidentified. Toxicity tests for sewage are therefore required to augment the chemical analyses.

Assessment of pollution discharge

Self monitoring by dischargers

Application of the main principles of pollution discharge assessment from Directive 91/271/EEC can be recommended as suitable for water users:

- Samples taken from the wastewater discharge system should be representative of discharge from the wastewater treatment plant;
- 24 hour samples, proportional to the flow, should be taken from the same, well defined points, at least in the discharge outlet;
- A minimum annual number of samples, taken at regular intervals, should be collected according to the size of wastewater treatment plant:
  2000-9999 RLM*: 1 to 2 samples,
  10 000-49 999 RLM 12 samples,
  50 000 RLM and more: 24 samples;
- Extreme values should be not taken into account.

* Equivalent inhabitants

Control monitoring by designated organisations

In each country, a designated organization (according to the legislation) should perform control measurements to check whether the parameters of the discharged sewage meet the requirements of the permits. In Poland, this is the Voivodeship Inspectorates of Environmental Protection, in Ukraine the Regional Boards of the Ministry of Environment and Natural Resources

Continuous measurements and early-warning systems for discharged sewage

Continuous measurements should be used for early-warning systems for hazardous sewage of high toxicity and for sewage discharged in large volumes, or when it is necessary to check the quantity and composition of the sewage. The inventory of pollution sources (and a risk assessment in the Polish part of the basin) indicated that continuous measurements should be installed in Belarus at the municipal wastewater treatment plants in Brest and Kobrin (Mukhavets), in Ukraine at the plants in L'viv (Poltva), Chervonohrad (Rata), Novovolyns'k (Bug), and in Poland at Chełm (Uherka), in Łukow (Krzna), Tomaszow Lubelski (Solokija), Siemiatycze (Kamianka), Losice (Toczna), Skolow Podlaski (Liwiec) and Siedlce (Liwiec). This list should be verified because of the rapid economic changes in the basin, which lead to the closure of existing plants and opening of new installations.

Assessment of pollution load carried by the Bug River and tributaries

Assessment of the pollution load carried by the river is based on water quality data and hydrological information. Measures undertaken in the basin contribute to a decrease in the discharged pollution loads. Changes in hydrological and meteorological conditions as well as sources of pollution both have significant influence on the creation of the carried loads. To detect trends in the quantity of the carried loads, long-term data are needed. Therefore the integration of hydrological and quality measurements is required. It is also necessary to characterize the influence of the river on the receiving water. This assessment is especially needed where the river crosses the border or flows into Lake Zegrzynskie.

It is proposed that each sub-basin in which river length exceeds 20 km will be monitored at the source section and the outlet section into the Bug River once every five years. Examinations at the outlets to the Bug River are suggested to help calculate the loads of pollution discharged to the main course of the river. If possible, locations of monitoring sections will be selected at water-level gauges, which allows for a close relationship between water quality examinations and hydrological surveys. If not, then interpreted estimates should be applied.

Diffuse pollution load

The diffuse pollution load is a significant part of the total pollution load discharged into water. Assessment of the importance of diffuse pollution sources is significant for the management plans in the basin and for the implementation of adequate control measures. Simple and clear methods are recommended to assess the diffuse pollution load. It is important to develop and agree the methods to be applied and the indicators to be used. In spite of agreements made, all three countries used different methods and different parameters to assess the diffuse pollution loads as part of the project activities.

III.9. Early Warning System (EWS)

Accidental spillages of oil can create a very serious hazard to the water environment in the Bug basin. Together with industrial plants, solid waste disposal sites and wastewater treatment plants located in former wetlands (which can be affected by floods) create the highest potential risk of accidental pollution. Existing flood-control facilities are insufficient for full protection of the basin of the Bug River. The danger of a hazard occurring results from the threat of a failure during transport or storage of dangerous substances.

At present there is no international early warning system in the Bug basin. Each country has its own system, which is at different stages of development [2, 3, 4]. Although transboundary information exchange has officially been agreed between the three countries, the actual procedure is not yet established. Current co-operation between Poland, Belarus and Ukraine in the case of accidental pollution is regulated by separate agreements signed by individual neighbouring local administrative units (voivodeship and "oblast"). The agreements cover co-operation in the case of accidental pollution, conducting inventories of the potential sources of accidental pollution, and warning and information systems if accidental pollution has occurred.

In relation to water quantity, water quality and effluent monitoring, the analogous early-warning systems are early warning of flooding, accidental pollution and effluent discharges*. Early Warning Systems (EWS) form part of an integrated strategy for monitoring and assessment of river water quality. If the direct use of the water is threatened by accidental pollution and if that use of water can be protected by emergency measures, it is recommended that an EWS be set up. The objectives of an EWS are to trigger an alarm as well as to make a diagnosis of the origin of the pollution.

The main tasks of an Early Warning System according to the UN/ECE Guidelines are:

- To establish immediate information transfer to the other affected authorities;
- To set up observation measures and sampling;
- To initiate a risk assessment procedure;
- To warn downstream water users;
- To establish transboundary transfer of information and warnings.

An Early Warning System was proposed by the Ukrainian TACIS projects and presented in their final reports [4]. Taking into account both proposals it can be concluded that:

- There is an urgent need to sign an official treaty between the Ukraine, Belarus and Poland as the legal basis for the Early Warning System and to establish the network and alarm procedure;
- Alert Centres should be set up in each country for co-operation within the basin;
- Such a role could be taken by the Hydromet Brest Centre in Belarus, the Ministry of Ecology and Natural Resources – Regional Boards in L'viv and Volyn in Ukraine, and Lublin Voivodeship Office in Poland;
- Guidelines for the involved authorities, containing procedures for information transfer (including forms, fax and phone codes of the contact persons), risk assessment and observation are needed;
- The internal organisation of information transfer, which was proposed and tested by the TACIS project in Belarus, together with the existing system in Poland could be the core elements of an international Early Warning System. In Ukraine, the present structure of information exchange and decision making has been described as very weak and needs substantial improvement;
- To be effective, the system will need at least a hydrological model that simulates residence times versus discharge and advection – diffusion processes;
- The system of flood warning should be further developed under the Early Warning System. To achieve credibility for the system, the optimal combination of measurement and modeling based on hydrologic and meteorological data should be applied;
- The effectiveness of the system depends on the training of the staff involved, the equipment for taking samples and analysis, and equipment for information storage, retrieval and exchange.

Risk assessment in the water pollution control system

To assess the potential hazard (with consideration of toxic substances and the risk caused by technological installations), a formal risk assessment method is recommended. The risk of accidental pollution and its impact on the environment can be decreased by effective risk control, together with proper early-warning procedures. Information about sewage discharges containing toxic substances is the basis for assessment of pollution risk control. A detailed inventory of use and storage of toxic

* The Convention on the Transboundary Effects of Industrial Accidents puts neighbouring countries under an obligation to establish and maintain warning systems for the possibility of accidental pollution in transboundary areas.

substances should be undertaken by each country. Information on the sources as well as the effluents is important. Studying the processes involved will lead to possible indicators for the composition of the effluents, and investigation of the effluents will prove which indicators are the most suitable ones.

Location of the highest risk potential

The locations of the selected stations with the highest risk potential, downstream of the main point sources and upstream of the important tributaries are given in Table III.7. In the case of accidental pollution of water, samples must be taken for documentation of the pollution plume. On the basis of risk assessment procedures, this selection of sampling stations should be updated.

Table III.7. Location of stations selected for the Early Warning System

River	Station	Remarks
Bug	Krylow/ Lytovezh	Krylow is below mining area in Novovolynsk, Lythovetz is above this area, but is the last sampling point in Ukraine
Bug	Horodlo	Below Luha, Studianka (very polluted) and Huczwa
Bug	Hrabove/Wlodawa/Tomashovka	Border location of all three countries
Bug	Terespol	Above the Mukhavets, and below Brest wastewater treatment plant, below Terespol
Mukhavets	Brest	The biggest tributary of the Bug, with catchment area fully in Belarus
–	Brest wastewater treatment plant	Observation of the discharge of the plant
Bug	Stary Bubel/Novosyolky	At the Polish – Belarusian border, the last part of the common stretch of the Bug. Below the Pulva River, an oil pipeline crosses this river
Bug	Frankopol	2 km below where the oil pipe line crosses the Bug River
Bug	Wyszkow	Inflow to Zegrzynskie Lake where water intake plant for Warsaw is located
–	L'viv wastewater treatment plant	Observation of the discharge of the plant
Poltva	Busk	Below L'viv
Luha	Ustiluh	Downstream of the municipal wastewater treatment and a mining area
Huczwa	Grodek	Toxic wastewater from the treatment plant at Hrubieszow
Krzna	Neple	Risk assessment indication - hazards can occur at Małaszewicze and SEDAR. In both cases, serious pollution could be caused by substances extracted with light petroleum
Solokija	Wierzbica/Uhniv	In Tomaszow Lubelski – a solid waste disposal site is located which should be observed. At the Polish – Ukrainian border. High concentration of heavy metals confirmed during the surveys, leading to high toxicity
Liwiec	Kamienczyk	Risk assessment result – production of metal elements factory and dairy work

The basis of the assessment of impact and its consequences from which to trigger an alarm are:

- The characteristics of the substances;
- The quantity of the substances;
- The characteristics of the location.

Dangerous substances and trigger values

An agreement on the list of dangerous substances and trigger values is one of the most important steps for an effective transboundary Early Warning System. The trigger value is understood as the critical quantity of a dangerous substance related to the average low flow of the river. The basis for setting these is a good inventory and risk assessment, which was undertaken only for the Polish part of the basin. In the TACIS projects in Ukraine and Belarus, a list of dangerous substances and trigger values has been proposed. The list of substances and values proposed by the two projects are different, according to the value of MNQ (the average low water discharge) in the upper and middle part of the main course of the Bug River. The approach of Directive 2000/60 of the European Commission and the experience in the Rhine, Elbe and Oder basins were used to derive the list in Table III.8.

Table III.8. Suggested trigger values for the Bug basin [2]

Substance	Trigger value [kg] or [l]
Polycondensated aromatic compounds	≥ 0.4
Polycycled aromatic compounds	≥ 2
Pesticides	≥ 2
Beryllium	≥ 4
Mercury	≥ 4
Organic micro compounds	≥ 12
Cadmium	≥ 12
Arsenic	≥ 20
Selenium	≥ 20
Cyanide	≥ 20
Oil	≥ 40
Dangerous substances level 1 (zinc, copper, nickel, lead, barium, beryllium, vanadium, thallium and their compounds)	≥ 12
Dangerous substances level 2 (tin, antimony, uranium, silver and their compounds)	≥ 12

III.10. Data collection and processing

Data produced by monitoring programmes should be validated, archived and made accessible. The goal of data management is to convert the data into information that will meet the specified information needs and associated monitoring objectives. The combined use of data from multiple sources makes high demands on the data exchange and data management system used [1].

The data management steps recommended by the guidelines are:

- data should be analyzed, interpreted and converted into defined forms of information using the appropriate data analysis techniques;
- data should be validated or approved before they are made accessible to any user or entered into any data archive;
- information should be reported to those who need to use it for decision-making, management evaluation or in-depth investigation. The information should also be made accessible to the public and presented in tailor-made formats for different target groups.

Data and information exchange

To facilitate the comparability of data, strict and clear agreements should be made on the coding of both data and meta-information. Attention should be given to standard software packages for data management, and to data storage formats, to improve the possibilities for data exchange. Furthermore, framework agreements regarding the availability and distribution of data may facilitate data exchange. In emergency situations and in the event of floods, droughts or accidental pollution, different data exchange procedures may be necessary. Agreements should be made on off-line and on-line data exchange between the centres responsible for such situations, relevant water and environment authorities, and between countries.

Flood protection in a transboundary river requires agreement on flood protection criteria and acceptable flood risks. Special attention should be paid to the comparability and unambiguity of flood forecasts. This concerns especially the terminology used and the structure of messages. Joint post-event evaluations should take place, to lay the basis for jointly upgrading the existing monitoring network, together with the data and information procedures.

Ukraine, Belarus and Poland should jointly agree upon the exchange of data, taking into consideration the time schedule, reliability of data, format, timescale (real-time data in an emergency situation, daily, yearly and/or long-term, average data and the means and forms of transmission. Existing obligations and commitments to international data exchange comprise:

- the Convention on the Protection and Use of International Watercourses and International Lakes;
- the Convention on Access to Information, Participation of the Public in the Process of Decision Making and Access to Justice in Matters Concerning the Environment;
- the agreement between the Governments of the Republics of Poland and Ukraine on co-operation in the field of water management on transboundary waters (Kiev, 10 October 1996);
- the agreement between the Ministry of Environmental Protection, Natural Resources and Forestry of Poland and the State Committee of the Belarus Republic for Ecology on Co-operation in the Field of Environmental Protection (20 May 1992);
- the agreement between the Governments of Belarus and Ukraine on Co-operation in the Field of Environmental Protection (Minsk, Belarus, 16 December 1994).

Data storage and validation

Quality control of the separate procedures for sampling, measurement and analysis and data validation should be an intrinsic part of data handling. Such regular control of the produced data should include the detection of missing values and other obvious mistakes. Computer software can help to perform the various control functions, but expert judgement and thorough knowledge of the water system are both needed for this validation. Besides monitoring data, additional data from other sources are often indispensable for such assessments.

The data available or needed for transboundary management of the Bug basin can be classified according to the following types: [2]

- data which do not require quality control, statistical evaluation or interpretation – i.e. geographical data or recorded meteorological data;
- data which require quality control only – i.e. simple physico-chemical parameters;
- data which require quality control and simple statistical evaluation – hydrobiological, representative data and outliers;
- data which have undergone quality control and require further detailed statistical evaluation and interpretation – seasonality, trend analysis etc.

There are different data sources in each country. Special attention should be paid to the validation and to the quality of the process of data collection from multiple sources. The use of software for the integration of data is unavoidable. Data derived from these various sources and institutions should have already been checked at source, but final validation is required in the central database system.

GIS systems

A geographical information system (GIS) is one of the most important tools for the integrated interpretation of data with other information (e.g. maps, satellite pictures, land use distribution etc.) that are needed for water quality and quantity assessments and in the event of accidental pollution or flooding. Such a solution allows external models to be used, and controlled access to the system to be given to a broad range of information users, and reports to be adapted to the recipients of the information. Preferably relational databases should be used for integration with a geographical information system, with models and for other users and producers of data and information.

Recommendations for the data management system

The most important recommendation for improved data management is to create one database for the monitoring and assessment system in the Bug basin to store Ukrainian, Belarusian and Polish data. A common water cadastre for the basin, integrated with a GIS system, should eventually be created in future. The implementation of this recommendation should be undertaken within one common project for the three countries. This project should be treated as a separate activity. For the time being, the data systems in each country should be compatible, and data should be exchangeable in electronic form. Data processing based on jointly accepted, compatible standards will make assessment and reporting comparable, even when the software used in the three countries is not the same.

An international data exchange system was proposed under the EU TACIS project in Belarus – the Transboundary Information Exchange System TIES [2]. TIES was developed and installed in Belarus during the project. The system proposed is fully in line with the recommendations in the UN ECE guidelines, but unfortunately does not take into account the present institutional, legal and technical situation with regard to data management in Ukraine and Poland. The proposed TIES is based on:

- standard technologies and standard tools (hardware and software);
- a database working with SQL principles;
- easy access via internet, with limitation of the access depending on the users;
- diversified website interfaces for different users;
- the system is "open", meaning that it can be developed further;
- direct connection is made with GIS;
- on-line data exchange is possible.

The present situation can thus be summarized as:

- the first important step in creating an information system for the Bug basin has already been made;
- TIES should be adjusted to take account of the legal obligations for data storage and data management in Ukraine and Poland;
- institutions responsible for data management and data exchange should be nominated in each country;
- it is important to agree between the countries the datasets to be exchanged and the frequency of data exchange;
- data exchange protocols should be agreed between the three countries;
- taking into account the present situation, it can be recommended to use Microsoft Excel or Access format to exchange agreed data, as such formats can easily be transformed to a future database system in any particular country or a common one;
- it is recommended that responsibility for data quality and information in the neighbouring countries is given to nominated institutions;
- exchange of data can be done via the internet.

III.11. Requirements for presentation of information

Reporting is the final step in the gathering of information and links this process to the information users. The main task is to present the interpreted data in an accessible way. How this information is to be presented depends strongly on the audience that is addressed, as discussed in the Guidelines. The level of detail contained in the report, its contents and the frequency of its compilation also depend on the receiver. The contents are likely to be different for managing institutions, administering institutions and for the wider society.

For managing institutions - the reports should indicate clearly the effectiveness of water protection policies, and the effects of investments in remediation activities or control measures in the basin, and the ecological effects of these activities at the scale of the country, voivodeships/oblasts, powiats and communes.

The shape of an international Polish, Ukrainian and Belarusian report for the purposes of water management in the basin should be agreed upon in detail between the countries. The agreement should include the scope of the report, the frequency of its compilation, the receivers of its contents, the procedure for publication and the conclusions that should be presented. Apart from the elements being the subject of detailed requirements specified by the receiver, it is suggested to present in each report;

- assessment of water quality in the current year in selected sections of the basin of the Bug River,
- analysis of trends of water quality changes in the selected sections.

In assessing water quality, an indication of exceedences of recommended concentrations should be included in a way which clearly shows the priority tasks to be undertaken to achieve the required level of water quality.

The institutions which administer rivers - need a report of similar scope. However, the report should generally be more detailed to allow for thorough analysis of the suitability and effectiveness of the tasks connected with water management and water protection, and it needs to describe the water quality with reference to the functions of the river and the identified problems. It is important to use simple parameters and a simple graphic layout in the reports, making them more readable and at the same time improving their value for decision-makers in managing and administering institutions.

Institutions dealing with water management and water protection – need information about the aspects of their statutory activities and their connection with water protection and water management policy.

Statistical institutions – collect the same type of information each year concerning environmental protection, water management, land use and spatial planning and inspection and supervision activities, as well as the economic aspects of environmental protection. This information may be published according to administrative subdivisions and boundaries rather than river basins.

For international institutions and organizations the rules concerning reporting are usually individual and they should be followed.

Non-governmental institutions, community organizations, mass media and society - often pose their questions in such a way that the answers cannot be included in regularly published reports. Reporting can take any shape in this case, and special attention may need to given to presentation of the reports in the Internet.

III.12. Monitoring costs

On the basis of costs currently prevailing in Poland, an estimation of monitoring costs was prepared. It should be taken into account that these costs are not precise and could be over-estimated.* Using this estimate, it is possible to plan the costs and adjust the programme to the available finances.

The estimate of sampling and analytical costs prepared for one sampling station (Table III.9) showed that these costs could be reduced significantly (by up to 50%) for a minimum programme compared to the full programme of investigations. The minimum programme provides for a reduced number of parameters and frequency of sampling (based on data given in Table III.1).

Table III.9. Costs of sampling and analysis for full and reduced monitoring programmes at one sampling station

	Full programme	Reduced programme (minimum required frequency and parameters)
	EURO	
Chemistry	6 556	3 867
Hydrology	358	358
Hydrobiology		
phytoplankton	1 673	836
macrozoobenthos	260	129
macrophytes	80	–
fish	100	–
Microbiology	3 834	956
Sediments	628	314
Ecotoxicology	costs are not taken into account	
Total	**13 489**	**6 460**

* The basis of estimation was *the Regulation of the Minister of Environment dated 7 November 2000 on the conditions and the method of establishing the costs of control of compliance with environmental requirements.*

Table III.10 below shows the costs of investigations for the realisation of the full and minimum programme, using as a basis the information about parameters and sampling frequencies given in Table III.1. The necessary minimum, which should be retained in the case of financial constraints, is the reduced programme of investigations for the first order stations (including the Bug River and its boundary stretch). The costs of carrying out the minimum programme at all th e stations are similar to the costs of the full programme realised at only the first order stations.

Table III.10. Costs of sampling and analysis for the full and minimum monitoring programmes at all stations

	Full programme	Minimum programme
	EURO	
First order stations (the Bug)		
Lytovezh/Krylov	21 496	10 364
Horodlo	6 915	4 226
Jahodin/Dorohusk	26 973	12 923
Hrabove/Wlodawa/Tomashovka	34 126	16 487
Terespol/Terespol	22 751	10 991
Stary Bubel/Novosyolky	25 718	12 296
Wyszkow	13 486	6 461
Total	**151 465**	**73 747**
Second order stations		
Poltva/Busk	9 653	5 506
Solokija Uhniv/Wierzbica	15 084	9 079
Solokija/Chervonohrad	6 915	4 226
Rata/Mezhyrichchia	9 026	5 192
Huczwa/Grodek	9 653	5 506
Luha/Ustiluh	9 653	5 506
Uherka/Rudka	9 653	5 506
Wlodawka/Wlodawa	9 653	5 506
Mukhavets/Brest	13 486	6 461
Krzna/Neple	13 486	6 461
Lesna/Tikhinichy	12 859	6 148
Bug/Frankopol	6 915	4 226
Nurzec/Tworkowice	9 026	5 192
Cetynia /Bialobrzegi	7 542	4 540
Brok/Zamoscie	6 915	4 226
Liwiec/Kamienczyk	9 653	5 506
Total	**159 169**	**88 784**
Third order stations		
Pulva Wyczolki/Wysokie	13 829	8 452
Kopayivka Pischa/Chersk	13 829	8 452
Bug/Sasiv	7 173	4 355
Lesnaya	7 173	4 355
Mysla	7 173	4 355
Total	**49 178**	**29 970**
Total costs of monitoring	***359 812***	***192 501***

IV. FINAL RECOMMENDATIONS FOR IMPROVEMENT

IV.1. General recommendations

1. For the purposes of adequate water management in the Bug River basin, a common monitoring and assessment system for surface water and groundwater should be developed and executed for Ukraine, Belarus and Poland.
2. It is recommended to implement the results of the Pilot Project and to make use of the lessons learned during its realization to create a common monitoring and assessment system for surface waters in the Bug River basin.
3. It is recommended to review and harmonize quantity monitoring with a view to conformity with quality monitoring and with the requirements of water management.
4. Due to the fact that surface water and groundwater are strongly interrelated, it is recommended to develop and carry out a Pilot Project for the implementation of the UNECE Guidelines for Groundwater [6].
5. The very final recommendation of the Belarusian part of the Pilot Project is to create threelateral Commission on the Protection and Use of the Bug Basin Water Resources.

IV.2. Recommendations for project implementation

1. In accordance with the agreement of the representatives of Poland, Ukraine and Belarus made during the closing workshop of the TACIS project for Belarus in Minsk in 2002, it is recommended to create a Polish-Ukrainian-Belarusian Working Group for the implementation phase of the Pilot Project.
2. The suggested composition of the Working Group is: two representatives from Belarus and Ukraine and three from Poland, from institutions responsible for monitoring activities in the Bug river basin, as well as two representatives of the Polish-Ukrainian Commission for Cooperation on Transboundary Waters, one from the Polish side and one from the Ukrainian side.
3. The Working Group will develop the monitoring programme for the Bug river basin, based on the recommendations for the monitoring strategy set out in this report. In this programme, the range of parameters, analyzed media and frequencies should be adjusted to the information needs and to the designated sampling points.
4. The monitoring programme should be feasible in the economic sense for all countries of the basin. In the case of financial difficulties, the number of sampling points, or the range of parameters may be reduced, as can the frequency of sampling, depending on the assumed priorities within the information needs. Securing adequate financial means for the execution of the agreed monitoring programme is of key importance for appropriate cooperation.
5. The proposed monitoring programme shall be implemented after approval of the appropriate institutions in Poland, Ukraine and Belarus.
6. A joint report for the Bug river basin should be agreed and issued every two years.
7. Until a common database is created, the monitoring results should be entered into simple temporary databases, making use of Microsoft Excel or Microsoft Access software. Data stored in this format can be easily converted to any other format used by the database of destination.

IV.3. Recommendations for further actions and tasks accompanying implementation

1. There is an urgent need to sign a trilateral agreement between Ukraine, Belarus and Poland to form the legal basis of an Early Warning System (including flood hazard), and to develop emergency procedures and networks.
2. Development of a database for data storage and exchange to meet the needs of water management in the Bug river basin should become a separate project. While developing this project, proposals made by the executors of the Ukrainian and Belarusian parts of the Pilot Project should be taken into account, together with the databases created within the framework of the Polish-Ukrainian Commission for Transboundary Waters.
3. Special attention should be paid to biological assessments and examinations, according to the requirements of the EU Water Framework Directive, and as the basis for ecological assessment.
4. A common water assessment system should be developed, and definition of reference conditions should be a key part of this system.
5. In spite of the three years' activities under the pilot project, including inventory and surveys, a lot of information is still needed to further develop the monitoring and assessment strategy, to fulfill information needs and to be "in line" with the latest developments in European Policy (WFD). Further work and research in the field of common monitoring for the Bug river basin should aim towards fulfilling the requirements of the Directive. To these ends, the most important activities are listed below:
   - further examination of the concentrations of heavy metals in water and sediments;
   - investigative monitoring programmes aimed at recognizing the threat to the water environment posed by micropollutants;
   - development of standards for heavy metals and micropollutants in water and sediments;
   - development of ecotoxicological examinations of water, sediments and wastewater
   - investigation of the interrelationships between groundwater and surface water, as well as development and execution of groundwater monitoring, involving quality and quantity assessments;
   - development of a common method for ecological and hydromorphological water quality assessment, as well as the identification of reference conditions for very good ecological state in the Bug river basin, should be the object of a separate scientific research programme;
   - improvement of the quality of inventory activities for identifying and characterizing sources of pollution;
   - application of a common method for assessment of diffuse pollution loads in the basin;
   - application of a common method for risk assessment in the whole basin;
   - further integration of analytical methods and improving data comparability.

REFERENCES

[1] Guidelines on monitoring and assessment of transboundary rivers. UNECE Task Force on Monitoring and Assessment, Lelystad, Netherlands, 2000.

[2] The TACIS CBC Bug River Project. Belarus. Project Completion Report. TACIS, 2002.

[3] Bug Report No. 2, Identification and Review of Water Management Issues. Task Force on Monitoring and Assessment under the UNECE Water Convention, Pilot Project Programme Transboundary Rivers, Lelystad, Netherlands, 2002.

[4] Transboundary Monitoring System for the Western Bug River between Belarus and Poland. Technical Documents. TACIS Bug River Project Belarus, 2002.

[5] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000.

[6] Guidelines for monitoring and assessment of transboundary groundwaters. UNECE Task Force on Monitoring and Assessment, Lelystad, 2000.

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