FIELD REPORT

DEMDESS 1994 SUMMARY REPORT

WASH Field Report No. 441
November 1994

WATER AND SANITATION for HEALTH PROJECT

Sponsored by the U.S. Agency for International Development
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December 15, 1994

Dear Colleague:

I am pleased to provide you with a copy of DEMDESS 1994 Summary Report, WASH Field Report No. 441 by Tim Bondelid. DEMDESS, the Danube Emissions Management Decision Support System, is a computer-based water emissions management system designed to support informed decision making regarding the control of emissions in Danubian countries. The report contains a description of the activities undertaken in 1993-94, summaries of results and status by country, conclusions, and recommendations.

Please let me know if you have any comments or suggestions and would like additional copies of this report.

Sincerely,

Craig Hafner
Deputy Director

WASH Field Report No. 441

DEMDESS 1994 SUMMARY REPORT

Prepared for the Bureau for Europe
and Newly Independent States, Environment Office,
U.S. Agency for International Development
under WASH Task No. 521

by

Tim Bondelid

November 1994

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RELATED WASH REPORTS

DEMDESS Summary 1993. Danube Emissions Management Decision Support System. September 1993. Field Report No. 412. Prepared by Tim Bondelid, Kathy Alison, Jonathan Darling, Lee Jennings, and John Tippett.

DEMDESS User Manual 1993 Update: Danube Emissions Management Decision Support System. September 1993. Field Report No. 413. Prepared by Tim Bondelid and John Tippett.

CONTENTS

APPENDIXES

FIGURES

ABOUT THE AUTHOR

Tim Bondelid is a research environmental engineer with the Center for Environmental Analysis, Research Triangle Institute. During his career, he has been involved in computer modeling, data quality and reliability analysis, environmental database development, and hydrologic-system mapping.

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ACRONYMS

C&C	command & control
DEMDESS	Danube Emissions Management Decision Support System
EPM	Emissions Policy Model
HIID	Harvard Institute for International Development
LEM	Local Environmental Management Project
MERP	Ministry of Environment and Regional Protection
MOF	Ministry of Finance
NPS	nonpoint source
PCU	Danube Programme Coordination Unit
PFS	prefeasibility studies
PI	Pollution Index
RWMA	Regional Water Management Authority (Poland)
UNCAS	uncertainty analysis
U.S. EPA	U.S. Environmental Protection Agency
WAWDEM	WAWTTAR-DEMDESS
WAWTTAR	Water & Wastewater Treatment Technologies Appropriate for Reuse
WWTP	wastewater treatment plant

EXECUTIVE SUMMARY

USAID's Bureau for Europe and Newly Independent States, Environment Office has been supporting development of the Danube Emissions Management Decision Support System (DEMDESS) in Central and Eastern Europe since 1991. DEMDESS is a computer-based water emissions management system designed to support informed decision making regarding the control of emissions in Danubian countries. DEMDESS answers the key questions: are there problems? Where are the problems? Who is causing the problems? Can the problems be fixed? What has to happen to fix the problems? What will it cost? Its focus is on controlling emissions from industrial and municipal point sources through evaluating the economic, financial, institutional, and stream quality impacts of various policy options (such as constructing treatment facilities, selecting effluent criteria and stream quality standards, providing subsidies for construction, and imposing fines and taxes on wastewater emissions).

DEMDESS is in the third phase of development in 1994. Starting in the winter of 1991, DEMDESS development and institutionalization has been supported by USAID in the Danubian countries of Bulgaria, Hungary, Romania, and Slovakia. The first phase emphasized the development of the Initial DEMDESS and building institutional support. The second phase, 1992-93, emphasized institutional strengthening through training and technical development. This third phase has been targeted at strengthening specific aspects of the decision process within DEMDESS, in direct response to host country needs. Also in this third phase, activities in Romania were suspended, and DEMDESS implementation was started in Poland.

This report contains a review of DEMDESS, description of activities undertaken in 1993-94, summaries of results and status by country, conclusions, and recommendations. Several appendices are included that describe the technical development and use of the enhancements implemented in this phase of DEMDESS.

Eight activities were undertaken during the third phase:

1. Development of Executive Interfaces, which provide simple, clear presentations oriented to decision makers.
2. Integrating a water quality model into DEMDESS, which completes the important link between changes in emissions and changes in water quality. The U.S. Environmental Protection Agency model Qual2e is used.
3. Development of an Emissions Policy Model, to evaluate macro-level emissions policy issues, such as effects of emissions charges versus command-and-control policies. This activity was developed in close cooperation with the USAID/Harvard Institute for International Development (HIID) project in Hungary.
4. Development of enhanced wastewater treatment plant characterization and costing methodologies, by incorporating the computer program, Water and Wastewater Treatment Technologies Appropriate for Reuse (WAWTTAR), a system developed by

the WASH Project under USAID sponsorship. A new WAWTTAR-DEMDESS component, named WAWDEM, was developed to facilitate and enhance the incorporation of WAWTTAR in the Danube basin.

5. Building a Scenario Manager into DEMDESS to provide a standard set of procedures for managing "what if" questions.

6. Development of an integrated, systematic approach to prefeasibility studies using a combination of enhanced analyses in DEMDESS and an Executive Interface to bring all of the elements together. The prefeasibility system was designed and implemented in close cooperation with the USAID/WASH prefeasibility study for Sevlievo, Bulgaria.

7. Producing documentation and training demonstrations, primarily oriented to supporting institutional development in the host countries. Documentation included a full report of the activities plus several stand-alone technical appendices for the new and enhanced components of DEMDESS.

8. DEMDESS start-up in Poland, working in cooperation with the Wroclaw Regional Water Management Authority and other institutes. This activity parlayed activities in the USAID-sponsored Local Environmental Management (LEM) project.

While no quantitative verification exists as yet, host country counterparts claim that they can project significant cost and management savings through the use of DEMDESS.

One outcome of these activities is a complete integrated system, referred to as the Extended DEMDESS. This system is installed and primary users have been trained in Bulgaria, Hungary, Slovakia, and Poland. Other indicators of success include increasing use of DEMDESS in real problems and the incorporation of DEMDESS as the standard "way of doing business" in the host countries. DEMDESS is able to be refined and to develop in response to evolving host country needs.

The DEMDESS project has broadened its cooperation and coordination with other efforts in the region, including the USAID-sponsored HIID and LEM projects and the USAID/WASH task in Sevlievo. The WAWTTAR system has been introduced to several new users through DEMDESS. Coordination continues with the Danube Programme Coordination Unit (PCU) in Vienna; DEMDESS is fitting in with immediate objectives of the new Danube Convention, a formal agreement among the Danubian countries that is the basis for cooperative efforts on environmental matters. The DEMDESS task cooperated with the Dutch-sponsored Delft Hydraulics project in Slovakia.

The introduction of WAWTTAR has generated great interest in the region, including within the PCU. Given the new economic and financial conditions in the region, accurate, systematic costing of facilities is a significant, continuing problem. WAWTTAR can help address this problem by providing a standardized, flexible tool for prefeasibility level costing and evaluation of wastewater treatment alternatives. WAWTTAR workshops would be very valuable, either on a country basis or for a regional audience.

Strong support exists in the host countries for continued development and use of DEMDESS. While most of this continued development can be accomplished by the host country DEMDESS experts, some continuing support would be invaluable in helping to avoid technical pitfalls and to maintain institutional momentum, especially in Bulgaria, Slovakia, and Poland. Each of these countries has indicated a strong desire for continuing support.

Chapter 1

INTRODUCTION

1.1 Background

The countries of central and eastern Europe have been collecting water quality related data for quite some time, but their governments have not used the information in formulating related policies. However, recent dramatic changes in these countries have placed new demands on the data; consequently, these statistics are now forming a necessary component of important decision-making processes concerning water and wastewater investments. Country officials also are recognizing that they will need to use new and different types of data not previously collected, especially data regarding regulations and costs. To address these concerns, from fall of 1991 to summer of 1992, a multidisciplinary WASH team assisted experts in Bulgaria, Hungary, Romania, and Slovakia to develop a computer-based water emissions management system, which is now named the Danube Emissions Management Decision Support System (DEMDESS).

DEMDESS is a comprehensive water pollution data management environment/system. It does not fit into traditional slots such as "computer model" or "pollution management program." These traditional slots can be incorporated into DEMDESS, however, and as such they are optional components of the system. DEMDESS can meet basic information management and reporting requirements while operating with a wide array of models as needed. Using modern information management techniques, DEMDESS is suitable both for beginners, who may be most comfortable with simple, menu-driven programs, and experts, who may prefer sophisticated applications.

The computer revolution of the last few years has completely changed the way computer systems are developed and has even blurred certain fundamental concepts, such as "computer programs." It is difficult at best to use standard terminology to define "DEMDESS." To provide an analogy, "Lotus" can be thought of as several different things. To the program developer, Lotus is a "computer program." To the average user, Lotus is a "spreadsheet." To a sophisticated user, Lotus is a "software development environment." Similarly, DEMDESS can mean different things to different people.

The conceptual framework for the DEMDESS decision process is illustrated in Figure 1 on the right. Decisions, such as emission control policies, are at the "top" of the system; DEMDESS can predict changes in polluter behavior, such as construction of wastewater treatment plants, in response to decisions. It can also predict effects on water quality and costs that follow these changes in behavior.

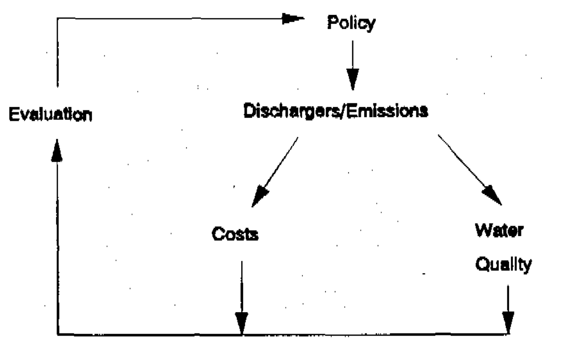

Figure 1
DEMDESS Conceptual Framework

The overall objective of the DEMDESS project has been to institutionalize DEMDESS; that is, to help the Danubian countries develop and use DEMDESS as an operational tool for water pollution decision support. DEMDESS is highly desirable as an operational tool because it can address several key technical and policy issues related to water quality and pollution control that face the environmental ministries of the Danubian countries.

Making DEMDESS operational requires efforts at both the technical and institutional levels. Technical activities have emphasized data base and applications development, while institutional activities have focused on training and outreach to build the proper environment for using DEMDESS.

A list of "milestones" in the development and institutionalization of DEMDESS can be found in Appendix A, and a list of primary contacts appears in Appendix B. In terms of DEMDESS's development, the key activities and outcomes of the multidisciplinary work done during 1991-92 were as follows:

1. Development of a conceptual framework for management of water pollution decision-making. This framework formed the macro-level requirements for DEMDESS.

2. An initial prototype of DEMDESS built using Bulgarian data, because the technical and institutional conditions for developing DEMDESS were most favorable in Bulgaria.

3. A workshop, held in December 1991, in Visegrad, Hungary, with representatives of the four Danubian countries to be assisted with DEMDESS. In this workshop, the country representatives were shown the conceptual framework and prototype DEMDESS as starting points for developing a full decision support system. They reacted quite favorably and supported continuing DEMDESS's development. Participants agreed on a strategy in which one major basin in each country would be targeted for full development of DEMDESS.

4. Technical development in the selected basins in each country continued through the spring of 1992. Significant progress was made in each country, with the fullest development occurring in Bulgaria.

5. A closeout workshop in May 1992 held near Bratislava, Slovakia. A "treatment policy" analysis using all of the major components of DEMDESS was used to demonstrate its decision-making capabilities. All of the countries expressed a strong desire to continue DEMDESS's development.

6. A user manual and country-specific versions of the Initial DEMDESS were completed and delivered in summer 1992.

From September 1992 to July 1993, Phase II of the project, 10 separate activities were performed in order to institutionalize DEMDESS:

1. continued assistance in interfacing DEMDESS to country-specific water data bases;

2. direct technical training of experts in each country;

3. coordination with related activities, especially those of the Program Coordination Unit (PCU) Subgroup on Monitoring, Laboratory, and Information Management;

4. development of a "user-friendly" version of DEMDESS with routine reporting and decision support applications;

5. revision of the *DEMDESS User Manual*;

6. application of DEMDESS in WASH prefeasibility studies;

7. a regional DEMDESS training workshop held in May 1993 in Budapest;

8. a Bulgaria-specific workshop, held in Mt. Vitosha, Bulgaria, in late June and early July 1993;

9. provision of computers and software to each country for using DEMDESS; and

10. participation in the closeout prefeasibility study meetings held in each country in May 1993.

1.2 Description of DEMDESS 1994 Activities

The Danube Emissions Management Decision Support System (DEMDESS) reached its third phase of development in 1994. As mentioned earlier, DEMDESS development and institutionalization has been supported in the Danubian countries of Bulgaria (Yantro basin), Hungary (Sajo-Hernad basin), Romania (Arges basin), and Slovakia (Nitra and Hornad basins) by USAID's Europe Bureau through a buy-in to the WASH Project. Activities in Romania were suspended in this third phase, and DEMDESS implementation was started in Poland (Upper Odra basin).

The selection and scope of the following activities is based on the outcomes of DEMDESS Phase II and a reconnaissance mission to the host countries in February 1994. Technical Development (Activities 1-4) took place during the spring and summer of 1994, with delivery (Activity 5) in late summer 1994. Activity 6 expanded the DEMDESS user community out of the Danube Basin into Poland. Finally, some "optional" activities are discussed.

Activity 1: Building "Executive Interfaces"

Central to DEMDESS is the decision-maker; to optimize DEMDESS, an active, willing decision-maker is needed. Experience has shown that simple, clear, graphically appealing displays are most useful to the busy decision-maker. To date, DEMDESS interfaces have been oriented more toward technical users. Fortunately, modern computer technologies now provide powerful tools for building such executive interfaces. This activity builds interfaces to DEMDESS using modern "Windows" capabilities, including sophisticated graphics, color maps, and publication-quality hard-copy output. This activity provides a "road map" for continued development of executive interfaces by the host country counterparts.

Activity 2: Integrating a Water Quality Model into DEMDESS

Determining the effect on water quality is of central importance when making emissions management decisions. Predicting changes in water quality requires modeling of the many complex chemical, physical, and biological processes that take place in receiving waters. DEMDESS has been designed to contain the essential information to support water quality modeling. This important dimension of the decision process is fully realized by interfacing DEMDESS with the U.S. Environmental Protection Agency's (U.S. EPA's) standard water quality model, "Qual2e." Qual2e is widely used in the United States as well as in many other countries, such as Hungary.

Activity 3: Development of an Emissions Policy Model

Most of the host countries are in the process of evaluating or revising their emissions control policies. These policies, such as setting charge levels and emission standards, will have significant effects on economic development and water quality. DEMDESS is built to provide the essential information and analyses needed to evaluate properly a wide variety of policy options.

This activity was done in cooperation with a Harvard Institute for International Development (HIID) project in Hungary that is evaluating various emission charge policies to assist the Ministry of Finance in drafting legislation. The HIID project has provided the framework for development of the DEMDESS Emissions Policy Model (EPM) which can be adapted to address specific issues in the other host countries. A major advantage of the EPM is its ability to use highly detailed emissions data in economic analyses; effects of emissions control policies are very sensitive to economies of scale and local receiving-stream effects. The detailed, nonaggregated data in DEMDESS provide a strong basis for evaluating the actual economic and environmental effects of emissions control policies.

Activity 4: Enhanced Cost and Emissions Control Analyses

An essential component of the DEMDESS decision process is the Wastewater Treatment Subsystem, which is used to predict costs and emissions reductions that will result from decisions (policy or site-specific). This activity has improved the Wastewater Treatment Subsystem of DEMDESS through the incorporation of the Water and Wastewater Treatment Technologies Appropriate for Reuse (WAWTTAR) model developed in 1993-94 under a completely separate WASH/USAID project. WAWTTAR is a self-contained PC program that can develop a wide variety of wastewater treatment alternatives for a given site. The system evaluates pollutant reduction and costs using robust methodologies that provide a greatly enhanced basis for cost estimates for a wide variety of wastewater treatment technologies. WAWTTAR can be seen as an expansion of the Wastewater Treatment Subsystem currently built into DEMDESS. The "open" nature of the DEMDESS design permits incorporation of WAWTTAR, with its expanded capabilities. WAWTTAR greatly enhances the ability of DEMDESS to examine the water quality and cost effects of pollution reduction alternatives.

As part of this activity, a new DEMDESS component, WAWDEM (WAWTTAR-DEMDESS), was developed. WAWDEM performs four functions: (1) it converts WAWTTAR outputs to a convenient "spreadsheet" format to help engineers evaluate the results; (2) it summarizes WAWTTAR results using simplified "pollution indexes" to help analysts explain WAWTTAR results to decision-makers; (3) it evaluates complex multifacility situations; and (4) it provides the interfaces to the core DEMDESS data bases.

Activity 5: Initial DEMDESS in Poland

Although the first word in "DEMDESS" is "Danube," there is in principle nothing specific to the Danube in DEMDESS. In cooperation with the USAID/Poland Local Environmental Management project, preliminary steps for implementing DEMDESS in Poland have begun. An Initial DEMDESS has been implemented within the Regional Water Management Authority (RWMA) in Wroclaw.

Activity 6: Scenario Manager

DEMDESS has used an ad hoc, expert-user approach to the development of emission control scenarios. Design and implementation of a more controlled, standardized scenario management system was begun last year. The DEMDESS Scenario Manager (SCENMGR) provides a standardized procedure for interfacing WAWTTAR and Qual2e into the Core DEMDESS. The completion of the SCENMGR has greatly enhanced the ease and flexibility of DEMDESS for non-expert users.

Activity 7: Integrated Prefeasibility Study

The integrated Prefeasibility Study brings all of the DEMDESS technical capabilities together in an easy-to-understand presentation that includes problem characterization; pollution source identification and ranking; analysis of treatment alternatives; effects on ambient water quality;

and costs, financing, and trade-offs. The specific case of Sevlievo, Bulgaria, is used as the model. The Prefeasibility Study application can perhaps be used in the future to standardize prefeasibility studies.

Activity 8: Training, Documentation, and Demonstrations

The above activities need to be properly delivered to our host country counterparts through training and documentation. Demonstrations of DEMDESS are a continuing activity to maintain momentum and support. The objective is to build support for DEMDESS with briefings, demonstrations, workshops, etc., and to involve decision-makers, emphasizing action items that will continue use and development of the system.

The following chapters present the "Extended DEMDESS" system, review DEMDESS 1994 activities by country, and close with some key findings and lessons learned. The appendices are technical guides to the DEMDESS components built in this phase and should be considered as addendums to the DEMDESS User Guides developed in the first two phases.

Chapter 2

EXTENDED DEMDESS 1994

2.1 Definition and Overview

The plan was to develop one integrated system that incorporates the applications developed for one country before installing the complete system in each country. This integrated system is referred to as the "Extended DEMDESS." (A more detailed description of the Extended DEMDESS design can be found in Appendix C.)

Figure 2 below shows the basic components of the Extended DEMDESS. Summaries of each component follow this section and more detailed discussions appear in Appendixes D-G.

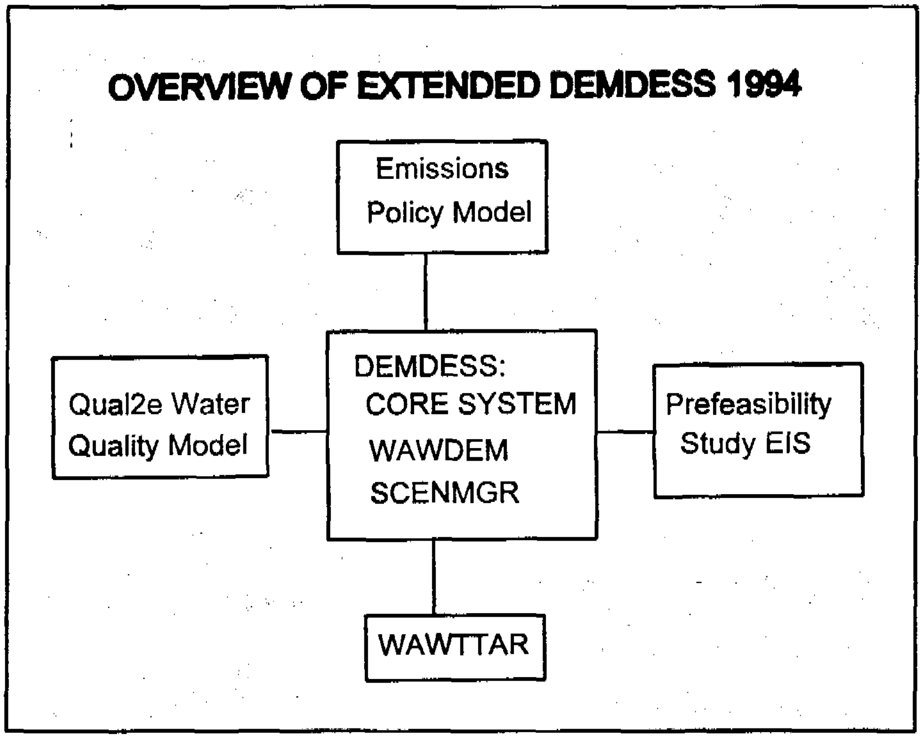

Figure 2

Some primary characteristics of DEMDESS are listed below.

- *DEMDESS runs on PCs*: Advances in computer technology permit building a comprehensive system such as this on widely available PCs, allowing broad access and use, user-friendly interfaces, and rapid development.

- *DEMDESS uses existing data bases*: DEMDESS relies on existing administrative data bases, e.g., water quality monitoring and emissions tracking. The most data-intensive components of DEMDESS do not have to be re-created, and the system can be kept up to date easily as the administrative data bases are updated. The system design is flexible, so that data from many countries fit into the system.

- *DEMDESS integrates many types of data*: The decision process requires the integration of many diverse types of data. Costs and regulations are an integral part of the process, in addition to the more traditional components of a water quality management system.

- *DEMDESS operates at many levels*: The same basic information is required at whatever level the user is operating. PC technology enables the same system to be operable at all levels. In the past, mainframes were usually required at the national level.

2.2 Elements of the DEMDESS Development Process

The DEMDESS development approach is iterative, in that the following elements involve various steps; a comprehensive decision support system cannot be built all at once.

Technical development

Technical development of DEMDESS has utilized the skills and knowledge of many people, including those with expertise in data processing, engineering, finance, economics, and institution-building. Modern, professional data processing standards have been employed throughout. We have benefited from the knowledge resulting from more than 20 years of related U.S. efforts, especially the experience of those who have developed U.S. EPA's information systems.

Central technical ownership

In each country, one technical agency has been identified as the central technical DEMDESS "owner." Having one owner has proven very effective and efficient, giving us one place to focus our technical training and system development work. The central owner is responsible for use and dissemination in the country. Examples include Vituki in Hungary, the Laboratory and Information Center (LIC) in Bulgaria, and Hydromet in Slovakia.

Involve decision-makers

Decision-makers, especially those in the various ministries of environment, have been kept involved throughout the development process, ensuring that DEMDESS responds to their needs and ensuring the involvement of technical owners.

Training and outreach

We have used facilitated workshops and technical training sessions extensively. We have publicized DEMDESS to other parties, such as the Danube Environmental Programme (DEP) in Brussels. We have held regional workshops, with representatives from all involved countries, as well as country-specific workshops (Bulgaria). These activities form a major component of institutional development.

Equal emphasis on technical and institutional development

Institution-building activities are at least as important as the strength of the technology. The most wonderful tool is worthless without a user who also has the capability to maintain it. In some ways, technical problems are more tractable than institutional problems. Powerful technical capabilities are of little use without skills, resources, and follow-through.

2.3 Summary of Extended DEMDESS Components

Following are brief summaries of each component of the Extended DEMDESS.

2.3.1 CORE DEMDESS

The Core DEMDESS is the heart of the system.

- Main features:
  - Integrated data bases containing Emissions, Water Quality, River Network, Regulations, and Wastewater Treatment Subsystems.
  - Works with existing national water quality data systems.
  - "Open" system: designed to bring experts together through data and analyses.
  - Designed to operate simultaneously at many levels: local, regional, basin, national, and international.
  - Adds new dimensions of regulations and wastewater treatment costing.
- Primary users
  - ministries of environment
  - technical institutes
  - universities
  - local governments
  - regional and basin planners
  - special studies
- Expertise required:
  - data management
  - decision-making

- economics
- engineering
- financial analysis
- modeling
- water quality monitoring

■ Issues and next steps:

- Evaluate data sufficiency, primary data gaps, and quality control.
- Establish strategy and resources for continued maintenance and enhancement.
- Define, establish, and support user community.

■ Documentation:

- WASH Reports from DEMDESS Phases I and II
- DEMDESS User Guides

2.3.2 WAWTTAR-DEMDESS System (WAWDEM)

The WAWTTAR-DEMDESS (WAWDEM) analysis system has been built to facilitate the incorporation of WAWTTAR into DEMDESS. WAWDEM has three primary objectives: (1) to serve as an interface between WAWTTAR and DEMDESS; (2) to provide post-processing tools for assisting the analyst in communicating with decision-makers; and (3) to provide analysis support for complex multisite situations.

■ Main features:

- Converts WAWTTAR output to convenient spreadsheet format.
- Summarizes WAWTTAR results using simple graphs of performance versus cost.
- Evaluates complex multisite and multifacility situations.
- Serves as the interface between WAWTTAR and DEMDESS.

■ Primary users:

- DEMDESS users who need to incorporate WAWTTAR results into scenarios.
- WAWTTAR users, especially in multisite situations.

■ Expertise required: Best used by experienced, qualified WAWTTAR users.

■ Issues and next steps: Examine use of pollution indexes.

■ Documentation: WAWDEM is documented in Appendix D.

2.3.3 DEMDESS Scenario Manager

The Scenario Manager (SCENMGR) acts on copies of Core DEMDESS components, with options to modify virtually any aspect of DEMDESS in defining a scenario. Options include manually editing discharger characteristics, emissions, and any regulations. SCENMGR can use data from WAWDEM to define any particular WWTP configurations built in WAWTTAR. A particular policy option outcome predicted in the EPM can be incorporated into a scenario. General coefficients of economic/demographic development can be applied to emissions by economic sector.

- Main features:
  - A comprehensive system for managing virtually any "what if" question within DEMDESS.
  - Used to incorporate WAWTTAR/WAWDEM and EPM results.
  - Manual overrides of any component of the Core DEMDESS.
- Primary users: DEMDESS users who are looking at alternative scenarios.
- Expertise required: DEMDESS
- Documentation: SCENMGR is documented in Appendix E.

2.3.4 Emissions Policy Model

The DEMDESS Emissions Policy Model (EPM) is designed to help decision-makers and analysts evaluate various emissions control policies. The model is designed to address key issues at several policy levels, especially evaluation and comparison of broad policy alternatives, such as command and control (C&C) versus emissions charges (taxes and fines). Within these broad policy alternatives, the model examines possible results, including likely wastewater treatment plant (WWTP) construction, emission changes, total costs to society, and the financing considerations (who pays what) under the various policies. For a given policy, such as taxes and fines, the model can help determine appropriate levels for fines and taxes given water quality objectives (e.g., a particular target level of emissions) and financial/economic objectives (e.g., balance taxes/fines and subsidies). After a policy is chosen, DEMDESS can be used to implement, track, and refine the policy, as the same basic data used to develop the policy is also the data needed for implementation and tracking.

- Main features:
  - Examines possible results of broad emissions control policies, such as taxes, fines, subsidies, standards, and financing of wastewater treatment construction.
  - Evaluates policies in terms of possible wastewater treatment construction, effect on emissions, costs, financing, revenues to the state, and efficiency.

- The EPM Executive Interface integrates the results of many policy alternatives in a package designed for decision-makers.

- Primary users:
  - decision-makers in ministries of environment and finance
  - economists

- Expertise required:
  - policy analysis
  - economics
  - wastewater treatment engineering

- Issues and next steps:
  - Need to calibrate to host country conditions, especially wastewater treatment options and costs and emission tax and fine structures.
  - Need to define the policy issues and enhance/modify the EPM as needed.

- Documentation: The EPM is documented in Appendix F.

2.3.5 Water and Wastewater Technologies Appropriate for Reuse (WAWTTAR)

WAWTTAR adds three important dimensions to DEMDESS:

- Solid engineering analyses of WWTP alternatives, with defensible pollution removals and costs.
- Greatly improved data on the baseline emissions in DEMDESS.
- A focus on community-level decision-making that greatly strengthens the multilevel uses of DEMDESS (local/regional/national).

In addition, WAWTTAR could be a valuable tool for developing country-specific generalized cost curves for use in more macro-level analyses, e.g., the EPM.

- Main features:
  - Provides comprehensive, process-level WWTP characterization: pollutant removal and costs.
  - Contains a rich data base of treatment technologies, both municipal and industrial.
  - Evaluates community resources in selecting feasible treatment technologies.
  - Treats wastewater as a resource to be reused.
  - All aspects are open to user modification and addition.

- Primary users:
  - community planners

- regional planners
- wastewater engineers

- Expertise required:

Local knowledge is essential in developing a set of site-specific alternatives. Wastewater treatment engineering background is necessary to properly use the system.

- **Issues and next steps:**
  - Evaluate role of WAWTTAR; permit-writing, basin planning, local community planning.
  - Training, workshops.
  - Strong interest in WAWTTAR within PCU.

- Documentation: WAWTTAR User's Guide

2.3.6 Qual2e and Qual2e-UNCAS Water Quality Model

- Main features:
  - Independent model developed by U.S. EPA.
  - Comprehensive water quality model that includes oxygen, nitrogen, phosphorous, algae, and coliform cycles, plus user-specified conservative and nonconservative constituents.
  - Steady-state or dynamic simulations.
  - Qual2e-UNCAS performs uncertainty analyses using either sensitivity analysis, first-order error analysis, or monte carlo simulations.
  - Widely used in the United States for wasteload allocations.

- Primary users: Water quality modelers

- Expertise required: Should be expert in water quality and modeling; hydrology and hydraulics.

- **Issues and next steps:**
  - Needs to be evaluated for use in host countries.
  - Training, workshops.

- Documentation: Qual2e is documented in the Qual2e User's Guide.

2.3.7 Prefeasibility Study Executive Interface (PFS)

- Main features:
  - Integrates results from Core DEMDESS, WAWDEM, SCENMGR, WAWTTAR, and QUAL2E; results from EPM can also be integrated.
  - Puts in one place most of the information needed to present a site-specific or basin-level prefeasibility study.
  - Provides many of the graphs and tables needed for report preparation.
  - The entire package provides a dynamic, well-documented study. Questions concerning methodology and assumptions are contained in the data files, and the study can be readily updated as new information becomes available.

- Primary users:
  - basin planners
  - regional control authorities
  - local governments
  - consultants or others performing the studies

- Expertise required: The full range of expertise for each DEMDESS component.

- Issues and next steps: Develop a "standard" prefeasibility report linked to the PFS.

- Documentation: The PFS is documented in Appendix G.

Chapter 3

DEMDESS 1994 ACTIVITIES BY COUNTRY

This chapter reviews DEMDESS 1994 activities in each country. For each country a brief background is provided, followed by a summary of activities, institutional and technical outcomes, a discussion of problems, and a look at future opportunities.

3.1 Bulgaria

Bulgaria has always been a leader of DEMDESS development in Eastern Europe, beginning with the prototype. Institutional development and training has been very successful there, culminating in a Bulgaria-specific DEMDESS workshop in June 1993. DEMDESS has a strong policy-level "home" in the Ministry of Environment and a solid national-level technical "home" in the Laboratory and Information Center (LIC), where national-level implementation of DEMDESS is proceeding. Use at the inspectorate level is well underway, especially in the Yantra basin. Bulgarian DEMDESS activities focus primarily on the Executive Interface and use of WAWTTAR, especially for conducting prefeasibility studies. The Qual2e and Emissions Policy Models will also be incorporated into the Bulgarian DEMDESS.

Major activities in Bulgaria included development of the Prefeasibility Study (PFS) for Sevlievo as model application; technical support, especially national Reach File standards; and promotion of DEMDESS in MOE and LIC through briefings and demonstrations.

Several outcomes have been achieved. Institution-building efforts have established DEMDESS as the center of the emerging Bulgarian national water quality information system and a key part of the Bulgarian Danube Programme Team. The link between DEMDESS and site-specific wastewater treatment decision-making has also been strengthened. Technical support efforts have resulted in the completion of Extended DEMDESS development, installation, delivery, and training.

Problems have included a lack of formal support within MOE and LIC, which has hampered immediate use of the system. However, MOE/LIC have been developing a longer-term strategy to rebuild their water quality management, and DEMDESS will be a central component. Short-term support may improve, especially through the establishment of the Danube Programme Team.

There are a number of opportunities for the future, including:

- WAWTTAR training and workshops
- Nonpoint sources (NPS), especially link with the USDA-NPS project in the Yantra basin.

- Incorporating water supply/water use.
- Creating links to economic analyses.

3.2 Slovakia

The Slovak national data systems are very well organized and form an excellent basis for the Core DEMDESS. The policy-level home for DEMDESS is the Slovak Ministry of Environment, with the designated technical home being the Hydrometeorological Institute (Hydromet). This designation of Hydromet is a significant advance for DEMDESS use in Slovakia; development had suffered in the past due to the lack of a clear technical home. There is a complementary decision support system, developed by Delft Hydraulics of the Netherlands, which has been applied in the Hron Basin; the combination of this system with DEMDESS could be very powerful for supporting decision-making in Slovakia.

Major activities in Slovakia included the rebuilding of Nitra DEMDESS, with strong cooperation from the Hydrometeorological Institute. In addition, Extended DEMDESS was delivered, and staff was trained in its use. A decision support workshop was organized by Hydromet and MOE that examined DEMDESS and the Delft Hydraulics systems, with participation from regional planning personnel.

Institutional outcomes achieved include the establishment of a much stronger technical home for DEMDESS in Hydromet, where staff are capable of using and enhancing DEMDESS on their own. MOE has clarified its position regarding decision support systems in Slovakia and would like to form an expert working group that includes itself, Hydromet, Water Research Institute (WRI), USAID/DEMDESS, and Delft Hydraulics. The Delft system and DEMDESS are now viewed as complementary systems that are both needed for a complete decision support process.

Among the technical outcomes are the operational status of the full Extended DEMDESS for the Nitra basin, including a very preliminary Qual2e model of the mainstream, menus in Slovak, and the first-ever implementation of the NPS and PERMITS components of DEMDESS. Also, there is a national Slovak Reach File with links to the national emissions and water quality data bases, which will permit fairly rapid implementation of the Core DEMDESS on a national level.

The beginning of this phase in Slovakia was not very promising because the MOE was viewing Delft and DEMDESS as competing systems; they wanted to pick one or the other. This situation has been resolved, with the systems being regarded as complementary.

Efforts by the U.S. and Dutch governments to assist in further development will be a great help in maintaining momentum. A fairly small level of support to participate in the "expert team" for decision support could be an excellent forum for cooperation between the United States and the Netherlands.

3.3 Poland

Implementation of DEMDESS in the Odra River basin has begun, in cooperation with the USAID-funded Local Environmental Management (LEM) Project. The Wroclaw Regional Water Management Authority (RWMA) is the technical home for DEMDESS, with "next steps" developed in conjunction with an evolving steering committee that is designed to coordinate water quality related activities in the basin. DEMDESS can serve as the focal point for cooperation and coordination in the data management and analysis activities, possibly as a model for more national-level coordination.

Activities included two visits to the RWMA, closely coordinated with the Institute of Environmental Protection and the Institute of Meteorology and Water Management. The first visit included training, installation of the Core DEMDESS system (with empty data bases), and a plan of action to complete at least the core system. Between visits, the Polish DEMDESS team developed most of the core data bases. In the second visit, the Core DEMDESS was completed and the Prefeasibility Study EIS was incorporated. A closeout briefing was held with about 15 participants from the cooperating institutes and the Technical University.

Institutional outcomes include the establishment of a clear need and role for DEMDESS in Polish decision-making. A new water law, currently in Parliament, will significantly enhance the role of the RWMAs in decision-making, creating a need that DEMDESS is well-suited to fill. At this time, no other operational system in Poland can meet those needs. DEMDESS has almost certainly changed the way the RWMAs will operate in the future.

DEMDESS has provided three important technical advances: (1) integration of Poland's existing standard river network with water quality and emissions; (2) implementation of a computerized regulatory system; and (3) implementation of a process for examining wastewater treatment alternatives and costs. RWMA staff are fairly well trained in DEMDESS, and should be able to use and enhance most aspects of the system.

However, the momentum established thus far could falter without some minimal level of technical and institutional support. A quite modest level of support could help make DEMDESS a significant resource throughout Poland. Two steps are needed: (1) to complete the Olawa Basin DEMDESS; and (2) to participate in efforts to demonstrate and "market" DEMDESS to other Regional Water Management Authorities.

3.4 Hungary

Hungary has quickly become an active DEMDESS user. The Ministry of Environment and Regional Protection (MERP) is the policy-level home and the Vituki Water Research Institute is a solid technical home. Vituki is actively developing its own major enhancements to DEMDESS, including language switching capabilities and dynamic interfaces to the national-level emissions, water quality, and Reach Files (in addition, the work with the HIID/Ministry of Finance (MOF) project is providing the framework for the EPM). Qual2e is the standard water quality model in Hungary. The Hungary DEMDESS work has focused on the EPM, Executive Interface, and Qual2e implementation. WAWTTAR will also be incorporated into the Hungary DEMDESS.

Most activities revolved around connecting DEMDESS and Vituki to the HIID/MOF project. The EPM was developed in close coordination with Zsuzsa Lehocki of HIID. Also, technical assistance was provided to Vituki on continuing national implementation of DEMDESS, especially the Hungarian National Reach File with the Core DEMDESS.

Institutional outcomes included the establishment of a working relationship between Vituki and the HIID project. Vituki and DEMDESS are important resources in emissions policy work, providing up-to-date, detailed national-level emissions data linked to other key components.

Technical outcomes include the development of the EPM and Executive Interface. Vituki has completed a national Reach File linked to water quality stations; linking of dischargers is ongoing. Several roadblocks to the implementation of the national-level DEMDESS were overcome through the technical support to Vituki.

MERP support for DEMDESS is contingent upon Vituki demonstrating the ability to run DEMDESS anywhere in Hungary. Vituki began developing an infrastructure to do this, including building a national Reach File. After a promising start, several problems were encountered. Other anticipated problems could be helped significantly by minimal continuing support. In addition, the emissions policy work frequently gets sidetracked by other "hot buttons" in MOF.

Future DEMDESS technical support could be very productive, depending on requests from HIID and/or Vituki.

3.5 Romania

There is a strong technical basis for DEMDESS in Romania, but the changing political situation has made it difficult to create the institutional conditions necessary for DEMDESS application. Implementation of DEMDESS in the Arges basin is fairly complete. There were no DEMDESS activities in Romania in this phase.

Chapter 4

SUMMARY AND CONCLUSIONS

- All DEMDESS components are finished and operating as one package: Core DEMDESS; SCENMGR; Qual2e water quality model; WAWTTAR-WAWDEM, EPM and Executive Interface; and PFS.
- DEMDESS has been installed and users trained in all of the countries targeted in this phase: Bulgaria, Hungary, Slovakia, and Poland.
- Qual2e was a good choice as the water quality model to incorporate into DEMDESS. Qual2e has a long-term, deep background in usage, it is appropriate for the low-flow criteria used in several of the countries, and the UNCAS options can provide robust measures of uncertainty. Workshops and/or continued support in Qual2e could be very useful.
- DEMDESS meets the immediate objectives of the new Danube Convention (a formal agreement among the Danubian countries that is the basis for cooperative efforts on environmental matters), especially its focus on inventorying point source emissions. David Rodda, head of the Danube PCU in Vienna, was briefed in July on the DEMDESS 1994 activities. His response was to identify points of correspondence between DEMDESS and the Convention. Also, discussions were held with several Danube Task Force members in the DEMDESS countries during this project.
- WAWTTAR has generated great interest in the region, including the PCU. WAWTTAR can help with a significant, continuing problem: properly costing WWTPs given the new economic and financial conditions in the countries. Either country-specific or regional WAWTTAR workshops would be very valuable. WAWTTAR costing should be validated, using actual WWTPs, to document the accuracy of the model results.
- The development of the PFS has demonstrated the efficiencies that can be gained by implementing a systematic, integrated water information system. Starting with a fully loaded DEMDESS and WAWTTAR, it should take two weeks to complete a full prefeasibility study, compared to five months for the "traditional" approach. Besides saving time, the DEMDESS approach is more dynamic, better documented, and provides standardized results that can be used for comparing studies.
- Poland is a good model for starting DEMDESS in a country that has a strong existing technical base.
- The analyses done in this phase of DEMDESS show that ambient water quality data without flows is of very limited usefulness in decision support; if flows are included,

the increased value in decision support is even more dramatic than originally anticipated.

- The DEMDESS process is a combination of short-term and long-term actions. In the short term, DEMDESS supports immediate issues, shows what can be done with available data, and points to institutional and technical gaps in the decision process. In the long term, DEMDESS provides a foundation and focal point for rebuilding the decision processes.
- There is an ebb and flow in the long-term DEMDESS process in each country, related to political, institutional, and technical conditions and the questions being asked at a given time.
- Three technical additions to DEMDESS would greatly enhance its scope and power: incorporation of an NPS model, a flux model, and water use/supply. The NPS model is very important, because in many cases NPS is more important than point sources. A flux model is an analytical/statistical procedure that can use the point source emissions and observed water quality data to estimate NPS loads. A water-use component for drinking water, irrigation, etc. should be added. This water-use component is a natural extension of DEMDESS that could be incorporated easily and that could be used for risk assessment, prioritization of emissions control, setting of standards, etc.

Following is a summary of indicators of success in the DEMDESS 1994 project.

1. DEMDESS is installed, running, and users have been trained.

Bulgaria:	YES
Slovakia:	YES
Hungary:	YES
Poland:	YES

2. DEMDESS has been used in a real problem.

Bulgaria:	YES	(Yantra, Sevlievo)
Slovakia:	Partial	(Nitra, Hornad)
Hungary:	YES	(emissions policy, Sajo/Hernad)
Poland:	NO	

3. The host country information has been modified/extended.

Bulgaria:	YES	(Reach File, Emissions Management, National Information System)
Slovakia:	YES	(Emerging Decision Support Process)
Hungary:	YES	(Reach File)
Poland:	YES	(Regulations, Reach File, Emissions)

4. DEMDESS is incorporated by the governments as a way of doing business.

Bulgaria:	YES
Slovakia:	Probably
Hungary:	Probably
Poland:	YES

Appendix A

DEMDESS MILESTONE DATES

DEMDESS Milestone Dates

Nov. 1991:	Phase I DEMDESS startup with development of prototype Bulgarian DEMDESS.
Dec. 1991:	Startup Workshop in Visegrad, Hungary with representatives from Bulgaria, Romania, Hungary, and Slovak Republic.
May 1992:	Phase I closeout Workshop in Bratislava.
Sept. 1992:	Begin DEMDESS Phase II
May 1993:	Regional DEMDESS Workshop in Budapest
June 1993:	Bulgarian National DEMDESS Workshop
Jan. 1994:	Begin DEMDESS Phase III
Feb. 1994:	Reconnaissance Trip to Hungary, Slovakia, and Bulgaria.
March 1994:	Poland LEM/USAID Nonpoint Source Workshop, introduced DEMDESS
April-June 1994:	Phase III technical development in the United States
July 1994:	Interim training/delivery visits to Poland, Slovakia, and Bulgaria
Aug. 1994:	Closeout visit to Hungary
Sept. 1994:	Final delivery, training, and closeout workshops in Slovakia, Poland, and Bulgaria
Oct. 1994:	Final report completed
Nov. 1994:	DEMDESS debriefing presentation at State Department

Appendix B

DEMDESS CONTACTS

DEMDESS Contacts

The following are the primary DEMDESS contacts, including the institutional and technical contacts in each country:

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Appendix C

DEMDESS DESIGN

Organization of DEMDESS Data Base System

DEMDESS is composed of six major systems, carefully integrated to provide for rapid, flexible development of decision analyses. Much of the work over the last two years has been building the data bases.

The DEMDESS data base is carefully designed as an "open" system. The design shown in Figure C.1 is the current system, which is open to other components and even other complete models (such as WAWTTAR and the U.S. EPA Qual2e water quality model). Some possible extensions include a complete nonpoint source (NPS) model and a drinking water subsystem. The data base systems are as follows:

- The *Emissions Subsystem* identifies existing dischargers and their emissions.
- Linked to the Emissions Subsystem is the *Reach File* river network, a powerful design adopted from the U.S. EPA River Reach File (the Reach File is becoming the U.S. standard for hydrographic data). The Reach File is also linked to the *Water Quality Subsystem*, which enables the identification of water quality problems as they relate to specific dischargers and permits development of water quality models.
- The *Regulatory Subsystem* links to Emissions, Reach File, and Water Quality, so that routine reporting of emissions and stream-standard violations can be determined and scenarios can be evaluated.
- The *Treatment Subsystem* interacts with the Emissions Subsystem to build alternative treatment scenarios. These scenarios include full costing capabilities, regulatory effects, and ultimately, effects on in-stream water quality. One major advance has been the incorporation of the WAWTTAR system into the Treatment Subsystem, an example of DEMDESS's open design.
- The *Institutional Subsystem* is shown as unlinked because institutional information permeates the other subsystems, e.g., the Emissions Subsystem includes information on the agencies responsible for emissions control and monitoring, and the Water Quality Subsystem includes information on agencies responsible for monitoring water quality.

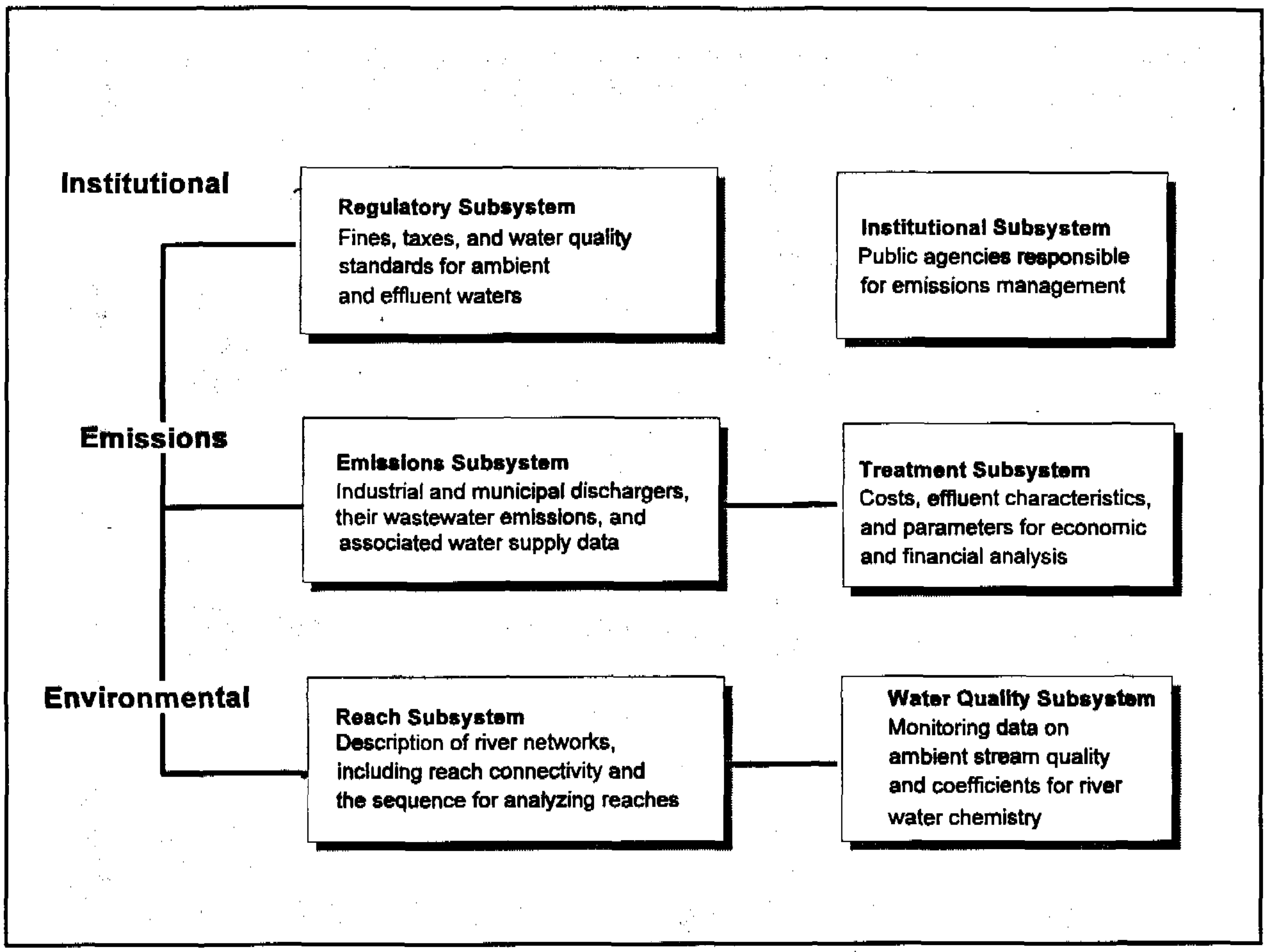


Figure C-1
Organization of DEMDESS Data Base System

Extended DEMDESS System Design

Figure C.2 shows the information flow among the major components in the Extended DEMDESS system. The arrows show the directions in which information can flow. The heart of the system is the Core DEMDESS, which includes the primary data bases plus basic analytical routines such as water quality graphs and emission profiles and rankings, and regulatory computations such as emissions taxes and fines, emission violations, and water quality standards. The Core DEMDESS includes a master user-friendly menu system to manage the data bases and perform analyses and reporting.

The SCENMGR receives and operates on data from WAWDEM, the EPM, and general coefficients of economic/demographic development. Information received through SCENMGR is passed onto the Core DEMDESS analysis routines. SCENMGR is incorporated into the master DEMDESS menu system.

The EPM uses a baseline set of emissions, which can be either existing conditions or a scenario. The EPM is an independent system developed in this project, and includes a full menu system to define policies, run the model, build a logical series of policies, and then report and graph the results. The EPM should be set up and used independently of the master DEMDESS menu system.

The Qual2e interface sends emissions loadings to the model, runs the model, and then brings the water quality profiles back into DEMDESS. The emissions sent to Qual2e can be existing conditions or predictions from a scenario. Qual2e also has the capability to use data from the Water Quality Subsystem as loadings when tributaries are configured as "point sources"; this is a common modeling technique in larger river systems. The Qual2e Interface is incorporated into the master DEMDESS menu system.

WAWDEM receives output files from WAWTTAR, loads them into DEMDESS-compatible tables, and provides a variety of analytical routines for individual WAWTTAR runs as well as multifacility analyses. WAWDEM contains a complete menu system that can be run as an independent system or incorporated into the master DEMDESS system.

There are two Executive Interfaces: one for the EPM and one for prefeasibility studies (PFS). The EPM Executive Interface includes routines to load data directly from the EPM. The EPM Executive Interface, which relies on clear graphical presentations, provides an easy way for decision-makers to assimilate the many dimensions of the EPM analyses.

The PFS Executive Interface brings in data from Core DEMDESS, SCENMGR results, WAWDEM, and Qual2e runs. The PFS has easy-to-use displays that show, in sequence, existing water quality and emissions conditions, results of zero discharge for the target polluter, WAWTTAR-WAWDEM summaries, and changes in water quality and emissions for two user-defined Treatment Options.

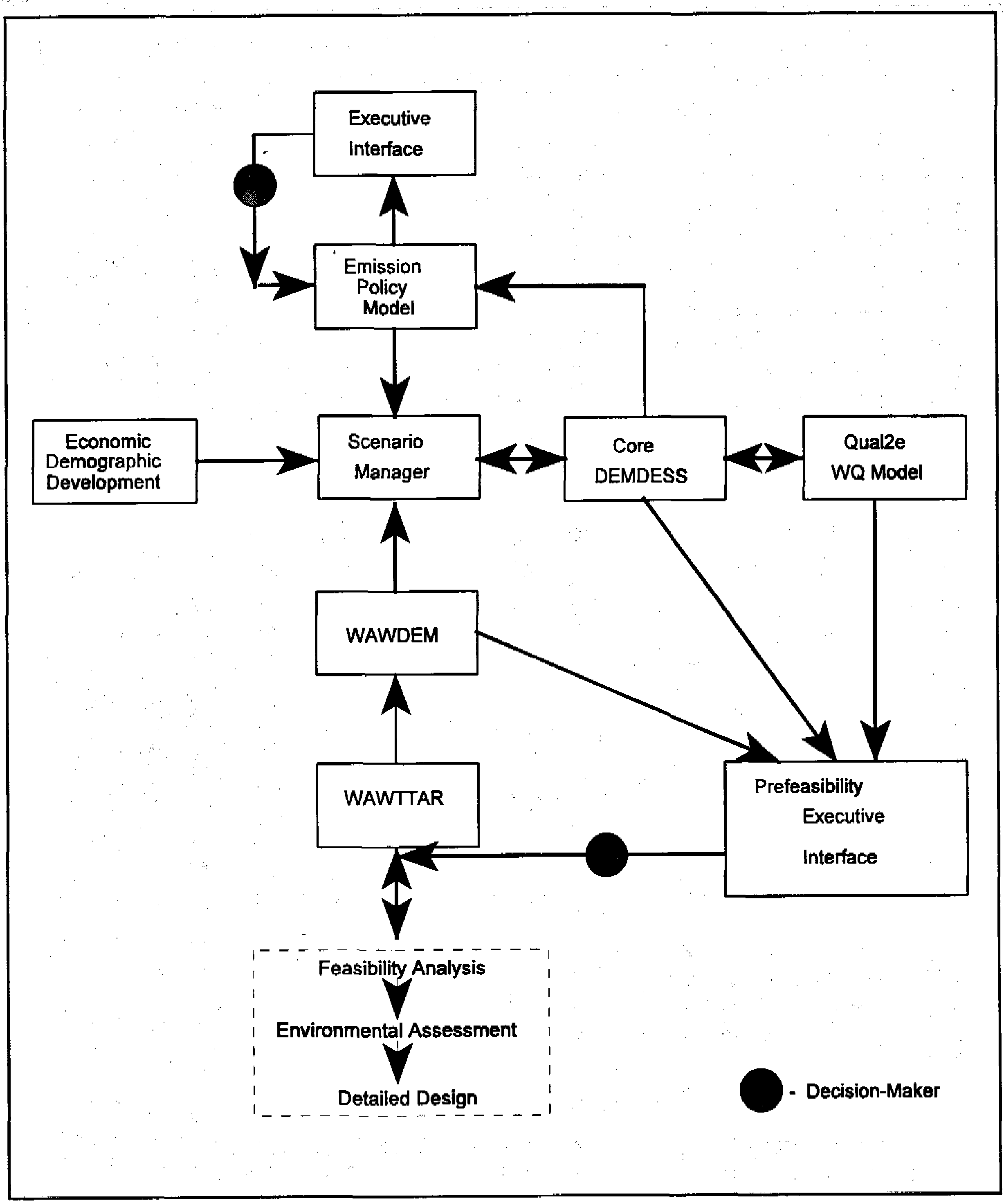


Figure C.2
Extended DEMDESS Data Flow Diagram

Figure C.2 provides a "roadmap" for using the Extended DEMDESS. For instance, to show the changes in water quality that may result from a particular WWTP option from WAWTTAR, follow the diagram to figure out what steps to take. The first step is to do the WAWTTAR runs, then move them into WAWDEM. Next, define a scenario with SCENMGR and bring the particular WWTP into the scenario. The scenario is run on the Core DEMDESS system, then the Qual2e model is run. Finally, the PFS is run and the Qual2e model results are loaded into one of the Treatment Option slots.

Executive Interfaces

Experts experienced in the development of Executive Interfaces and presentation graphics were consulted to ensure that these Interfaces would be properly designed for decision-makers. Some basic principles were followed as a result of these consultations. Basic Windows standards for screen layout were maintained in the interfaces. The screens are simple and consistent, with a graphic on the left and clearly defined buttons on the right. The graphics are clear and use simple fonts, with only one graph displayed at a time. Most important, the interfaces operate at high speed, so that busy decision-makers do not have to wait for the next screen to appear.

Two complete Executive Interfaces were developed, one for the EPM and one for prefeasibility studies. The figures at the end of Appendix G show example screens from the interface for prefeasibility studies. Note the graphic on the left, selection buttons to the right, standard Windows menus at the top, and the simple "speed bar." The Executive Interfaces are more fully explained in Appendixes F and G.

Programming Languages

Paradox 4.0 for DOS is used for the Core DEMDESS, SCENMGR, WAWDEM, and the EPM. All data bases are in standard Paradox 4.0 format (".DB" files). The applications are programmed in Paradox Application Language with menu systems developed using the Paradox Application Workshop.

WAWTTAR is a stand-alone system distributed as executable code running under Windows. WAWTTAR is implemented in Microsoft Visual Basic for Windows.

Qual2e is written in Fortran and distributed as a stand-alone DOS executable file.

The Executive Interfaces are implemented in Borland Quattro Pro 5.0 for Windows. All programming is done using the Quattro Pro Macro Language.

Appendix D

WAWDEM

Introduction

The WAWTTAR-DEMDESS (WAWDEM) analysis system has been built to facilitate the incorporation of WAWTTAR into DEMDESS. There are three primary objectives to WAWDEM: (1) act as an interface between WAWTTAR and DEMDESS; (2) provide post-processing tools for assisting the analyst in communicating with decision-makers; and (3) provide analysis support for complex multisite situations.

WAWDEM receives output files from WAWTTAR, loads them into DEMDESS-compatible tables, and provides a variety of analytical routines for individual WAWTTAR runs as well as multifacility analyses. WAWDEM contains a complete menu system that can be run as an independent system or incorporated into the master DEMDESS system.

This document explains the functions and operation of WAWDEM and how to incorporate WAWTTAR results into DEMDESS.

Loading WAWTTAR Output Into WAWDEM

The first step in WAWDEM is loading WAWTTAR results into the WAWDEM data bases. WAWDEM reads the text output files from WAWTTAR, parsing the file to locate the data. Critical data loaded into the WAWDEM data bases include the flow, population, and for each WWTP, the costs, effluent concentrations, and sludge quantities.

WAWTTAR runs as used in WAWDEM should use "no standards" as the effluent standard, so that all WWTP alternatives are in WAWDEM. WAWDEM will be able to screen the alternatives for DEMDESS.

Also, WAWTTAR should be run with a "no treatment" WWTP alternative, having zero costs and no pollutant removal. The no treatment alternative lets WAWDEM compute influent concentrations, which correspond to "existing conditions" in DEMDESS. Being able to upgrade existing conditions based on the intensive WAWTTAR analyses is an important use of WAWTTAR for DEMDESS.

WAWTTAR limits output to a maximum of pollutants at a time. If you want to evaluate more than five pollutants, then multiple WAWTTAR runs need to be loaded into WAWDEM. There is no limit to the number of WAWTTAR runs that can be loaded into WAWDEM.

Interface to DEMDESS

Three steps are required to bring a WAWTTAR Treatment Plant into DEMDESS.

1. For each WAWTTAR run, enter the DEMDESS discharger identifiers into the WAWDEM file. The DEMDESS variables are "DISCHID" and "TREATLEV," which uniquely define a single DEMDESS discharger. WAWDEM provides special data entry screens to enter this link.

2. Each pollutant output from WAWTTAR needs the corresponding DEMDESS pollutant code, which is the DEMDESS variable "PARMCODE." WAWDEM contains a correspondence table that automatically assigns the PARMCODE for many WAWTTAR pollutants. For WAWTTAR pollutants not in this table, WAWDEM provides data entry screens to manually enter these PARMCODES as necessary.

3. Use the DEMDESS Scenario Manager (SCENMGR) to import WAWTTAR runs. This is a menu item in SCENMGR that walks the user through the necessary steps. First, the user selects the scenario to import into. Second, the user selects the specific WAWTTAR run to import. Third, the user selects which specific WAWTTAR WWTP to bring in. SCENMGR updates all of the necessary DEMDESS tables based on the user selections.

If more than five pollutants are being considered, this process will need to be run multiple times, with five pollutants being incorporated at a time. If WAWTTAR is being used to update existing emissions, selection of the "no treatment" WWTP will result in updating the EMISS table in DEMDESS.

Pollution Indexes

WAWDEM computes a single "Pollution Index" (PI) for each WWTP alternative from WAWTTAR. This index is computed as:

$PI = Q * (\sum Wi * Ci)$, i=1 to 5

Q = emission flow (cmd)

W_i = user-defined weighting factor for pollutant i

Ci = effluent concentration (mg/l) for pollutant i with the given WWTP alternative

i goes from 1 to 5 because WAWTTAR limits output to a maximum of 5 pollutants.

The units for the PI are weighted pollutant loading in thousand kg per day. The assignment of the weighting factors is very critical, and needs to be used in a logical, consistent manner. Also, over-reliance on the PIs for ranking WWTP alternatives could be misleading.

Two techniques for using the PI weighting factors are suggested. First, you could examine a single pollutant at a time by setting the weight for pollutant of choice to 1 and setting all other weights to zero. Second, you could set the weights proportionally by the relative magnitude of effects on water quality. Work on using the PIs has just begun, and other techniques may be possible. Also, a third technique is suggested in the section on multisite analyses.

Pollution Index vs. Cost Analyses

The advantage of the PI is that it provides a simple procedure for evaluating the cost-benefit relationships of the many treatment alternatives in WAWTTAR. WAWDEM plots the PI as a function of the total annual cost. Under the given weighting scheme, this graph shows very clearly which technologies are cost-effective. An example graph is shown as Figure D.1. Each point on the graph represents one WWTP defined in WAWTTAR. WAWDEM determines the "envelope" of the PI vs. Cost data points and marks these points with larger circles, as shown on Figure D.1. These marked points are the most efficient selections, in that they are the least costly alternatives for a given level of PI. All other points have higher costs and higher PIs than an alternative on the envelope.

These graphs can be used as dramatic evidence to decision-makers of the importance of selecting the right WWTP alternative. The costs and performance characteristics vary greatly, so the stakes are high.

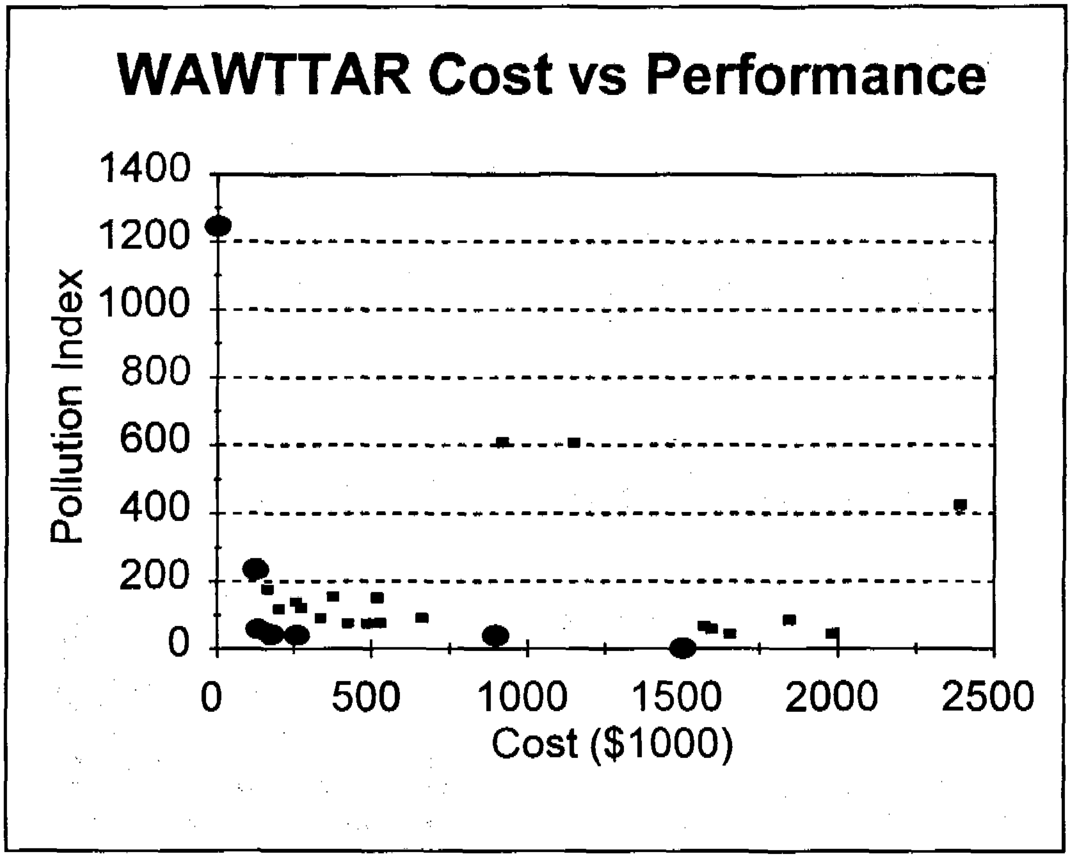


Figure D.1

Multisite Analyses

WAWDEM can evaluate complex multisite situations. Multisite situations are complex primarily because of the large number of possible combinations of treatment. For example, if there are 10 possible WWTP alternatives at 3 separate sites, the total number of possible configurations is 1000 (10*10*10). The WAWDEM multisite analysis tools help the analyst sort through these vast numbers of possibilities and provide graphics to communicate the situation to decision-makers.

WAWDEM uses the PI to look at multiple sites. Since the PI is a measure of pollutant loading, the PIs are additive for multiple sites. The steps in the multisite analysis are:

1. Load all relevant WAWTTAR runs. These can include analyses for each site as an independent facility as well as analyses that combine two or more sites into one treatment facility. For instance, for a municipality and one large industry, three WAWTTAR analyses could be employed: one for the municipality only, one for the industry only, and one for the two combined.

2. Set the PI weighting factors the same for all runs. This is necessary for consistency when adding the PIs.

3. Define the treatment configurations. In the example above, two configurations are employed: the municipality and industry as separate facilities, and the two combined. WAWDEM provides a data entry screen to easily define these configurations.

4. Manually edit the "optimum" treatment alternatives (the larger circles shown in Figure D.1) for each WAWTTAR run, as desired. The multisite analysis first extracts the individual "optimums" from each run as a first screen. It may be desirable to manually override the optimums computed by WAWDEM, to reduce the overall number of treatment configurations being examined. There is no theoretical limit to the number of permutations examined by WAWDEM, but the numbers can quickly get huge. WAWDEM provides for manual overrides "optimum" flag.

5. Load the WAWTTAR runs into the multisite data base. This operation may be automated in future versions of WAWDEM, but for now, the user has to specify each relevant WAWTTAR run to be used. The loading extracts the "optimum" configurations from each WAWTTAR run.

6. Run the multisite analysis and evaluate the results. WAWDEM determines each possible WWTP configuration and computes the total PI and the total annual cost for each. WAWDEM plots the PI-cost values and determines the "optimum" solutions on the "envelope" of the curve.

The result is similar to a single WAWTTAR run, except the total number of alternatives is *much* larger. Figure D.2 shows an example from a multisite analysis; this curve has over 2,000 possible WWTP configurations, examining 6 separate sites at one time. From a cost-benefit perspective, the knee of the curve is perhaps the best solution, if the water quality consequences are acceptable. Figure D.2 is useful to show decision-makers the stakes and complexity in making the right choices and the wide range of choices that are available.

Next Steps

WAWDEM meets its primary objectives: (1) to act as an interface between WAWTTAR and DEMDESS; (2) to provide post-processing tools for assisting the analyst in communicating with decision-makers; and (3) to provide analysis support for complex multisite situations.

In addition to meeting the above objectives, WAWDEM is a new system with some intriguing potential. Investigation into the use of the PI has just begun, but applications can be seen in areas such as risk assessment/ranking and basinwide screening. "Calibrating" the PI based on water quality objectives may be feasible. The multisite analyses is a new approach to an inherently complex optimization problem and may be able to provide valuable insights.

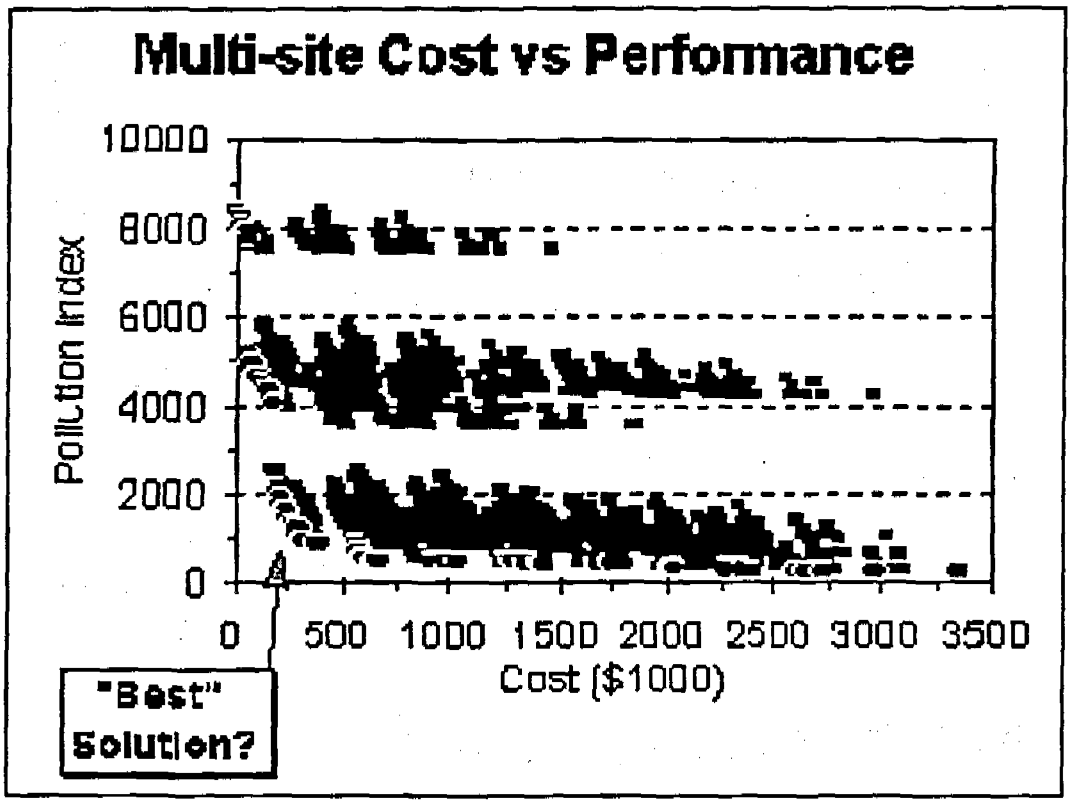


Figure D.2

WAWDEM Menu Structure

```
— WAWDEM                 Run WAWTTAR-DEMDESS Interface
|
| ├─ LOAD                [PLAY:Wawload] Load a WAWTTAR RUN Into DEMDESS
| |
| ├─ TEXTVIEW            [MULTI:Wawtext] View WAWTTAR Text File Output
| |
| ├─ ANALYSIS            Analyze a Single WAWTTAR RUN
| |
| | ├─ INDEXES           [PLAY:Wawindex] Edit Indexes, View Graph
| | |
| | ├─ GRAPH to Screen   [PLAY:Wawgrphs] Graph Index vs. Cost
| | |
| | ├─ GRAPH to Printer  [PLAY:Wawgrphp] Graph Index vs. Cost
| | |
| | ├─ EDIT SOLUTIONS [PLAY:Wawopted] Edit "optimum" solutions
| | |
| | └─ STANDARDSExamine WAWTTAR Runs Re. Standards
| |
| | ├─ ADD A NEW STANDARD [PLAY:Wqstdadd]
| | |
| | ├─ EDIT STANDARDS [EDIT:WAWWQSTD]
| | |
| | ├─ COMPUTE [PLAY:Wqstdcmp] Compute if Standards Met
| | |
| | ├─ GRAPH to Screen [PLAY:Wawgrfws] Show Standards
| | |
| | ├─ GRAPH to Printer [PLAY:Wawgrfwp]
```

```
| | |
| | └─ VIEW [PLAY:Wawstded] View Standards Comparison
| |
| ├─ MULTI-SITE Build and Analyze Multisite Solutions
| |
| | ├─ TRTMNT CORRESPONDENCE TABLE [EDIT:TRTOPTS]
| | |
| | ├─ MULTI-SITE ADD [PLAY:Multiadd] Add to Multisite DB
| | |
| | ├─ MULTI-SITE DELETE [PLAY:Multidel] Del from Multisite DB
| | |
| | ├─ VIEW MULTI-SITE DATABASE [EDIT:MULTISIT]
| | |
| | ├─ MULTI-SITE ANALYSIS [PLAY:Multibld] Run Analysis
| | |
| | ├─ MULTI-SITE GRAPH to Screen [PLAY:Multigrs]
| | |
| | ├─ MULTISITE ANALYSIS to Printer [PLAY:Multgrp]
| | |
| | ├─ GRAPH OPTIMUMS to Screen [PLAY:Multgr2s]
| | |
| | ├─ GRAPH OPTIMUMS to Printer [PLAY:Multgr2p]
| | |
| | ├─ TREATMENT ALTERNATIVES [EDIT:MULTIOPS]
| | |
| | ├─ TREATMENT SUMMARY [EDIT:MULTISUM]
| | |
| | ├─ VIEW OPTIMUMS [EDIT:MULTSUM2] View "Optimum" Solutions
```

| | |

| | └─ TREATMENT TYPES IN A WINDOW [PLAY:Multirng]

| |

| ├─ UTILITIES Export to Spreadsheets

| |

| | ├─ QUATTRO PRO - Full Run [PLAY:Wawtoqp]

| | |

| | ├─ QUATTRO PRO - SUBSET [PLAY:Wawtoqpy] Export "Optimums"

| | |

| | ├─ LOTUS 1-2-3 Full [PLAY:Wawto123]

| | |

| | └─ LOTUS 1-2-3 SUBSET [PLAY:Wawt123y] Export "Optimums"

| |

| └─ DEMLINK [PLAY:Wawdemed] Edit Link to DEMDESS

|

Appendix E

THE DEMDESS SCENARIO MANAGER

Introduction

The DEMDESS Scenario Manager (SCENMGR) acts on copies of Core DEMDESS components, with options to modify virtually any aspect of DEMDESS in defining a scenario. Options include manually editing discharger characteristics, emissions, wastewater treatment plants (WWTPs), and any regulations. SCENMGR can use data from WAWDEM to define any particular WWTP configurations built in WAWTTAR. A particular policy option outcome predicted in the Emissions Policy Model (EPM) can be incorporated into a scenario. General coefficients of economic/demographic development can be applied to emissions by economic sector.

SCENMGR receives and operates on data from WAWDEM, EPM, and general coefficients of economic/demographic development. Information received through the SCENMGR is passed onto the Core DEMDESS analysis routines. SCENMGR is incorporated into the master DEMDESS menu system.

How SCENMGR Works

SCENMGR works with copies of the DEMDESS tables that are related to "what if" questions. The nine tables and their descriptions are listed below.

Table	Description
DISCH	Dischargers
EMISS	Emissions
TPCST	Treatment Plant Costs
TPCHR	Treatment Plant Pollutant Removal Characteristics
WQSTDES	Ambient and Emission Standards Descriptions
WQSTDS	Parameter-specific Standards
TAXES	Emission Tax Schedule
FINES	Emission Fine Schedule
INDCODE	Industrial/municipal growth factors

Different scenarios are identified with a 1-character suffix to the table name. "Existing Conditions," the current real values, are always identified with a suffix of "X." For instance, the DISCH table for Existing Conditions is named "DISCHX." Note that in the Paradox/DOS environment, the actual table name "DISCHX.DB," and other members of the DISCHX "family" will have other DOS suffixes, e.g., the index table for DISCHX.DB is named DISCHX.PX. For convenience the scenario is identified by this suffix.

The "Current" scenario is always given a suffix of "1," e.g., "DISCH1"; it is also identified as "Scenario 1." The Core DEMDESS programs always operate on the "Current" scenario set of tables. These programs include emission profiles, emission rankings, emission violations, taxes, fines, etc. To report and analyze existing conditions, the Scenario X tables are first copied to Scenario 1, and then any emission analyses can be run.

Scenarios 2 to 9 are used for user-defined "what if" questions. SCENMGR first copies the set of tables from a scenario into the new scenario table names, e.g., copy "DISCHX" to "DISCH2." This new scenario can then be edited to reflect the scenario definition. For instance, if scenario 2 is to evaluate a new set of emission standards, edit the WQSTDE2 and WQSTDS2 tables. SCENMGR contains menu options to edit any scenario table.

WWTPs can be incorporated into a scenario in three ways:

1. Manually edit the TPID-TPLEV fields in DISCH records, also editing the TPCST and TPCHR tables if necessary.
2. Import a WWTP from WAWTTAR via the WAWDEM data bases.
3. Import WWTP information from the EPM.

Transferring a user-defined scenario to the "Current" scenario (Scenario 1) is not a simple matter of copying the tables. Several operations need to done, especially related to WWTPs. The program "RUNSCEN" performs these operations. RUNSCEN modifies emissions to reflect pollutant removals from WWTPs and also computes the costs of these WWTPs, using data in TPCHR and TPCST, respectively. The DEMDESS User Guides should be referenced for further information on the mechanics of these operations.

Note that virtually any aspect of emissions and regulations is open to modification in a scenario. Also, a new scenario can be built either from existing conditions or from another scenario.

Finally, scenarios can be deleted through a SCENMGR menu option.

SCENMGR has been designed to maximize flexibility and ease of use, at some sacrifice of disk space. Disk space is plentiful and cheap these days, so the sacrifice is well worth the benefits.

Scenario Analyses

The SCENMGR menu structure is shown in the next section. Most of the menu options should be self-explanatory. Most of the analyses are standard Core DEMDESS operations, such as emission profiles.

There is one new set of analyses for running the U.S. Environmental Protection Agency's water quality model "Qual2e." The analyses provide a link between emissions in Scenario 1 and the emission loadings in the Qual2e model runs. The model results are returned to DEMDESS for graphing and reporting and also for use in the Prefeasibility Study Executive Interface.

Scenario Manager Menu Structure

SCENMGR is implemented with a user-friendly menu system using the Paradox Workshop. The SCENMGR software can be completely tracked via documentation that is inherent in the Workshop system. A schematic of the menu options is provided below.

```
├─ SCENARIOS DEMDESS Scenario Manager and Analyses
|
| ├─ MAKE/REPLACE SCENARIO Set up or Replace Emissions Scenario
| |
| ├─ EDIT SCENARIO Edit Scenario or Import From WAWDEM or EPM
| |
| | ├─ EDIT SCENARIO Manually Edit Scenario Tables
| | |
| | ├─ WAWDEM IMPORT Import From WAWDEM/WAWTTAR
| | |
| | | ├─ LINK EDIT Edit Link Between WAWDEM and DEMDESS
| | | |
| | | └─ IMPORT Import WAWDEM Treatment Plant to DEMDESS
| | |
| | └─ EPM IMPORT Import From Emissions Policy Model
| |
```

```
| ├─ RUN SCENARIO Run a Scenario, Making it the Current Scenario
| |
| ├─ ANALYSES Analyze Current Scenario
| |
| | ├─ EMISSIONS PROFILE Setup and Run Emissions Profile Plot
| | |
| | | ├─ RUN Setup, Run, and View Emissions Profile Plot
| | | |
| | | └─ VIEW TABLE View Emissions Profile Table
| | |
| | ├─ RANKING EMISSIONS Setup and Run Emissions Ranking
| | |
| | | ├─ SETUP AND RUN Run Emissions Ranking Program
| | | |
| | | └─ VIEW RANKING TABLE
| | |
| | ├─ SCENARIO SUMMARY View Scenario Summary Table
| | |
| | └─ WQ MODEL Water Quality Model
| |
| | ├─ EDIT Edit Qual2e Input File
| | |
| | ├─ RUN Run Qual2e on Current Scenario
| | |
| | ├─ VIEW View Qual2 Output File
| | |
| | ├─ TABLE VIEW View Table of Results
| | |
```

| | └─ GRAPH Graph DO and BOD Model Results

| |

| └─ DELETE SCENARIO Delete A Scenario from the System

|

Appendix F

THE DEMDESS EMISSIONS POLICY MODEL

The DEMDESS Emissions Policy Model (EPM) is designed to help decision-makers and analysts evaluate various emissions control policies. The model is designed to address the following key issues at several policy levels:

1. Evaluation and comparison of broad policy alternatives, such as command and control (C&C) versus emissions charges (taxes and fines). The null alternative is also considered.

2. Within these broad policy alternatives, evaluation of key results, including likely WWTP construction, emission changes, total costs to society, and the financing considerations (who pays what) under the various policies.

3. For a given policy, such as taxes and fines, the model can help determine appropriate levels for fines and taxes given water quality objectives (e.g., a particular target level of emissions) and financial/economic objectives (e.g., balance taxes/fines and subsidies).

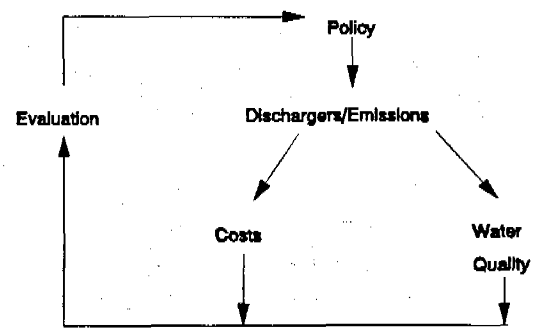
4. After a policy is chosen, DEMDESS can be used to implement, track, and refine the policy. The same basic data used to develop the policy is also the data needed for implementation, e.g., setting fines. This data can also be used to track the success or failure of the emission policy and its economic and financial effects. This tracking can be used on an ongoing basis to refine the emissions control policies.

DEMDESS Approach and the EPM

The DEMDESS EPM fits exactly into the DEMDESS Conceptual Framework discussed in Chapter 2 of the DEMDESS 1994 report. The conceptual framework is illustrated in Figure F.1 below.

In this framework, the EPM evaluates two policy options: C&C and taxes and fines. Each policy formulation affects dischargers and their emissions through decisions by dischargers on whether or not to build additional wastewater treatment facilities. The decisions by the dischargers are based on behavioral models built into the EPM. These decisions in turn affect water quality by reducing emissions and affect costs. Cost components include existing O&M, additional O&M costs, construction costs, taxes, fines, and subsidies. The evaluations are presented succinctly in graphs comparing the various policy options. Four primary bases for comparison are presented: (1) changes in total emissions; (2) number and types of treatment plants that will be built; (3) total costs to society (construction and O&M costs); and (4) financial effects (who pays what).

DEMDESS builds on existing detailed water quality and emissions data bases maintained by the Ministry of Environment. The emissions data bases contain information on each discharger, including current levels of emissions and current treatment levels. DEMDESS is unique among water quality information systems in that it dynamically integrates both the environmental and the economic/financial elements of water quality control.



DEMDESS Conceptual Framework

Figure F.1

The model focuses, for now, on "end of pipe" solutions, specifically building WWTPs. The nature of WWTP costing analysis requires highly disaggregated discharger data because WWTP costs (construction and O&M) are highly dependent on economies of scale.

The combination of detailed emissions data and integrated financial components enables the DEMDESS emissions policy model to frame questions in specific, real terms. The answers have a strong basis in the actual conditions in Hungary, providing answers that are as "real" as possible.

DEMDESS EPM Components:

1. *Existing emissions*. DEMDESS is designed to be updated as additional data becomes available. While current implementations of DEMDESS are on a basin level, DEMDESS is designed to incorporate national-level data. For now, the use of a single basin can provide many useful results.

2. *Wastewater treatment alternatives*. The model currently considers five levels of WWTP: no treatment, two levels of primary treatment, and two levels of secondary treatment. Emissions reductions for each treatment level are based on typical engineering experience with the efficiencies of each. The costs are based on U.S. cost curves, normalized for host country conditions. Separate cost curves are provided for construction and the O&M categories of labor, energy, and materials. All of the cost curves provide answers that reflect the economies of scale in WWTP construction and O&M. The model is built to be very flexible, so that additional treatment types and/or more country-specific cost curves can be incorporated.

3. *Regulations*. Taxes, fines, and emission limits are principle policy implementation instruments. The model incorporates all of these elements that are dynamically linked to dischargers and treatment alternatives. The tax, fine, and emission limits are key model input parameters.

4. *Financial factors*. Key financial factors include construction subsidy percent (treated as a grant); loan interest rate and period; labor, energy and material cost factors; and currency conversion. The model annualizes all costs based on the input interest rate and amortization period.

5. *Existing treatment plant O&M costs*. In the Hungary implementation, a simple cost in Ft per m3 is used, with different values for primary, secondary, and tertiary treatment. These factors do not contain any economies of scale.

6. *Behavioral models*. Two basic behavioral models are incorporated into the policy model:

   i. For the C&C policies, each discharger will build the minimum (least cost) additional wastewater treatment that will meet emissions standards. If the discharger is already meeting standards, then no additional treatment will be built. Even if the highest level of treatment does not meet standards, then the discharger will build the highest (highest cost) level of additional treatment available for use in the model.

   ii. For the taxes and fines policies, the discharger will take the minimum absolute cost option, factoring in taxes and fines paid; existing O&M costs; the costs of new construction and O&M; and construction subsidies, if included.

Model MENU Options

The EPM is implemented with a user-friendly menu system using the Paradox Workshop. The EPM software can be completely tracked via documentation that is inherent in the Workshop system. A schematic of the menu options is provided below.

```
MAIN

├─ Data Edit; Change Model Input Parameters
│
│  ├─ Fines; edit emission fines
│  │
│  ├─ Taxes; edit emission taxes
│  │
│  ├─ Emissions Standards
│  │
│  ├─ Loan Terms; Interest Rate, Amortization Period, Subsidy
│  │
│  └─ Local Currency Factors; Conversion Rate, Energy, Labor,   |          Material Costs
│
├─ Model Runs
│
│  ├─ Run DEMDESS Emissions Policy Model
│  │
│  ├─ Add Last Run to Comparison Tables
│  │
│  └─ Delete Selected Run From Comparison Tables
│
├─ Graphs: View Graphs of Results
│
│  ├─ View Graphs of Last Model Run
```

| |

| └─ View Comparison Graphs of Alternatives Saved by User

|

└─ Leave Exit

├─ To Paradox

|

└─ To DOS

Model Runs

Each model run combines the above components and user input, then evaluates and compares the three broad policy options of C&C, Charge, and the null alternative. The following steps are followed in each run:

1. Assemble existing dischargers and current emissions for the parameter chosen, e.g., Chemical Oxygen Demand.
2. Set up all five treatment alternatives for each discharger, computing the following:
   i. Emissions and loads after treatment
   ii. Treatment plant construction and O&M costs
   iii. Taxes on emissions
   iv. Fines on emissions
3. Compute existing O&M costs (note: in the Hungary version, this step goes back to the original VITUKI emissions data base for additional data).
4. Determine treatment options based on the behavioral models for C&C and Charge policies.
5. Aggregate and organize results for display and analysis.
6. At the user's option, the model results can be added to a scenario comparison data base for display and analysis.

Model Results

Two sets of graphs are available. The first presents results for the last model run, comparing the results for C&C, Charge, and Current Conditions. The second set of graphs permits comparisons of the Charge option for user-selected model runs. There are four graphs in each set: (1) total emissions; (2) treatment plant construction; (3) total costs; and (4) finances.

Model Extensions, Enhancements, and Possible Next Steps

The following "next steps" address current limitations in the EPM. Implementing all of these items would obviously be a long-term, significant effort. These items should be prioritized, balancing policy evaluation importance and level of effort to implement.

1. Extend the analyses to encompass the entire country by loading the complete national emissions data bases into DEMDESS. The model could also be enhanced to be able to alternatively examine policies on regional or national levels.
2. Enhance the analyses to evaluate economic effects within and across economic sectors. The economic sector corresponding to each discharger needs to be incorporated into the discharger data.

3. Enhance the model capabilities to operate on multiple water quality parameters. The model currently operates one parameter at a time. The emissions data bases currently contain all parameters monitored, but the Treatment and Regulatory components (taxes, fines, emission standards) will need to be checked for completeness on each parameter added. The software will also need to be modified to incorporate multiple parameters.

4. Extend the model to evaluate ambient water quality effects under the various scenarios. Total loadings is currently being used to evaluate the water quality effects; ideally, the criteria should be ambient water quality. DEMDESS is designed to dynamically incorporate instream water quality modeling. The "Extended DEMDESS," with its link to the Qual2e water quality model, could be used for this enhancement.

5. Develop improved country-specific wastewater treatment cost models. WAWTTAR could be used to develop general cost curves.

6. Improve the "existing O&M" costing and analyses.

7. Incorporate more treatment alternatives, including "low tech" alternatives (e.g., land treatment) and add-ons to existing treatment plants.

8. Incorporate additional key technical and financial elements, such as collector costs and sludge management.

9. Include, as an alternative "behavior," shutting down existing treatment plants.

10. Look at the total pollution picture by incorporating nonpoint source pollution.

11. Develop alternatives to "end of pipe" solutions, including Pollution Prevention, Waste Minimization, and Pollution "Trading."

12. Implement DEMDESS as an ongoing tool for evaluating and refining the emissions policies.

Emissions Policy Model Executive Interface

Central to DEMDESS is the decision-maker; an active, willing decision-maker is needed to make the best use of DEMDESS. Experience has shown that simple, clear, graphically appealing displays are most useful to the busy decision-maker. To date, DEMDESS interfaces have been more oriented to technical users. Fortunately, modern computer technologies provide powerful tools for building such executive interfaces. The EPM Executive Interface provides an enhanced presentation using modern Windows capabilities, including sophisticated graphics and publication-quality hard-copy output.

Experts experienced in the development of executive interfaces and presentation graphics were consulted to ensure that the Interface would be properly designed for decision-makers. Some basic principles were followed as a result of these consultations. First, the screens are kept simple and consistent. Consistency is maintained by always having a graphic on the left, and buttons along the right. Second, moving around the Interfaces is kept simple, relying on clear buttons and a very simple button bar. Third, the graphics are clear, with only one graph displayed at a time. Simple fonts are used in the graphics. Fourth, speed is essential, so that busy decision-makers do not have to wait around for the next screen to appear. Fifth, basic Windows standards for screen layout were maintained in the Interfaces.

The EPM Executive Interface is implement in Quattro Pro for Windows 5.0. Menu options are included to import results directly from the EPM and also to run the EPM directly from the Executive Interface.

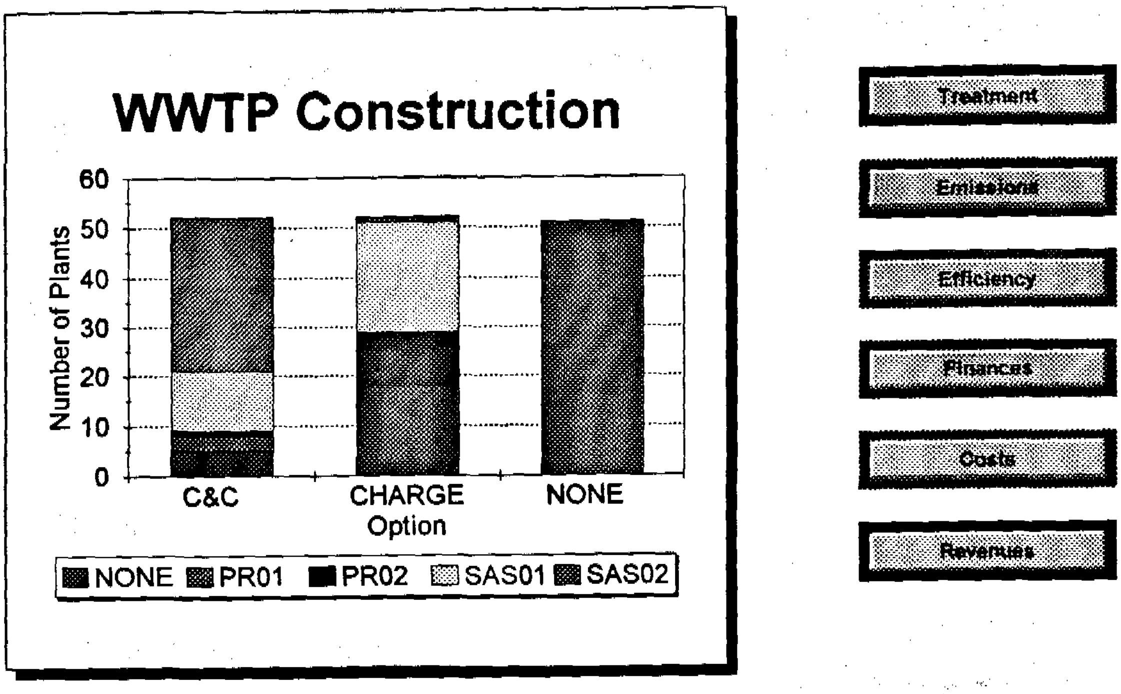
Sample outputs

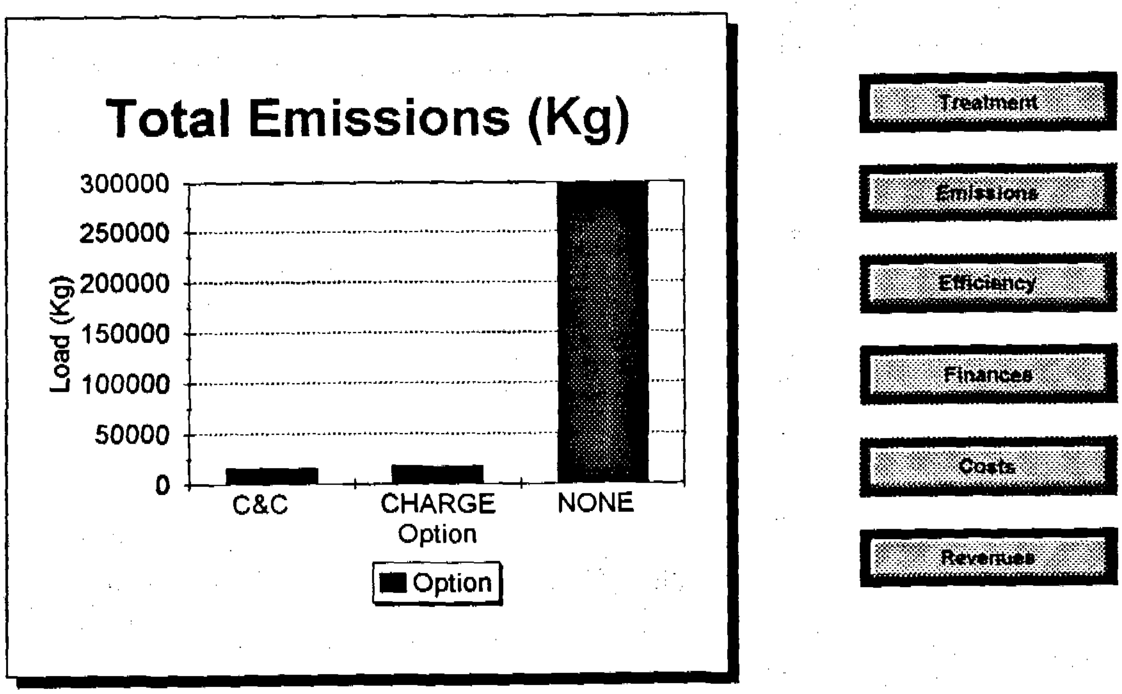
The following pages show sample outputs from the EPM. These samples are from the Executive Interface. Three sets of graphs are shown, with six graphs for each set. The first set shows results for a single run of the EPM. The second set shows a scenario of 10 individual EPM runs. The third set compares several 10-run scenarios. The six graphs show, in order:

1. Numbers and types of WWTBs predicted to be built;
2. Total emissions (Kg/day);
3. Unit cost of treatment (Lev/Kg);
4. Breakdown of financial components, i.e., capital costs of treatment, O&M costs, taxes, fines, and subsidies;
5. Total costs of treatment per year; and
6. State revenues and expenditures per year.

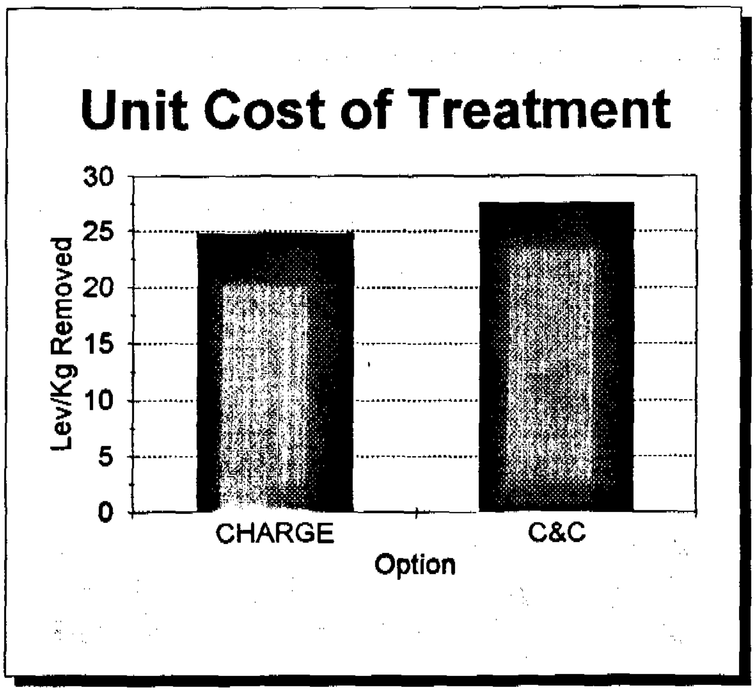
The samples are taken from the Bulgarian version of the EPM, in which the emissions tax is varied from 20 to 200 Lev/Kg.

Example of a Single Run

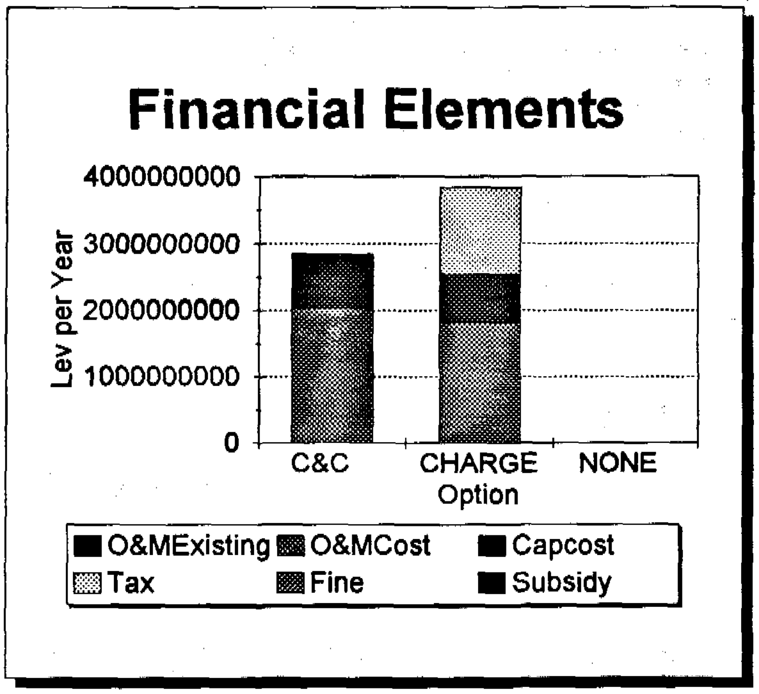




Example of a Single Run

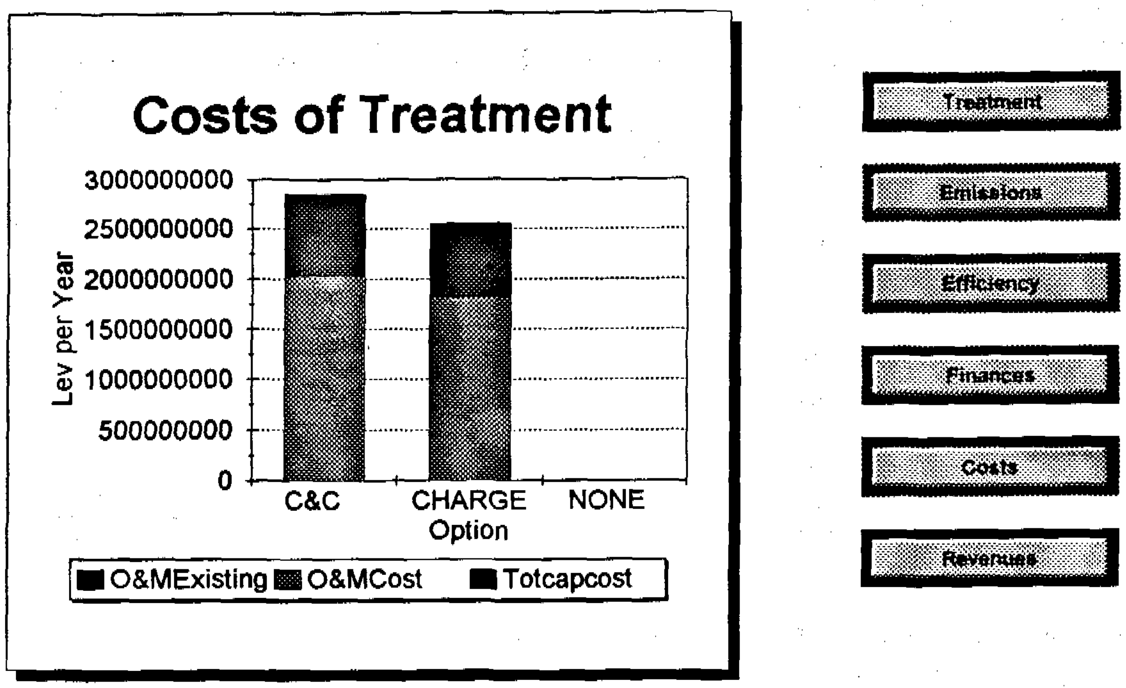


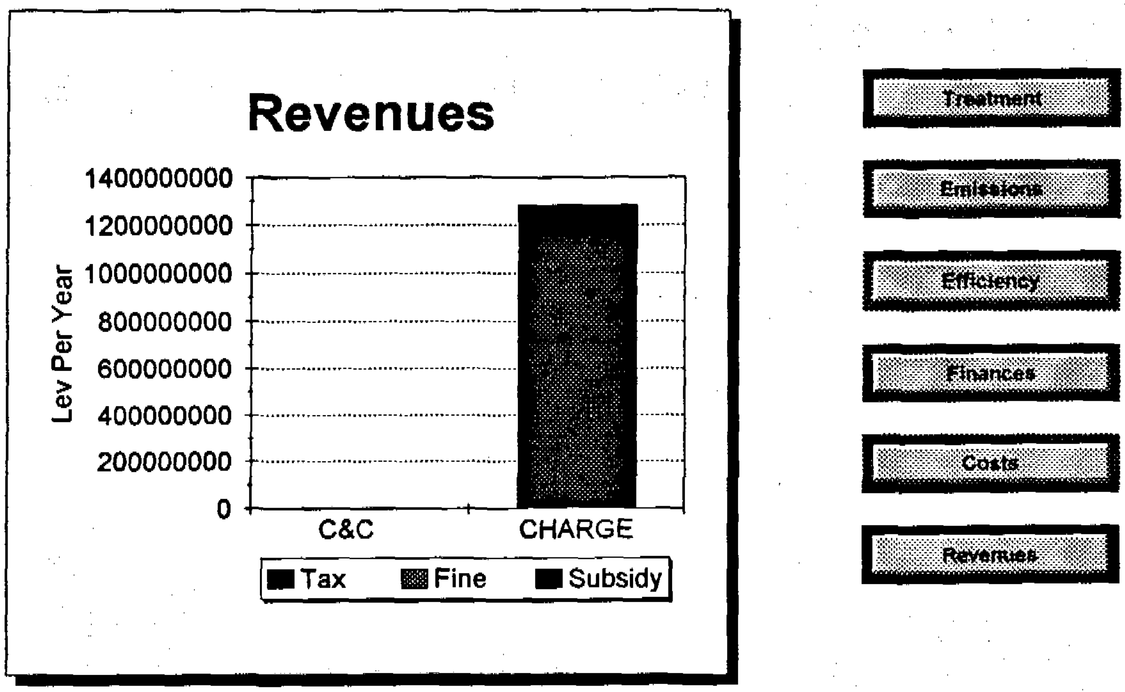
Treatment
Emissions
Efficiency
Finances
Costs
Revenues



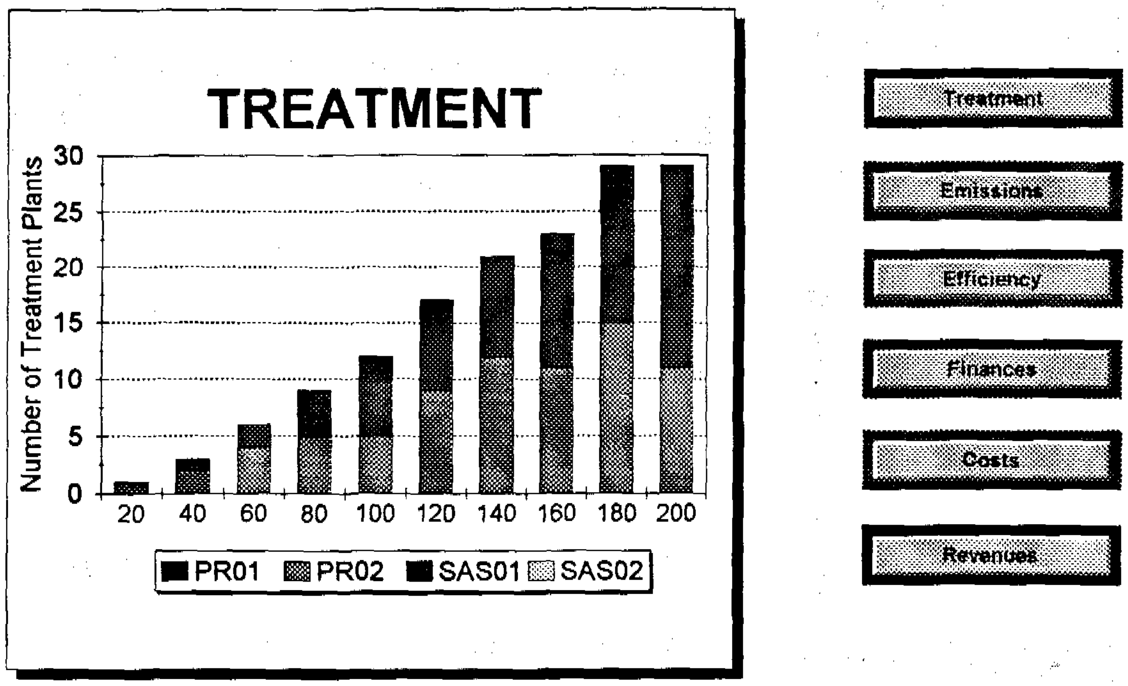
Treatment
Emissions
Efficiency
Finances
Costs
Revenues

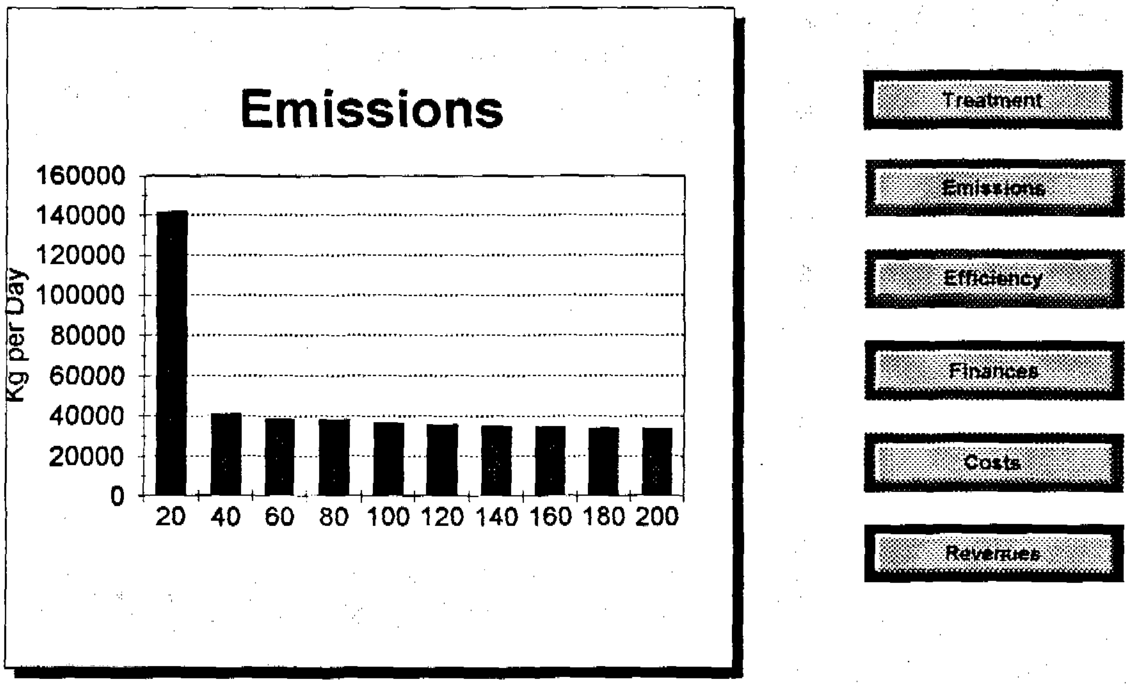
Example of a Single Run





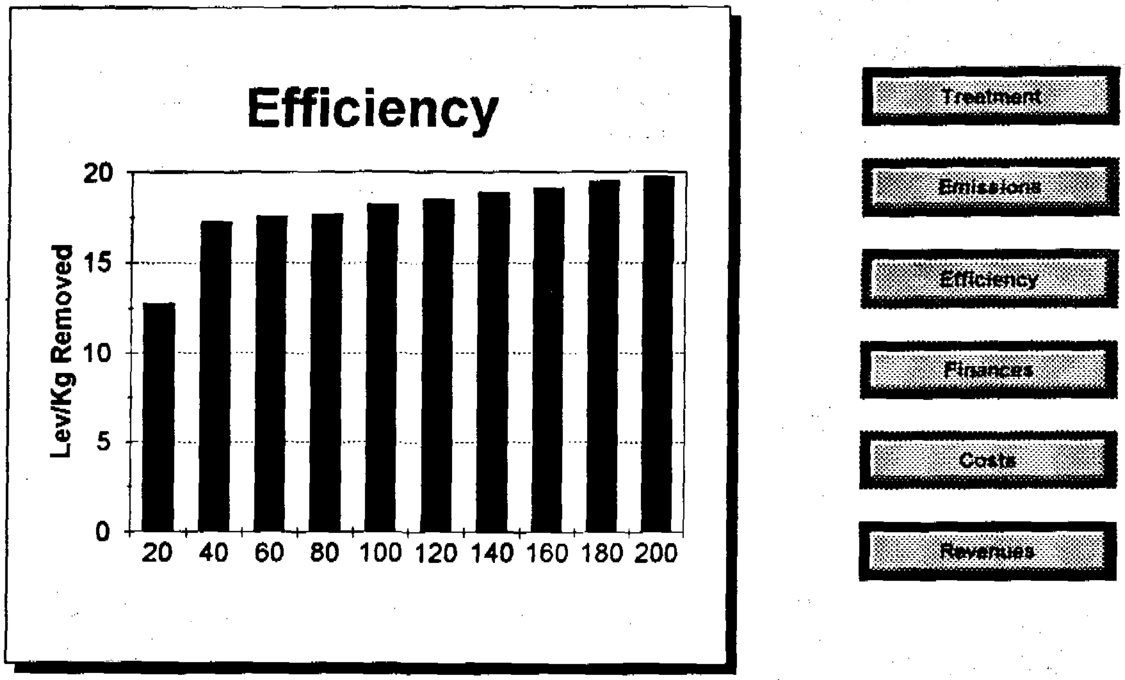
Example of a Scenario Sequence: Emissions Tax from 20 to 200 Lev/Kg

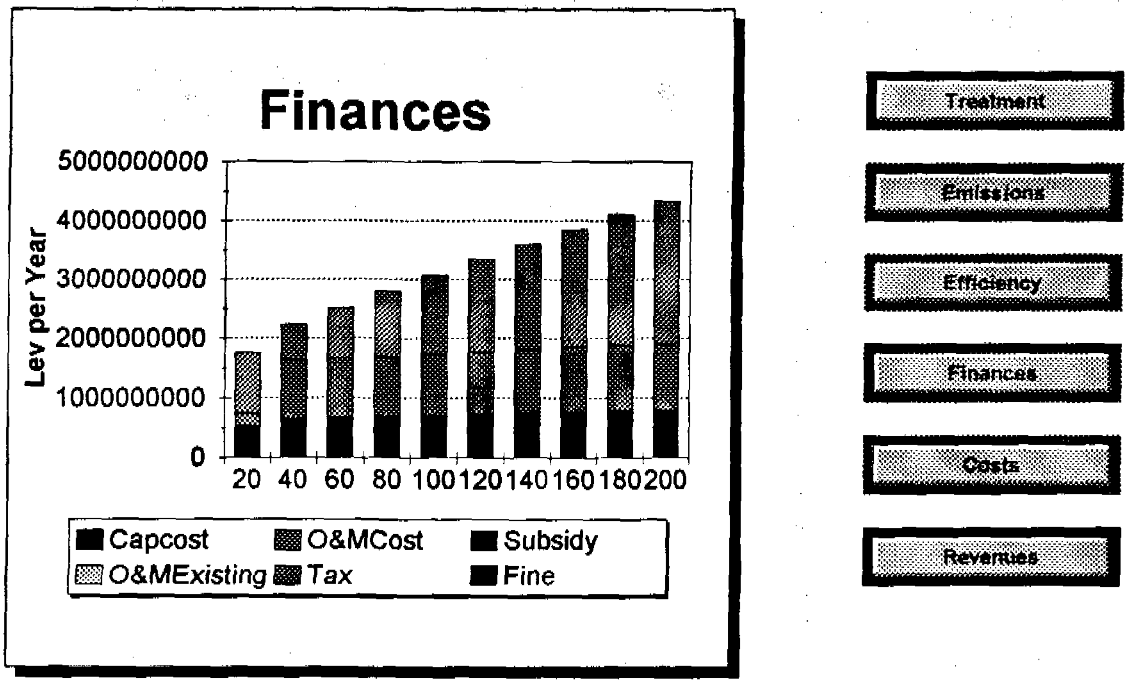




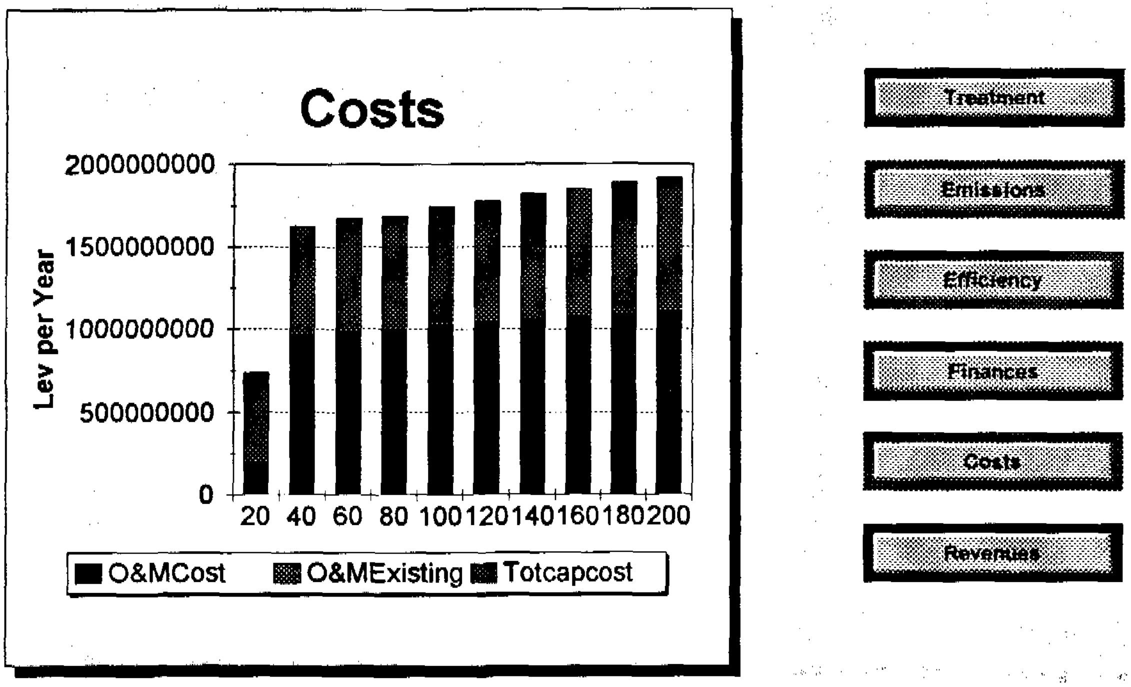
DEMDESS Emissions Policy Model

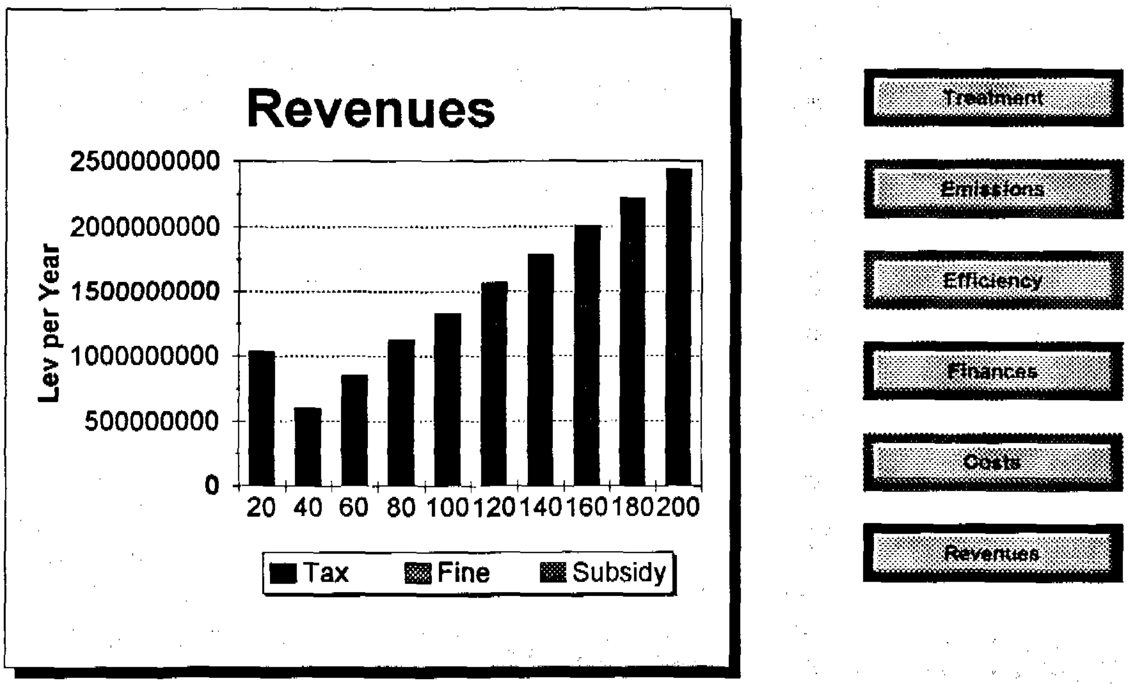
Example of a Scenario Sequence: Emissions Tax from 20 to 200 Lev/Kg





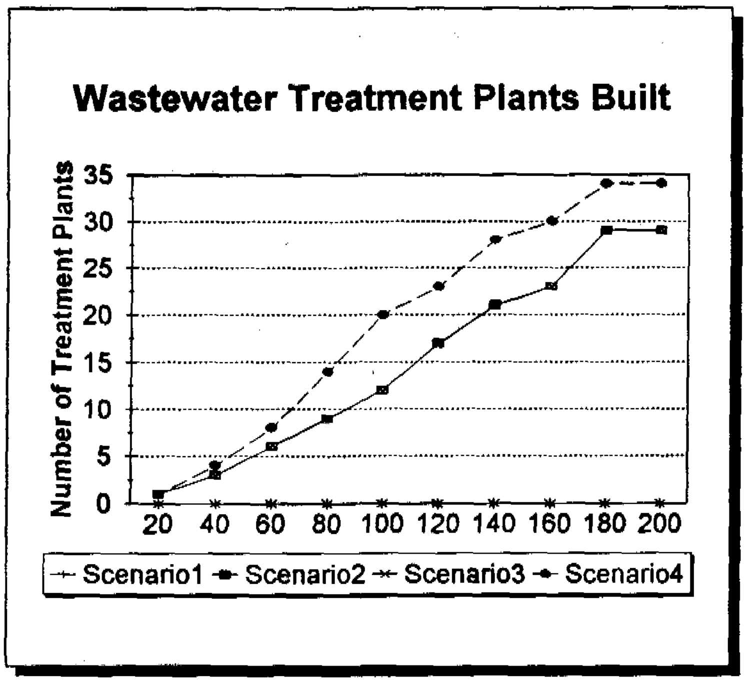
Example of a Scenario Sequence: Emissions Tax from 20 to 200 Lev/Kg





DEMDESS Emissions Policy Model

Example of Scenario Comparisons: Charges from 20 to 200 Lev/Kg



Treatment

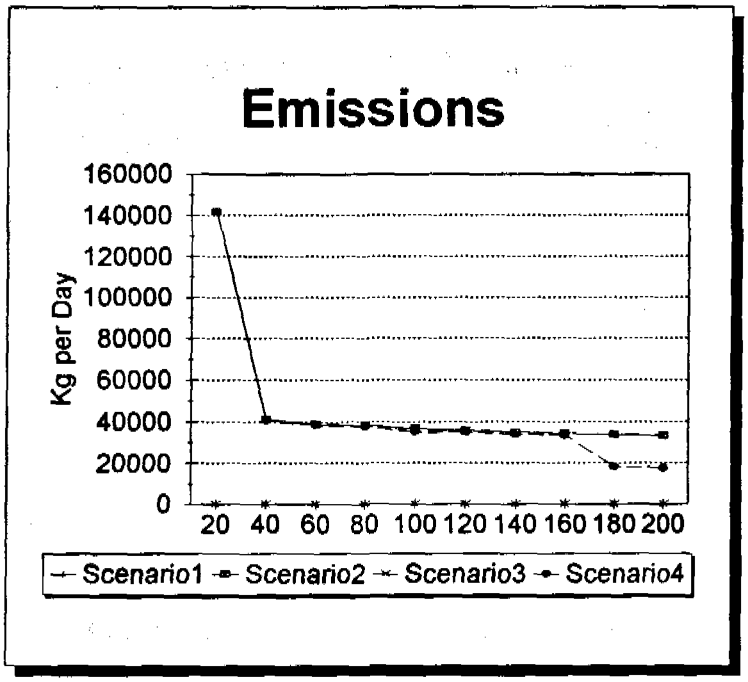
Emissions

Efficiency

Finances

Costs

Revenues



Treatment

Emissions

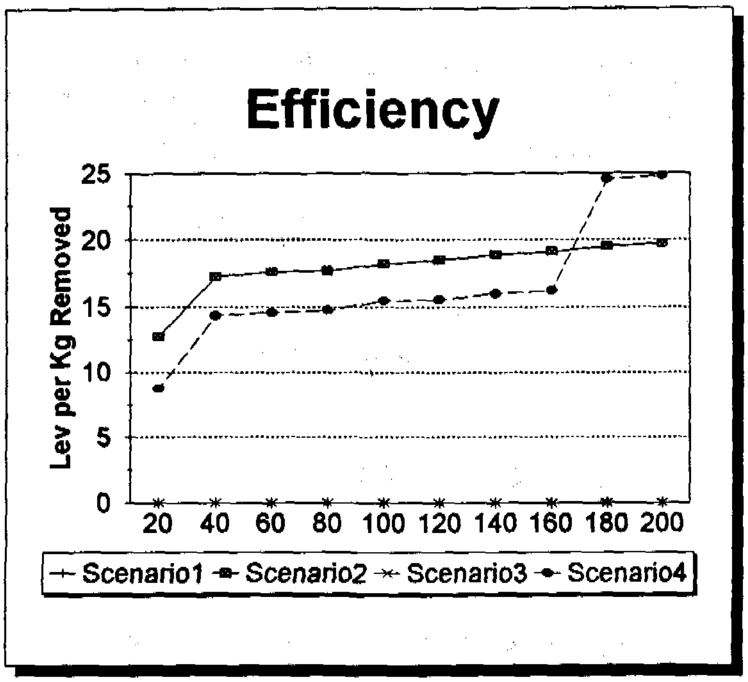
Efficiency

Finances

Costs

Revenues

Example of Scenario Comparisons: Charges from 20 to 200 Lev/Kg



Treatment

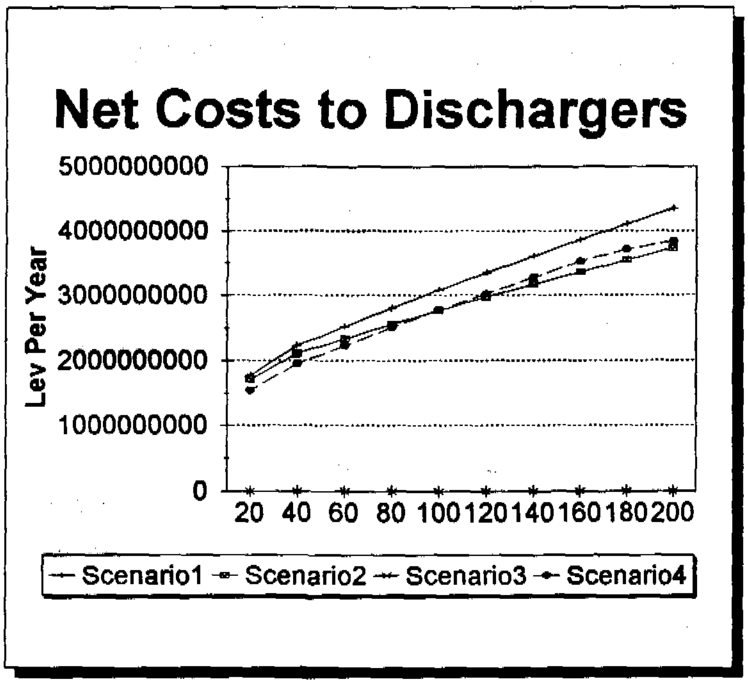
Emissions

Efficiency

Finances

Costs

Revenues



Treatment

Emissions

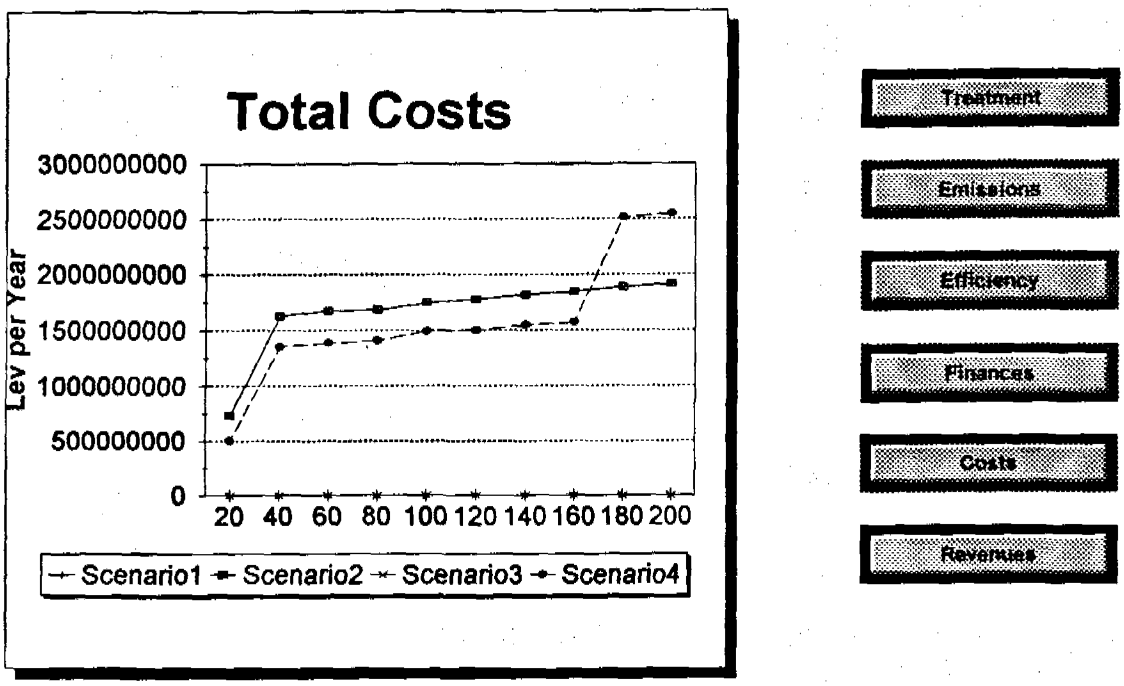
Efficiency

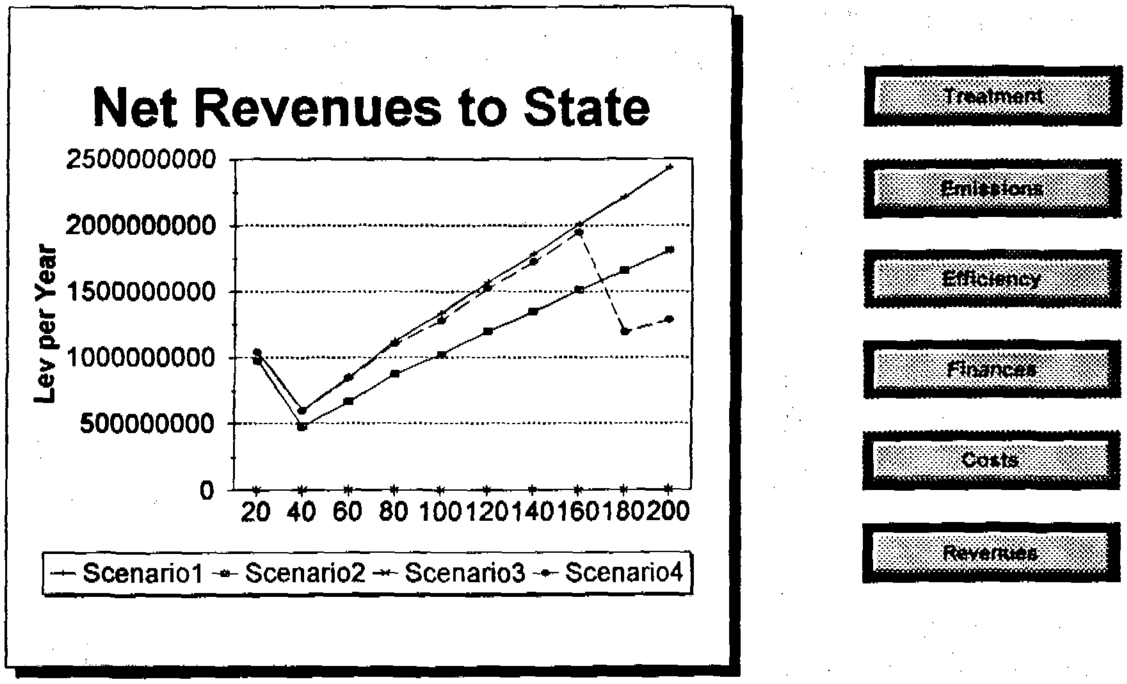
Finances

Costs

Revenues

Example of Scenario Comparisons: Charges from 20 to 200 Lev/Kg





Workshop Design for the DEMDESS Emissions Policy Model

Preliminary results and feedback from the DEMDESS EPM are very encouraging; the model has a potential role to play in the emissions policy development process, especially in setting appropriate effluent charges. A workshop is an entirely appropriate forum for continuing the process started in DEMDESS 1994 and for making best use of the model. The objectives of the workshop could be:

1. Communicate the model capabilities, limitations, and results.
2. Determine the relevance of the model in formulation of emissions control policies, especially setting of effluent charges.
3. Identify users, support entities, logistics, etc.
4. Identify key technical issues related to the model's validity, use, and further development.
5. Identify key policy ramifications of the model.
6. Address the model limitations and develop a priority list and plan of action for resolving these limitations.
7. Develop coordination plans for use of the model.

We propose a two-day workshop, with the first day primarily technical in nature and with a limited group of participants. The second day would have a wider audience, with representatives of all or most interested parties.

The first day would concentrate on the first four objectives. One principle outcome would be development of the presentations and working sessions for the second day.

Technical Description of the DEMDESS EPM

This section describes the data bases and equations used in the EPM.

A. Core DEMDESS Data

The EPM uses the following tables from the Core DEMDESS:

1.DISCH1	Table of Dischargers
2.EMISS1	Table of emissions concentrations for each discharger; only direct emissions to surface waters are considered in the EPM.
3.TPCST	Treatment plant cost data
4.TPCHR	Treatment plant pollutant removal characteristics
5.CURRCNVT	Currency conversion and local cost factors
6.TAXES	Tax Rate schedule, by pollutant, e.g., Ft/Kg

7.FINES Fine rate schedule, by pollutant, e.g., Ft/Kg
8.WQSTDS Emission standards, by pollutant, in mg/l

The use of each table is described in the next section.

B. Input Variables and Computations:

1. Pollutant Code (P): the EPM examines one "indicator" pollutant at a time, e.g., COD. P is the DEMDESS Parameter Code for the target pollutant. P is a user input variable.

2. Discharger Characteristics: for each direct discharger in the study area: effluent flow in m3/day (Q); existing effluent concentration of P in mg/l (C_{ex}); effluent load (LOAD) for each discharger is computed as:

   LOAD = Q * C_{EX} / 1000,where LOAD is in Kg/day

   Q and C_{EX} are extracted from the Core DEMDESS Emissions Subsystem, based on existing conditions or a scenario developed by the DEMDESS Scenario Manager (SCENMGR). SCENMGR could be used, for instance, to construct projections for a point in the future, e.g., year 2010, and EPM could be applied to this projection.

3. Wastewater treatment plant options: at this time, five general treatment levels (TREATLEV) are incorporated: no treatment (NONE), primary treatment (PR01), enhanced primary (PR02), single stage secondary treatment (SAS01), and two-stage secondary treatment (SAS02).

   All of the wastewater treatment data is derived from the Core DEMDESS Treatment Subsystem. All of these data are modifiable by the user, through the Core DEMDESS Menus.

4. For each treatment level, effluent removal percentage (EFFLPCT) for the target pollutant P. For each discharger and TREATLEV, effluent load with treatment is computed as:

   TRTLOAD = LOAD * EFFLPCT/100,where TRTLOAD is in Kg/day

   Treated effluent concentration (C_{EFF}) is computed as:

   C_{EFF} = C_{EX} * EFFLPCT/100

   The input data are extracted from the TPCHR table in the Core DEMDESS, and are fully modifiable by the user through the Core DEMDESS menus.

5. Local currency and cost factors:

   CURRCNV Exchange rate in Units/$, e.g., Ft/$.

   LOCLabor Average labor costs in local currency per hour

LOCEnergy Electricity costs in local currency per 1000 Kw

LOCMatl Local material factor as overall proportion of material costs as compared to U.S. costs.

The input data are extracted from the CURRCNVT table in the Core DEMDESS, and are fully modifiable by the user through the Core DEMDESS menus.

6. For each discharger and TREATLEV, capital costs (CapCost) in local currency are computed, as a function of effluent flow Q and currency conversion rate. Capital costs are computed using:

$$CapCost = (1+E\&C)AQ^{B} * CURRCNVT$$

where A and B are empirical coefficients derived primarily from U.S. cost curves, E&C is an input Engineering and Contingency coefficient, usually set at 0.20.

The input data are extracted from the TPCST table in the Core DEMDESS, and are fully modifiable by the user through the Core DEMDESS menus.

7. For each discharger and TREATLEV, annual operation and maintenance costs (O&MCost), in local currency, are computed as the sum of labor, energy, and material costs:

$$O\&MCost = O\&MLab + O\&MEnergy + O\&MMat$$

Each O&MCost component is computed as a function of effluent flow Q, using the general form:

$$O\&MLab = HQ^{M} * LOCLabor * 1000,$$

$$O\&MEnergy = KQ^{L} * LocEnergy * 1000, \text{ and}$$

$$O\&MMat = IQ^{J} * LOCMat$$

where H, M, K, L, I, and J are empirical coefficients derived from U.S. cost curves. These coefficients are extracted from the TPCST table in the Core DEMDESS, and are fully modifiable by the user through the Core DEMDESS menus.

7. Subsidy percent (Subpct): A subsidy applied to the capital costs

Subsidy = CapCost * (Subpct/100),where

Subsidy is the dollar value of the construction grant.

Net capital cost to the discharger (NetCap) is computed as:

NetCap = CapCost - Subsidy

Subpct is modifiable in the EPM menu system.

8. Loan terms applied to NetCap: Interest rate (INTRATE) and years of amortization (AMORT). CapCost, Subsidy, and NetCap are annualized using INTRATE and AMORT.

   AnnCap = Annualized CapCost,

   AnnSubsidy = Annualized Subsidy,

   AnnNetCap = Annualized NetCap

   INTRATE and AMORT are modifiable in the EPM menu system.

9. Total annual treatment costs are computed as:

   AnnTotCost = AnnCap + O&MCost

   NetAnnCost = AnnNetCap + O&MCost

   AnnTotCost is the total annualized cost of treatment; NetAnnCost is the net annual cost to the Discharger factoring in the subsidy for capital cost.

10. Unit cost of pollutant removal is computed as:

    CostperKg = AnnTotCost / ((LOAD - TRTLOAD) * 365)

    Note that CostPerKg is not considered for TREATLEV = NONE because in that case LOAD = TRTLOAD.

11. Regulatory data: effluent standard (C_{STD}), in mg/l; the tax rate on emissions (TAXRATE) in local currency per Kg of emissions (e.g., Ft/Kg); the fine rate (FINERATE) in local currency per Kg, applied to emissions above C_{STD}. C_{STD} can vary by discharger, but in most model runs a single C_{STD} is uniformly applied to each discharger.

    Annual taxes (TAX) and fines (FINE) are computed for each discharger and TREATLEV by:

    TAX = TRTLOAD * TAXRATE * 365

    If $C_{EFF} > C_{STD}$, then

    FINE = FINERATE * Q * (C_{EFF} - C_{STD}) / 1000 * 365

    otherwise FINE = 0.

    C_{STD}, TAXRATE, and FINERATE are modifiable through the EPM menu system.

12. Annual O&M costs for existing treatment (O&MExisting) are computed in the Hungarian version of EPM by applying general cost factors per unit flow. These cost factors are:

    O&MExPrim = for primary treatment

    O&MExSec = for secondary treatment

    O&MExTert = for tertiary treatment

    O&MExisting = Q times the appropriate cost factor (O&MExPrim, O&MExSec, or O&MExTert)

    The original Vituki source data bases from the "SFKAT" system (the primary source of the DEMDESS Emissions Subsystem data) are queried to determine the general level of existing treatment, and then the appropriate cost factor is applied.

13. Net annual cost (NetCost) for each discharger and TREATLEV is computed as:

    NetCost = NetAnnCost + TAX + FINE + O&MExisting

14. For each discharger, three TREATLEVs are flagged, as follows:

    MINC&C = The minimum cost TREATLEV for the discharger that meets the criteria $C_{EFF} <= C_{STD}$. This TREATLEV is used to represent the discharger response under "Command and Control," in which the discharger must meet standards regardless of cost. If there is no TREATLEV that meets the criteria, then the highest cost (most emission removal) TREATLEV is flagged.

    MINCOST = The TREATLEV with the minimum value of NetCost. This TREATLEV is used to represents the discharger response under "Charge Policy," in which emissions are controlled by taxes and/or fines.

    MINCostPerKg = The TREATLEV that has the minimum cost per Kg removal. This TREATLEV represents, for the discharger, one measure of the most cost-effective treatment.

    Note that for each discharger, O&MExisting is uniformly applied to each TREATLEV, so it has no effect on which TREATLEVs are flagged.

15. Aggregation of data

The computations are performed for each discharger-TREATLEV combination. The results are aggregated for analysis and display, using the MINC&C and MINCOST flags as aggregation criteria. For each flag, the following aggregations are performed:

i. Counts of the number of each TREATLEV value (NONE, PR01, PR02, SAS01, SAS02) for MINC&C and MINCOST.

ii. Total emissions (Kg/day) for MINC&C, MINCOST, and TREATLEV = NONE.

iii. Total costs per year for MINC&C and MINCOST; key cost factors are aggregated separately, including CapCost, NetCapCost, Subsidy, TAX, FINE.

iv. Overall unit cost of treatment per Kg.

Appendix G

EXECUTIVE INTERFACE FOR PREFEASIBILITY STUDIES

The purpose of the DEMDESS Prefeasibility Study Executive Interface (PFS) is to present DEMDESS analyses in a structured, logical manner, showing the "normal" steps included in a typical prefeasibility study. It brings all of the DEMDESS technical capabilities together in an easy to understand presentation, going through all of the major steps: problem characterization; pollution source identification and ranking; analysis of treatment alternatives; effects on ambient water quality; and costs, financing, and tradeoffs. The specific case of Sevlievo, Bulgaria, is used as the "model" for development of the system. This application can serve as the prototype to standardize the prefeasibility study process.

The presentation includes interactive viewing of results as well as production of high-quality hard-copy outputs. The interface uses several intensive models and analyses that should be run prior to use of the interface; this approach will provide a fast running, polished presentation. The intensive computer "work" leading to the results can be quite time consuming and slow, which will lessen the impact of the interface. To put it another way, this interface should be thought of more as a report than as the analytical tool itself.

The PFS combines many demensions of the Core DEMDESS, SCENMGR, WAWDEM, and Qual2e. Programs and menu options have been added to the Core DEMDESS especially for the PFS. Appendixes C, D, and E should be consulted for more information regarding these aspects of the PFS. The Executive Interface includes Quattro Pro Macro programs to load data directly from DEMDESS, plus the macros to run and manage all aspects of the Interface.

Steps in the DEMDESS Prefeasibility Study

A fully operational Core DEMDESS, with SCENMGR, WAWDEM, and Qual2e, needs to be set up before beginning the PFS process. The Quattro Pro spreadsheets that make up the PFS need to be available. The first spreadsheet to include is named "PREFEAS.WB1." This spreadsheet includes all of the macro programs that drive the interactions, menu bars, loading of data, and utility functions. The second spreadsheet, "PREFEAS1.WB1," contains the actual prefeasibility study. PREFEAS1.WB1 is set up with all of the graphs, tables, and selection buttons predefined. There are more than 70 separate predefined graphs in the PFS.

The first screen that comes up in the PFS is a map of the basin, with buttons for each prefeasibility study. This screen is shown in Fig. 1 (all figures appear at end of appendix). Note the button for Sevlievo on the map. The PFS is designed to include multiple studies; at this time, only one study is implemented. The button for the study of interest should be clicked with the mouse.

Fig. 2 shows the opening screen for the Sevlievo study. A site map of the Sevlievo area is provided to aid in describing the situation. The buttons to the right of the map show the sequence of steps in the study. The DEMDESS PFS has been defined as a 5-step process:

Step 1: Evaluate existing conditions, establish the existence of water quality problems, and identify the possible/probable source(s), leading to definition of the PFS "target" site (e.g., Sevlievo, Bulgaria). Core DEMDESS analyses are the basis for this step.

Water quality profiles are available for several constituents, including DO, BOD, NO3, NH3, and PO4. These profiles display minimum, mean, and maximum values for a selected, recent period. Cumulative emissions profiles are used to visually correlate water quality problems with "jumps" in emissions for the target site. Emissions rankings are used to compare the target site's emissions to overall basin emissions. Figs. 3 and 4 show the water quality profiles for DO and BOD, respectively.

Step 2: For the PFS "target," e.g., point sources in Sevlievo, compare existing conditions to zero discharge. The comparisons include Qual2e-generated water quailty profiles replacing the measured data profiles, comparing model predictions under existing conditions to predictions with zero discharge. Model-generated profiles for DO and BOD are shown in Figs. 5 and 6, respectively. Cumulative emissions profile comparisons are shown, and revised emissions rankings under zero discharge are also shown. Fig. 7 shows the cumulative emissions profile for BOD.

The purpose of evaluating the zero discharge scenario is two-fold. First, it establishes whether or not further work in the PFS is useful for the target site by clearly showing how much the site affects water quality. Second, zero discharge defines the upper bound of improvement through further point source controls. A given treatment/control scenario can then be compared to the range of existing conditions and zero discharge.

The development of the calibrated Qual2e model for the river being studied is essential for this step. Modeling experts are presumed to be involved in the development of the stream model.

Step 3: Develop preliminary wastewater treatment options using WAWTTAR. This is an intensive wastewater treatment engineering expert analysis, preferably with community involvement. In the DEMDESS PFS, WAWDEM Pollution Index (PI) versus cost graphs are used to communicate the range and rationale for subsequent selection of particular treatment options. Fig. 8 shows a typical cost versus PI graph at a single site. Fig. 9 shows the corresponding table associated with Fig. 8. Fig. 10 shows an example of the multisite analysis from WAWDEM. The WAWDEM Appendix provides more information about how these graphs and tables are generated, and how to use the graphs.

Step 4: Select and evaluate specific treatment options for evaluation. The PFS allows two different options to be "active" at one time. The displays for each option are exactly like the Zero Discharge displays, showing comparisons between existing conditions and the treatment option. The PFS menu system is designed to move directly from zero discharge and the two options.

Fig. 11 shows the PFS menu option to run the CORE DEMDESS that can be used to set up a treatment scenario. Fig. 12 shows the menu options for loading from the Core DEMDESS into a treatment option "slot." Fig. 13 shows the DO profile for a typical Treatment Option.

While only two treatment/control "slots" are provided at this time, the PFS has been designed so that it is relatively straightforward to add new "slots." Also, it is easy to run different treatment/control options "on the fly" and then load and display them in the PFS.

Step 5: Compare the financial considerations of the treatment options. A simple table of the basic cost elements (capital, operation and maintance, total) is available for this purpose. Figure 14 shows a typical Financial Summary screen.

The above steps reflect a particular philosophy towards prefeasibility studies, especially regarding the role of regulations in the process. Note that regulations are not specifically included in this process. The philosophy adopted is to first evaluate the physical and financial realities, and then relate these realities to the regulatory framework in place. A sixth step, which would show the relationships of the physical and financial realities in relation to the existing regulatory framework, was not implemented due to time constraints.

PFS Presentations to Decision-Makers

Below is an outline for a typical presentation to decision-makers.

Step 1: Review existing conditions, establishing the nature of the problem(s).

Step 2: Compare existing conditions to zero discharge, to establish that point source controls can be effective and to define the upper and lower bounds for comparison of treatment alternatives.

Step 3: Review WAWTTAR treatment alternatives

Step 4: Build a scenario "from scratch," evaluate in PFS

i. What do you want to look at? Specific treatment plant(s) from WAWTTAR? General treatment levels? Waste minimization? One or more dischargers turned off?

ii. Go to the DEMDESS:

(1) Make new scenario

(2) Edit Scenario

(3) Run Scenario

(4) Run Qual2e

(5) Run Emission Profiles and Rankings

iii. Go Back to the PFS:

(1) Load into a Treatment Option

(2) Compare to Existing Conditions, Zero Discharge, and other Treatment Options.

Running the PFS

Quattro Pro 5.0 or 6.0 for Windows needs to be installed on the computer running the PFS. The PFS is run by starting Quattro Pro and then opening the spreadsheet file named "PREFEAS.WB1." PREFEAS.WB1 macros take over as soon as it is opened. The macros will open the other spreadsheet files and control all user activities.

There are three ways to navigate within the PFS:

1. The menu bars at the top of the screen are standard Windows-style drop-down menu bars.

   The FILE Main Menu option includes to RUN the Core DEMDESS, LOAD data from DEMDESS, SAVE the PFS results after loading, and EXIT the PFS. The

   The EDIT option includes COPY, UNDO, and RECALC options. COPY will copy whatever is "selected" to the Windows Clipboard. This option is very useful to transfer graphs and tables from the PFS to other documents, e.g., a PFS report. First, "click" on the graph or table to select it, then select the COPY option, then use "alt-Tab" to switch to another Windows application (such as a word processor), and then "Paste" the graph or table into the document. UNDO reverses the last operation performed by the user. RECALC should be selected whenever the status bar at the bottom of the screen says "CALC"; the PFS is set up with auto-calculate mode off to improve performance, so this operation is manual with the RECALC selection.

   The TABLE option moves directly to the Financial Summary table. The GRAPH options move directly to a set of graphs, e.g., the Zero Discharge display page.

   The ABOUT option will run a "slide show" with explanations different aspects of DEMDESS. This is included, so that the presentation can include an introduction on DEMDESS, if desired. The "slide show" is stopped by pressing the Esc key.

2. The "SPEED BAR" contains options to "PRINT," "GO BACK," "HOME," and "EXIT." The PRINT option brings up the Quattro Pro Print Preview for the current display. The

display can be re-sized, headers and footers added if desired, and sent to the printer if desired. The Print Preview is exited by pressing the Esc key.

GO BACK returns to the specific PFS opening screen, shown in Fig. 2.

HOME returns to the beginning of the PFS, as shown in Fig. 1.

EXIT has the same effect as the EXIT Menu option.

3. Button bars are on the display screen, always to the right of the graphic. These button bars are very context-specific.

Some Tips for Modifying the PFS

As with all aspects of DEMDESS, the PFS is completely open to enhancement and modification. To modify the PFS you need to start Quattro Pro in "Developer" mode. This can be done by starting Quattro Pro from the File|Run option in Windows Program Manager, entering:

C:\QPRO/QPRO /d

Next, open PREFEAS.WB1, which will start the PFS. To stop the execution of the PFS Macro programs, press Shift-Control-N, preferably while on the opening screen. The PFS Macro control will be ended, and all Quattro Pro capabilities are now available. Pressing Control-C will restore PREFEAS.WB1 to a "standard" Quattro Pro spreadsheet format, with page tabs, standard speed bar, etc. All of the macro programming code, graphs, and tables are now accessible for changes, additions, enhancements, etc.

The PFS can be easily set up to run from a program icon in Windows. First, open the Program Group where you want to put the PFS (I chose the GAMES Program Group, for fun). Next, select "New," and enter the command line:

C:\QPRO\QPRO /d C:\DEMDESSB\PREFEAS.WB1

The above command line assumes DEMDESS is installed in the C:\DEMDESSB directory; change the directory as needed for your installation. The "/d" option is needed only if you waNT TO start off in "Developer" mode.

By convention, all macro names start with a "_"; it is strongly suggested that PFS developers retain this convention. The PFS can be re-started from PREFEAS.WB1 at any time by pressing Control-m. The on-line Quattro Pro Help and the User Guide should be consulted as needed to understand the actions of the macros.

Conclusions

The development of the PFS has demonstrated the efficiencies that can be gained by implementing a systematic, integrated water information system. A full prefeasibility study should be able to be completed in two weeks when starting with a fully loaded DEMDESS and WAWTTAR. This compares to five months for the "traditional" approach. Besides the time savings, there are many other advantages to the DEMDESS approach: it is a more dynamic, better documented, standardized approach with results fully comparable between studies.

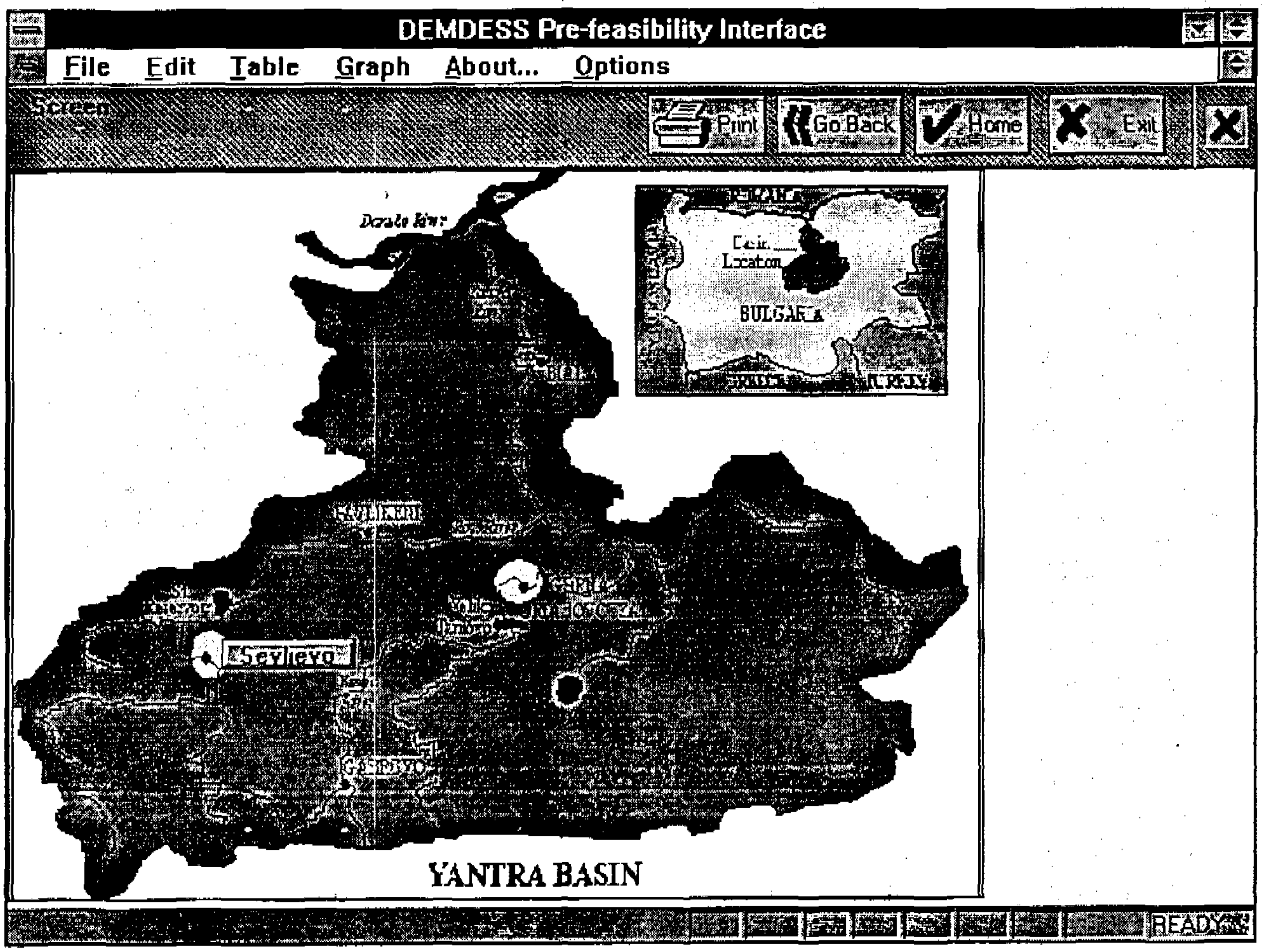


Fig. 1 Pre-feasibility Study Opening Screen

{pfsfigs.94}

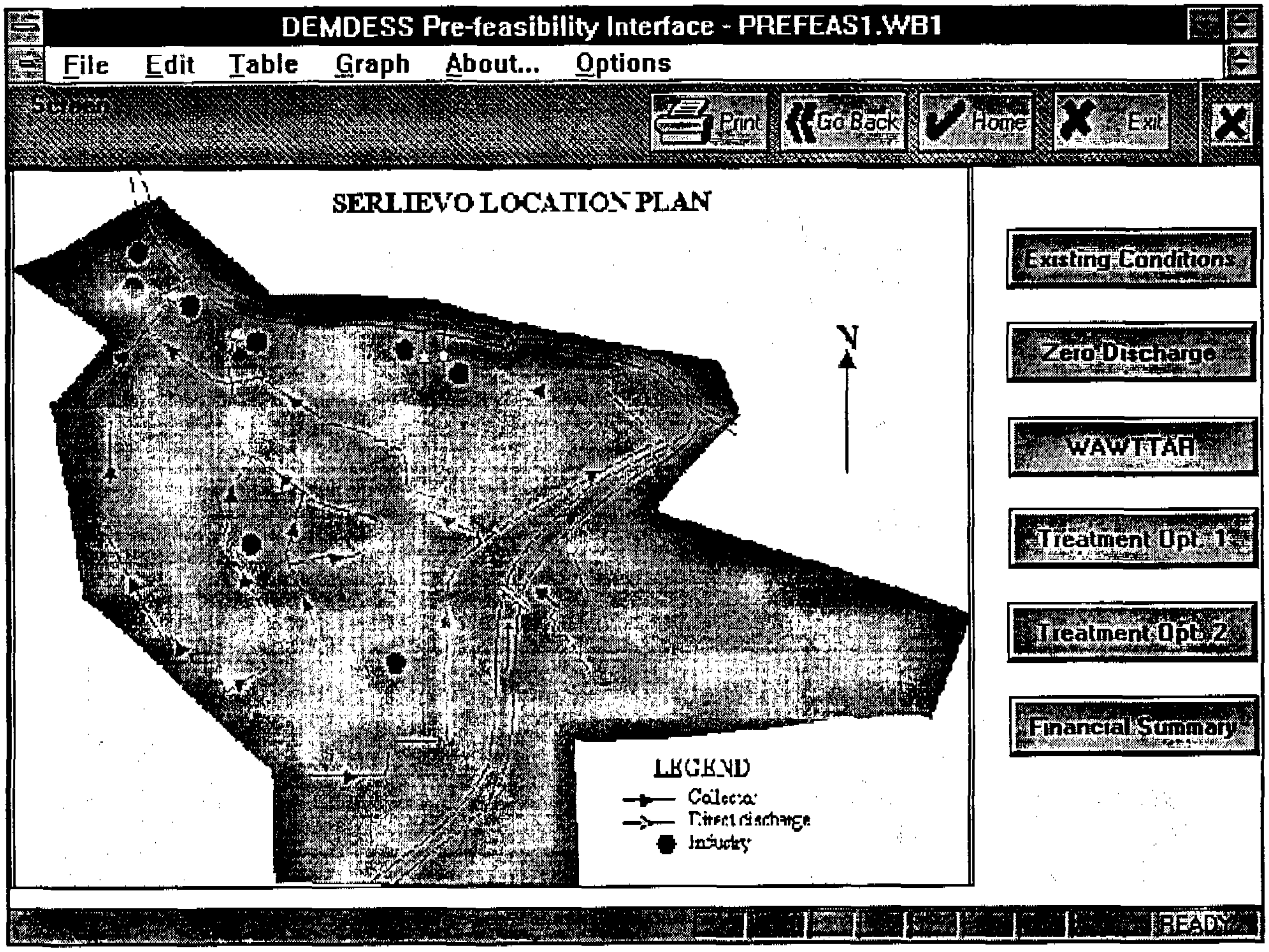


Fig. 2 Sevlievo Pre-Feasibility Study

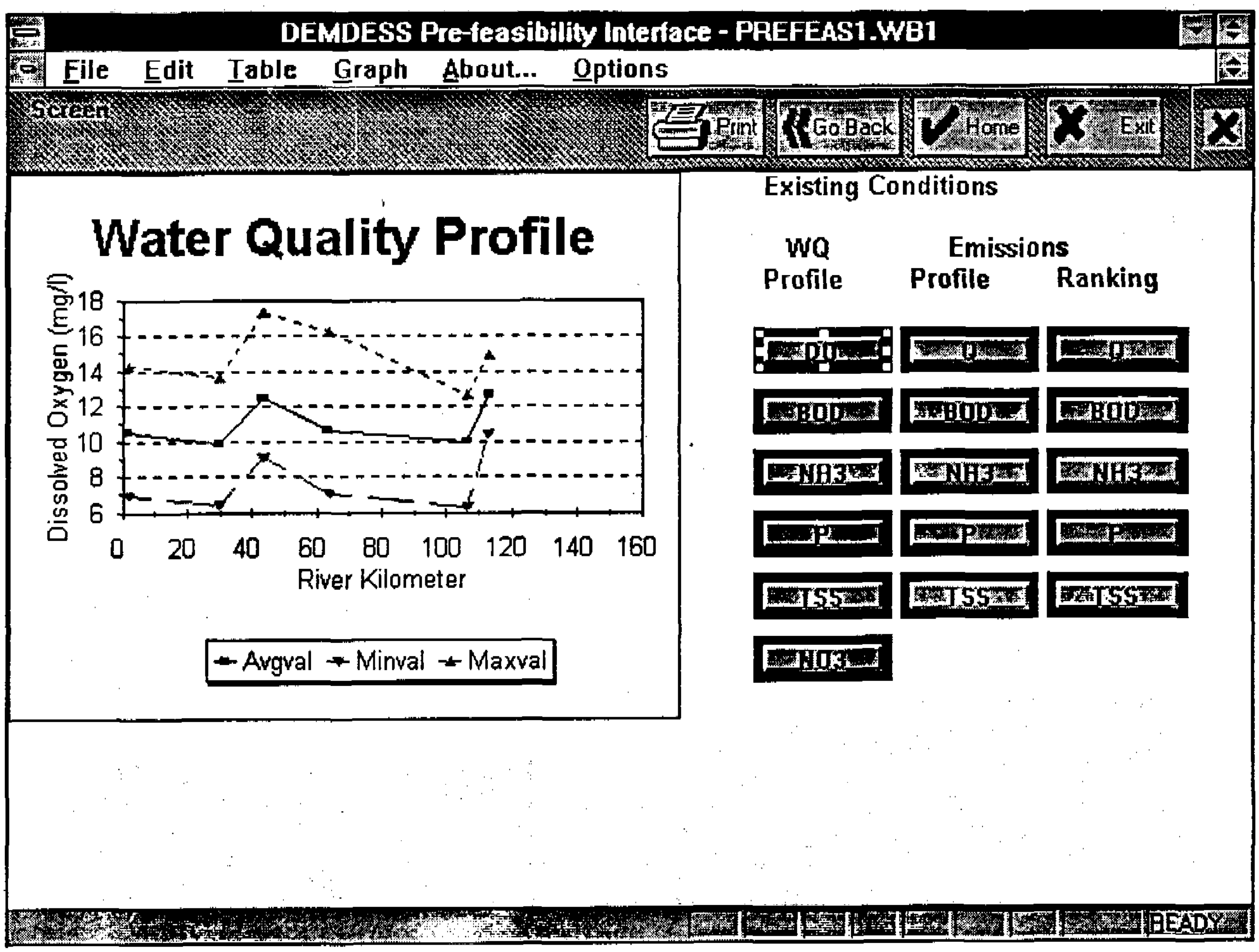


Fig. 3 Existing Conditions: Dissolved Oxygen Profile

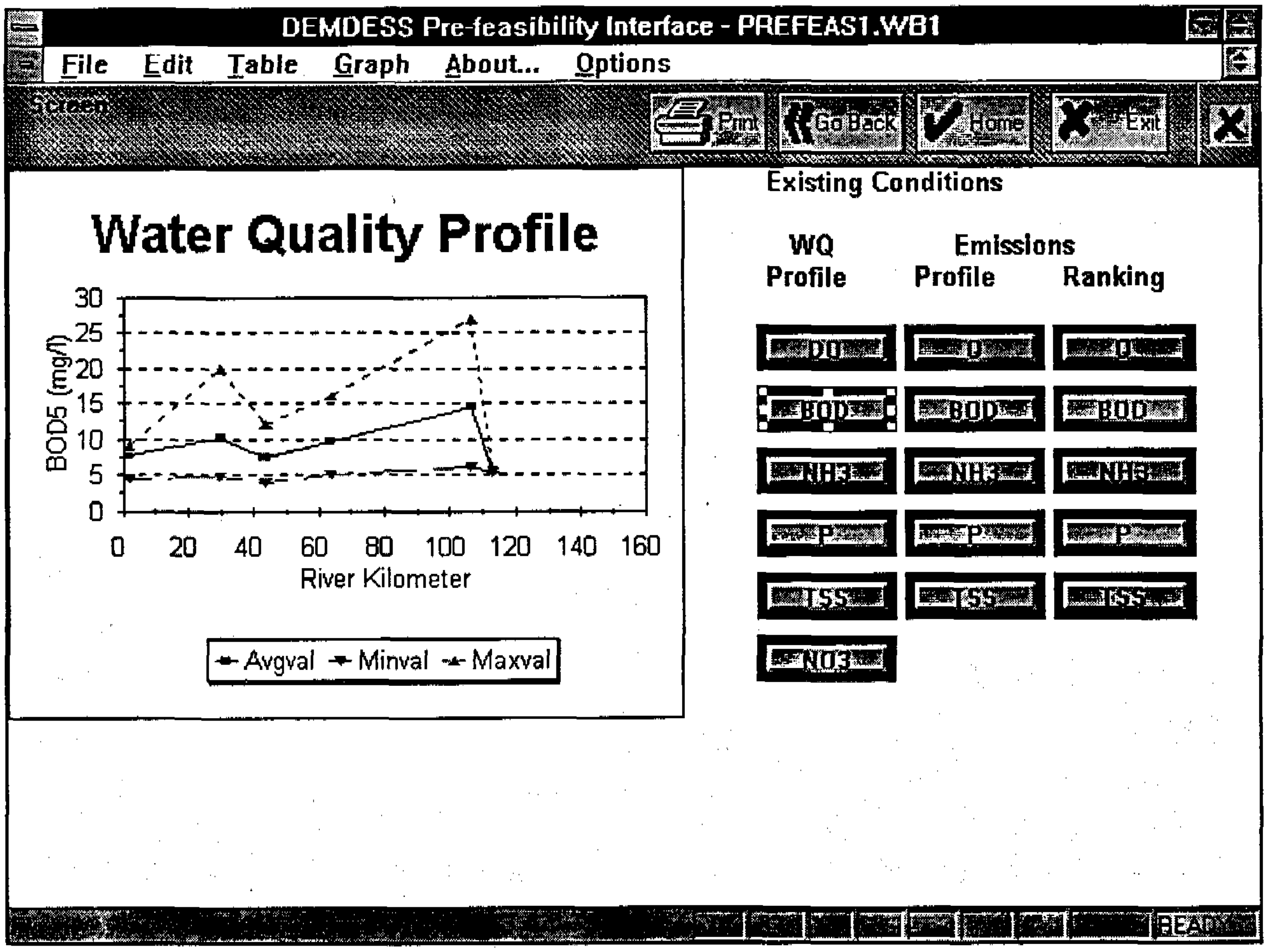


Fig. 4 Existing Conditions: BOD Profile

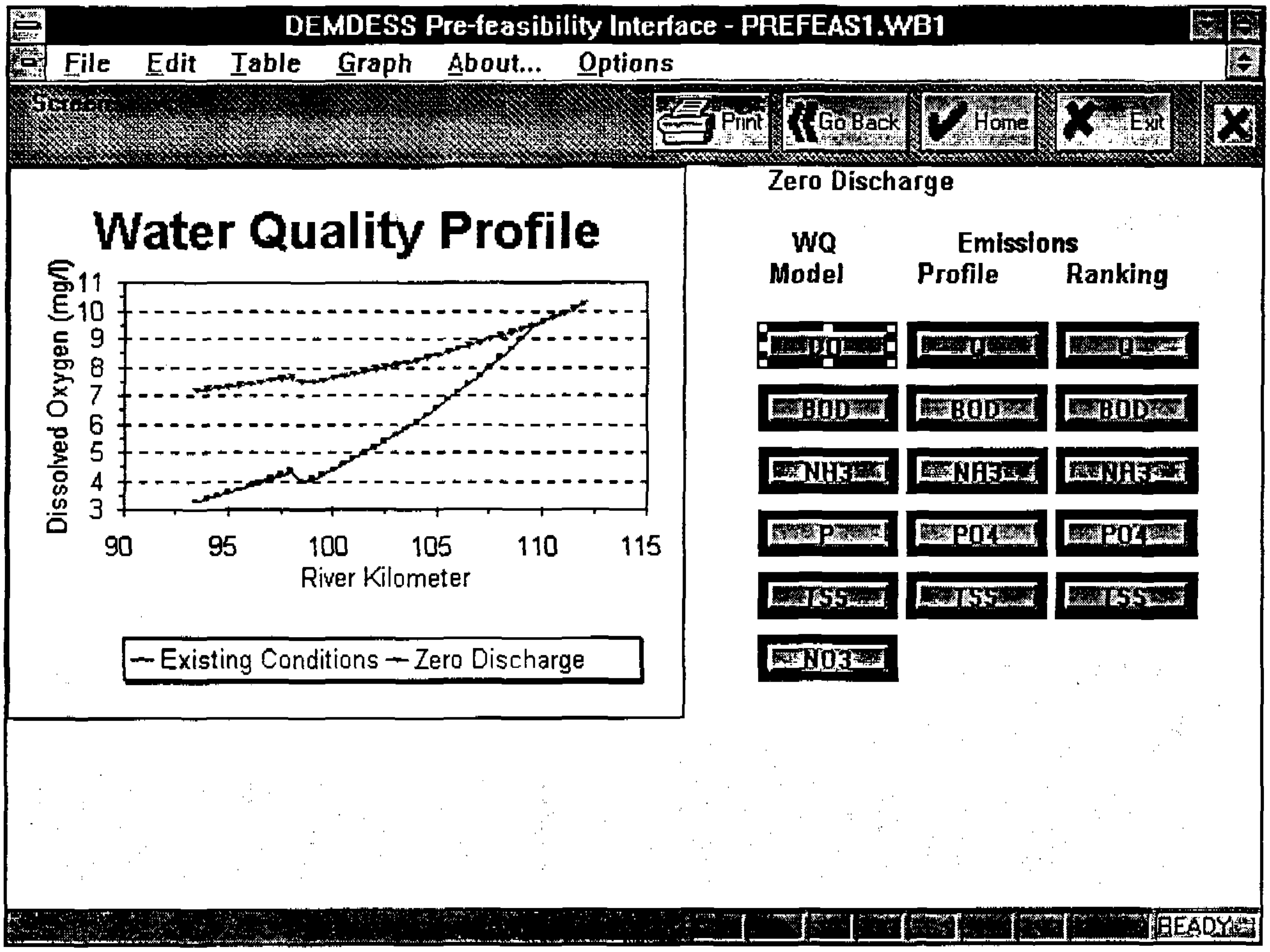


Fig. 5 Zero Discharge Scenario: Dissolved Oxygen Profile

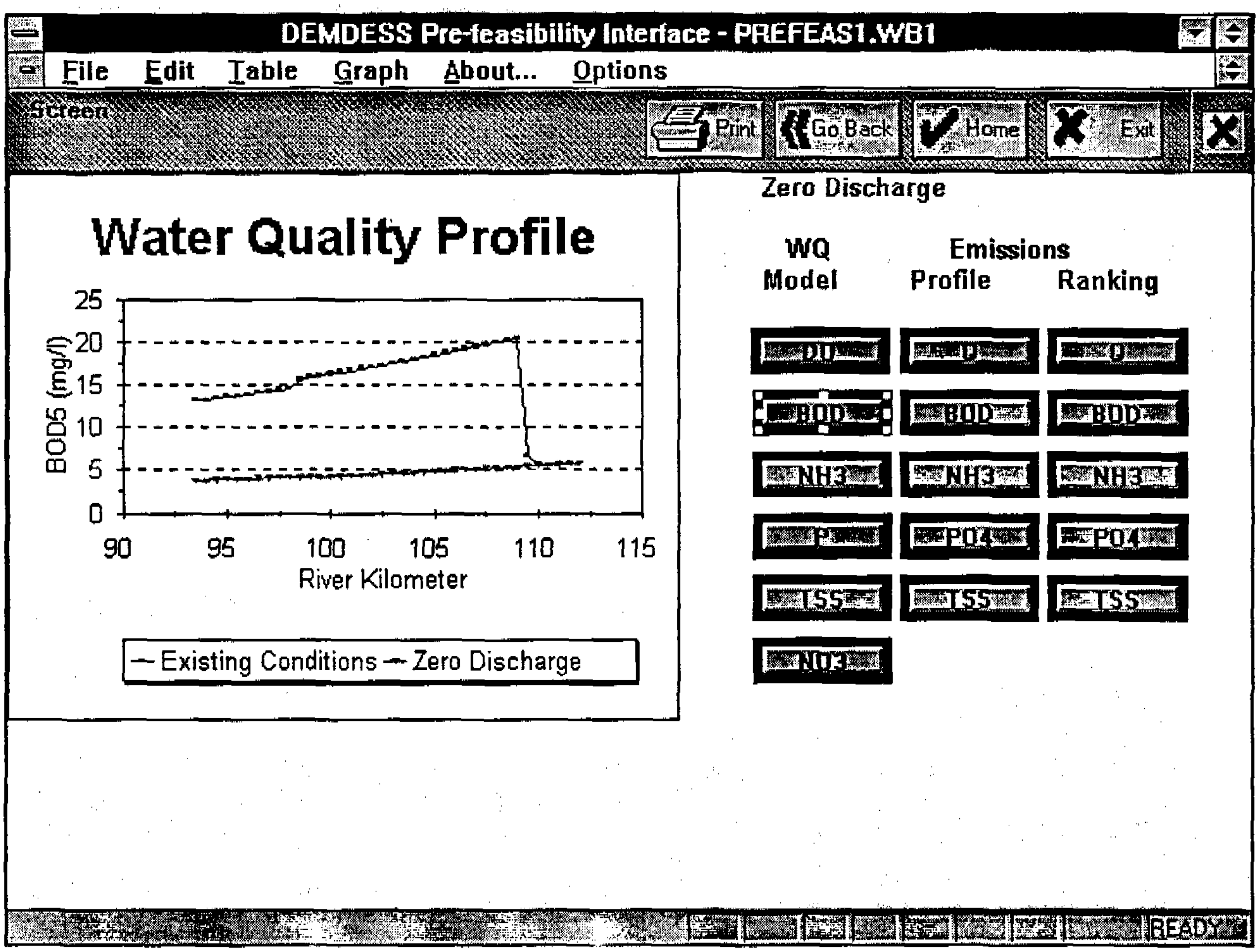


Fig. 6 Zero Discharge Scenario: BOD Profile

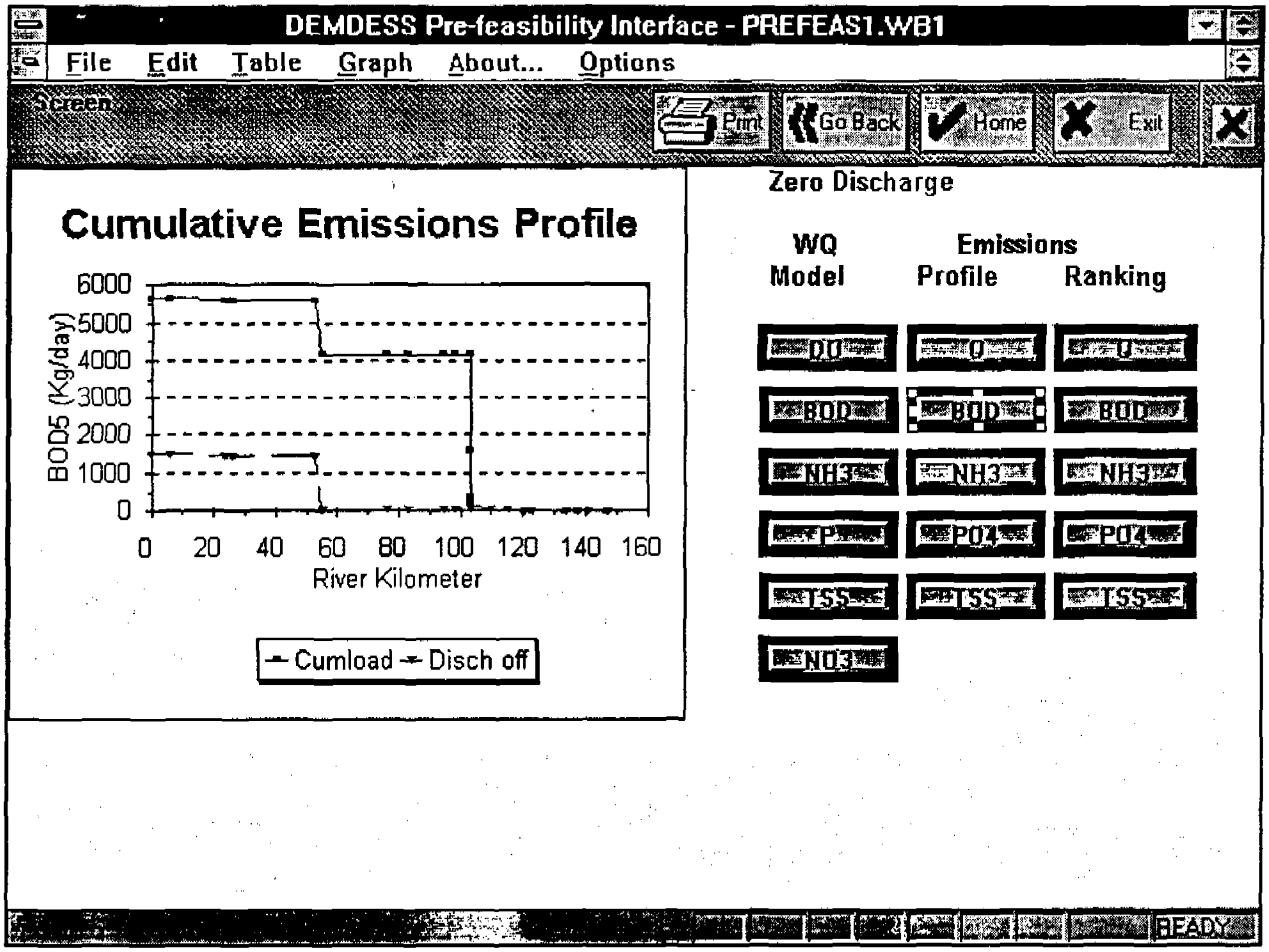


Fig. 7 Zero Discharge Scenario: Cumulative Emissions Profile for BOD

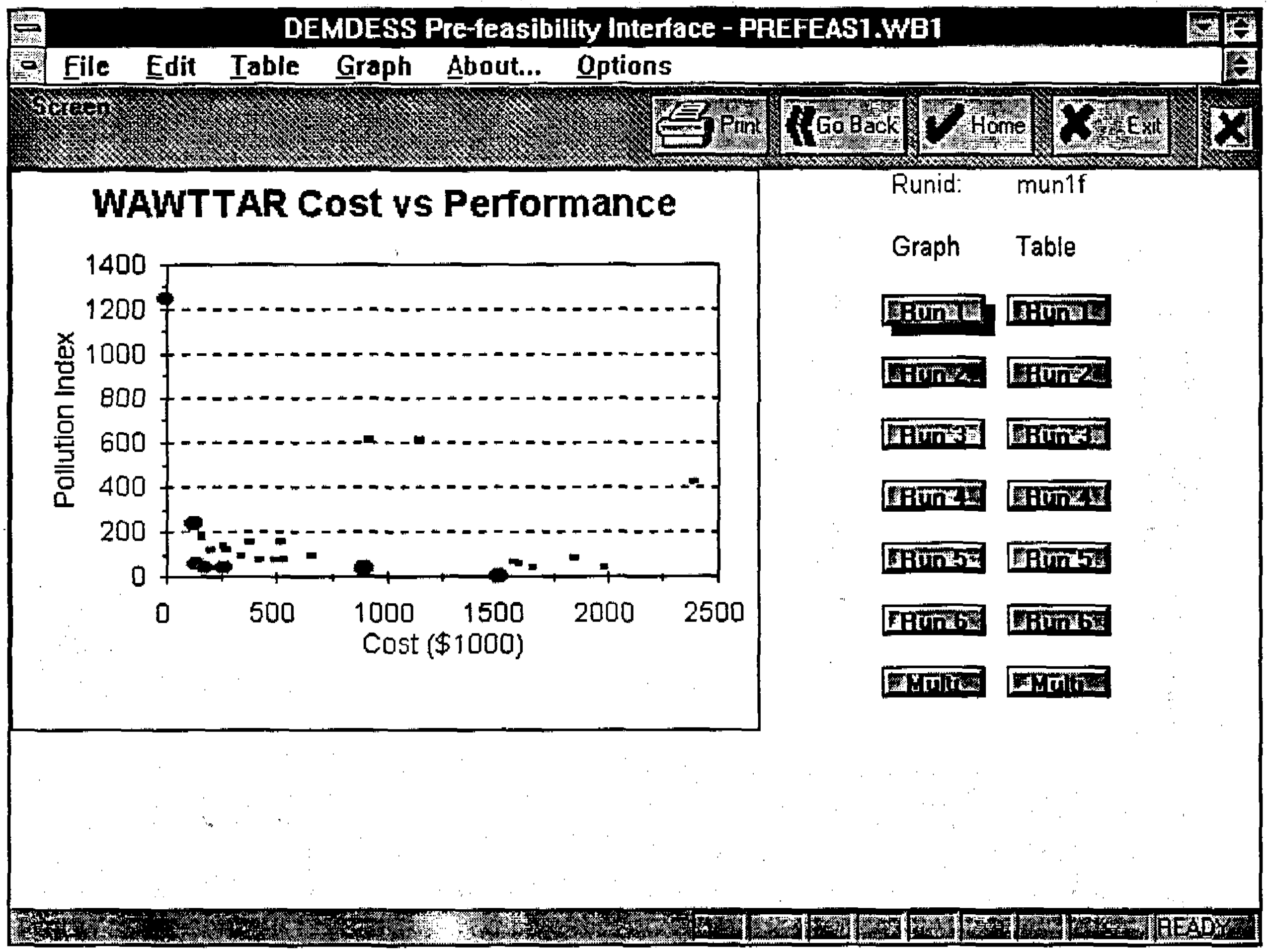
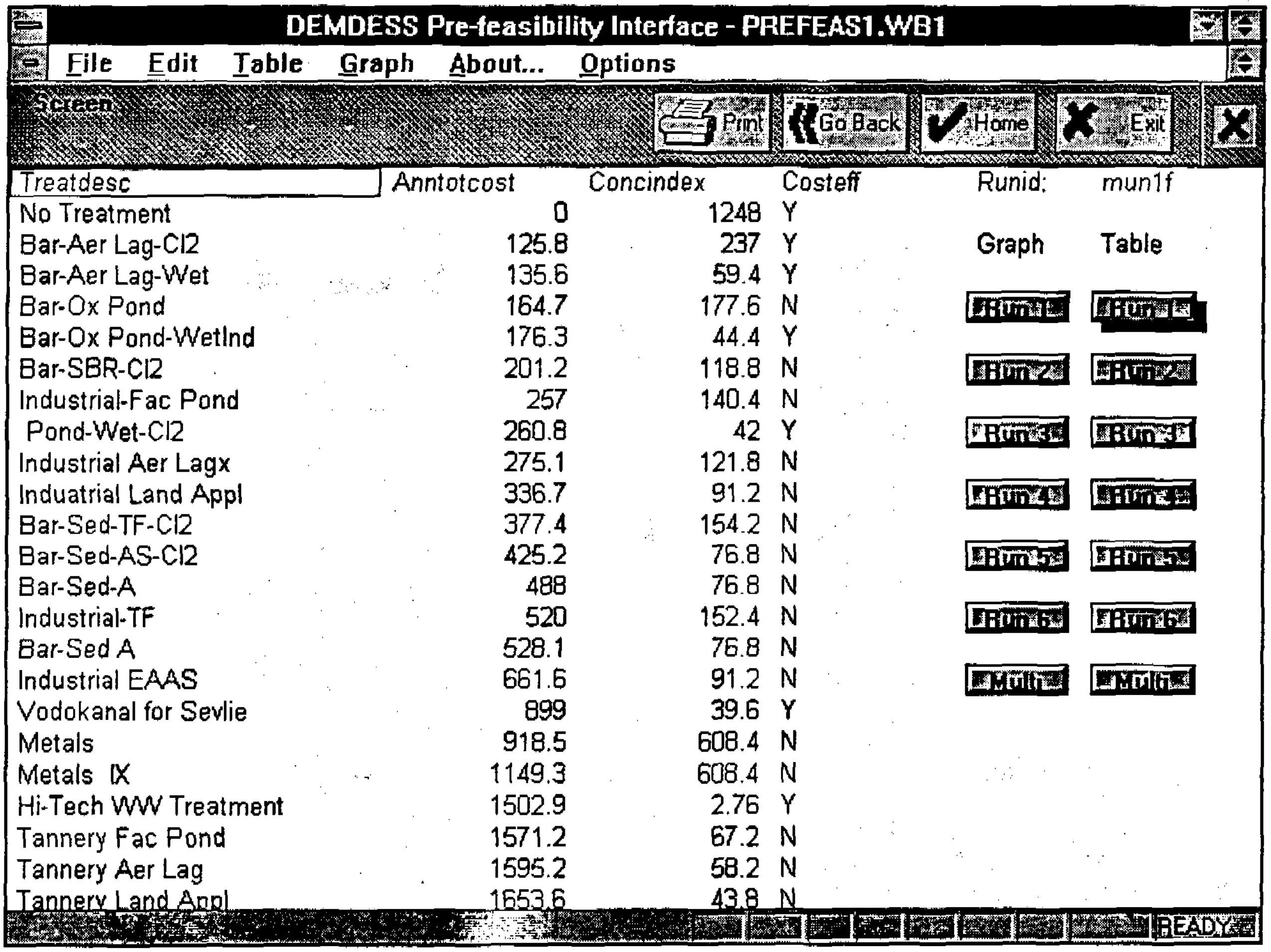


Fig. 8 WAWDEM Single Site Cost vs. Performance Graph



Treatdesc	Anntotcost	Concindex	Costeff
No Treatment	0	1248	Y
Bar-Aer Lag-Cl2	125.8	237	Y
Bar-Aer Lag-Wet	135.6	59.4	Y
Bar-Ox Pond	164.7	177.6	N
Bar-Ox Pond-Wetlnd	176.3	44.4	Y
Bar-SBR-Cl2	201.2	118.8	N
Industrial-Fac Pond	257	140.4	N
Pond-Wet-Cl2	260.8	42	Y
Industrial Aer Lagx	275.1	121.8	N
Induatrial Land Appl	336.7	91.2	N
Bar-Sed-TF-Cl2	377.4	154.2	N
Bar-Sed-AS-Cl2	425.2	76.8	N
Bar-Sed-A	488	76.8	N
Industrial-TF	520	152.4	N
Bar-Sed A	528.1	76.8	N
Industrial EAAS	661.6	91.2	N
Vodokanal for Sevlie	899	39.6	Y
Metals	918.5	608.4	N
Metals IX	1149.3	608.4	N
Hi-Tech WW Treatment	1502.9	2.76	Y
Tannery Fac Pond	1571.2	67.2	N
Tannery Aer Lag	1595.2	58.2	N
Tannery Land Appl	1653.6	43.8	N

Fig. 9 WAWDEM Single Site Table

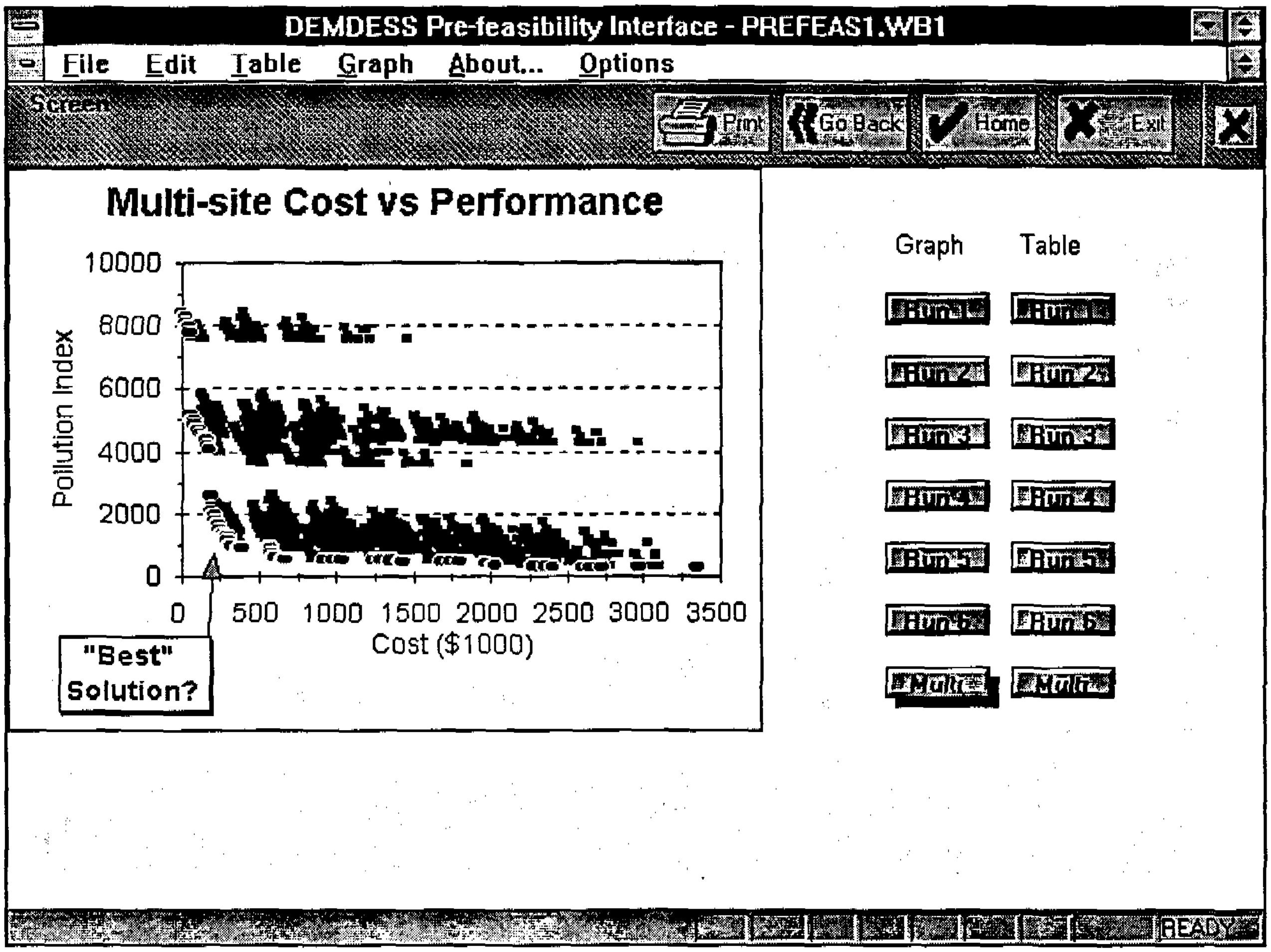


Fig. 10 WAWDEM Multi-site Cost vs. Performance Graph

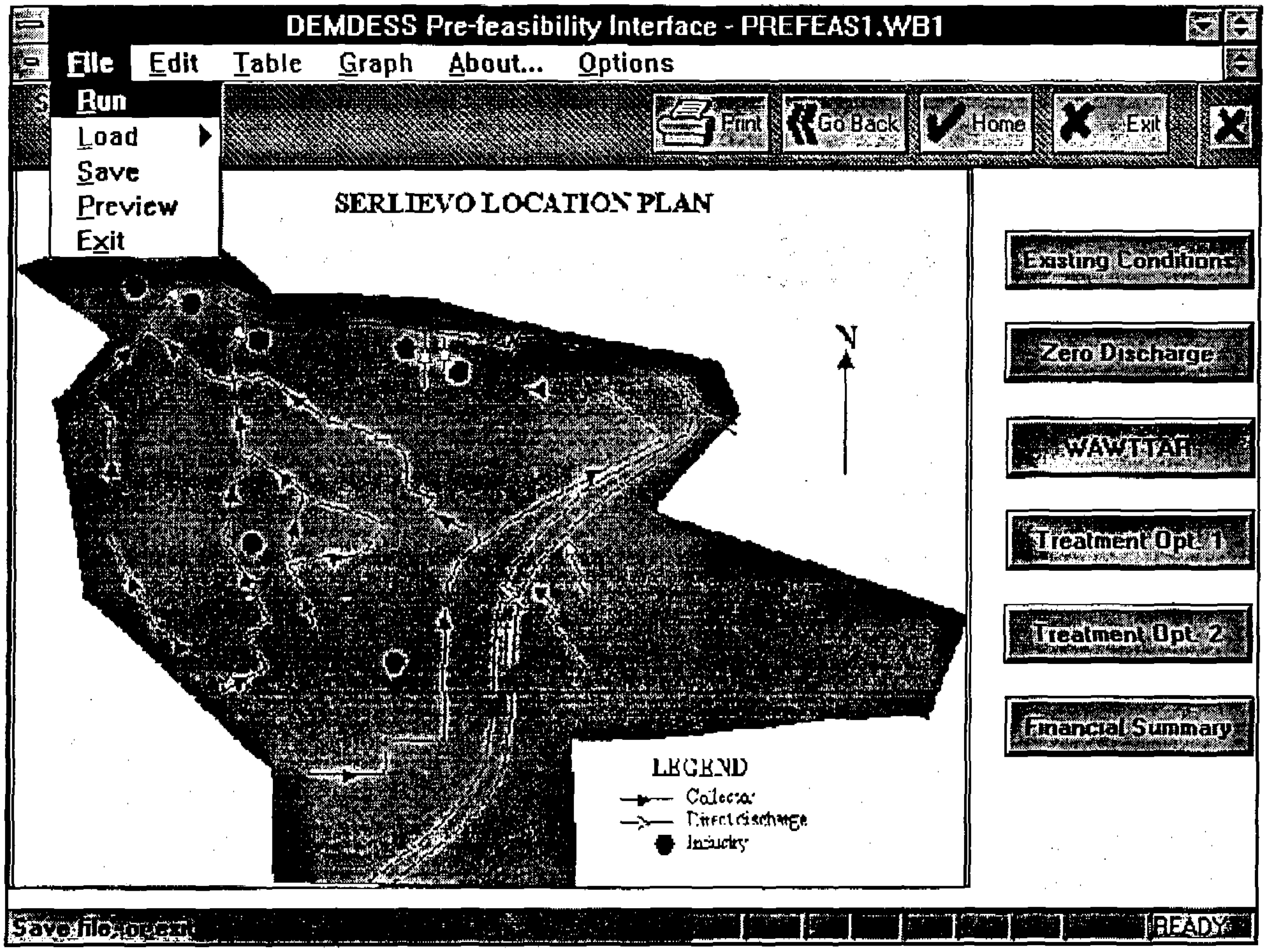


Fig. 11 Menu Option to Run Core DEMDESS

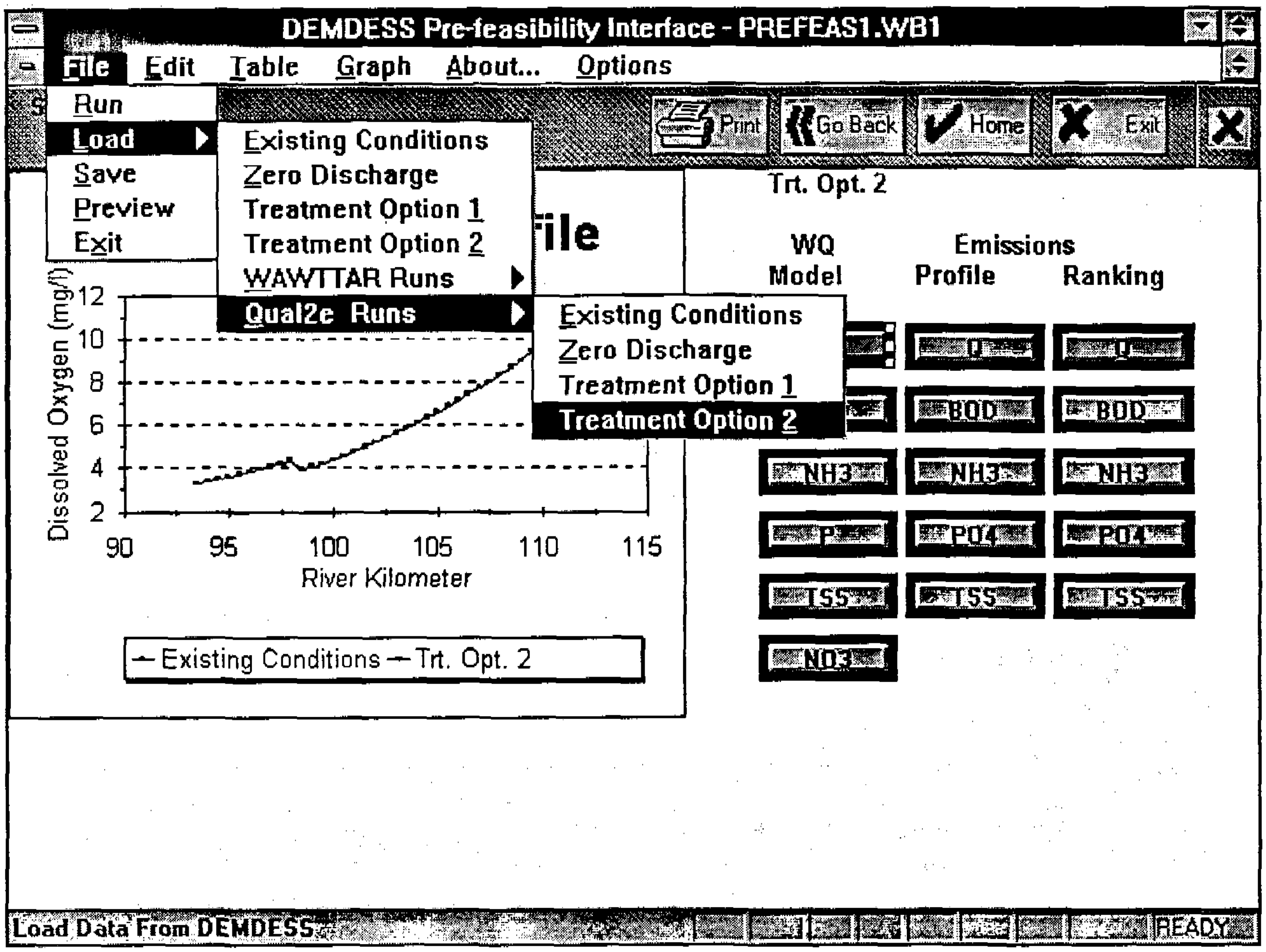


Fig. 12 Menu Option to Load From Core DEMDESS

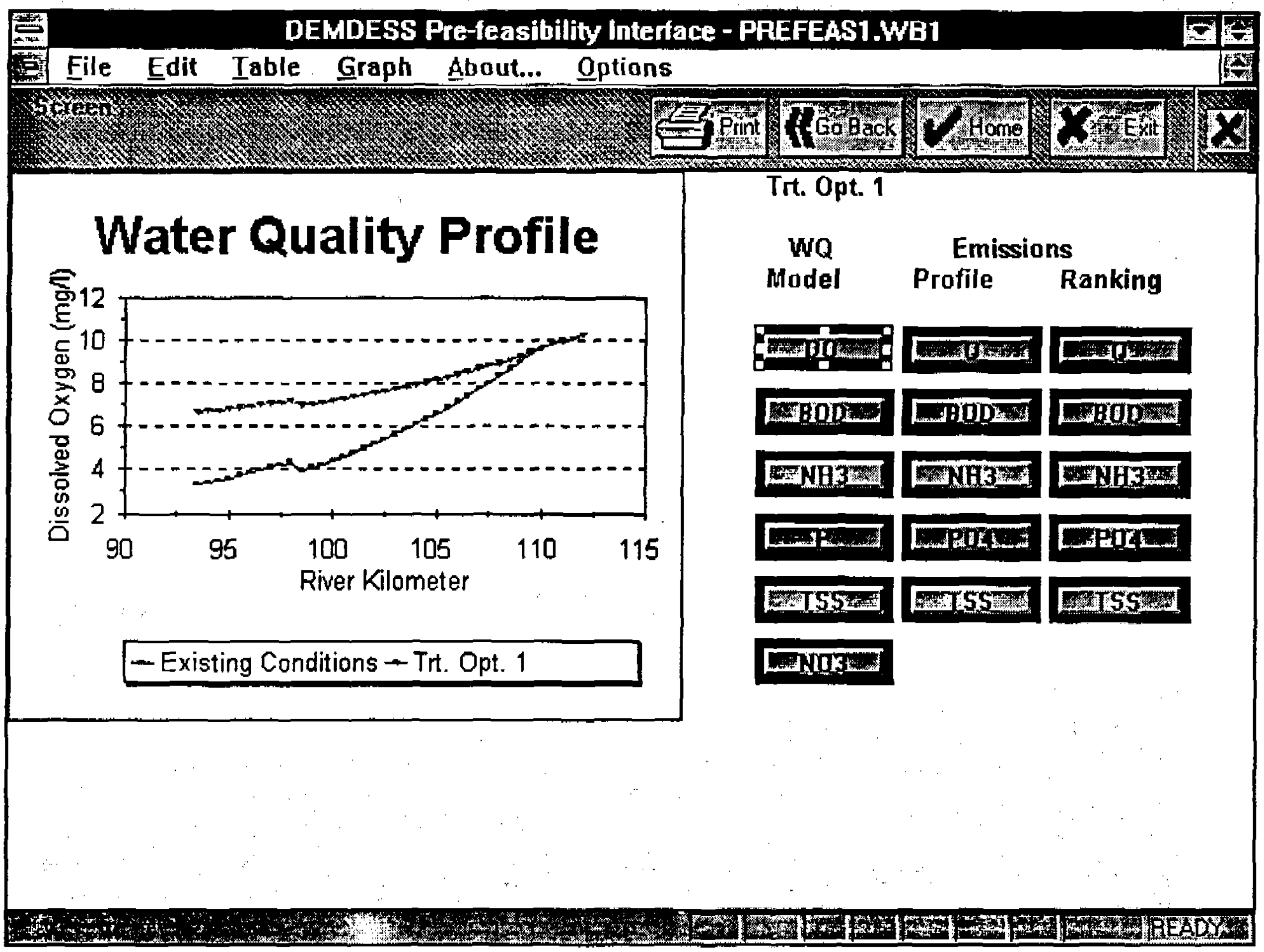


Fig. 13 Treatment Option 1: Dissolved Oxygen Profile

DEMDESS Pre-feasibility Interface - PREFEAS1.WB1

File Edit Table Graph About... Options

Screen — Print — Go Back — Home — Exit

FINANCIAL SUMMARY FOR TREATMENT OPTION 1

DISCHID	TREATCLAS	QTOT	TPLEV	Captot	O&mtot	Anntot
SEVCAN		600	600	149,100	176,400	325,500
SEVDAIRY		110	600	130,300	155,600	285,900
SEVMEAT		150	603	31,800	117,000	148,800
SEVMUNI		6,000	300	145,400	61,800	207,200
SEVTAN		1,300	700	705,300	584,800	1,290,100
Total		*8,160*		*1,161,900*	*1,095,600*	*2,257,500*

FINANCIAL SUMMARY FOR TREATMENT OPTION 2

DISCHID	TREATCLAS	QTOT	TPLEV	Captot	O&mtot	Anntot
Total		0		0	0	0

READY

Fig. 14 Financial Summary