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# Issue Paper on Hazardous Substances Pollution in the DRB

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## Status Cover Page

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This draft issue paper on hazardous substances pollution, prepared by the P&M EG provides an overall guidance on how to approach the implementation of measures according to the EU Water Framework Directive (2000/60/EC).

It is still a living document that will need continuous input and improvements as application and experience build up in all Danube countries and beyond.

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Preliminary drafts of the issue paper on nutrients were discussed at the P&M EG and RBM EG meetings. The MA EG had also discussed and commented the draft.

At the 9<sup>th</sup> ICPDR Ordinary Meeting in December 2006, as well as at the 5<sup>th</sup> Standing Working Group Meeting in June 2007, guidance was provided for finalising the document, expected to be endorsed by the ICPDR at the 10<sup>th</sup> ICPDR Ordinary Meeting in December 2007. This current draft, based on the discussions at the last P&M EG Meeting, September 2007, is presented to the 24<sup>th</sup> RBM EG meeting, October 2007.

For general remarks and comments on the paper please contact the members of the Drafting Group on Hazardous substances of the P&M EG (Joachim Heidemeier, Emilia Kunikova, Zsuzsa Steindl, Elena Tuchiu and Mihaela Popovici) as well as the members of the MA EG.

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# 1 Introduction

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The Water Framework Directive (2000/60/EC) has replaced, harmonized and further developed the control and reduction of point and diffuse discharges of dangerous substances according to Council Directive 2006/11/EC.

Article 16 of the Water Framework Directive sets out a "Strategy against pollution of water" which demands specific measures against pollution of water by individual pollutants or groups of pollutants presenting a significant risk to or via the aquatic environment (e. g. by drinking water consumed). On the basis of Article 16 of Directive 2000/60/EC a list of 33 priority substances has been adopted by the decision of the European Parliament and of the Council of November 2001. This list I identifies 11 priority hazardous substances, 14 substances subject to a review for identification as possible priority hazardous substances and 8 priority substances. The planned measures aim at the cessation or phasing out of discharges, emissions and losses to the aquatic environment within 20 years for the priority hazardous substances and at the progressive reduction for the priority substances.

For these priority substances community-wide water quality standards have to be established - currently included in the Proposal for a new Directive to protect surface water from pollution on 17 July 2006 (COM(2006)397 final). The proposed Directive, which is required to support the Water Framework Directive, will set limits on concentrations in surface waters of 41 dangerous chemical substances (including 33 priority substances and 8 other pollutants) that pose a particular risk to animal and plant life in the aquatic environment and to human health. This proposal is part of the new strategy against chemical pollution of waters introduced by the WFD and is accompanied by a Communication (COM(2006)398 final) which elaborates on this approach and an Impact Assessment. The detailed progress in the negotiations includes 22 May 2007 - the European Parliament - First Reading adoption and 28 June 2007, at the Environment Council – Political Agreement. The negotiations are now going into Second Reading, which is likely to take place in the first half of 2008.

The WFD places obligations on Member States to implement measures to achieve specific environmental objectives for water bodies including rivers, lakes, groundwater and estuaries. The WFD requires that for most surface water bodies, the target of good ecological and chemical status should be achieved within 15 years of adoption of the Directive. "River Basin Management Plans" (RBMPs) will provide the context for setting out a comprehensive programme of measures designed to achieve the objectives that have been set for water bodies.

The first main output of the joint efforts to implement the WFD in the Danube River Basin is the Roof Reports 2004, which has been prepared in line with Art. 5, 6 and Annexes II, III, IV of the WFD. The RBM EG provides the coordination of the development of a Danube River Basin Management Plan, according to the agreed ICPDR documents related to the specific strategy DOC-101 "Development of a Danube River Basin District Management Plan – Strategy for Coordination a Large River Basin" and related DOC 110, 2005 "Road Map for the Development of a Danube River Basin District Management Plan 2005- 2010". As part of the strategy, issue papers are being developed on the key water management issues, which are subsequently described (Chapter 2).

This issue paper addresses pollution by hazardous substances in compliance with the requirements of the Danube River Protection Convention and the EU legislation, including the WFD. In addition, at the ICPDR Ministerial Meeting in December 2004 the Danube countries endorsed the Danube Declaration expressing their commitment to further reinforce transboundary cooperation on sustainable water resource management within the Danube Basin. The Danube Declaration contains the following goals and objectives related to hazardous substances pollution issues (Part 6):

***We, the Ministers, High Officials and the Representative of the European Commission, being responsible for the implementation of the DRPC,***

*(6) agree that in the coming years we aspire to achieve the following goals and objectives, taking into account the sometimes more ambitious commitments already made by other countries at the national or EU level:*

*6 iv) to stop, by 2015 at the latest, all discharges of untreated wastewater from towns with more than 10,000 inhabitants and from all major industrial installations and to increase the efficiency and level of treatment thereafter;*

*6 v) to phase out entirely the discharge of those substances which we identify as constituting the highest risk to the aquatic ecosystems in the Danube basin and to reduce significantly the discharge of other pollutants;*

*6 viii) to improve monitoring systems and the availability of data, in particular in relation to the assessment of trans-boundary impacts;*

*6 xiii) to take all reasonable measures to prevent industrial accidents resulting in dangerous substances being released into surface or groundwater, to improve the Danube Accident Emergency Warning System and in particular to strengthen further the synergies with regional and national systems.*

Finally, the agreed goals of the Memorandum of Understanding (ICPBS and ICPDR, 2001) will be considered: "the long-term goal in the wider Black Sea Basin is to take measures to reduce the loads of nutrients and **hazardous substances** discharged to such levels necessary to permit Black Sea ecosystems to recover to conditions similar to those observed in the 1960s. As an intermediate goal, urgent measures should be taken in the wider Black Sea Basin in order to avoid that the loads of nutrients and **hazardous substances** discharged into the Seas exceed those that existed in the mid 1990s."

This issue paper will be the basis of making the objectives - outlined in the Danube Declaration and the Memorandum of Understanding - operational within Danube River Basin Management Plan by 2009.

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## 2 Problem Description: Hazardous Substances - general frame

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The work carried out so far on characterization of water bodies for the Water Framework Directive suggests that across the Danube Basin a high proportion of water bodies will be at

risk of failing to meet the Water Framework Directive's 'good status' objectives. Organic pollution, nutrient pollution, pollution caused by **hazardous substances** and hydromorphological alterations are the four basin-wide key water management issues.

The EU Water Framework Directive defines in its Article 2 (29) the term hazardous substances - as substances or groups of substances that are toxic, persistent and liable to bio-accumulate; and other substances or groups of substances which give rise to an equivalent level of concern.

Exposure to excessive loads of hazardous substances can result in a series of undesirable effects to the riverine ecology and to the health of the human population. Hazardous substances may affect organisms by inhibition of vital physiological processes (acute toxicity), or they may cause effects threatening population on a long-term basis (chronic toxicity). If a substance is persistent, i.e. its degradation process exceeds certain time span; it remains in the environment and leads to a continuous and/or long-term exposure. Substances with a high lipophilicity that enter the water environment tend to accumulate in a solid phase and in living organisms.

The evaluation of a risk of failure to achieve the WFD environmental objectives for hazardous substances presented in the Danube Basin Analysis Report 2004 shows, that the major risks are available at the middle and lower part of the Danube River (Fig. 1). The Middle Danube is classified as "possibly at risk" for the largest part. The part of the Danube shared by Croatia, and Serbia and Montenegro is "possibly at risk" since not enough data is available for a sure assessment. The lower Danube is "at risk". In total, 74 % of the Danube is "at risk" or "possibly at risk" due to hazardous substances while 36 % of the Danube tributaries with the catchments > 4.000 km<sup>2</sup> are "at risk", or "possibly at risk".

The lack of data on hazardous substances is a problem caused mostly by the deficiency of adequate analytical instrumentation in the downstream countries and the lack of legal instruments for obligatory measurements in the past. An additional factor is the high costs of the trace analysis.

Moreover, it is necessary to emphasize that out of the 33 priority substances identified from the Decision No. 2455/2001/EC only seven were included in the TNMN. Concerning the other 26 substances very limited basin-wide information is available. The major sources of information are the Joint Danube Survey (1 and 2). Therefore, to achieve a reliable assessment of the risk of failure to reach the good status, a large amount of information on the "new" substances must be collected. This is the task for the **national screening surveys** and the **operational monitoring**.

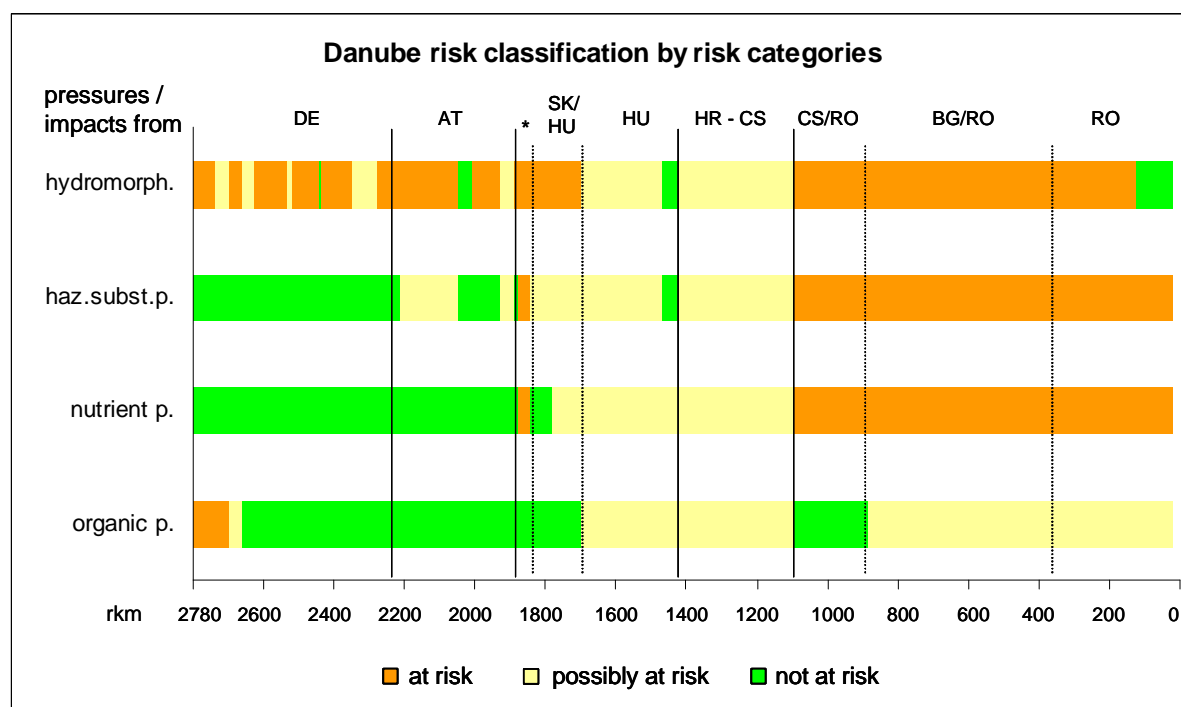


Figure 1: Risk classification of the Danube, disaggregated into risk categories. Each full band represents the assessment for one risk category (hydromorphological alterations, hazardous substances, nutrient pollution, organic pollution). Colours indicate the risk classes. \* SK territory.

### 3 Scope and General Aims of this Issue Paper

#### 3.1 Aims of this issue paper

In order to preserve and improve the ecosystem quality in the Danube Basin in accordance to the DRPC and thereby fulfilling the requirements of the EU WFD by 2015, the relevant measures addressing the significant water management issue of the pollution by hazardous substances have to be considered within the Danube River Basin Management Plan.

**This issue paper provides an overall strategy and guidance how to address the management issue of hazardous substances pollution, how to develop a relevant management approach regarding measures and how an improvement of status can be achieved - all on a basin-wide scale. The document includes objectives for the basin wide scale, which are based on visions and which will guide the Danube countries towards a common environmental aim.**

***The ICPDR's basin wide vision for hazardous substances pollution is no risk or threat to human health and the aquatic ecosystem of the waters in the DRB and Black Sea Basin.***

**The objective is to give guidance to develop the Joint Programme of Measures (JPM) within the frame of the Danube RBM Plan. The issue paper might also support the development of the national Programmes of Measures.**



### 3.2 What is covered by this document?

The subsequent issues are addressed within this document:

#### *Measures related to **current** pressures*

Starting point for this issue paper is the analysis of pressures and impacts according to the WFD Roof Report, December 2004. For each pressure the needed input for the DRBM Plan and the preparatory process and the respective management objective is outlined in order to achieve a Joint Programme of Measures on the basin wide scale. The JPM is based on a compilation of national measures (bottom-up approach).

#### *Approach for **future** pressures*

Recommendation of planning and operating of new installations with possible impact on chemical status of water bodies in the DRB will be developed as part of the DRBM Plan to ensure the achievement of environmental objectives. The issue paper outlines needed inputs for the DRBM Plan.

The issue paper addresses the *improvement* related to the procedures within the Danube River Basin Analysis (e.g. updated inventory of hazardous substances pollution sources) in order to achieve comparable approaches. Further, this includes the need to identify weaknesses in data and recommendations for data improvements. *Environmental objectives and exemptions* will be generally addressed in the document on Significant Water Management Issues (ICPDR document IC/WD/268). The correct application of exemptions should be ensured providing clarification when exemptions can be applied. This issue paper supplements the general approach by outlining specific examples regarding environmental objectives and exemptions. Further, the role of *monitoring within the JPM* is highlighted.

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## 4 Measures related to current pressures

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The list of current hazardous substances pressures in the DRB based on findings of the Danube River Basin Analysis and on the national reports will be provided as a starting point.

The current information received from the Danube countries show that from the pressures side, the existing national legislation prohibits any discharges into surface waters of those List I (Directive 76/464 EEC) substances whose production, marketing and/or use has been previously banned, or whose production, marketing and/or use has never taken place in the respective country, even in the absence of an explicit ban.

Discharges of the remaining List I substances are subject to emission limit values. In some examples, these limit values are identical to or more stringent than those specified in the various “daughter” directives. Comprehensive surveys of all discharges of substances regulated in the directive covering plants operating the particular technologies that can potentially emit the dangerous substances have been undertaken in several Danube countries.

A set of measures are suggested to be part of the first international Danube River Basin Management Plan 2009, built upon national measures. Hence, the JPM within the Danube

RBMP is a continuation of the previous Joint Action Programmes and should build upon the past experiences.

#### **4.1 Measures to eliminate Hazardous Substances from point sources**

##### **Drivers DRB scale:**

Main point sources of hazardous substances of basin wide significance are industrial effluents, storm water overflow and discharges from mining sites. Effluents from cleaning equipment are usually of local significance. The following DRB key hazardous substances drivers can be considered:

1. *Industry (including mines)*
2. *Agriculture*
3. *Urban development*

##### **Possible impacts – failure of good status:**

1. *Toxicity*
2. *Bioaccumulation*
3. *Persistence*

#### **Basin Wide Management Objectives – Hazardous Substances Pollution**

The way towards the vision will be achieved through the implementation of the following management objectives by 2015:

##### **EU Member States, Accession Countries and Non EU MS:**

- ⇒ Elimination/reduction of the total amount of hazardous substances entering the Danube and its tributaries to levels consistent with the achievement of the good chemical status by 2015.
- ⇒ Implementation of Best Available Techniques and Best Environmental Practices including the further improvement of treatment efficiency, treatment level and/or substitution.
- ⇒ Explore the possibility to set up quantitative reduction objectives for pesticide emission in the Danube River Basin.

##### **In addition, for EU Member States**

- ⇒ Implementation of the Integrated Pollution Prevention Control Directive (96/61/EC), which covers also the Directive 76/464/EEG.

#### **Inputs for the Danube RBM Plan**

The deliverable for the Danube River Basin Management Plan/JPM will be established on the base of national planned measures (bottom up reporting) The measures will relate to regulation of discharges, emissions and losses of hazardous substances, covering mainly with Directive 96/61/EC (IPPC directive) and other installations falling under the scope of the 2006/11/EC Directive.

### Possible Basic measures

- stop, by 2015 at the latest, all discharges of untreated wastewater from towns with more than 10,000 inhabitants and from all major industrial installations and to increase the efficiency and level of treatment thereafter;
- phase out entirely the discharge of those substances which are identified as constituting the highest risk to the aquatic ecosystems in the Danube basin and to reduce significantly the discharge of other pollutants;
- all installations discharging hazardous substances into the environment have to have permits;
- prescription emission limit values in permits as minimum requirements for dischargers;
- full implementation of the IPPC directive for EU Danube countries;
- BAT based permits for the installation entering dangerous substances into waters;
- fulfil the Danube BAT guidance requirements in non EU Danube countries;
- wide use of the integrated pollution prevention and control principle in permitting of industrial activities (not only for IPPC installations);
- local and regional level pollution reduction plans for reaching the EQS goals with the most appropriate combination of measures taking into consideration the subsidiarity principle.

### Possible Supplementary measures

- effective authority pollution (emission) control activities;
- self monitoring programs of dischargers;
- establish an inventory of emission, discharges and losses;
- carry out the review of the permits identified in water bodies affected by discharges of priority substances.

### Preparatory Process

#### *First step*

- Updated reporting of countries in the emission inventories on priority hazardous substances both discharging into surface water and sewage systems
- Updated reporting of countries in the emission inventories on hazardous substances both discharging into surface water and sewage systems
- Compilation of List of priority measures for point sources including other hot spots (mining) and of any other national measures, including implementation targets regarding industrial discharges (timelines). The information will be collected using appropriate templates. Hence, the positive effect of the national measures will be translated to the basin wide level to analyse if the international environmental objectives are achieved.

#### *Second step*

- The Significant Water Management Issues (including the deliverables for the JPM) will be provided for review to the public by the end of 2007. Integrating the review results, the first draft of the Danube River Basin Management Plan will be available by the end of 2008.

**Documentation of implementation success:**

Two steps are proposed:

- Design options to illustrate implementation objectives in a clear and measurable way in comparison with the basin wide management objective
- Develop suitable indicators/criteria to measure the implementation success by ICPDR EGs.

**Economic aspects**

General conclusion of EU impact assessment is that the most cost-effective way to achieve the EQS objectives for priority substances is to leave the level and combination of measures, mainly based on existing EU legislation, to be decided by Member States. This refers also to chapter 4.2. In close cooperation with the ICPDR expert groups, the Economics Task Group will investigate on economic issues, which should be addressed on the basin wide scale. The Task Group will develop a general scheme and approach on economics according to WFD requirements for the basin wide level in relation to consideration on national level.

Therefore priority should be given to implementation and revision of existing instruments rather than establishing new controls, which may duplicate existing ones.

As regards emission controls of priority substances from point and diffuse sources as referred to in Article 16(6) and (8) of Directive 2000/60/EC, it seems more cost effective and proportionate for Member States to include, where necessary, in addition to the implementation of other existing Community legislation, appropriate control measures in the programme of measures to be developed for each river basin in accordance with Article 11 of Directive 2000/60/EC.

The BAT prescribing in IPPC permits for installation take into consideration the economical aspects as well.

**4.2 Measures to eliminate hazardous substances from diffuse sources of pollution****Drivers DRB scale:**

The following DRB key hazardous substances drivers can be considered:

1. *Agriculture*
2. *Industrial development (including mining sites)*

**Possible impacts – failure of good status:**

1. *Toxicity*
2. *Bioaccumulation*
3. *Persistence*

**Input for the Danube RBM Plan**

The subsequent deliverables will be part of the Danube River Basin Management Plan/JPM and will include a list of national projects (planned measures) – with or without available financing – related to:

**Possible Basic measures**

1. Implement Directive 91/414/EEC – The Plant Protection Products Directive
2. Implement Directive 86/278/EEC – The Sewage Sludge Directive
3. Implement Directive 75/442/EEC – Waste Framework Directive

**Possible Supplementary measures**

- Legislation measure - Immediate pesticide ban for the most hazardous priority pesticides like Atrazine, Lindane, Diuron and Endosulfan in non-EU countries
- Implement Promotion of BAP regarding pesticides input from agriculture (guidelines/recommendations and national reporting of actions) linked to CAP
  - reduce field pesticides application rates by integrated pest management measures;
  - encourage substitution of priority pesticides by less harmful ones;
  - encourage substitution of pesticides by biological or mechanical control methods;
  - encouragement of organic farming;
  - optimisation of spraying technique;
  - careful filling of spray tank, cleaning of sprayer, disposal of PPP;
  - development of strategies to avoid pesticide resistance;
  - appropriate pesticide storage;
  - consideration of pesticide use economy for plant protection decisions;
  - mandatory farmer training on pesticide use/licensing of farmers;
  - dissemination of appropriate knowledge on integrated pest management, organisational support and legal definitions;
  - availability of a current list of all authorised products for all advisors;
  - awareness raising about pesticide misuse;
  - pesticide phase-out of all other priority pesticides and substitution by less-dangerous pesticides, including non-chemical alternatives;
  - definition of pesticide cut-off criteria for the approval of other pesticides, persistent pesticides should not receive authorisation;
  - improve controls on the use and distribution of pesticides/control of black market;
- Inventory and remediation projects of old contaminated sites (including the abandon mining sites);
- Careful waste treatment and disposal measures;
- Reasonable measures to prevent industrial accidents resulting in dangerous substances being released into surface or groundwater, to improve the Danube Accident Emergency Warning System and in particular to strengthen further the synergies with regional and national systems:
  - inventories of the potential risk sites,
  - contingency plans,
  - international and national alert systems,
  - improving the technical tools for intervention against pollution.
- Emission and process controls to reduce losses during the production of chemicals and during their subsequent incorporation into other products.
- Restrictions on the marketing and use of chemicals, including authorization and approval procedures, can further reduce the potential contamination of the environment;
- Full account of the objectives and provisions of other Community legislation, in particular the chemicals policy including REACH and the Pesticides Directive, the IPPC Directive and the Thematic Strategies (eg. sustainable use of pesticides).

## **Preparatory Process**

### ***First step***

Compilation of List of measures for diffuse sources, including implementation targets (timelines). The information will be collected using appropriate templates. Hence, the positive effect of the national measures will be translated to the basin wide level to analyse if the international environmental objectives are achieved.

The comprehensive list of measures will be completed by the Drafting Group based on countries contributions.

### ***Second step***

The Significant Water Management Issues (including the deliverables for the JPM) will be provided for review to the public by the end of 2007. Integrating the review results, the first draft of the Danube River Basin Management Plan will be available by the end of 2008.

## **Documentation of implementation success**

- Development of ways to illustrate implementation objectives in a clear and measurable way in comparison with the basin wide management objective.
- A list of monitoring and evaluation indicators will be developed and used in documenting the implementation results.

## **Economic aspects**

See chapter 4.1.

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# **5 Approach for future pressures**

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The procedure related to future pressures and measures will be different than for current pressures/impacts. The subsequent conclusions can be drawn for future projects:

- future projects must fulfil the conditions set out in Article 4
- specific future projects must be subject to an Environmental Impact Assessment and/or a Strategic Environment Assessment during the planning phase which takes account of the pressures and impacts to the aquatic environment and ensures that the conditions of Article 4 are met.
- according to the article 10 WFD a licence for operation of future plant has to respect combined approach of environmental quality objectives and emission limit values. treatment techniques and technological innovation, such as best available techniques, may enable to diminish the concentration of pollutants in the proximity of points discharge in the future
- effective use of wide range of instruments available and in place, from product controls (e.g. restriction on marketing and use), to process controls (e.g. best available techniques, emission limit values) and economic instruments (e.g. pesticide taxes).

## 6 Improvement of methodologies and data availability

This chapter addresses issues, which need improvement related to the knowledge base and procedures within the Danube River Basin Analysis. Further, the issue of data availability will be dealt with - necessary improvements to fill specific data gaps will be identified. An updated inventory of pressures from point and diffuse sources of hazardous substances pollution will be available by the end of 2007 as an important basis for preparing the detailed List of basin-wide hazardous substances reduction measures as part of the Danube River Basin Management Plan.

One important element is the improvement of emission inventory. The ICPDR Emission Inventory, which provided the basis for the pressure assessment in the WFD Article 5 Analyses (Roof Report), has to be refined in the course of the preparation of the River Basin Management Plan. In order to avoid duplication of work by establishing this inventory and to ensure the coherence of the inventory with other existing tools in the area of surface water protection, information collected under Directive 2000/60/EC and under Regulation (EC) No 166/2006 of the European Parliament and Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC should be used.

The new activity in E-PRTR compared to IPPC related to the wastewater treatment plants should be analysed. The wastewater treatment plants with a capacity exceeding 100,000 population equivalent as defined in Article 2 point (6) of Directive 91/271/EEC are included in Annex I and projects below that capacity are included in Annex II of the EIA Directive 85/337/EEC. Also, concept on reporting for the independently operated industrial wastewater treatment plants, which serve one or more activities of this annex, should be also defined.

### Preparatory process

The procedure covers:

- Collect findings from risk based assessment performed at national level
- Application of MONERIS on heavy metals –Danube specific Priority Substances
- Assessment of supplementary measures that will need to be introduced.

## 7 Environmental Objectives and Exemptions

For Environmental objectives and exemptions a formalised EU procedure exists which can only start after a monitoring supported risk analyses is performed. The WFD environmental objectives are clearly defined within the WFD and have to be reached in the most efficient way by 2015. After the finalisation of the risk analysis (Roof Report) – these theoretical objectives now have to be translated into practice on the different implementation levels (national, sub-basins and basin wide scale). The procedure and agreement on environmental objectives and exemptions are performed in parallel.

On the national level, the Danube countries have agreed to phase out entirely the discharge of those substances which are identified as constituting the highest risk to the aquatic ecosystems in the



Danube basin and to reduce significantly the discharge of other pollutants. On the basin-wide scale the following objectives and visions are suggested by P&M EG:

For all water bodies relevant for the Roof part to reach the concentration level of hazardous substances, which are to be specified in the Directive of the EP and of the Council on environmental quality standards in the field of water policy and amending Directive 2000/60/EC).

The agreed visions to achieve environmental management objectives will enable the specific demonstration of implementation success.

In addition, the application of exemptions throughout the Danube basin should be comparable and consistent. To this end, the exchange of information on national approaches and experiences should be ensured (e.g. through workshops) and the, if appropriate, guidelines for application of exemptions in the Danube River Basins should be developed.

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## 8 Monitoring and the Joint Programme of Measures

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The monitoring of the implementation of JPM will be based on suitable indicators for the different sets of measures. This will give knowledge on the implementation successes, but not on the ecological effects.

This information will be provided by the monitoring and assessment according to the WFD. The monitoring results will be used for the subsequent tasks:

- a. Validation of the risk assessment performed according to Article 5: Status class assessments deliver clarification if respective water bodies are at risk. Operational as well as surveillance monitoring results are implemented for these analyses.
- b. Evaluation of the ecological efficiency of nutrient measures: The success of measures to improve the ecological status is assessed. Operational monitoring results are implemented for these analyses.

In the Danube River Basin the revised TNMN and national monitoring results according to the WFD will be used to implement the above tasks.

### **Precondition for this approach:**

- Use of WFD compliant sampling and assessment methods in all Danube countries;
- Operating WFD compatible TNMN system;
- Analytical capabilities of laboratories are improved;
- Data exchange using the Danube GIS;
- The ICPDR serves as a platform for knowledge and information exchange (e.g. a brief document on WFD compliant methods is drafted defining their composition and included elements).