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A manual for water reuse management

Alternative water sources are expected to play a significant role in areas suffering water shortages. In many places waste water reuse is becoming a valuable component of sustainable water management practises. However substantial and practical information is still needed in view to safely design, implement and operate waste water reuse schemes.

The project AQUAREC "Integrated concepts for reuse of upgraded wastewater" was funded by the Fifth Framework Programme of the European Commission. Its major aim was to investigate and develop concepts and methodologies supporting rational and knowledge-based waste water reuse strategies.

This publication presents practical information on waste water reuse concepts based on actual and proved management and operational practises. A broad approach has been considered by addressing institutional, organisational, legal, economics, financial, social and environmental issues together with technological aspects. The targeted readers are mainly practitioners concerned with implementation of waste water reuse schemes, but we are convinced that this publication will also become 'the wastewater reuse manual' for decision makers, local authorities, consultants and research bodies involved in the area.

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water reuse system management manual

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Water Reuse System Management Manual

AQUAREC

edited by Davide Bixio and Thomas Wintgens

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2006 Global change and ecosystems

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FOREWORD

Water scarcity is a problem of growing importance and magnitude in Europe today and research has shown how present fresh water resources are struggling to meet demand. This situation is having serious environmental, economic and social consequences. Confronted with this challenge Community research is investigating and developing alternative sources of water, such as water reclamation, reuse and desalination, which will contribute to a sustainable management of water resources.

The regions in Europe worse affected by this problem have increasingly begun to recognise the benefits of, and the huge potential for reuse of treated sewage water. However a major barrier to developing this potential is the lack of rational integration of reuse strategies in water management schemes. Local authorities, investors, water companies and end-users have for quite some time been calling for a legal framework for water reuse. Despite this there have been only a few attempts to establish national or international legislation or guidelines on water quality parameters for reuse. In a global economy and in the face of common environmental challenges a concerted approach at European level is required to foster and promote water reuse and to provide an adequate driver (legislative or otherwise) for institutional reform and better governance in the water reuse sector. Moving in this direction, the EU funded AQUAREC project has helped to demonstrate the scientific and practical feasibility of implementing municipal water reclamation and reuse.

The FP5 AQUAREC project on “Integrated concepts for reuse of upgraded wastewater” was launched in 2003 with the strategic aim of consolidating dispersed knowledge in the area of water reclamation and reuse. More specifically the project addressed policy guidelines, quality requirements for water reuse, suitable technologies for treatment and monitoring, best management practises including socio-economic aspects and public participatory approaches. As the project now draws to a close, the AQUAREC consortium has successfully delivered a series of publicly available reports together with a commitment for their widespread publication and dissemination.

The results of the AQUAREC project provide a comprehensive overview of water reuse concepts together with valuable knowledge and guidance to a whole range of stakeholders on their practical implementation. The present manual describes the best management practises in the water reuse sector and comprehensively addresses organisational, economic and financial considerations together with social and environmental aspects. The extensive presentation of technological issues, such as treatment processes, disinfection, monitoring and distribution, covers many of the end-use requirements and specifications.

I have no doubt that this manual will be recognised by stakeholders as a sound reference for water reclamation and reuse practices in Europe and as a solid basis for future progress in this area.

José Manuel Silva Rodríguez
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WATER REUSE SYSTEM MANAGEMENT MANUAL

May 2006

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PREFACE

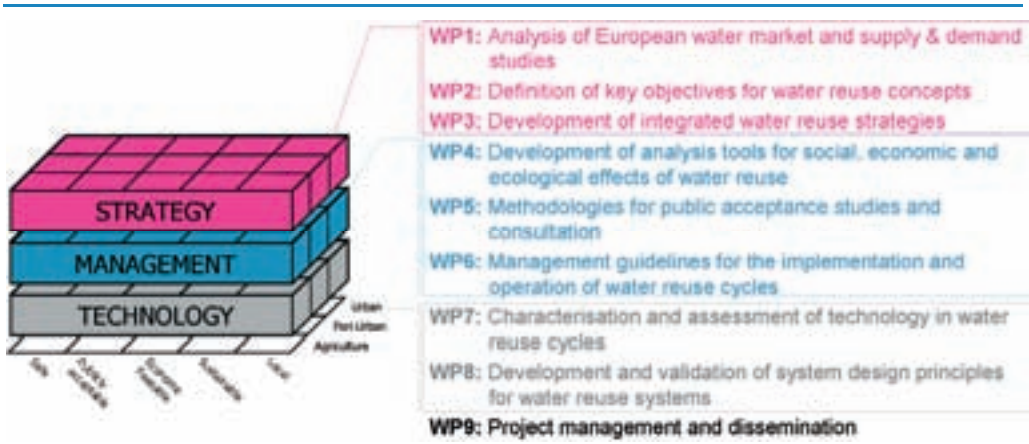
This work has been developed as part of the project “Integrated Concepts for Reuse of Upgraded Wastewater” (www.aquarec.org), a research project supported by the European Commission under the Fifth Framework Programme and contributing to the implementation of the Key Action "Sustainable Management and Quality of Water" within the Energy, Environment and Sustainable Development under Contract number: EVK1-CT-2002-00130 and coordinated by RWTH Aachen University. The general objective of the Aquarec project is to provide knowledge for a rational wastewater reuse strategy as a major component of sustainable water management practices.

The establishment of a rational wastewater reuse strategy in the context of sustainable water management depends on variables that have to be handled at national level (e.g. through implementation of legislative reform and regulation), sectoral level (e.g. tariff and price adjustments to ensure appropriate incentives) and project level (e.g. agreement of long-term supply contracts, appropriate technology and level of service, etc.).

In the Aquarec project, those three levels have been addressed by different task forces (work packages).

This work is situated in the context of the management dimension, which looks more specifically at the possibilities offered at the project level with the underlying governmental and sectoral considerations as boundary conditions.

Figure 1 Structure, application contexts, evaluation criteria and work packages of the AQUAREC Project



The management dimension of water reuse schemes is investigated in three work packages:

1. WP4 focuses on the development of a sustainable planning methodology,
2. WP5 focuses on the methodologies for public acceptance and consultation,
3. WP6 focus on the management of water reuse schemes.

With this trilogy the Aquarec project hopes to deliver substantial information to plan, implement and operate water reuse schemes.

With this manual we aim at providing a single source of information on commonly used or applicable management practices in implementing and operating water recycling and reuse schemes. The aim is not to contribute to additional research but to disseminate the knowledge that has accumulated over many years, the results of which are often still not readily accessible (in a single document).

Our will is to warn the reader about the key impediments for sustainable water reuse practice while at the same time also informing him or her about positive experiences that might be used as models to overcome them.

We hope that this information will open up new possibilities for business and public administrations to include water reuse options in the integrated water resources management scenarios and make precautionary judgements, taking into account imperfect but, still, available information.

We hope that this manual can be useful in encouraging best practice and generating discussion, directing research and deepening understanding in the development of safe and sustainable direct non-potable water reuse schemes.

We hope that this manual will be considered a living document, subject to change as practices evolve. We do not pretend that this document will give you the ultimate answers to how to manage water reuse schemes, but we see it rather as a milestone to reach international consensus on best practice. We hope that a continuous reviewing process will be put in place, reflecting up-to-date developments in the use and management of reclaimed water in the European Union and overseas.

Davide Bixio and Thomas Wintgens
On behalf of the Aquarec team on management practices and the project consortium

CONTENT

1 INTRODUCTION

1.1 BACKGROUND

In the framework of the international project "Integrated Concepts for Water Reuse" (Aquarec) - partially funded by the European Commission and the Australian Government, and coordinated by RWTH Aachen - an interdisciplinary team composed of water and wastewater utility professionals, consultants and researchers got together to produce a manual of management practices for water reuse schemes. This introductory chapter will give some background on water re-use and its status in different parts of the world, on different aspects of management practices and on the scope of the work covered in this manual.

The water sector in Europe, as well as in many other parts of the world, is in a transitional phase with unique opportunities for water reuse to be implemented on a larger scale as a sustainable practice within a framework of integrated water management. Hochstrat *et al.* (2006) estimated that in the time span between 2000 and 2025, in Europe alone, the direct utilisation of treated municipal wastewater could more than double, growing from 750 million m³ per year to 1,540-4,000 million m³ per year.

To fully benefit from this unprecedented favourable momentum, the European water industry urgently needs to establish a best practice framework for water reuse projects:

- In the last decade, regulatory and industry practice evolved from the traditional command and control approach towards a more integrated and flexible paradigm, not prescribing the means to achieve the desired outcome (e.g. requiring the adoption of water reuse "whenever appropriate"), but prescribing the adoption of a best practices framework (on top of the local permit requirements). Examples are the Directive on Environmental Liability and the Integrated Pollution and Prevention Control Directive (cfr. Chapter 2).

- Despite the numerous successful schemes (Bixio *et al.*, 2006), and the common practice of indirect reuse through rivers and aquifers, water reuse is not accepted yet as a standard European water industry practice, and water reuse options are often inadequately considered in traditional business-as-usual water resources management plans. One reason for this neglect of reuse is a lack of common knowledge of reuse-specific management practices including the water resource benefits, financing, community consultation, environmental management and aspects such as operation, maintenance and quality control.

- Clear references are needed to support decision-makers. A lot of information is available regarding water reclamation and reuse, yet this information is dispersed and, sometimes, contradictory. Even information for a straightforward mapping of such basic indicators as facility location, treatment train and performance is difficult to collect, not to mention the basic management practices attached to the scheme.

1.2 SCOPE AND OBJECTIVES OF THE MANUAL

This manual has been prepared to help decision makers answer their questions about initiating, implementing or improving water reclamation and reuse schemes.

The documentation addresses structural, non structural and managerial conditions to implement and operate water reuse scheme in a way that is safe, publicly acceptable and economically, financially and environmentally feasible.

For each of these conditions:

- reference principles are outlined,
- European Union and overseas experience, preferences and trends, apparent and latent problems, and factors promoting or hindering best practice are documented and
- successful case projects are illustrated to inform the reader about positive experiences in the field.

The manual focuses on the European, Israeli and Australian full-scale experience.

In particular, it explores the managerial possibilities offered at the project level, in cases of planned direct non-potable reuse of reclaimed water from centralized municipal wastewater treatment plants.

1.3 TARGETED READER

The main target readers are operators entering the field - practitioners concerned with actual implementation questions or professionals in headquarters, where the focus is on planning, monitoring and concept development.

This manual is also intended for public health officials and other decision makers - such as technical departments of public institutions, sponsors and financing institutions. Additionally, it can be a useful reference for qualified supporters such as academics, consultants and civic groups.

It is expected that the reader has a good understanding of the water sector and of water and wastewater treatment. This document will emphasise the factors that are unique to water reclamation and reuse.

1.4 WATER RECLAMATION AND REUSE – WHAT DO WE MEAN?

In this manual, *water reclamation* refers to the treatment or processing of water to make it reusable, while *water reuse* does refer to the use of treated wastewater for beneficial purposes (Lens *et al.*, 2002). There is no consensus on these definitions worldwide. The reader should note, for instance, that in Australia, water reclamation and reuse is termed *water recycling*, a term that in Europe is used in many instances for internal recycling, e.g. in industrial facilities.

1.5 HOW THIS MANUAL IS ORGANIZED

The manual is divided into three parts:

PART 1 Management of organisational aspects, including economics and financing

Chapter 2 *Institutional background, organisation arrangements and legal aspects*: clarifies which aspects of water reuse are given priority in the European Union water policy and which regulations, standards and guidelines exist within the European Union. The legal basis for liability, contractual agreements and water rights is also discussed.

Chapter 3 *Cost management and optimisation*: addresses three aspects of cost optimisation: planning, managing current performance and improving future performance.

Chapter 4 *Financial sustainability*: summarises principles applicable in economically developed markets, and depicts the current funding mechanisms (process and source of funding), as well as successes and difficulties.

PART 2 Management of social and environmental aspects

Chapter 5 *Environmental management systems*: describes available tools such as Ecological Footprint Analysis, Life Cycle Assessment, Material Flow Analysis, Sustainable Process Index and other methodologies that are applied in the context of water recycling.

Chapter 6 *Stakeholder Communication*: *best practices for water reuse operations* examines stakeholder views of water reuse and water reuse organisations, gives evidence of how water reuse organisations communicate with stakeholders, provides guidelines on how to pass key messages to stakeholders and on how to prepare and deliver the message, including aspects of public crisis communication.

PART 3 Management of technical aspects

Chapter 7 to 17 depicts reference technologies used to reclaim secondary effluent of municipal wastewater treatment plants for a broad spectrum of water uses:

Chapter 7 to 10 *advanced disinfection techniques*: describes and compares the three primary agents (and their possible combination) for advanced disinfection used in water reclamation and reuse, namely: Chapter 8 *Chlorination*, Chapter 9 *Ultraviolet irradiation* (UV) and Chapter 10 *Ozonation*.

Chapter 11 "Title 22-compliance" benchmark: the Title 22 technology as it was introduced in the homonymous Californian regulation, includes a coagulation/flocculation, sedimentation, filtration and a disinfection step. Title 22 allows filtration without flocculation, if the effluent turbidity before filtration is less than 5 NTU. It is considered the yardstick for unrestricted irrigation against which all the other systems are evaluated because of its long history of

Table 1.1 Structure of the Chapters on Best Available Technologies

SECTION	CONTENT
1. Fact-sheet	Brief description of the system including a fact-sheet on process efficiency and reliability, operability characteristics, economics, maintenance needs and by-products management
2. Practical aspects	Overview of basic things to know to properly operate the system, e.g. process reactions, the effects of operating conditions on the process performance, by-product generation, etc.
3. Equipment	Synopsis of possible types of equipment that are available on the market
4. Application	Summary of what the technology is applied for
5. Process operation and maintenance	Documentation of management concerns and of trouble shooting practices
6. Monitoring and quality control	Account of specific monitoring and record keeping needs for the proper operation of the system. Monitoring and record keeping requirements that are common to all reuse applications are discussed in a separate chapter.
7. Knowledge gaps	Enumeration of knowledge gaps in operational criteria that need further attention in order to optimise the removal performance of the system and to use energy and chemical products with restraint and efficiency.
8. Full-scale references	Provision of full-scale references, including a description of one or more relevant full-scale case study(ies)

Increased levels of compliance and safety requirements need to look at all aspects of operational reliability and not only at best available technology. Therefore Chapter 18 and 19 consider specifications about monitoring and control of water reuse schemes and failure and failure management procedures:

Chapter 18 *Monitoring and control of water reuse systems, including testing and laboratory procedures:* gives an account of reference analytical procedure and monitoring devices available and their cost. Recent advances and trends in instrumentation, monitoring and automation are discussed, to assure that the quality of reclaimed water is guaranteed and if possible improved in an economically efficient way.

Chapter 19 *Failure and failure management*: intends to provide operators with a framework for best practice in managing, analysing and preferably avoiding failures in reclamation and reuse schemes.

Chapter 20 to 23 *End-use specifications*: describes agreements for the technical performance of water reclamation schemes reached with water reuse suppliers and end-users. Four major uses are considered: agricultural irrigation (Chapter 20), urban applications (Chapter 21), industrial uses (Chapter 22) and artificial groundwater storage and recharge (Chapter 23).

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